Work Package 5: Development of an epidemiological disease model

Work Package 6: Development of a cost-effectiveness model

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Foreword

This report contains the methods and results of deliverables 02. Development of a disease model and 04. Develop a cost-effectiveness simulation model.

These deliverables have been combined in a single report since the results are intertwined. For each country we present the outputs from the risk factor and disease projections (Work package 5, deliverable 02) and then the results of the economic modelling (Work package 6, deliverable 04). This creates a better flow to the reporting of the results and enables interested parties to read a single complete report by country. This also prevented comparison across countries since data were so heterogeneous comparison is not appropriate and provided a more lay style report than the technical documents.

An in depth technical document about the development of the disease model can be found in appendix B4. An in depth technical document about the development of the cost-effectiveness model can be found in appendix B6.

Work package 5, deliverable 02:

Development of an epidemiological disease model

Work package lead: UK Health Forum

Collaborators: International Diabetes Federation- Europe, European Heart Network, University of Groningen, Health Equalities Group, Lithuania University of Health Sciences, National Health Institute Doutor Ricardo Jorge

Work package 6, deliverable 04:

Development of a cost-effectiveness simulation model

Work package lead: University of Groningen

Collaborators: UK Health Forum, Lithuania University of Health Sciences, National Health Institute Doutor Ricardo Jorge

Authors of this report

UK Health Forum modelling team, Arti Bhimjiyani, Pepijn Vemer, Jennifer Saxton

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Abbreviations

ACEi - Angiotensin-Converting-Enzyme Inhibitor

ACR – Albumin Creatinine Ratio

AER – Albumin Excretion Rate

BG - Bulgaria

BMI – Body Mass Index

CE – Cost-effectiveness

CEA – Cost-effectiveness Analysis

CHD - Coronary Heart Disease

CKD – Chronic Kidney Disease

CKDEpi - Chronic Kidney Disease Epidemiology Collaboration

COPD – Chronic Obstructive Pulmonary Disease

CVD - Cardiovascular Disease

DPP – Diabetes Prevention Programme

DYNAMO-HIA - Dynamic Model for Health Impact Assessment

EConDA - The Economics of Chronic Diseases

eGFR – Estimated Glomerular Filtration Rate

FEV1 - Forced Expiratory Volume in one second

FI – Finland

GFR - Glomerular Filtration Rate

GOLD - The Global Initiative for Obstructive Lung Disease

GP – General Practitioner

GR – Greece

HCA – Human Capital Approach

HICP - Harmonised Index of Consumer Prices

HSE – Health Survey for England

ICERs - Incremental Cost Effectiveness Ratios

IFG - Impaired fasting glucose

IGT - Impaired glucose tolerance

IOTF - International Obesity Task Force

IRR – Incidence Rate Ratio

KDOQI - Kidney Disease Outcome Quality Initiative

LCFS – Living Costs and Food Survey

LT - Lithuania

MCLI – Multi-Component Lifestyle Intervention

MI – Myocardial Infarction

NDNS – National Diet and Nutrition Survey

NL - The Netherlands

ONS – Office for National Statistics

OPE – Own Price Elasticity

PREVEND - Prevention of Renal and Vascular End-Stage Disease

PL – Poland

PE – Price Elasticity

PT - Portugal

QALYs - Quality Adjusted Life Years

RR - Relative Risks

SCS – Smoking Cessation Services

SSB – Sugar Sweetened Beverage Tax

T2DM – Type 2 Diabetes

UAC – Urinary Albumin Concentration

UAE - Urinary Albumin Excretion

UK – United Kingdom

UKHF – UK Health Forum

WHO – World Health Organisation

WP – Work Packages

WTP – Willingness to Pay

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Structure of this report

This report gives the methods, results and conclusions for work packages 5 and 6. The methods section provides details of data collection to obtain input data for WP5 and WP6 models including data on risk factors, disease, demography and health economics. The report goes on to describe the WP5 microsimulation model and its component modules: 1) Risk factor projections 2) Projections of disease incidence and prevalence 3) Population module 4) Interventions 5) Health economic module. The general methods section concludes with the development of intervention scenarios to be tested in the model. The latter part of this report contains the methods and results for each country separately. Comparison of model and findings across countries was not possible due to the heterogeneity of the data.

Introduction

The Economics of Chronic Diseases (EConDA) project examines the cost-effectiveness of interventions to reduce chronic disease in the populations of eight European countries: Bulgaria (BG), Finland (FI), Greece (GR), Lithuania (LT), The Netherlands (NL), Poland (PL), Portugal (PT), United Kingdom (UK).

EConDA consists of seven work packages (WP). This report focuses on WP 5 and WP6. WP5 describes the development and results of an epidemiological disease model; WP6 describes the development and results of a cost-effectiveness (CE) model.

The six diseases modelled within WP 5 were: 1) Type 2 diabetes (T2DM), 2) Chronic Obstructive Respiratory Disease (COPD), 3) Chronic Kidney Disease (CKD), 4) Coronary Heart Disease (CHD), 5) Stroke and 6) Hypertension. CKD, stroke and hypertension were not originally key deliverables in EConDA but were deemed important to include given their relevance to cardiovascular diseases. Smoking and overweight/obesity were included as risk factors.

The WP 6 CE model was built onto the epidemiological disease model from WP 5; the choice of CE method was guided by results of the consensus meeting delivered as part of WP4 (1). The CE model serves several purposes. Firstly, it tests the cost-effectiveness of different integrated interventions to prevent, screen and treat the six EConDA chronic diseases in the eight EConDA countries; secondly it predicts the effect of certain interventions on future chronic disease trends for each country based on existing chronic disease trend data; finally, it calculates the short and long term cost-effectiveness of different interventions through comparison of costs and health outcomes using different scenarios.

Methodology

Data collection

Literature review – Work package 5

The aim of the WP5 literature review was to obtain epidemiological data for each risk factor (BMI and smoking) and disease (CHD, T2DM, COPD, CKD, stroke and hypertension) by country. For risk factors all available national data by age and sex were collected. For each disease, the most recent prevalence, incidence, and relative risk data by age and sex were obtained as well as mortality and survival data for fatal diseases. The following databases and search engines were used to find published articles: Pubmed, Science Direct and Google Scholar; Articles written in English or Dutch were included. EConDA partners and collaborators supplemented this search by identifying and obtaining relevant secondary datasets and grey/unpublished literature. Where data were not available, they were calculated using available data or proxy[1] data were used. Details of extracted data are given within the relevant country reports and in appendix A1-8.

Literature review – Work package 6

During steering meeting 3 of the EConDA project there was a discussion amongst partners about the interventions that should be tested in the EConDA models. These interventions were then reviewed by the WHO collaborators and wider partners where appropriate. The following interventions were agreed upon:

1. A multi-component lifestyle intervention
2. A 20% sugar-sweetened beverage tax
3. Smoking cessation services
4. Hypothetical treatment that results in movement between COPD stages
5. Albumin screening

More detail about each intervention is provided below.

The aim of the WP6 literature review was to identify studies that measured each of these interventions in each country. Specifically, data on the cost of the intervention and the, impact on risk factor or disease were obtained as appropriate.

Table 1 provides a summary of the key parameters that were required for input into the models and for which data were collected. Data were sub-divided into the follow categories: risk factor data, disease data, demographic data, health economic data, and intervention data. As far as possible, all data sources were country-specific except for utility weights and relative risks; sources and definitions of input data are provided in further detail after Table 1.

Table 1. Input data for WP5 and WP 6 models

DATA FOR WORK PACKAGE 5

Risk factor data

1. Historical and current prevalence of body mass index (BMI) groups (healthy weight, overweight and obese) by age, sex and education and/or income
2. Historical and current prevalence of smoker status (never smoker, ex-smoker and current smoker) by age, sex and education and/or income

Disease data

3. Most recent incidence, mortality and survival of the diseases of interest by age and sex
4. Relative risk of acquiring the diseases of interest by category of smoking and/or BMI, stratified by age and sex, where available

Demographic data

5. Population data by age and sex (including death rates)
6. Birth distribution by age and fertility rate of the population

DATA FOR WORK PACKAGE 6

Health economic data

7. Mean utility weights of the diseases of interest without medical intervention (not-country specific)
8. Most recent direct health-care cost associated with the diseases of interest
9. Most recent indirect cost associated with the diseases of interest

Intervention data

10. Impact of the intervention on risk factor or disease
11. Cost of the intervention[2]

[2] Additional data required for each intervention is specified in the detailed description of each intervention (Appendix C).

Risk factor data

Current and past prevalence of BMI, and smokers and ex-smokers was collected for each country. Sources of information varied by country and are detailed in each country report. These data were used to project BMI and smoking prevalence to 2050.

BMI (weight kg/height m^2) was categorised according to WHO cut-offs for normal weight (18.50 - 24.99), overweight (25.00 - 29.99; also referred to as pre-obese by the WHO) and obese (≥30.00) (2).

Smoking was categorised as: never smoker, ex-smoker and current smoker.

Disease data

Prevalence, incidence and mortality

Country specific data were collected on prevalence, incidence and mortality of each disease by age, sex and disease stage.

CHD: As morbidity and mortality data for CHD were incomplete or unavailable, myocardial infarction (MI) data (with three levels: health failure, angina and MI) were used as a proxy for CHD for all countries. This was deemed appropriate as MI is one of the major sub-classification of diseases that falls within the category of CHD. It was acknowledged that these figures would underestimate CHD cases in the population, but would avoid double counting by including MI, angina and heart failure within the same total incidence figure.

T2DM, COPD and CKD: These diseases are recognised as progressing through discrete stages as follows: T2DM (no T2DM, pre-diabetes, T2DM), COPD (no COPD, stage 1, stage 2, stages 3-4; stages 3-4 were grouped because they contained very few cases), CKD (no renal disease, stage 1, stage 2, stages 3+).

Stroke and hypertension: Stroke and hypertension were included as binary variables (i.e. no stroke/stroke; no hypertension/hypertension).

Transition probabilities

In order to develop multi-stage disease models, transition probabilities between stages (e.g. pre-diabetes to diabetes to CHD) were necessary. The literature was explored for these data and where possible longitudinal data were sourced to estimate these values. Full details of how these values were calculated are found in the technical appendix relating to each disease model (appendix B1-3).

Survival

When survival data were not found in the literature, survival was calculated in the microsimulation programme using incidence and mortality data, based on DISMOD-II equations (3).

Relative risks

BMI-related relative risks (RR) for each disease were collected from the World Obesity Federation (formerly International Obesity Task Force (IOTF)) (4). Smoking-related RRs were obtained from the Dynamic Model for Health Impact Assessment (DYNAMO-HIA) (5). The same RRs were used for each of the countries.

Relative risks of disease conditional on other diseases, for example, risk of CHD among diabetics compared with non-diabetics, were also obtained from the literature. Where several studies detailing relative risks were found, the following preference criteria were used to select those to be used in the model: 1) RR of acquiring disease preferred over RR of death due to death; 2) Larger studies preferred over smaller ones 3) Average RR data derived from meta-analysis preferred over types of study design; 4) More recent data preferred over older ones 5) RR data stratified by BMI, smoking status, age and sex preferred over single RR data.

Ex-smoker RRs were assumed to decrease over time since smoking cessation. The ex-smoker RR was computed using a decay function method developed by Hoogenveen and colleagues (6). This function uses the current smoker RR for each disease as the starting point and then models the decline in relative risk of disease for an ex-smoker over time.

Demographic data

National population distribution data, stratified by age and sex, birth by mothers age and total fertility rates were taken from the UN Population Prospects database 2012 (7) . Unfortunately, the 2015 update was not available at the time of computation, but future updates with these new data are possible. For the UK demographic data were extracted from the Office for National Statistics database to provide 2015 estimates.

Health economic data

Data were collected based on the conclusions of Work Package 4 as summarised in Table 2 (8).

Table 2 Summary of consensus meeting outcomes

1. Cost-effectiveness Analysis (CEA) should be used
2. Provide outcomes in terms of Incremental Cost Effectiveness Ratios (ICERs). No threshold should be used to determine cost-effectiveness
3. Include country-specific discount rates
4. Use actual costs of disease and intervention where possible, or tariffs/expert opinion where necessary
5. Health outcomes should be measured using Quality Adjusted Life Years (QALYs)
6. A societal perspective should be taken
7. Direct health care costs and indirect costs should be presented separately to account for country-specific differences in perspective
8. Take a friction cost rather than human capital approach to indirect costs
9. Cost-effectiveness outcomes should not be compared between countries since parameters are country-specific

Utility weights

Utility weights were represented by EQ-5D scores (9), based on recommendations in the NICE guidelines (10) necessary to calculate Quality Adjusted Life Years (QALYs). QALYs were calculated by 'estimating the years of life remaining for a patient following a particular treatment or intervention, and weighting each year with a quality of life score (on a zero to one scale)' (11).

Discount rates

The cost year used in EConDA models was 2013. In order to translate future costs and health outcomes to the year 2013, country-specific discount rates were used (Table 3) (12). In most countries, the same discount rate was used for both health outcomes and costs. Both The Netherlands and Poland use differential discounting, with a lower discount rate for the health outcomes than for the costs (13). No health-economic of pharmaco-economic guidelines have been published for Bulgaria or Greece. The discount rate of 3% for both health outcomes and costs was therefore based on three recent publications, all from Greece which used 3% (14-16).

All costs and prices that were used in the EConDA models were translated to the year 2013. This is done using the Harmonised Index of Consumer Prices (HICP) (17)(appendix B5). The HICP is a consumer price index which is compiled according to a methodology that has been harmonised across all EU countries.

Table 3. Discount rates used in EConDA

	Health outcomes	Costs	Source
Bulgaria	3.0%	Same as health outcomes	(14-16)
Greece	3.0%	Same as health outcomes	(14-16)
Finland	3.0%	Same as health outcomes	(18)
Lithuania	3.0%	Same as health outcomes	(19)
Netherlands	1.5%	4.0%	(20)
Poland	5.0%	3.5%	(21)
Portugal	5.0%	Same as health outcomes	(22)
United Kingdom	3.5%	Same as health outcomes	(23)

Direct healthcare costs

Direct health-care costs for each disease by stage were collected from the literature. The European Cardiovascular Disease Statistics 2012 (24) provided population level direct healthcare costs for hypertension, CHD and stroke while the Diabetes Atlas, 6th edition (25).

For other diseases the majority of data were available for the Netherlands and UK so these estimates were used as proxies adjusting costs for exchange rates and purchasing price parities. Further details of this calculation can be found in appendix B5. Data by disease stage were particularly difficult to obtain. A detailed outline of data collection and manipulation for costs is provided in appendix B6.

Indirect costs

Indirect costs by disease and disease stage were collected. A human capital approach (HCA) was taken to estimate the indirect costs associated with the disease of interest. Since costs using the friction costs approach were not available. A detailed outline of data collection and manipulation for costs is provided in appendix B6.

The UKHF microsimulation model and developments for EConDA (WP5+6)

Module 1: Risk factor projections

A dual-module modelling process written in C++ software, developed by the UK Foresight working group (26), was refined and then utilised for EConDA. In this model, four risk factors were projected individually: BMI, smoking, albumin and eGFR. The future projections were then used to predict the burden of diseases from 2015 until 2050. Note due to lack of data, projection on albumin were available for The Netherlands only.

Module one uses a nonlinear multivariate, categorical regression model fitted to cross-sectional risk factor data to create longitudinal projections to 2050. The categories are defined by ten-year age groups and sex. Within each age and sex category of the population, the predicted proportions of each of the risk factor categories are constrained to sum to 100%.

Module 2: Projection of disease incidence

Module two uses a microsimulation model to predict disease burden using longitudinal risk projections from module 1. A microsimulation is a computer model of any specified population which accurately reflects age profiles, births, deaths and health statistics of a particular population to make future projections – this module therefore includes demographic data specific to each country/region of interest. The simulations specifically target the relationship between individuals' evolving risk factors and disease incidence. Risk factor distributions are determined by past and current trends and the model can simulate and compare the impact and cost of various public health interventions. Events compete to occur in each simulated life. Individuals can be born and die in the model. The UKHF model was expanded as part of the EConDA project to include multi-stage disease models. Thus, instead of a person having a disease or not having a disease, they can pass through various stages of a disease e.g. pre-diabetes, diabetes or COPD stage 1, 2 or 3. This enabled a range of interventions to be tested from prevention, screening/maintenance to treatment within the same model. Fifty to 100 million simulations were run for the EConDA project, taking approximately 8 hours per intervention.

Four multi-stage disease models (T2DM, COPD, CKD, CHD) were developed as part of this project, each of which were implemented in the 8 EConDA countries. Experts from the European Chronic Disease Alliance were consulted on the concept and design of each of the disease models. The model concepts were put together as the 'ideal' model. However, data limitations meant that only single-stage diseases could be run for some countries.

Type 2 diabetes model structure

Type 2 diabetes occurs when the body fails to produce enough insulin to function properly, or when body cells do not react to insulin. This means that glucose remains in the blood rather than being used for energy. Type 2 diabetes is the most common form of diabetes - approximately 90% of cases are type 2 (27) and are primarily caused by obesity.

Previous models of diabetes have focused on diabetes as a single stage disease, see Watson and colleague's review for recent examples (28). The EConDA microsimulation model was adapted to include a 2 stage-diabetes model to enable 'at-risk' individuals to proceed through three stages: no diabetes, pre-diabetes, type 2 diabetes.

Pre-diabetes and diabetes can be diagnosed by measures of impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) using cut-offs described in appendix B1[3].

The glucose concentrations by diabetes stage and glucose measure are presented in Table 4.

[3] A summary review on the reliability of glucose testing is presented in appendix B1.

Table 4. Glucose measures and the outcomes for determining both pre-diabetes and diabetes.

Diabetes stage	***Glucose measure***	
	Impaired fasting glucose (IFG)	Impaired glucose tolerance (IGT)
Pre-diabetes	≥6.1 mmol/L and <7 mmol/L	≥7.8 mmol/L and <11.1 mmol/L
T2DM	≥7 mmol/L	≥11.1 mmol/L

The structure of the model is shown in Diagram 1. Obesity is included as a risk factor for both stages of diabetes. As summarised above, an individual's BMI, age and sex will dictate the probability of an individual developing a disease or progressing through stages of a disease such as diabetes. In the EConDA model diabetes is not modelled as a terminal disease, so a simulated individual may die from other causes or terminal diseases in the model.

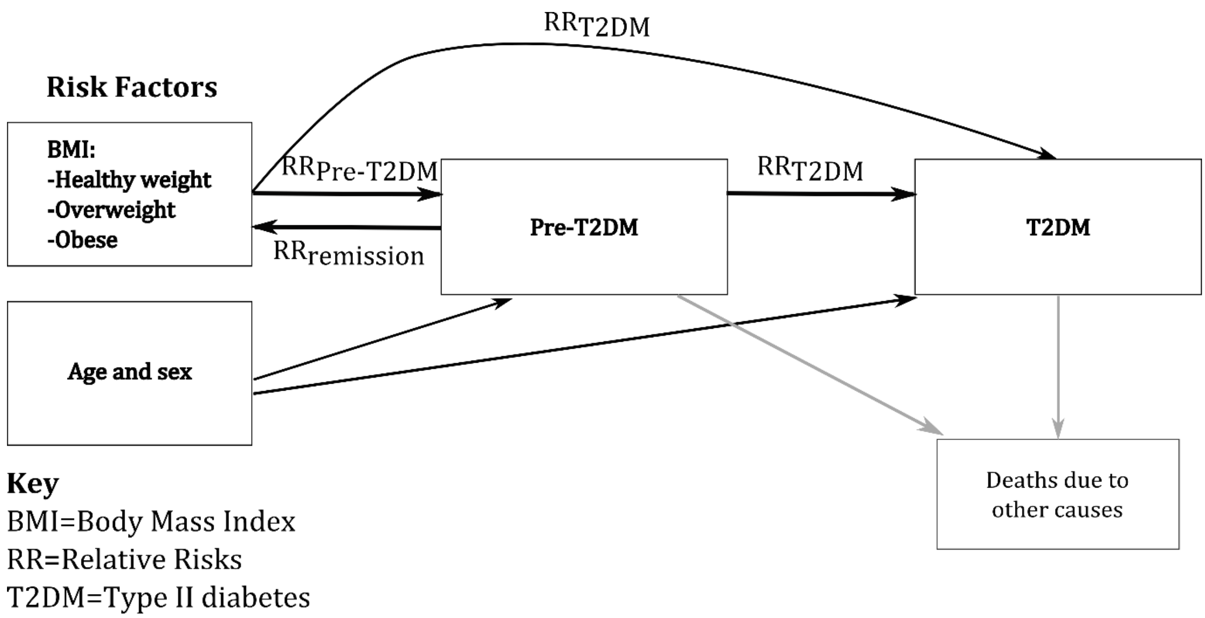


Diagram 1 Schematic diagram of diabetes multistage model structure

The Prevention of Renal and Vascular End-Stage Disease (PREVEND) database, a longitudinal study from the Netherlands (29), was used to approximate incidence and prevalence data for both pre-diabetes and diabetes. Where possible the results were stratified by the BMI categories: healthy weight; over-weight and obese. Incidence statistics were approximated for the following transitions:

- Disease free (stage 0) → Pre-diabetes (stage 1)
- Disease free (stage 0) → Diabetes (stage 2)
- Pre-diabetes (stage 1) → Diabetes (stage 2)
- Pre-diabetes (stage 1) → Normal stage (state 0)

Approximating one year transition matrices for T2DM

The follow ups in the PREVEND study were not completed annually. In order to obtain annual relative risks the incidence data obtained from 2, 3 and 4 year follow ups were used to approximate the 1 year incidence risk for PREVEND. A small number of people were followed up after 5 or 6 years, however the dataset was too small to use for this analysis. The EM algorithm was used to compute an estimation for the 1 year transition matrix (Craig & Sendi, 2002) (appendix B1).

Model assumptions

The following model assumptions were made:

1. When an individual enters into the final stage of the T2DM they are unable to transition back to pre-diabetes or normoglycaemia.
2. Pre-diabetes has been determined from measurements for impaired fasting glucose (IFG) measurements.
3. Pre-diabetes and diabetes are non-terminal diseases (30),
4. For the baseline model (without any interventions) pre-diabetes and diabetes screening is not being considered.
5. The time lag between diagnosis and contraction of both diabetes and pre-diabetes is not being considered.
6. BMI is assumed to be a risk factor for pre-diabetes and diabetes. The effect of diabetes on BMI has not been considered.

Appendix B1 provides an in-depth technical description of the multi-stage diabetes model development.

Chronic Obstructive Pulmonary Disease structure

Chronic obstructive pulmonary disease (COPD) is characterised by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases (31). COPD is a major cause of chronic morbidity and mortality in the world. It is the third leading cause of death globally, causing close to three million deaths in 2010 only (32, 33). The disease is preventable and treatable and given its enormous contribution to the global burden of disease was selected to be modelled as part of the EConDA project.

COPD is diagnosed using spirometry[4] to measure forced expiratory volume in one second (FEV_1) of the lungs (31). The presence of a post-bronchodilator $FEV_1/FVC < 0.70$ confirms persistent airflow limitation and thus COPD.

Table 5 shows the classification of airflow limitation severity in COPD proposed by the Global Initiative for Chronic Obstructive Lung Disease (GOLD). This classification is widely used in epidemiological research, so was included here. Severity classification is based on FEV_1.

Table 5. GOLD COPD staging criteria (31)

GOLD grade	Severity	FEV1/FVC	FEV_1 % pred
1	Mild	<0.7	>80%

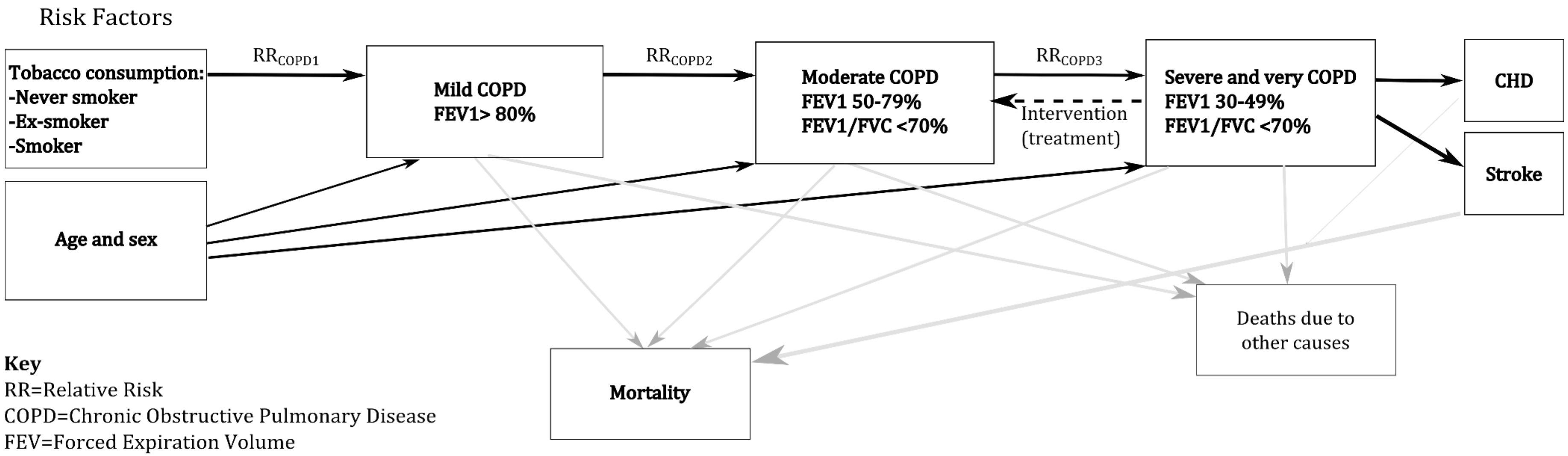
[4] Spirometry measures ventilation, the movement of air into and out of the lungs, the nature of any lung dysfunction and its severity

2	Moderate	<0.7	50-79%
3	Severe	<0.7	30-49%
4	Very severe	<0.7	<30%

The structure of the model is shown in Figure 1. An individual's smoking status, age and sex will dictate the probability of an individual developing a disease or state of a disease such as COPD.

In its most simple configuration the model considers the effect of changes in smoking prevalence over time on incidence of COPD, associated comorbidities and mortality. The multi-stage disease model further considers transitions from one COPD severity stage to the next. Prevention and treatment interventions can then be tested.

Due to lack of available longitudinal data to calculate COPD incidence by disease stage, multi-stage COPD was only run for Finland and the UK. For the other countries, single stage COPD was run to provide some estimate of future burden of COPD. However, treatment was not tested in these models since the treatment intervention focused on moving individuals from COPD stages 3 and 4 back to stage 2.



Key
RR=Relative Risk
COPD=Chronic Obstructive Pulmonary Disease
FEV=Forced Expiration Volume
FVC=Forced Volume Vital Capacity
CHD=Coronary Heart Disease

Figure 1 COPD multi-stage model concept

Model assumptions

1. COPD GOLD stages 3 and 4 have been combined. This was done in order to produce better prevalence and incidence estimates given that there are relatively few COPD stage 3 and 4 cases in the population.
2. In the baseline model, only forward transitions through COPD disease stages are possible.
3. In the intervention model a hypothetical treatment is simulated which if successful enables the remission from COPD stages 3 to 2.
4. Incidence by stage was calculated using prevalence and mortality assuming that remission was not possible and individuals were only able to move progressively through the disease.
5. COPD prevalence in the UK may by slightly overestimated given that it is based on pre-bronchodilator spirometry data in the HSE. To deal with this problem as best as possible asthmatics with lung obstruction (as detected by spirometry) were assumed to be free of COPD (i.e. asthmatics have a poor lung function because of asthma and not because of COPD).
6. COPD can be fatal at any COPD stage.
7. Mortality rate by stage was estimated by proportioning total COPD mortality based on respiratory deaths by COPD stage in the Finland T2000/T2011 study. It was assumed that respiratory deaths among individuals with COPD were due to COPD. It was further assumed that all COPD deaths in Finland occur after age 30 and after 35 in the UK (34).
8. The risk of COPD of smokers compared to non-smokers was estimated from the Finnish T2000/T2011 study because the study sample was representative of the entire population. It is assumed that these relative risks hold in the UK.

Further technical details of the development of the COPD model can be found in appendix B2.

Chronic Kidney Disease Model structure

Chronic Kidney Disease (CKD) is progressive loss of kidney function over time. It is more common in older people, with one in five males and one in four women between the ages of 65 and 74 diagnosed with some stage of CKD[5]. Individuals with diabetes and high blood pressure are at higher risk of developing CHD. Therefore, it was deemed important to include CKD within the EConDA models. This model development goes beyond the work package 5 deliverable.

CKD is classified according to three parameters: cause, glomerular filtration rate (GFR) category, and albuminuria category (35).

[5] http://www.nhs.uk/Conditions/Kidney-disease-chronic/Pages/Introduction.aspx

GFR is a measure of the level of kidney function and can be estimated using serum creatinine or cystatin C levels. For the present project, eGFR was estimated from serum creatinine using the 'Chronic Kidney Disease Epidemiology Collaboration' (CKDEpi) equation which takes account of age, gender and ethnicity. eGFR categories of kidney function are presented in Table 6.

Table 6 GFR categories

GFR (ml/min/1.73 m2)	GFR categories
>90	Normal or high
60-89	Mildly decreased
45-59	Mildly to moderately decreased
30-44	Moderately to severely decreased
15-29	Severely decreased
<15	Kidney failure

Albuminuria is the presence of higher than normal amounts of albumin in the urine indicating kidney damage. It is measured by Albumin Excretion Rate (AER). The albuminuria categories in CKD are defined in Table 7 below.

Table 7 Albuminuria categories

AER (mg/24 hours)	ACR (mg/mmol)	Albuminuria categories
<30	<3	Normal to mildly increased
30-300	3-30	Moderately increased
>300	>30	Severely increased

AER - Albumin excretion rate; ACR – Albumin-Creatinine Ratio

The stages of CKD can be summarised using the Kidney Disease Outcome Quality Initiative (KDOQI) system (36). This classification system defines the stages of CKD based on the level of renal function (i.e. a decline in eGFR) and the presence of markers of kidney damage such as albuminuria (Table 8).

Table 8 Stages of CKD

	AER (mg/24h)		
eGFR (mL/min/1.73m^2)	<30	30-300	>300
90+	No CKD	Stage 1	Stage 1
60-89	No CKD	Stage 2	Stage 2
45-59	Stage 3a	Stage 3a	Stage 3a
30-44	Stage 3b	Stage 3b	Stage 3b
15-29	Stage 4	Stage 4	Stage 4
<15	Stage 5	Stage 5	Stage 5

Individuals in the EConDA CKD model were assigned an eGFR and albuminuria value based on the distribution of these measures, which were obtained from Health Survey for England data for the United Kingdom (UK).

Relative risks

A literature search identified studies that quantified the association between CKD and developing cardiovascular disease. Relative risk data from a prospective population-based cohort study undertaken in Reykjavik, Iceland was selected to model the relationship between CKD and the risk of coronary heart disease (CHD) ((37).

Model assumptions

The following assumptions were made in the CKD model:

1. eGFR and albumin are independent predictors of CKD and CVD progression (Ron Gansevoort, personal communication, 4th March 2015)
2. Serum creatinine (and therefore eGFR) levels and AER observed at a single time point, such as at each follow-up in the PREVEND study, reflected chronic abnormalities (i.e. >3 months) in renal structure and function.
3. In the baseline model the distribution of albuminuria and GFR for each age and sex group is assumed to be independent of time.
4. In the baseline model initially individuals are randomly assigned a percentile in both the albuminuria and GFR distributions which is assumed to be fixed for the entire simulation.
5. In the baseline model individuals could only be screened once.
6. In the intervention model, it was assumed that in the same year of screening individuals who has an albuminuria level of ≥ 30 mg/24h had a probability of 0.55 and 0.327 of fixing their albuminuria and eGFR levels, respectively (38, 39).

Model runs

Due to lack of available longitudinal and cross-sectional data that included CKD, the CKD model was only run for the UK. Appendix B3 and B4 provide a detailed description of the development of the CKD model.

CHD and stroke model structure

Each individual in the model has a risk of developing and dying from CHD or stroke as a function of their age, sex and risk factor status. The model architecture was designed so that an individual's disease profile could be included as a risk factor when calculating the risk of CHD and stroke. Diagram 2 presents a conceptual diagram of this interaction between diseases and risk factors in the model. The model has been designed in a way that allows the user to choose whether or not an individual's disease profile will be included in the risk calculation for CHD and stroke. In general, this will be limited by that amount of available data. In the case of CKD, this disease was included as a risk factor for CHD and stroke in addition to age and sex.

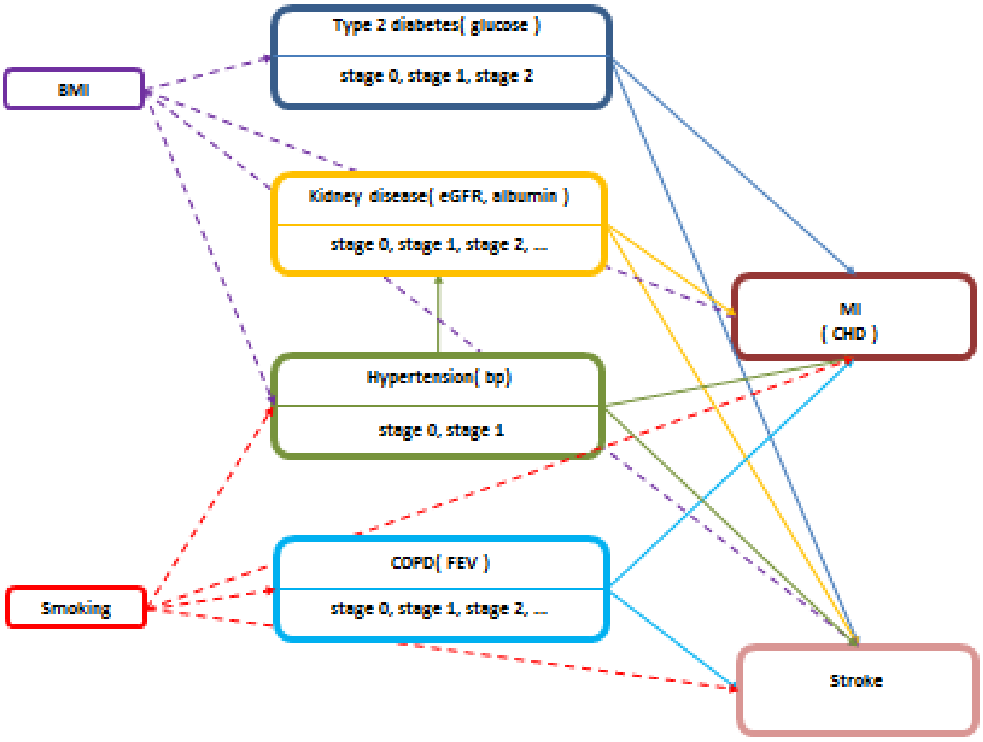


Diagram 2. Concept of the CHD and stroke models as a function of risk factor and disease status

Module 3: The population module

To generate individual case histories, the microsimulation model incorporates a population module. This includes the distribution of males and females in a given population, births by mother's age and the total fertility rate. This enables the model to accurately simulate the specified population such that it includes the correct number of males and females of a given age and that individuals are born in and die in the model at an appropriate rate.

Module 4: The intervention module

The microsimulation programme enables different intervention scenarios to be tested so that policy makers can assess the impact of public health interventions on future chronic disease burden and related costs. As part of the EConDA project the intervention module was developed to test the impact of prevention, screening and treatment interventions within the same module. The specific interventions tested are outlined below (see 'Developing intervention scenarios'). All interventions are compared with a baseline or 'no change' scenario.

Module 5: The health economic module

The microsimulation also incorporates an economic module. The economic module assigns costs and health effects to each individual each year based on the disease stage (if any) the individual is in at that time. Costs and health outcomes were aggregated in the microsimulation over the number of simulated years in the microsimulation. The module was further developed as part of the EConDA project (Work package 6) to include measures of indirect costs (productivity losses) and outputs of the cost-effectiveness of specified interventions. Input data therefore included the costs of the intervention under investigation, direct health care costs of each disease, indirect costs of each disease and utility weights to calculate QALYs. The QALY approach was included to allow for the comparison between scenarios taking quality of life into consideration. The model was used to project the number of QALYs, total health care and indirect costs over a specified time scale. The difference in costs and health outcomes between two scenarios, usually an intervention and a comparator, was then used to calculate the cost-intervention compared with the comparator.

Within EConDA, cost-effectiveness is expressed as an Incremental Cost-effectiveness Ratio (ICER). ICERs are calculated as the difference in costs divided by the difference in health outcomes. Since the economic module outputs all possible outcomes separately, it is possible to calculate the ICER from both a health payer perspective (only including the direct health care costs) and the societal perspective (also including the indirect costs). It is also possible to express ICERs as a cost per life year gained, and per QALY gained. The ICER can be compared to a societal Willingness-to-pay (WTP), often called the threshold (40), which is the "price" a society is willing to pay for an extra unit of health "output". Such a threshold value has not been determined by EConDA, as this was deemed a political decision. EConDA has simply stated the outcomes in terms of an ICER, which the model user, such as a decision maker, may interpret as "cost-effective" or "not cost-effective", depending on their conceived threshold. Figure 2 outlines a basic process map of the modelling and simulation component model described above.

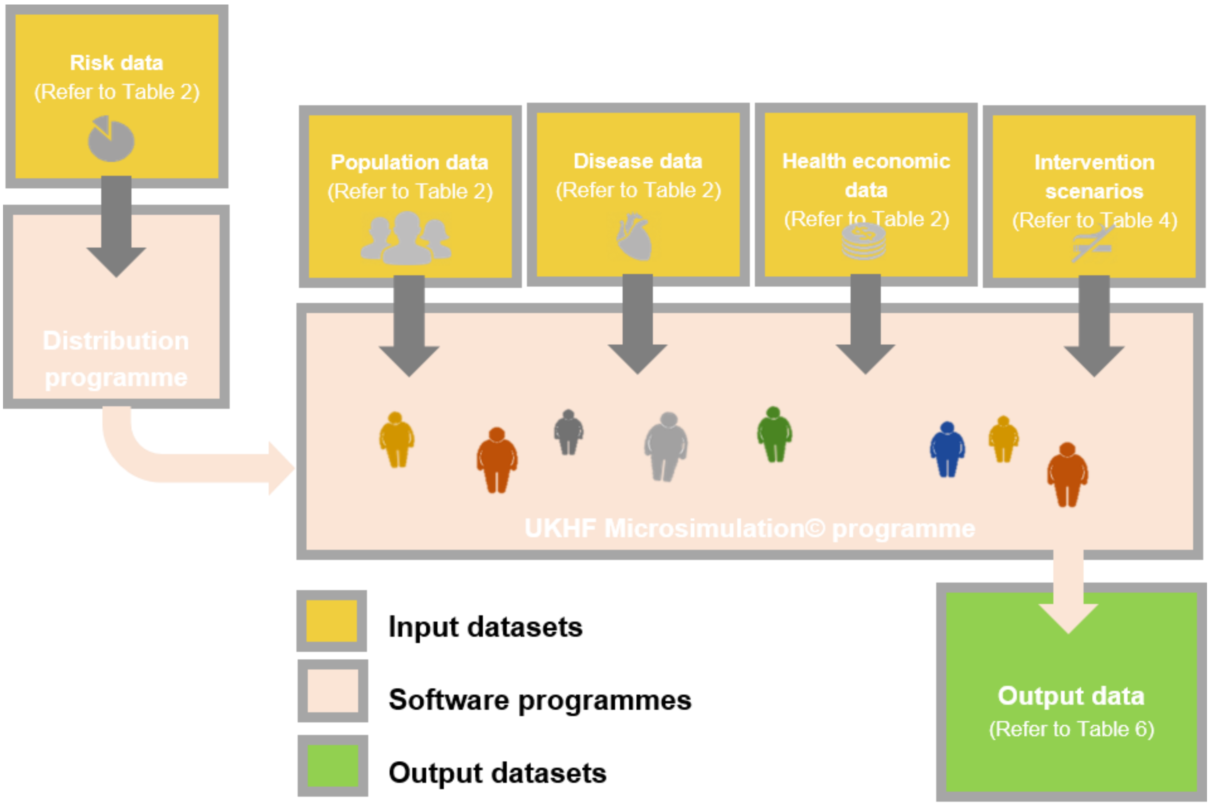


Figure 2 Schematic of the modelling and simulation process

Developing intervention scenarios

A range of interventions were modelled to demonstrate the utility of the EConDA model to test a range of different interventions within the same model.

For BMI, multi-component lifestyle intervention (MCLI) and a sugar-sweetened beverage (SSB) tax were tested in each country. For smoking, smoking cessation services (SCS) and a hypothetical treatment for COPD were tested.

Albumin screening was implemented in the chronic kidney disease model to quantify the impact of a screening programme on future burden of CKD and CHD. Note that evidence for a direct link between both BMI and smoking and CKD is weak so these relationships were not implemented in the model.

BMI model Interventions

Multicomponent lifestyle interventions

A multicomponent lifestyle intervention (MCLI) is defined as a programme that aims to reduce a person's energy intake and help them to be more physically active by changing their behaviour. To be considered multicomponent, the programme must include diet, physical activity and behavioural therapy (for example, counselling sessions) (41). Behavioural techniques most commonly used are goal setting and review of goals (behaviour and outcome), action planning, barrier identification and problem solving, self-monitoring of behaviour, feedback on performance, instruction on how to perform behaviour and planning social support and social change (42).

Effect on weight loss

A comprehensive review of the literature on MCLI that included a meta-analysis of randomised controlled trials concluded that there was strong evidence that MCLI can lead to a greater weight loss over a 12 to 18 month period compared to control arms (pooled mean difference -2.6kg, 95%CI -2.8 to -2.4) (41). This may be a conservative estimate because it is based on analyses which assume that the weight of individuals lost to follow up did not change over the course of the study. Studies report an average 17% attrition of programme participants, therefore, participants finishing MCLI programmes are likely to have lost more than an average of 2.6kg.

Weight regain

Most studies with follow-ups beyond the active period of intervention have shown that there is gradual weight regain after MCLI. Dansinger et al's meta-analysis of 46 trials concluded that, on average, patients regain 0.03 BMI units per month during maintenance phases of dietary–based weight loss interventions (43). At this rate, patients would return to their baseline weight after approximately 5.5 years (43). A similar conclusion was reached by the NICE review, which found that on average, intervention groups regained 0.047kg/month more than control groups in the maintenance phase (44). Based on this, participants of MCLI would return to their baseline weight after approximately 4.6 years. Few characteristics of the preceding MCLI were associated with rate of weight regain (44).

Country specific MCLIs

Although partner countries were asked to submit details of MCLIs that were active or had been tested in their countries, little information was retrieved this way. This was probably due to very few MCLI programmes being rolled out at national or regional level in EConDA countries. Therefore research studies which investigated the effect of MCLI on body weight in adults carried out in EConDA countries were also retrieved (see search methodology and results in appendix C1 and C2). Studies investigating six different interventions were identified for the UK, one each for Greece, Finland and Portugal and two for the Netherlands. For the UK, an intervention delivered by the NHS was selected. For Netherlands, the intervention with best weight loss results was selected. The characteristics of interventions selected per country and their effect on weight loss are described in Appendix C2.

Table 9 summarises the data included when modelling this intervention.

For Lithuania, Poland and Bulgaria, the Greek intervention was used in the absence of country specific information. An assumption was made that a similar intervention delivered in these countries would have a similar effect on weight loss and would cost the same.

Table 9 Summary input data for multi-component weight management interventions

Country	Reduction in BMI*	% BMI lost regained after 5 years	Cost of intervention per patient
Greece (45)	0.6	100	175 Euros
UK (46)	0.7	100	£91.87
Finland (47)	1.6	100	110 Euros (Proxy)
Netherlands (48)	1.1	100	110 Euros (Proxy)
Portugal (49)	2.2	100	110 Euros
Lithuania (45)	Greece Proxy	Greece Proxy	Greece Proxy
Poland (45)	Greece Proxy	Greece Proxy	Greece Proxy
Bulgaria (45)	Greece Proxy	Greece Proxy	Greece Proxy

* Absolute units of BMI; reduction in intervention group at 12 moths for UK, Finland, Netherlands and Portugal and at 3 months for Greece

Model assumptions

Three different combinations of multi-component lifestyle interventions (MCLI) were run to demonstrate the importance of regularity of intervention and weight maintenance, and to show the effect on disease outcomes based on data in the literature:

1. **MCLI, annual, with regain** – this shows the impact of a MCLI that is available to 10.44% percentage of obese individuals (as suggested by the literature) each year of the simulation. This is a realistic reflection of weight management services that are currently available in UK primary care. We know from the literature that individuals who take part in MCLI lose weight but gradually put the weight back on over the subsequent 1-5 years. This was implemented in the model such that 20% of the weight was regained each year, until 100% was regained by year 5. Fifty million simulations were run.

2. **MCLI, annual, with no regain** – Similar to above the MCLI was available each year of the simulation. However, we wanted to explore the impact on disease outcomes if weight loss was maintained following the MCLI. Fifty million simulations were run.

3. **MCLI, not annual, with no regain –** in this implementation of the intervention we followed the literature by showing the impact of a MCLI if it took place in the start year only with no weight regain (the evidence was drawn from literature that reports on MCLI effects at a single time point (Although we ran the same intervention with fifty million and then one hundred million simulations to improve the accuracy of results, no effect was observed. Therefore, we assumed that the same results would be observed with weight regain (MCLI combination 1 above).

For the SSB tax intervention, due to the small associated BMI reduction identified in the literature, 100 million simulations were run to provide more accurate results. It should be noted due to the stochastic nature of the simulation running 50 million simulations for MCLI but 100millon simulation results in slight differences in the baseline results.

Further assumptions for scenarios 1 and 2 are:

1. 12% of obese persons take up a MCLI when offered by their General Practitioner or Family Doctor. This figure is based on the response rate reported in Jolly et al's study where over 6,000 letters were sent out from GP practices inviting eligible patients to participate in a MCLI (41, 46).
2. 87% of those who start a MCLI complete it. This figure is based on the average attrition/follow-up rate of the 11 interventions identified for EConDA countries (41).
3. Only obese individuals (BMI≥30) will be offered a MCLI as it has been previously shown that interventions achieving weight loss of a similar magnitude to interventions in appendix C2 are more cost-effective in obese rather than over-weight individuals (50).
4. Individuals taking up the MCLI will be selected at random from the entire obese population distribution.

The model used country specific information on the effect of MCLI on weight loss (Table 9). The model then estimated the impact of rolling out the country specific MCLI at national level on population body weight and associated future disease burden to 2050.

Sugar-sweetened beverage tax (SSB)

The impact of a 20% excise tax applied to SSBs on BMI prevalence was modelled. This level of taxation is in keeping with current recommendations proposed by the UK Faculty of Public Health (51). Appendix C3 outlines the pathway by which an excise tax applied to SSBs impacts on BMI. The key assumptions made at the various stages along this pathway are described below.

The price of SSBs

The price of SSBs in each of the EConDA countries was collected from a number of different data sources; it was not possible to obtain price data for Greece, Lithuania and Poland. The price of SSBs was identified from published data for all countries, with the exception of the UK for which it was calculated from survey data.

Pass-on rate

The degree to which the price of a product changes in response to an imposed tax depends on the pass-through rate of the price change from the manufacturer to the consumer (52). Based on a variation in empirical evidence, it was considered reasonable to assume a pass-on rate of 100% (53), which indicates that the full price of the tax applied to SSBs would be passed through from the manufacturer to the consumer.

Baseline consumption of SSBs

With the exception of the UK, data on the consumption of SSBs in each EConDA country, were derived from 2012 data published by Eurostat. The following product category from the Eurostat database was considered to be in keeping with our definition of SSBs: "*Waters, with added sugar, other sweetening matter or flavoured, i.e. soft drinks (including mineral and aerated)*". Baseline consumption of SSBs was derived by taking account of the total volume of SSBs (in litres) imported, exported and produced annually by each country from which the quantity of sugar consumed was calculated on the basis that there are 35 grams (g) of sugar in every 330 millilitres (mL) can of Coca-Cola (54) (equivalent to 106g in every litre of Coca-Cola). Individual consumption of SSBs was calculated using 2015 UN World Population Prospects data (55) and finally, converted to consumption per day.

Data on the consumption of SSBs in the UK were derived from the most recent National Diet and Nutrition Survey (NDNS) dataset, 2008-2011 (56). Consumption of SSBs (in grams/person/day), was defined in the survey as 'soft drinks, not low calorie, concentrated', 'soft drinks, not low calorie, carbonated' and 'soft drinks not low calorie, ready to drink, still' (the latter two categories referred to as 'soft drinks, not concentrated, not low calorie' for this project to align with LCFS definitions). Consumption of SSBs in millilitres was converted into grams per day using the standard conversion rule that 1 millilitre is equivalent to 1 gram.

Change in consumption of SSBs

In order to predict the effect a change in price would have on individual consumption, price elasticities were sought from the published literature. Country-specific price elasticities were identified in the case of Finland and The Netherlands only. However, it was not possible to utilise these data, as either the data were not specific for SSBs or not in the format required for inclusion in background calculations. Recently published price elasticities (PE) of demand for the whole UK population (57) were utilised for the UK and used as a proxy measure for the remaining EConDA countries.

To delineate the percentage change in consumption, the PEs (specifically own PEs for concentrated and not-concentrated SSBs in the case of the UK, and non-concentrated SSBs for the remaining EconDA countries) was multiplied by the change in SSB consumption (the percentage increase as a result of the tax). For example, for a 20% excise tax in the UK, the own PEs for concentrated and non-concentrated SSBs were added together and multiplied by 20. This calculation assumed that the purchase of SSBs would change to the same degree as consumption.

Change in energy intake as a result of fiscal policy applied to SSBs

In order to deduce the effect an excise tax would have in reducing daily energy intake from SSBs, the reduction in consumption of SSBs in grams was converted to kilojoules (kJ) using recently published energy densities for these beverages (57). Based on the assumption by Wang et al (58), it was assumed that for every 100kJ saved from not consuming SSBs, there would be a 60% net kJ reduction (with 40kJ being substituted by other food and beverage intake).

Change in body weight as a result of fiscal policy applied to SSBs

Change in body weight as a result of reduced total daily energy intake was calculated using the assumption that *"every change of 100kJ per day will lead to an eventual weight loss of 1kg" (*Hall et al, 2011) (59). The majority of the predicted weight loss (95%) would be achieved in approximately 3 years, with 50% and 45% of the total weight change being achieved within the first and second years, respectively, and the final 5% being achieved between the third and tenth years (59).

Change in body mass index as a result of fiscal policy applied to SSBs

In order to estimate the change in individual BMI, the average height of an adult in metres (m) in each of the countries modelled was determined as outlined in Table 10 and the change in BMI was calculated using the WHO reference calculation (BMI= kg/m^2) (60, 61).

Table 10. Average height of an adult

Country	Average height (m)	Reference (height data)
Bulgaria	1.69	B News, 28/01/10
Finland	1.71	Health Behaviour and Health among the Finnish Adult Population, Spring 2013
Greece	1.71	Society At A Glance 2009: OECD Social Indicators
Lithuania	1.74	Tutkuviene J.
The Netherlands	1.74	CBS Statline
Poland	1.71	Society At A Glance 2009: OECD Social Indicators
Portugal	1.67	Society At A Glance 2009: OECD Social Indicators
UK	1.72	HSE 2012

Table 11 summarises the outputs from the development of the SSB intervention.

Table 12 summarises the outputs from the development of the SSB intervention in the UK since slightly different data were used to conceptualise this intervention.

Table 11. Estimated effect a 20% excise tax applied to SSBs would have on BMI by EConDA country

Country	Baseline consumption of SSB (g/day)	Post-tax consumption of SSBs (g/day)	Reduction in total energy intake accounting for substitutions (kJ/day)	Reduction in body weight (kg)	Reduction in bmi (kg/m2)
Bulgaria	19.92	16.74	-2.86	-0.03	-0.01
Finland	19.74	16.59	-2.84	-0.03	-0.01
Greece	13.10	11.01	-1.88	-0.02	-0.01
Lithuania	5.20	4.37	-0.75	-0.01	0.00
The Netherlands	37.38	31.42	-5.37	-0.05	-0.02
Poland	19.80	16.64	-2.84	-0.03	-0.01
Portugal	21.42	18.00	-3.08	-0.03	-0.01

Table 12. Estimated effect a 20% excise tax applied to SSBs would have on BMI in the UK

Age	Baseline consumption of SSBs (g/day)		Post-tax consumption of SSBs (g/day)		Reduction in total energy intake accounting for substitutions (kJ/day)	Reduction in body weight (kg/year)	Reduction in BMI (kg/m^2) per year
	Concentrated	Not concentrated	Concentrated	Not concentrated			
20-39	65.56	107.44	55.83	90.29	24.19	0.24	0.08
40-59	34.49	56.51	29.37	47.49	12.72	0.13	0.04
60+	21.60	35.40	18.40	29.75	7.97	0.08	0.03
Average	40.55	66.45	34.53	55.85	14.96	0.15	0.05

Smoking model interventions

Two interventions were modelled, smoking cessation services and a hypothetical treatment scenario for smoking-related COPD.

Smoking cessation services

Smoking cessation services was defined as a 12-week smoking programme involving the administration of varenicline alongside face-to-face counselling. This was based on the Maudsley model which is an evidence based approach to treating dependent smokers using a combination of regular meetings (with a trained advisor using structured, withdrawal-oriented behavioural therapy) combined with smoking cessation medications such as nicotine replacement therapy (NRT), bupropion or varenicline (62).

Varenicline was used for all of the EConDA countries except for the Netherlands whereby bupropion was used as the pharmacological intervention of choice (due to availability of data). Varenicline, a relatively new drug (approved by the FDA and EMA in 2006), was evaluated instead of bupropion as it is known to deliver higher smoking cessation rates, be more cost effective and is relatively safe and well tolerated (63, 64) – hallmarks of a pharmacological intervention that would make it ideal for rolling out nationwide.

The EConDA model requires three types of input data:

- Effectiveness of the intervention
- Reach of the intervention
- Cost of the intervention

Effectiveness of the intervention

Effectiveness of the intervention in terms of cessation rates was expressed as 12-months continuous abstinence. Only cessation rates that were biochemically validated through the measurement of the smoker's carbon monoxide levels (as opposed to self-reported data) were included in the model. Given that these type of data were not available for most countries, proxy data from other countries were used Table 14). It was deemed appropriate to use proxy data based on the assumption that the pure biological effect of a drug can be expected to be the same, irrespective of the country (65). Studies by West et al. found that the first 28 days since quitting is the most crucial period for likelihood of relapse. Thus the rate of relapse was assumed negligible following the use of 12-months continuous abstinence rates.

'Reach' of the intervention

Typically, various demand- and supply-side constraints contribute to the overall 'reach' of a public health intervention within a given population. This means that even if an intervention is rolled-out on a national scale, the intervention may only go on to be taken up by a fraction of the target population.

Data on 'willingness to quit smoking' was publicly available from four of the EConDA countries (Table 13) – these figures were then incorporated into the model to reflect the demand-side constraint of the 'reach' of the intervention. In the model, the cost of the service at the point of delivery was assumed to not act as a barrier to the uptake of the SCS by the target population, given that data on the relationship between the cost and demands of the SCS were not available. In the model, the SCS was free for all patients, in that the payer (National Health Service or national/federal health insurance) covered the total cost of the service (66), keeping in line with making the economic case for providing public health interventions that are free at the point of delivery.

It was assumed that only 50% of those wanting to quit smoking would actually participate in the intervention owing to supply-side constraints, such as the supply of healthcare professionals and current availability of intervention infrastructure (67). This figure was applied across all of the eight EConDA countries (appendix C4), since country-specific data in this area was lacking.

Cost of the intervention

The intervention cost, expressed as total cost per quit attempt, was based on estimates of real resource use. Unless otherwise stated, the price typically covered the duration of a 12-week course of varenicline tablets as well as the administrative costs incurred by healthcare professionals leading the counselling sessions. Costs of adverse effects were assumed to be negligible. Costs varied considerably between the EConDA countries (Table 13) – in countries where cost data were not available, proxy data from another country were used in its place (Table 14).

Model assumptions

The following assumptions in the model were made:

- An individual eligible for the intervention is selected at random from the entire population distribution of smokers.
- A smoker is defined as an individual who has smoked for at least a year
- All smokers in the model are eligible for the intervention (but in reality, for example, smokers who present with a known history of epileptic seizures, brain tumour, renal disease, hepatopathy, severe hypertension or suicidal ideation would be ineligible for a course of bupropion medication)
- The willingness to quit and the effectiveness of the intervention are the same across age, sex, severity of addiction and socioeconomic gradients
- A smoker's willingness to quit smoking stays the same throughout the entire simulation period i.e. no other changes in cultural or political trends would occur that might alter the smoker's willingness to quit smoking over time
- The 'reach' of the intervention stays the same throughout the entire simulation period i.e. no other changes in the supply or demand of the intervention is expected to occur within the time horizon
- The 'reach' of the intervention is the same across age, sex, socioeconomic gradients and geographical areas
- Once a smoker quits smoking as a result of the intervention, the smoker stays an ex-smoker throughout the rest of the time horizon (the relapse rate is captured within the 12-month continuous abstinence rate)
- For both the baseline and the policy intervention scenario, smokers can also quit smoking by means other than that of the intervention e.g. unassisted attempt to quit (smokers who quit smoking via these routes may still relapse and become a smoker again at some point in the future)
- The cost of the intervention is free at the point of delivery i.e. it is paid in full by the national health service, local government or national/federal health insurance
- A smoker cannot use the intervention more than once in any given year, but has the potential to use the SCS at the start of each new year within his/her lifetime regardless of the number of times he/she has had the intervention

More details about this intervention are presented in appendix C4.

Table 13. Summary input data for the smoking cessation service intervention

	Bulgaria	Finland	Greece	Lithuania	Netherlands	Poland	Portugal	UK
Reach								
Willingness to quit smoking (%)	59%	59%	65%	59%	40%	59%	59%	68%
Accessibility of the intervention (%)	50%	50%	50%	50%	50%	50%	50%	50%
Overall reach (%)	30%	30%	33%	30%	20%	30%	30%	34%
Impact of the intervention								
Type of pharmacological drug	Varenicline	Varenicline	Varenicline	Varenicline	Bupropion	Varenicline	Varenicline	Varenicline
12-month abstinence rate (%) *	34%	34%	22%	34%	17%	34%	34%	34%
Long-term relapse rate (%) **	0%	0%	0%	0%	0%	0%	0%	0%
Outcome criteria ±	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous
Validation method ¶	Biochemical	Biochemical	Biochemical	Biochemical	Biochemical	Biochemical	Biochemical	Biochemical
Cost								
Cost (cost/quit-attempt)	429 лв	€ 248	€ 220	€ 621	€ 282	621 zł	€ 209	£ 164

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Table 14. Data sources for the smoking cessation service intervention model

	Bulgaria	Finland	Greece	Lithuania	Netherlands	Poland	Portugal	UK
Reach								
Willingness to quit smoking (%)	FL proxy	(68)	(69)	FL proxy	(70, 71)	FL proxy	FL proxy	(72, 73)
Accessibility of the intervention (%)	NL proxy	NL proxy	NL proxy	NL proxy	(67)	NL proxy	NL proxy	NL proxy
Overall reach (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Impact of the intervention								
Type of pharmacological drug	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12-month abstinence rate (%) *	UK proxy	UK proxy	(74)	UK proxy	(75)	UK proxy	UK proxy	(76)
Long-term relapse rate (%) **	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Outcome criteria ±	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Validation method ¶	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cost								
Cost (cost/quit-attempt)	NL proxy	Norway proxy	NL proxy	NL proxy	(75)	NL proxy	NL proxy	(76)

Treatment for COPD

The drug treatment Roflumilast was researched as a potential treatment intervention to be implemented in the EConDA model. Roflumilast is a treatment for COPD which reduces exacerbations and promotes remission from GOLD stage 4 to 3 (77).

Adding Roflumilast to usual treatment protocols would have the effect of reducing the probability of going from the severe to the very severe stage, with a risk ratio of 0.861 (78). Since Roflumilast is a simple add-on to current treatment, it was deemed relevant for implementation in the EConDA model. However, due to lack of epidemiological data for COPD it was not possible to include all four GOLD stages - stages 3 and 4 were combined - therefore no distinction between the severe and very severe stages could be made. Instead, a hypothetical drug was implemented based on Roflumilast, but also targeted at moderate COPD demonstrating the flexibility of the model to test treatment interventions.

Hypothetical treatment

This intervention reduces the number of COPD exacerbations, leading to a lower cost of disease, and will slow the progression from Moderate to Severe COPD (GOLD stages 2 and 3).

The RR of going from the Moderate to Severe disease stage was 0.90, based on one off improvement of lung function of 46 mL, an average patient of 1.70 metres (males) or 1.65 (women), and where the average maximum lung function in litres (FEV1 – forced expired volume in 1 second) of patients was calculated using the following function (79):

FEV1[litres] = 4.30*height[metres] - 0.029*age[years] - 2.49.

FEV1[litres] = 3.95*height[metres]-0.025*age[years] - 2.60.

For this calculation an age of 65 years old was used. It was assumed in this RR calculation that the cohort exists of an equal number of males and women.

The one-off improvement in lung function may also lead to patients moving to a better disease stage. For patients in Stage 3, assuming a uniform distribution over the disease stage, an improvement of 2.41% means that 2.41/20 = 12.1% will go to Stage 2. We further assumed that the lung function increase did not lead to GOLD stage 1 (i.e. the best case was that patients were at 80% FEV1% predicted). Finally, it was assumed that the increase was persistent.

Cost of the intervention

Roflumilast is targeted as an add-on to current treatment for patients with severe or very-severe COPD. Based on Dutch data, annual treatment or Roflumilast would cost €604 (80), while the yearly costs would be €294 lower, due to a 20% reduction in the number of exacerbations (81).
Using PPPs (2013), the costs of Roflumilast in the UK and Finland are: £377 and €680 respectively.

Model assumptions

1. All COPD patients get the treatment, for the rest of their life as an add-on to existing treatment.
2. There is no minimum age.
3. Costs of treatment are considered for each year of the intervention.
4. If a COPD patient is in stage 3 in the first year of their treatment, they have a probability of remission to stage 2. This one-off probability is estimated to be 0.121.
5. The RR of going from the Moderate to Severe disease stage is 0.90.
6. If a COPD patient is in stage 2 and treated a reduced risk of transitioning to stage 3 is assumed. This risk ratio of going from stage 3 to 2 is 0.90.

CKD model interventions

Albumin screening

CKD was deemed an important disease to include as part of the CHD model, however a relationship between BMI and smoking was not confirmed in the literature so was not implemented in the model. Instead albuminuria and eGFR were included as risk factors for CKD progression. Screening for albuminuria was implemented to demonstrate the ability of the model to quantify the impact of screening interventions.

Albuminuria is a risk factor for end stage renal disease (ESRD), independent of the traditional measure of kidney function, the estimated glomerular filtration rate (eGFR) (82). Raised albuminuria is also associated with cardiovascular disease (CVD), even after adjustment for traditional cardiovascular risk factors and eGFR (83, 84). The adjusted risk of cardiovascular mortality more than doubles at the upper end of the microalbuminuria category (30–299 mg/g), compared with the risk in individuals with normal albuminuria (83-85). Elevated albumin is preferably assessed by the urinary albumin-to-creatinine ratio (35). The reason for screening for albuminuria is that patients with elevated levels of urinary albumin would be identified and treated earlier, thereby reducing the proportion of people presenting late to their GP with lower eGFR and related complaints. It has been shown that reducing albuminuria using pharmaceuticals may reduce the incidence of CVD and renal adverse outcomes such as T2DM and hypertension, even in the general, otherwise healthy population (86-92). By treating these patients, renal disease, ESRD and CVD may potentially be delayed or even prevented. Population based screening for albuminuria is therefore a potentially cost-effective way of preventing CKD, ESRD and CVD (93).

Screening for albuminuria has been implemented in the EConDA model following the guidelines used in the Prevention of REnal and Vascular ENdstage Disease (PREVEND) study (29). In this study, a vial of morning urine from the screened population is sent by mail to a central lab for measurement of the urinary albumin concentration (UAC). If it is elevated (≥30 mg/L UAC), a confirmatory test is conducted at primary care level. This confirmatory test consists of two 24 hour urine samples, which are tested for urinary albumin excretion (UAE). The impact of screening an individual once in the general population at national level, on associated future disease burden was modelled to 2050.

Patients confirmed with an elevated UAC are given annual treatment with angiotensin-converting-enzyme inhibitor (ACEi). Costs were based on the cost-effectiveness study by Boersma and colleagues and include drug costs, an annual prescription fee for the pharmacist and primary care costs (93). Costs for the screening programme by country can be found in Table 15. When more data become available the CKD model can be run for countries other than the UK, and include these costs.

The effect of screening was implemented as a risk ratio (RR) on the transition probabilities due to treatment. The RR to go from the "30-299" to ">=300" albuminuria state is 0.45, and the RR to go to a worse eGFR state is 0.673 (94, 95).

Table 15. Intervention costs for albuminuria screening used in EConDA (93)

Intervention costs	BU	FI	GR	LT	NL	PL	PT	UK
	(in лв)	(in €)	(in €)	(in €)	(in €)	(in Zł)	(in €)	(in £)
Cost of screening								
Prescreening for UAC[a]	15	9	6	4	8	17	6	6
Confirmatory test for UAE[a]	129	74	51	35	66	146	49	56
Annual costs of treatment								
Treatment with ACEi[a]	170	98	68	46	87	192	64	73
Prescription fee pharmacist	56	32	22	15	29	63	21	24
Primary care costs	157	91	63	42	80	177	60	68

a UAC = Urinary Albumin Screening, UAE = Urinary Albumin Excretion, ACEi = angiotensin-converting-enzyme inhibitor

Summary

A summary table of the interventions run in the EConDA model are summarised in Table 16.

Table 16 BMI and Smoking intervention scenarios modelled in WP5 and WP6

Scenarios/interventions	Details
BMI scenarios	
1. Baseline BMI scenario	No change in overweight and obesity prevalence projections; maintain projections as predicted using country specific BMI data
2. MCLI- scenario A	Individuals who take up the intervention regain 100% of the lost weight 5 years post-intervention. The intervention takes place annually.
3. MCLI- scenario B	Individuals who take up the intervention do not regain any lost weight. The intervention takes place annually.
4. SSB excise tax	20% excise tax is applied to SSBs resulting in a certain reduction in baseline overweight and obesity prevalence projections
Smoking scenarios	
1. Baseline smoking scenario	No change in smoker prevalence projections; maintain projections as predicted using country specific smoking prevalence data
2. Smoking cessation service	Smokers take part in a smoking cessation service
3. Hypothetical COPD treatment	A hypothetical drug treatment whereby individuals go from COPD GOLD stage 3 to 2
CKD scenarios	
1. Baseline CKD scenario	No change in smoker prevalence projections; maintain projections as predicted using country specific albumin and eGFR data
2. Albumin screening	A screening intervention is applied to reduce the risk of an individual moving from "30-299" to ">=300" albuminuria state and through eGFR states.

Tool development

A tool was developed to test the impact of either obesity or smoking interventions on the future burden of chronic diseases. The tool provides projections of the future attributable burden of disease based on changes in respective risk factors and the future health and cost impact of planned interventions. As a consequence, it enables users to make more informed decisions about the commissioning of tailored services and interventions.

The tool processing is different from that of the microsimulation in two main ways.

1. The tool processing is 'deterministic'[6]
By 'deterministic' we mean that the tool processes cohorts of weighted individuals (e.g. a group of overweight 20-39 year old males) rather than a whole population of a variety of individuals. A cohort is a group of individuals whereby the user specifies, for each individual, their initial risk factor status (e.g. obese, smoker) and medical history. Individuals are processed one at a time from the simulation start year until they either die or reach the simulation stop year. In each simulated year they can contract, recover or die from a specified or non-specified disease. The tool is coded in C++ and includes a graphical user interface (GUI) that can be downloaded and used by the lay person.

2. Risk factor trajectories
In the microsimulation individuals have a risk factor status that is determined by the risk factor trajectory entered into the model. For example, an individual may have a BMI point of 27.5 or 32.5. However, in the tool they will be classified as either overweight or obese. In this sense the tool is less granular than the microsimulation. Importantly though, the risk factor trajectory follows the same pattern such that obesity by age and sex is generally increasing over time and smoking prevalence is generally decreasing over time (as set by the input data).

More information about the tool development is presented in appendix D1.

[6] See appendix B4 for an in-depth description of the microsimulation method and appendix D2 for more detail on the differences between the microsimulation and tool method.

Results by country

This section presents the results of for each country separately. Each country report is structured as follows:

Section 1: Results of data collection

This section outlines the specific risk factor, disease and intervention data collected for that country, specifying the proxy data used.

Section 2: Risk factor projections to 2050

This section outlines the risk factor projections for BMI-group and smoker status by age and sex, and by education level.

Section 3: Results of the microsimulation modelling

This section presents the results of the microsimulation modelling. The following outputs are provided:

- *Incidence cases*

  The number of new disease cases per 100,000 population
- *Cumulative incidence cases*

  The total number of incidence cases over a given period. Cumulative incidence cases are presented from year 2015 to 2050 at 5-yearly increments such that, for example, the 2050 cumulative incidence case figure represents the sum of all of the incidence cases from the start of the simulation to 2050 – presented in terms of per 100,000 population.
- *Prevalence cases avoided*

  The number of disease prevalence cases that are avoided relative to the baseline scenario (i.e. scenario 0). The prevalence cases avoided are presented from year 2015 to 2050 at 5-yearly increments. A positive value represents the number of cases avoided per 100,000 population.
- *Cumulative incidence cases avoided*

  The total number of disease incidence cases that are avoided relative to the baseline scenario (i.e. scenario 0) over a given period. Cumulative incidence cases avoided are presented from year 2015 to 2050 at 5-yearly increments such that, for example, the 2050 cumulative incidence case avoided figure represents the sum of all of the incidence cases avoided from the start of the simulation to 2050 – presented in terms of per 100,000 population. A positive value represents the number of cases avoidable per 100,000 population.
- *Direct healthcare costs avoided*

  The total direct healthcare cost that are avoided relative to the baseline scenario (i.e. scenario 0). A positive value represents the amount of direct cost avoidable relative to baseline. Costs are presented in terms of per 100,000 population.

- *Indirect costs avoided*

  The total indirect costs that are avoided relative to the baseline scenario (i.e. scenario 0). A positive value represents the amount of indirect cost avoidable relative to baseline. Costs are presented in terms of per 100,000 population. The indirect costs refer to productivity costs (which are obtained by accruing their expected yearly wages over their working life-time, usually up to the age of 65), which are composed of mortality costs and morbidity costs. Mortality cost refers to the productivity loss attributable to pre-mature mortality due to a given disease. Morbidity cost refers to the productivity loss attributable to pre-mature morbidity due to a given disease. Indirect costs are estimated using the human capital approach unless otherwise stated; to note, morbidity cost reflects absenteeism only for this project.
- *QALYs gained*

  The total number of QALYs that are gained relative to the baseline scenario (i.e. scenario 0). A positive value represents the amount of QALYs gained relative to baseline. QALYs are presented in terms of per 100,000 population.
- *Incremental cost-effectiveness ratio (ICER)*

  The ICER allows us to compare an intervention of interest with a baseline scenario (i.e. no intervention) in terms of both costs and QALY values. The equation to calculate ICER can be found in appendix B4.

  The interpretation of the ICER depends on the signs of the numerator (costs) and denominator (QALY):

  - If the ICER is negative:
    - as a result of the numerator being negative and the denominator being positive, then the intervention dominates as the intervention costs less than baseline and results in higher QALY gains.
    - as a result of the numerator being positive and the denominator being negative, then the intervention is dominated as the intervention costs more than baseline and gains less in terms of QALY.
  - If the ICER is positive:
    - as a result of both the numerator and denominators being positive, then a cost effectiveness threshold is required to determine whether or not the intervention is cost effective because the intervention is more effective in terms of QALY but costs more than baseline.
    - as a result of both the numerator the denominator being negative, then the intervention is questionable as the intervention is less expensive and less effective in terms of QALY.

The confidence limits that accompany the sets of output data represent the accuracy of the microsimulation (stochastic, or aleatoric uncertainty) as opposed to the confidence of the input data itself (parameter uncertainty). Errors around the input data were not available.

BMI intervention results

Three different combinations of multi-component lifestyle interventions (MCLI) were run to demonstrate the importance of regularity of intervention and weight maintenance, and to show the effect on disease outcomes based on data in the literature:

1. **MCLI, annual, with regain** – this shows the impact of a MCLI that is available to 10.44% percentage of obese individuals (as suggested by the literature) each year of the simulation. This is a realistic reflection of weight management services that are currently available in UK primary care. We know from the literature that individuals who take part in MCLI lose weight but gradually put the weight back on over the subsequent 1-5 years. This was implemented in the model such that 20% of the weight was regained each year, until 100% was regained by year 5. Fifty million simulations were run.

2. **MCLI, annual, with no regain** – Similar to above the MCLI was available each year of the simulation. However, we wanted to explore the impact on disease outcomes if weight loss was maintained following the MCLI. Fifty million simulations were run.

3. **MCLI, not annual, with no regain** – in this implementation of the intervention we followed the literature by showing the impact of a MCLI if it took place in the start year only with no weight regain (the evidence was drawn from literature that reports on MCLI effects at a single time point. We ran the same intervention with fifty million and then one hundred million simulations to improve the accuracy of results, no effect was observed. Therefore, we assumed that the same results would be observed with weight regain (MCLI combination 1 above).

For the SSB tax intervention, due to the small associated BMI reduction identified in the literature, 100 million simulations were run to provide more accurate results. It should be noted due to the stochastic nature of the simulation running 50 million simulations for MCLI but 100millon simulation results in slight differences in the baseline results.

Smoking intervention results

The impact of Smoking Cessation Services was tested in all countries. However, due to data constraints a multi-stage COPD was model was developed for the UK and Finland only. Because the treatment impacted stage 3-4 of the COPD model, this intervention could be tested in the UK and Finland only.

Report sequence

The country reports are presented in alphabetical order:

1. Bulgaria
2. Finland
3. Greece
4. Lithuania
5. The Netherlands
6. Poland
7. Portugal
8. United Kingdom

Bulgaria

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m2) in Bulgaria are presented in Table 17 and for smoking prevalence by age and sex are presented in Table 18. Data were also collected by personal communication where possible.

Data disaggregated by education level were not available for Bulgaria. Therefore it was not possible to explore future prevalence of each risk factor by sub-groups.

Table 17. References used in the model for BMI prevalence

Reference	Year	Sample size		Age group	Measured/ Self-reported	National/ Regional
		M	F			
WHO; Survey of the Health Status of the Population	2001	8,008		25-74	Self-reported	National
WHO; Petrova et al 2006	2004	515	516	25-74	Self-reported	National
Eurostat database: Health Interview Survey 2008 Bulgaria	2008	5,664		25-84	Self-reported	National
International Social Survey Programme: Health and Health Care - ISSP 2011	2011	422	581	20+	Measured	National

Table 18. References used in the model for smoking prevalence

Reference	Year	Sample size	Age group	National/Regional
(96)	1997	1,548	20-100	National
European Health Interview Survey (Eurostat)	2002	7,792	20-100	National
European Health Interview Survey (Eurostat)	2008	3,597	20-100	National

Disease data

Disease data sources are detailed in appendix A1. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. For Bulgaria, Lithuanian proxy data were used for CHD and COPD incidence (Pers comm V Kraucioniene). Diabetes statistics for Greece (as proxy) and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, Appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using incidence and mortality data (see technical appendix B4 for details). Hypertension incidence was calculated within the programme using prevalence data. Dutch data were used as proxy for direct costs of COPD and hypertension, utility weights for CHD, COPD and stroke accounting for exchange rates and purchasing price parities (appendix B5). UK data were used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Intervention data

Table 19 and

Table 20 present the intervention input data for each of the interventions modelled:

Table 19. BMI intervention input data

Scenario	BMI reduction	% BMI regain	Cost of intervention (Lev)
Baseline	None	-	-
MCLI regain	0.6	100	342*
MCLI no regain	0.6	0	342*
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. *Greece proxy (converted to Bulgarian Lev)

Table 20. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59% (Finland proxy)
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method	Biochemical
Cost	
Cost (cost/quit-attempt)	429 лв (Netherlands proxy)

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; either self-reported or validated by biochemical testing

Section 2: Risk factor projections to 2050

BMI projections by age and sex

Table 21 presents the prevalence of normal weight, over-weight and obesity (according to BMI) in the adult population, by sex. Obesity prevalence is projected to increase in Bulgarian males reaching 22% by 2050 whilst overweight prevalence is projected to decline. Among females obesity prevalence is projected to remain stable but a large increase in overweight prevalence is projected reaching 76% in 2050. The proportion of healthy weight males is projected to increase slightly over the next 35 years, but will decrease amongst females.

Figure 3 to Figure 7 present BMI-group projections to 2050 for males 20-69 years (normal weight=<25 kg/m2, in green; overweight=25-29.9 kg/m2, in blue; obesity=≥30 kg/m2, in red) by 10-year age groups. Two WHO surveys in 2001 and 2004, the Bulgaria Health interview survey (2008) and the International Social Survey Programme (2011) were used as a proxy for the Bulgarian population. The increase in obesity prevalence described above is expected among 20 to 29 year olds and 50 to 69 year olds. Among males 70 to 79 years old, obesity prevalence could surpass 60% by 2050. The proportion of healthy weight males is predicted to increase in 30 to 49 year olds, but decline in other age groups.

Figure 8 to Figure 12 present the BMI-group projections to 2050 for females 20-69 years (normal weight=<25 kg/m2, in green; overweight=25-29.9 kg/m2, in blue; obesity=≥30 kg/m2, in red) by 10-year age groups. An increase in obesity prevalence is only expected among the 60-69 age group, but overweight is projected to increase sharply among 20-59 year old females, in whom prevalence is expected to surpass 90% by 2050. The proportion of healthy weight females is predicted to decline in all age groups.

It is important to note that as more data points become available, these projections may be modified. Currently, possibly due to the fact that country BMI data arises from different sources and different methodologies (Table 17), there may be significant error even within the measured data points. For example, the last data point (2011) refers to measured weight and height whereas; the first three arise from self-reported weight and height. Overweight and obesity in the first three data points may be underestimated compared to 2011 thus influencing projections.

Table 21. Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	BMI<25	+/-95% CI	BMI 25-29.9	+/-95% CI	BMI≥30	+/-95% CI	BMI<25	+/-95% CI	BMI 25-29.9	+/-95% CI	BMI≥30	+/-95% CI	BMI<25	+/-95% CI	BMI 25-29.9	+/-95% CI	BMI≥30	+/-95% CI
2015	51.0	10.1	35.0	10.2	14.0	7.3	33.0	9.6	53.0	9.6	15.0	7.0	42.0	9.9	44.0	9.9	14.0	7.2
2020	52.0	14.6	33.0	14.7	15.0	10.4	25.0	13.9	60.0	13.8	15.0	10.2	38.0	14.3	47.0	14.3	15.0	10.3
2025	54.0	19.2	30.0	19.3	16.0	13.7	20.0	18.3	65.0	18.1	15.0	13.4	36.0	18.8	49.0	18.7	16.0	13.5
2030	55.0	23.9	28.0	23.9	17.0	16.9	15.0	22.7	69.0	22.4	15.0	16.6	34.0	23.3	50.0	23.2	16.0	16.7
2035	55.0	28.5	26.0	28.6	19.0	20.2	12.0	27.1	72.0	26.7	16.0	19.8	33.0	27.8	50.0	27.7	17.0	20.0
2040	56.0	33.2	24.0	33.2	20.0	23.4	10.0	31.5	74.0	31.1	16.0	23.0	32.0	32.3	50.0	32.2	18.0	23.2
2045	57.0	37.8	22.0	37.9	21.0	26.7	8.0	35.9	75.0	35.4	17.0	26.2	31.0	36.9	50.0	36.7	19.0	26.5
2050	57.0	42.5	20.0	42.5	22.0	30.0	7.0	40.3	76.0	39.7	18.0	29.5	31.0	41.4	49.0	41.2	20.0	29.7

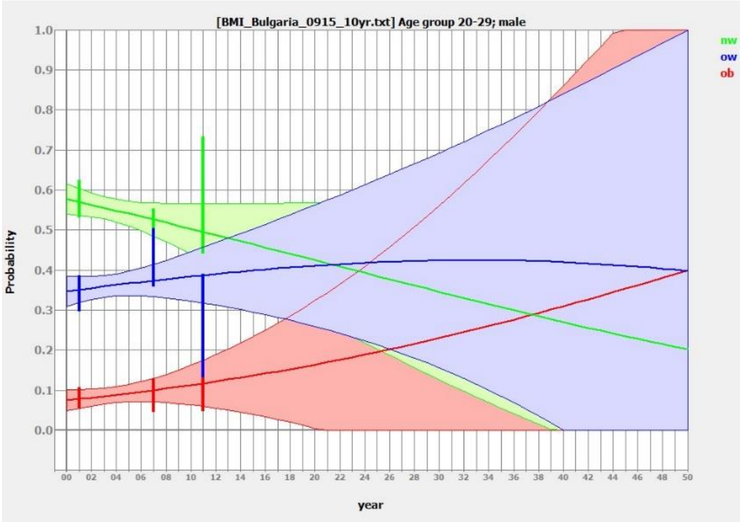


Figure 3. Projected BMI-group in 20-29 year old males

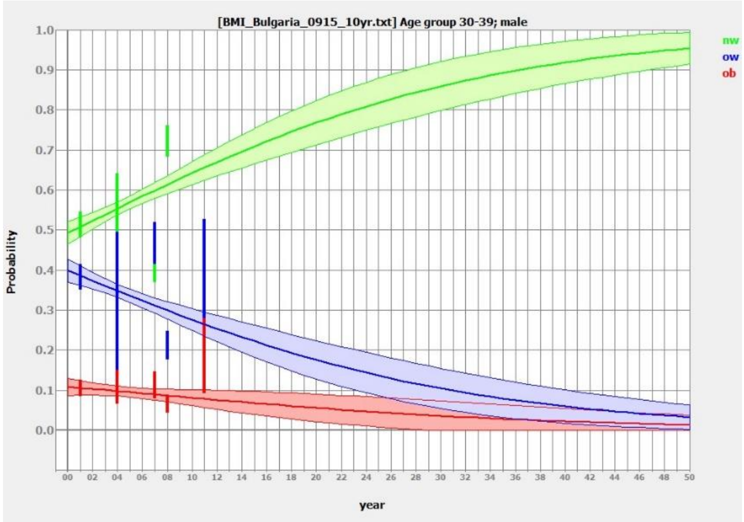


Figure 4 Projected BMI-group in 30-39 year old male

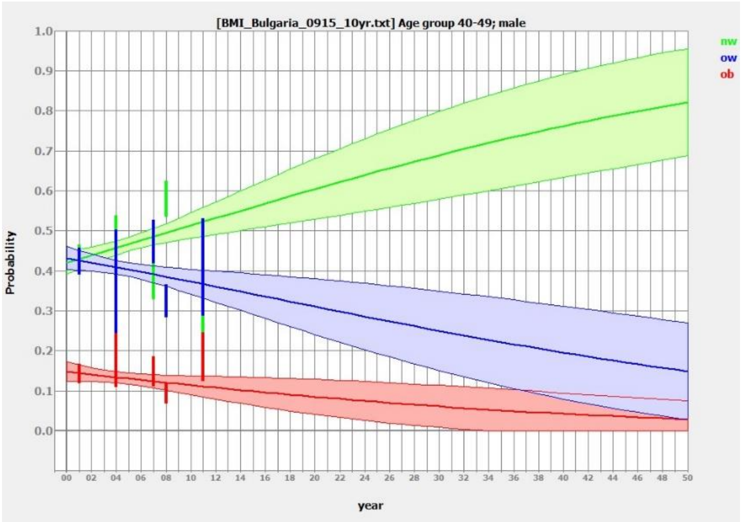


Figure 5. Projected BMI-group in 40-49 year old males

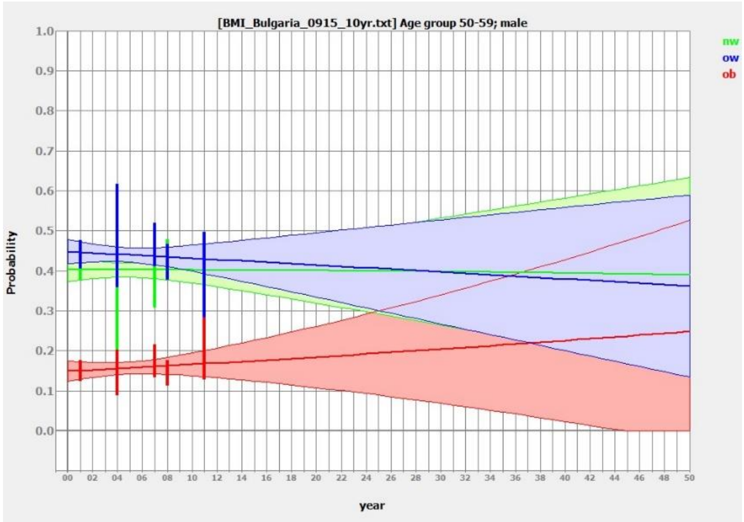


Figure 6 Projected BMI-group in 50-59 year old males

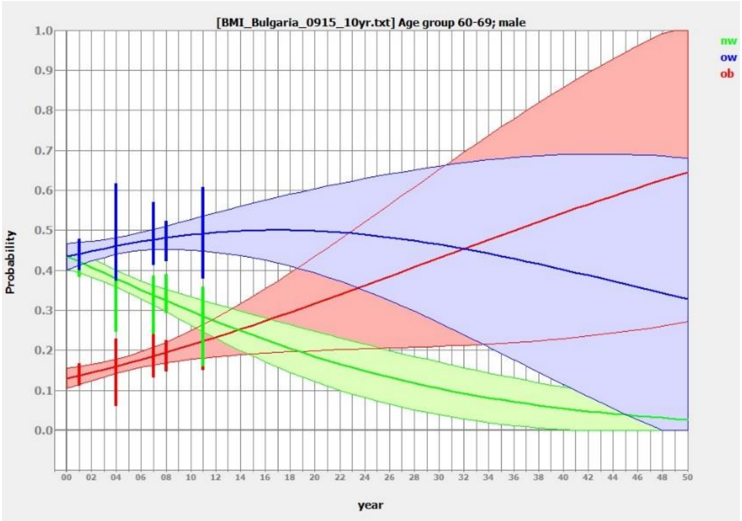


Figure 7. Projected BMI-group in 60-69 year old males

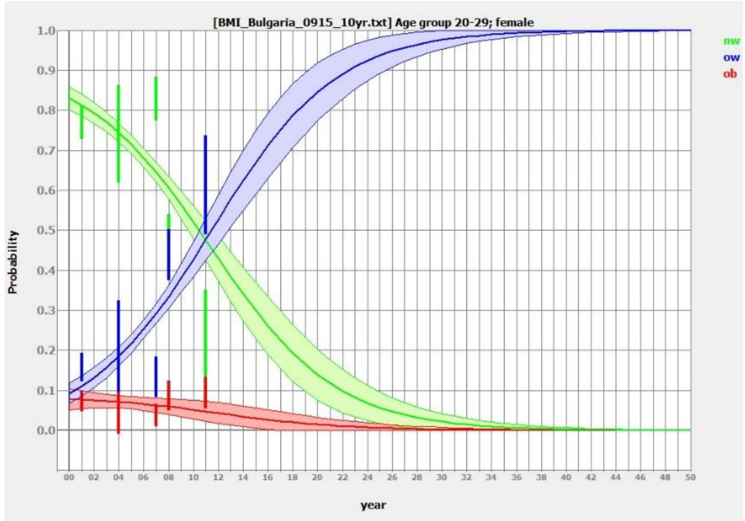


Figure 8. Projected BMI-group in 20-29 year old females

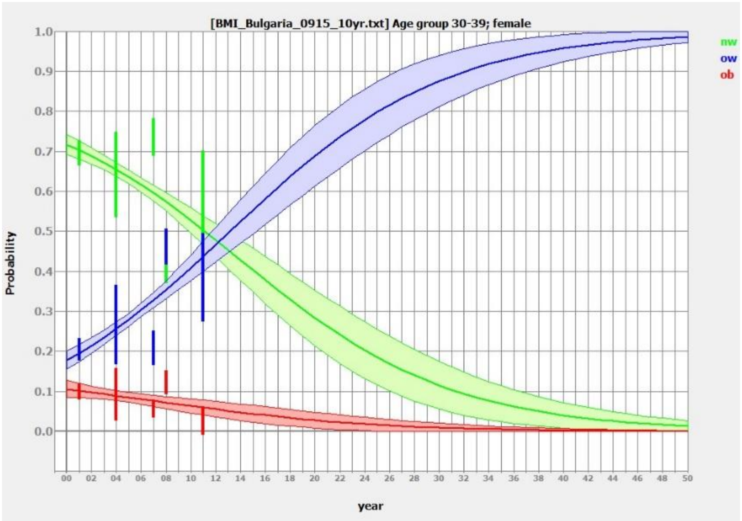


Figure 9. Projected BMI-group in 30-39 year old females

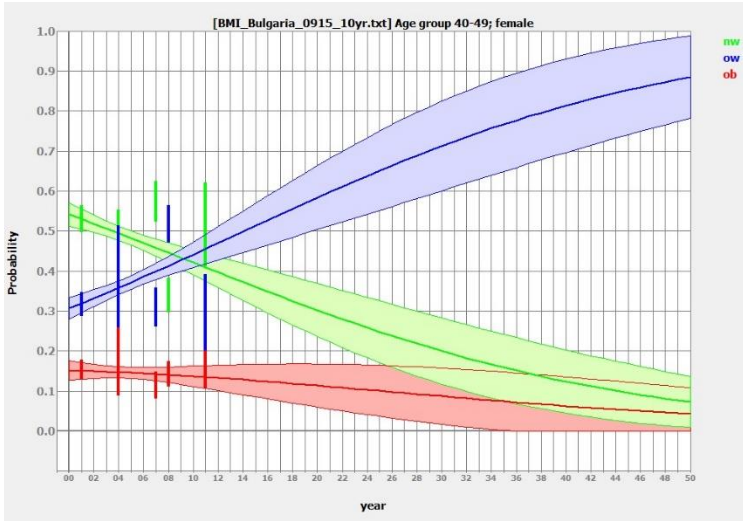


Figure 10. Projected BMI-group in 40-49 year old females

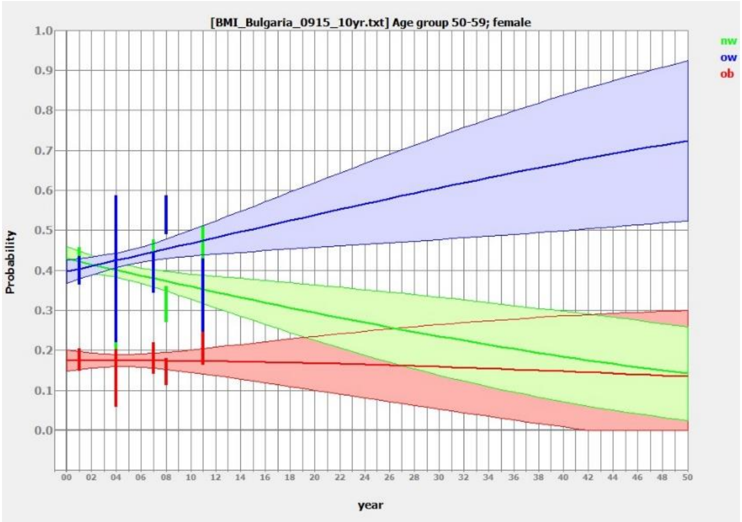


Figure 11. Projected BMI-group in 50-59 year old females

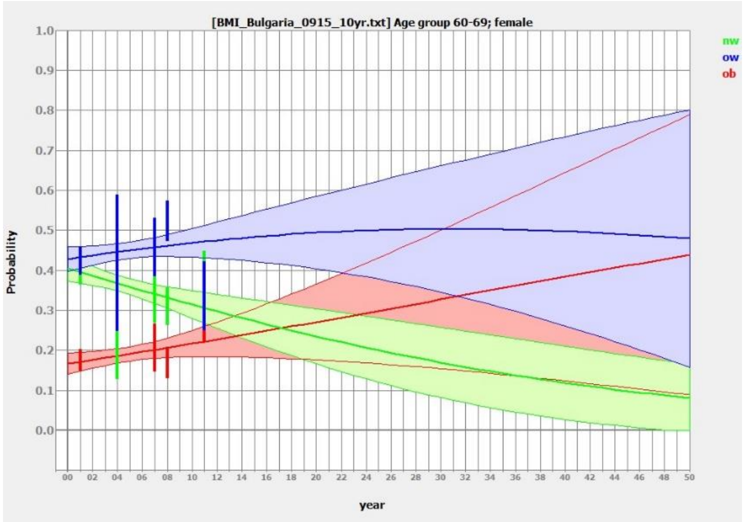


Figure 12. Projected BMI-group in 60-69 year old females

Smoking projections by sex and age group

Table 22 presents smoking prevalence projections to 2050 for males and females aged 20 to 100. Smoking prevalence is predicted to decline in Bulgarian males reaching 34% in 2050, but to increase among Bulgarian females reaching 32% in 2050.

The decline in smoking prevalence is expected across most age groups in males, except 60-69 year olds for whom prevalence is predicted to increase (Figure 13 to Figure 17). The largest improvement is projected among 30 to 39 year old males in whom the prevalence of smoking will decline from approximately 55% in 2000 to 22% in 2050 (Figure 14).

Smoking prevalence among Bulgarian females is predicted to decrease amongst 20-39 year olds, but to increase amongst females 40 to 69 years (Figure 18 to Figure 22). Whilst prevalence of smoking amongst 20-29 year old females could decrease to below 5%, smoking prevalence amongst 60-69 year olds is predicted to increase to 76% by 2050 (Figure 18 and Figure 22).

Only two data points were available to project smoking trends in Bulgaria. The error around the projections is therefore large. More data is needed to arrive at more precise estimates.

Table 22. Smoking prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	**Non-smokers**	+/-95% CI	**Smokers**	+/-95% CI	**Non-smokers**	+/-95% CI	**Smokers**	+/-95% CI	**Non-smokers**	+/-95% CI	**Smokers**	+/-95% CI
2015	**58.0**	5.3	**42.0**	5.3	**77.0**	4.4	**23.0**	4.4	**67.0**	4.9	**33.0**	4.9
2020	**59.0**	10.1	**41.0**	10.1	**76.0**	8.1	**24.0**	8.1	**68.0**	9.2	**32.0**	9.2
2025	**61.0**	15.5	**39.0**	15.6	**74.0**	12.4	**26.0**	12.4	**68.0**	14.0	**32.0**	14.0
2030	**62.0**	21.2	**38.0**	21.2	**73.0**	16.7	**27.0**	16.7	**68.0**	19.1	**32.0**	19.1
2035	**63.0**	26.9	**37.0**	26.9	**71.0**	21.1	**29.0**	21.1	**67.0**	24.2	**33.0**	24.2
2040	**64.0**	32.6	**36.0**	32.6	**70.0**	25.5	**30.0**	25.5	**67.0**	29.3	**33.0**	29.3
2045	**65.0**	38.4	**35.0**	38.4	**69.0**	29.9	**31.0**	29.9	**67.0**	34.4	**33.0**	34.4
2050	**66.0**	44.1	**34.0**	44.1	**68.0**	34.4	**32.0**	34.4	**67.0**	39.5	**33.0**	39.5

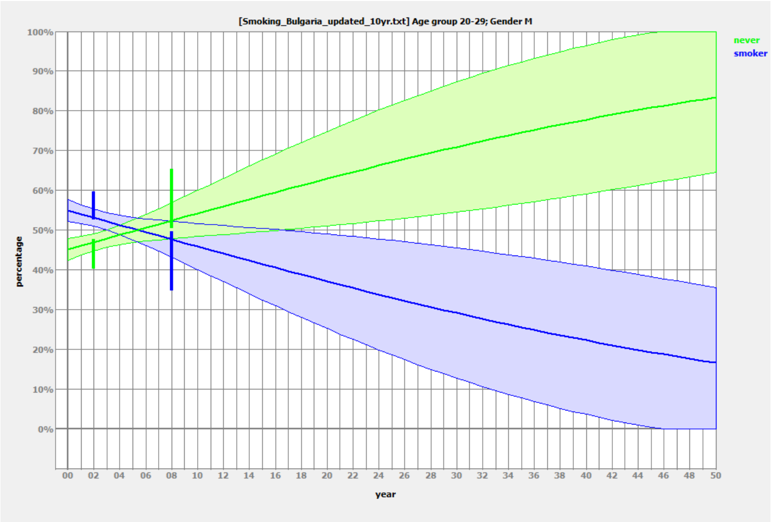


Figure 13. Smoking prevalence projections among males aged 20 to 29

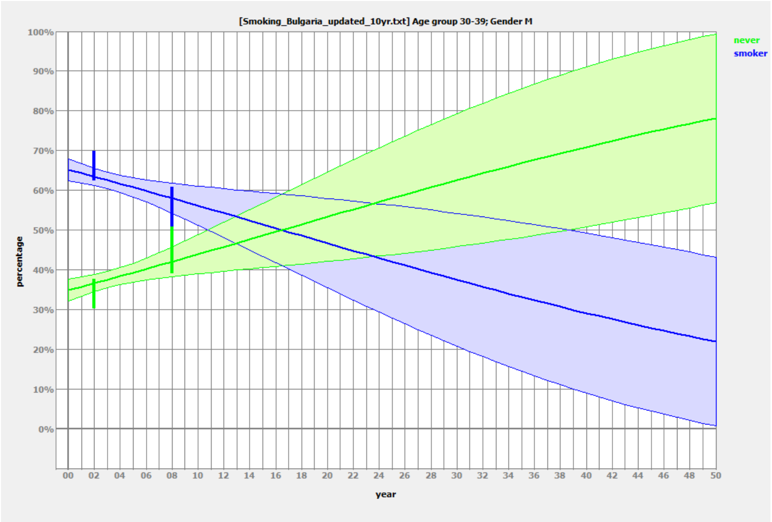


Figure 14. Smoking prevalence projections among males aged 30 to 39

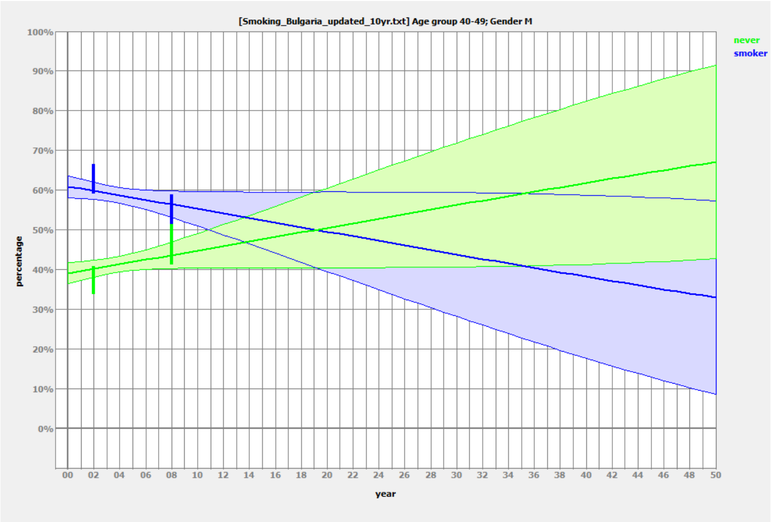


Figure 15. Smoking prevalence projections among males aged 40 to 49

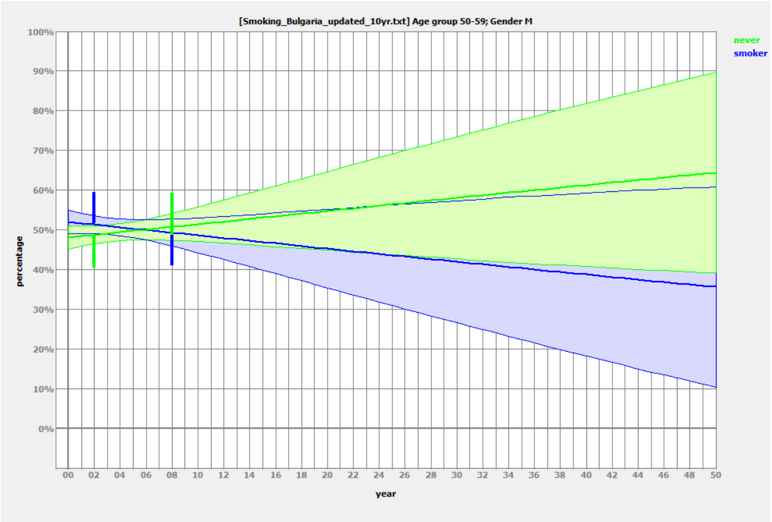


Figure 16. Smoking prevalence projections among males aged 50 to 59

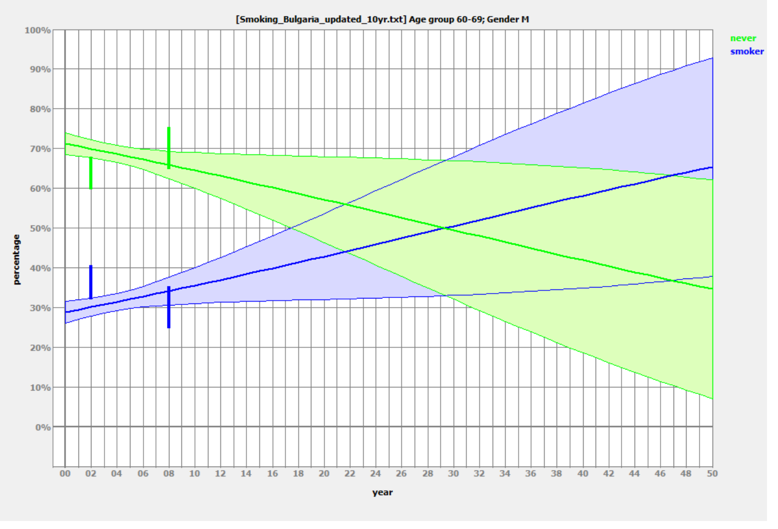


Figure 17. Smoking prevalence projections among males aged 60 to 69

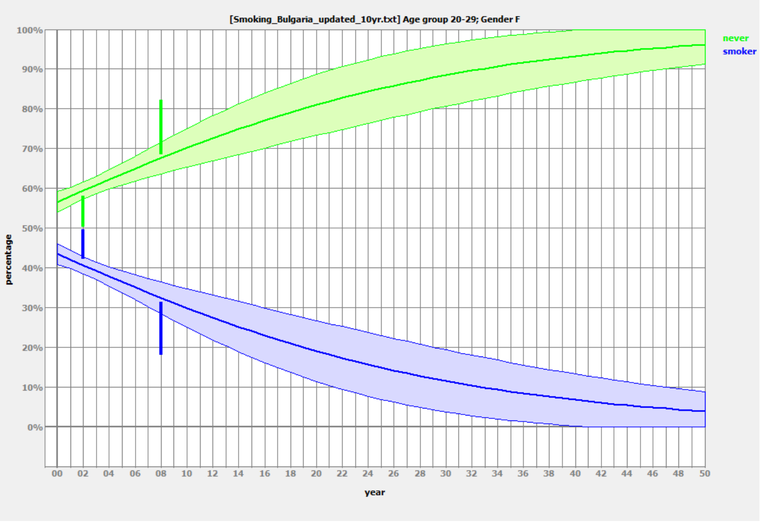


Figure 18. Smoking prevalence projections among females aged 20 to 29

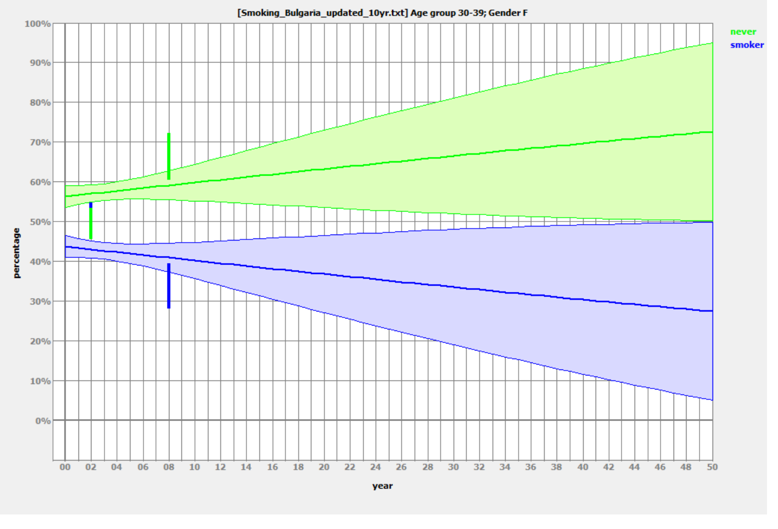


Figure 19. Smoking prevalence projections among females aged 30 to 39

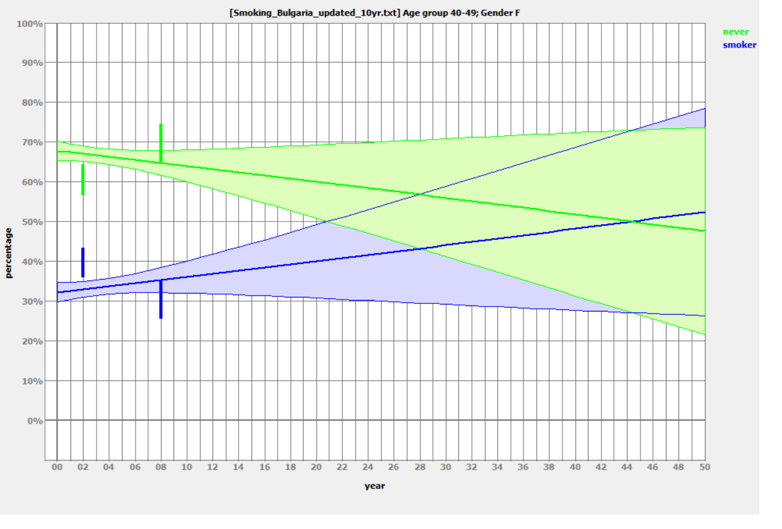


Figure 20. Smoking prevalence projections among females aged 40 to 49

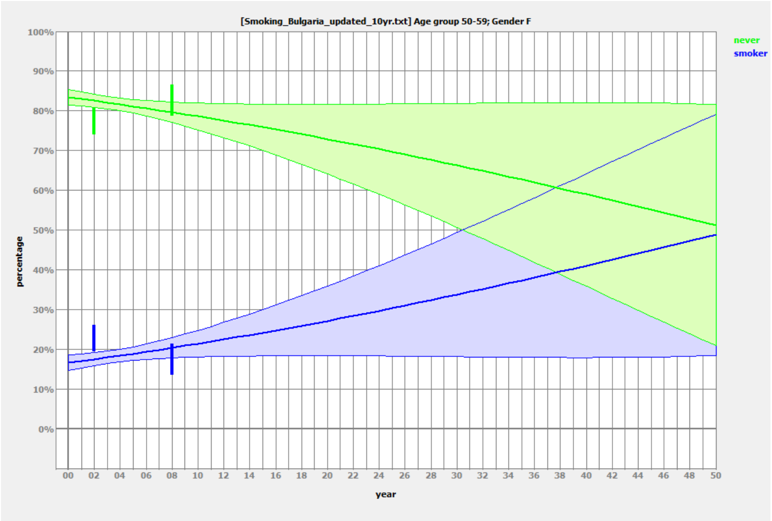


Figure 21. Smoking prevalence projections among females aged 50 to 59

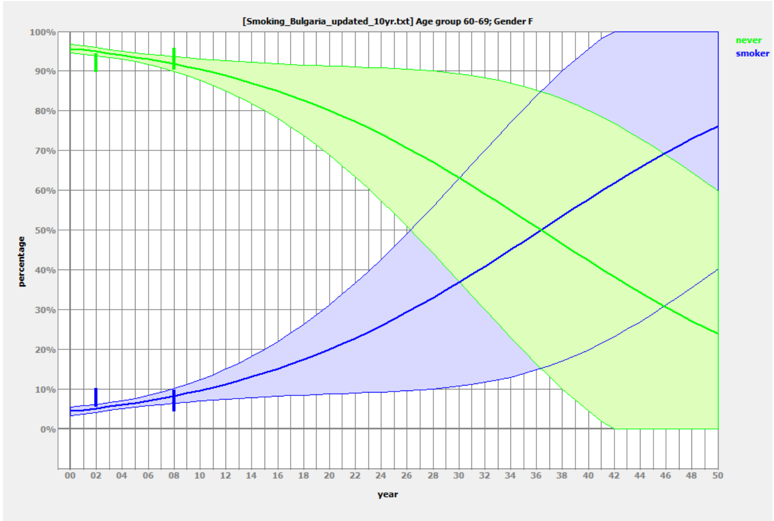


Figure 22. Smoking prevalence projections among females aged 60 to 69

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 23. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

Table 23. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (Lev)
Baseline	None	-	-
MCLI regain	0.6	100	342*
MCLI no regain	0.6	0	342*
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. * Greece proxy (converted to Bulgarian Lev)

Multi-component lifestyle interventions (MCLI)

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of Section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain** – these results are presented in appendix E1.

Impact on disease incidence and prevalence

Table 24 presents the incidence cases per 100,000 to 2050 for baseline (no intervention) and each intervention scenario. Incidence cases of all diseases increase over time. The interventions are effective in reducing the projected incidence cases over time as can be seen in Table 25 which presents cumulative incidence cases per 100,000 to 2050 for baseline and each intervention and in Table 26 and Figure 23 which presents the cumulative incidence cases avoided by the intervention compared to baseline from 2015 to 2050. Not surprisingly, the scenario of no weight regain yields more positive results. However, even if participants of MCLI regained 100% of the lost weight after five years, population health improvements would be seen. Up to 147 per 100,000 fewer diabetes cases and 134 per 100,000 fewer cases of CHD would be observed over the study period 2015-2050.

Table 27 and Figure 24 present the prevalence cases avoided for each intervention relative to baseline, per 100,000. Both figures indicate that each MCLI intervention would result in a reduced number of prevalence cases per 100,000 compared to baseline for all diseases by 2050, and for each five year increment from 2030 to 2050. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for diabetes (61/100,000 and 70/100,000 for MCLI regain and no-regain scenarios respectively), followed by CHD (54/100,000 and 57/100,000 respectively).

Table 24. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Prediabetes	Diabetes	Stroke
Baseline	2015	499 [+-2]	629 [+-2]	698 [+-2]	326 [+-2]	308 [+-2]
	2020	520 [+-2]	628 [+-2]	727 [+-2]	339 [+-2]	321 [+-2]
	2025	549 [+-2]	638 [+-2]	757 [+-2]	356 [+-2]	337 [+-2]
	2030	577 [+-2]	660 [+-2]	787 [+-3]	370 [+-2]	359 [+-2]
	2035	609 [+-2]	681 [+-2]	813 [+-3]	390 [+-2]	381 [+-2]
	2040	639 [+-2]	680 [+-2]	832 [+-3]	405 [+-2]	397 [+-2]
	2045	658 [+-3]	670 [+-3]	834 [+-3]	415 [+-2]	410 [+-2]
	2050	670 [+-3]	649 [+-3]	840 [+-3]	428 [+-2]	424 [+-2]
MCLI (annual, with regain)	2015	497 [+-2]	628 [+-2]	697 [+-2]	324 [+-2]	308 [+-2]
	2020	522 [+-2]	627 [+-2]	725 [+-2]	338 [+-2]	319 [+-2]
	2025	546 [+-2]	639 [+-2]	755 [+-2]	353 [+-2]	336 [+-2]
	2030	574 [+-2]	660 [+-2]	784 [+-3]	371 [+-2]	360 [+-2]
	2035	607 [+-2]	679 [+-2]	814 [+-3]	387 [+-2]	379 [+-2]
	2040	633 [+-2]	679 [+-2]	828 [+-3]	399 [+-2]	396 [+-2]
	2045	654 [+-3]	665 [+-3]	833 [+-3]	412 [+-2]	407 [+-2]
	2050	664 [+-3]	646 [+-3]	838 [+-3]	424 [+-2]	421 [+-2]
MCLI (annual, with no regain)	2015	497 [+-2]	628 [+-2]	698 [+-2]	325 [+-2]	308 [+-2]
	2020	519 [+-2]	627 [+-2]	725 [+-2]	336 [+-2]	320 [+-2]
	2025	545 [+-2]	640 [+-2]	755 [+-2]	351 [+-2]	334 [+-2]
	2030	573 [+-2]	659 [+-2]	784 [+-3]	370 [+-2]	359 [+-2]
	2035	607 [+-2]	680 [+-2]	814 [+-3]	387 [+-2]	379 [+-2]
	2040	633 [+-2]	678 [+-2]	827 [+-3]	400 [+-2]	396 [+-2]
	2045	654 [+-3]	664 [+-3]	833 [+-3]	411 [+-2]	407 [+-2]
	2050	664 [+-3]	646 [+-3]	837 [+-3]	424 [+-2]	421 [+-2]

Table 25. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Prediabetes	Diabetes	Stroke
Baseline	2015	499 [+-2]	629 [+-2]	698 [+-2]	326 [+-2]	308 [+-2]
	2020	3099 [+-5]	3812 [+-5]	4323 [+-6]	2018 [+-4]	1910 [+-4]
	2025	5920 [+-7]	7142 [+-7]	8224 [+-8]	3852 [+-5]	3640 [+-5]
	2030	9026 [+-8]	10733 [+-9]	12480 [+-10]	5864 [+-7]	5568 [+-7]
	2035	12471 [+-10]	14644 [+-10]	17131 [+-11]	8077 [+-8]	7720 [+-8]
	2040	16270 [+-11]	18814 [+-12]	22154 [+-13]	10495 [+-9]	10084 [+-9]
	2045	20387 [+-13]	23180 [+-13]	27499 [+-14]	13111 [+-10]	12645 [+-10]
	2050	24823 [+-14]	27706 [+-14]	33186 [+-15]	15942 [+-12]	15423 [+-12]
MCLI (annual, with regain)	2015	497 [+-2]	628 [+-2]	697 [+-2]	324 [+-2]	308 [+-2]
	2020	3097 [+-5]	3801 [+-5]	4317 [+-6]	2011 [+-4]	1910 [+-4]
	2025	5906 [+-7]	7128 [+-7]	8210 [+-8]	3832 [+-5]	3635 [+-5]
	2030	8998 [+-8]	10709 [+-9]	12454 [+-10]	5826 [+-7]	5559 [+-7]
	2035	12429 [+-10]	14613 [+-10]	17087 [+-11]	8018 [+-8]	7706 [+-8]
	2040	16203 [+-11]	18776 [+-12]	22092 [+-13]	10413 [+-9]	10064 [+-9]
	2045	20294 [+-13]	23122 [+-13]	27417 [+-14]	12999 [+-10]	12613 [+-10]
	2050	24689 [+-14]	27630 [+-14]	33078 [+-15]	15795 [+-12]	15375 [+-11]
MCLI (annual, with no regain)	2015	497 [+-2]	628 [+-2]	698 [+-2]	325 [+-2]	308 [+-2]
	2020	3089 [+-5]	3796 [+-5]	4315 [+-6]	2005 [+-4]	1909 [+-4]
	2025	5888 [+-7]	7120 [+-7]	8206 [+-8]	3820 [+-5]	3631 [+-5]
	2030	8971 [+-8]	10700 [+-9]	12446 [+-10]	5809 [+-7]	5554 [+-7]
	2035	12397 [+-10]	14601 [+-10]	17078 [+-11]	7998 [+-8]	7698 [+-8]
	2040	16168 [+-11]	18761 [+-12]	22085 [+-13]	10390 [+-9]	10054 [+-9]
	2045	20259 [+-12]	23104 [+-13]	27412 [+-14]	12974 [+-10]	12602 [+-10]
	2050	24653 [+-14]	27615 [+-14]	33069 [+-15]	15769 [+-12]	15364 [+-11]

Table 26. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Prediabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	2 [+-3]	1 [+-3]	1 [+-3]	2 [+-3]	0 [+-3]
	2020	2 [+-7]	11 [+-7]	6 [+-8]	7 [+-6]	0 [+-6]
	2025	14 [+-10]	14 [+-10]	14 [+-11]	20 [+-7]	5 [+-7]
	2030	28 [+-11]	24 [+-13]	26 [+-14]	38 [+-10]	9 [+-10]
	2035	42 [+-14]	31 [+-14]	44 [+-16]	59 [+-11]	14 [+-11]
	2040	67 [+-16]	38 [+-17]	62 [+-18]	82 [+-13]	20 [+-13]
	2045	93 [+-18]	58 [+-18]	82 [+-20]	112 [+-14]	32 [+-14]
	2050	134 [+-20]	76 [+-20]	108 [+-21]	147 [+-17]	48 [+-16]
MCLI (annual, with no regain), relative to baseline	2015	2 [+-3]	1 [+-3]	0 [+-3]	1 [+-3]	0 [+-3]
	2020	10 [+-7]	16 [+-7]	8 [+-8]	13 [+-6]	1 [+-6]
	2025	32 [+-10]	22 [+-10]	18 [+-11]	32 [+-7]	9 [+-7]
	2030	55 [+-11]	33 [+-13]	34 [+-14]	55 [+-10]	14 [+-10]
	2035	74 [+-14]	43 [+-14]	53 [+-16]	79 [+-11]	22 [+-11]
	2040	102 [+-16]	53 [+-17]	69 [+-18]	105 [+-13]	30 [+-13]
	2045	128 [+-18]	76 [+-18]	87 [+-20]	137 [+-14]	43 [+-14]
	2050	170 [+-20]	91 [+-20]	117 [+-21]	173 [+-17]	59 [+-16]

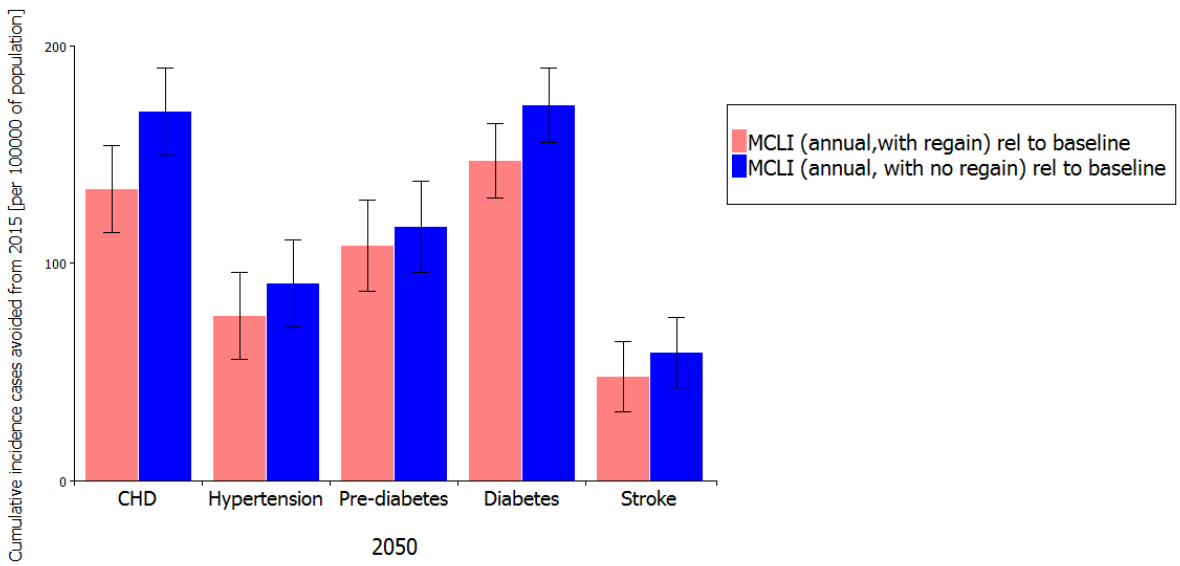


Figure 23. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 27. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	14 [+-10]	8 [+-16]	1 [+-6]	2 [+-10]	2 [+-4]
	2020	13 [+-10]	22 [+-16]	3 [+-6]	4 [+-11]	1 [+-4]
	2025	22 [+-11]	23 [+-16]	5 [+-6]	13 [+-11]	8 [+-6]
	2030	31 [+-11]	32 [+-17]	1 [+-6]	27 [+-11]	3 [+-6]
	2035	31 [+-11]	34 [+-17]	3 [+-6]	37 [+-11]	1 [+-6]
	2040	44 [+-13]	30 [+-17]	4 [+-6]	46 [+-13]	6 [+-6]
	2045	47 [+-13]	38 [+-18]	1 [+-6]	56 [+-13]	7 [+-6]
	2050	54 [+-14]	42 [+-18]	5 [+-7]	61 [+-13]	12 [+-6]
MCLI (annual, with no regain) relative to baseline	2015	13 [+-10]	15 [+-16]	0 [+-6]	3 [+-10]	2 [+-4]
	2020	19 [+-10]	31 [+-16]	3 [+-6]	11 [+-11]	2 [+-4]
	2025	32 [+-11]	30 [+-16]	5 [+-6]	23 [+-11]	10 [+-6]
	2030	44 [+-11]	39 [+-17]	4 [+-6]	37 [+-11]	4 [+-6]
	2035	43 [+-11]	43 [+-17]	4 [+-6]	48 [+-11]	5 [+-6]
	2040	55 [+-13]	39 [+-17]	4 [+-6]	56 [+-13]	7 [+-6]
	2045	54 [+-13]	54 [+-18]	-1 [+-6]	66 [+-13]	9 [+-6]
	2050	57 [+-14]	51 [+-18]	7 [+-7]	70 [+-13]	13 [+-6]

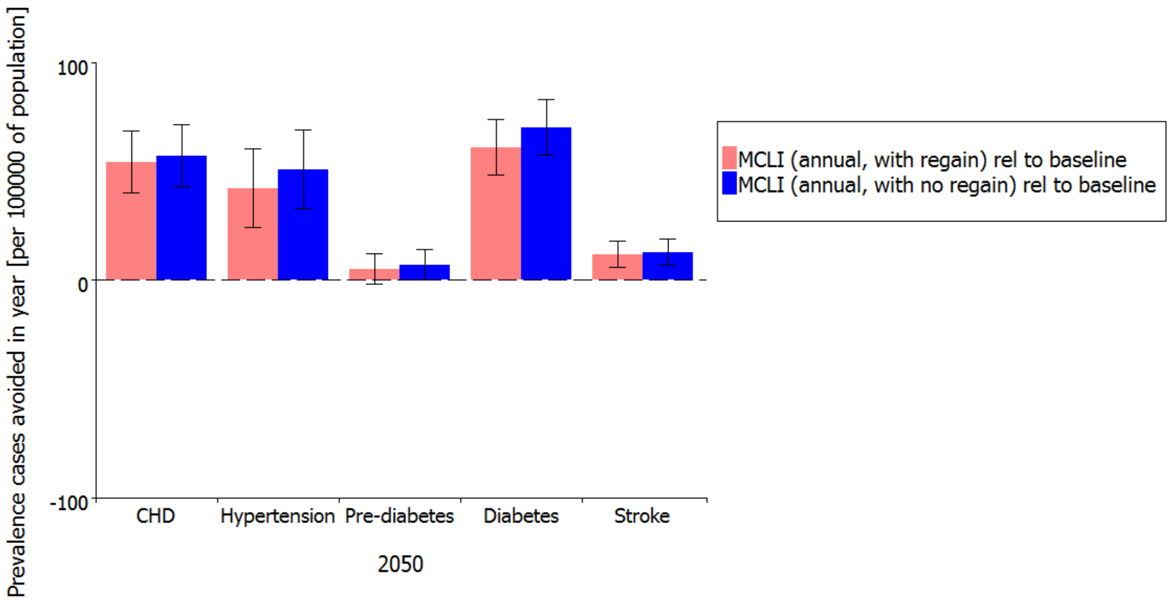


Figure 24. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 28 and Figure 25 present the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* are expected to occur in stroke for both MCLI interventions (0.18 and 0.19 million Lev per 100,000 population in 2050 for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Table 29 and Figure 26 present the indirect costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to occur in stroke (0.38 and 0.41 million Lev per 100,000 population in 2050 for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively) and CHD (0.27and 0.29 million Lev per 100,000 population in 2050 for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Figure 27 and Figure 28 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the baseline. For both males and females, both variations of the MCLI interventions are expected to lead to increasing gains in QALYs between 2015 and 2030, and then remain steady thereafter.

In Figure 29 the positive ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both versions of the MCLI scenarios *may* or *may not* be cost effective, depending on what cost effectiveness threshold value is chosen in Bulgaria. This is because a cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. However, since no cost effectiveness thresholds are currently not used in this country, we cannot categorically determine whether or not this set of interventions is cost effective. Over time, however, the ICER is expected to approach near zero, indicating that the interventions are likely to become cost effective.

Table 28. Direct healthcare costs (Lev millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	0.081142 [+-0.004213]	0.002471 [+-0.000827]	0.000072 [+-0.00001]	0.001375 [+-0.000734]	0.049904 [+-0.002667]
	2020	0.068745 [+-0.003924]	0.005981 [+-0.000747]	0.000296 [+-0.00001]	0.003552 [+-0.000663]	0.043964 [+-0.002728]
	2025	0.093609 [+-0.003693]	0.005021 [+-0.000681]	0.000437 [+-0.000009]	0.008699 [+-0.000607]	0.270416 [+-0.002604]
	2030	0.112644 [+-0.003507]	0.006352 [+-0.000626]	0.000087 [+-0.000008]	0.015617 [+-0.000564]	0.097763 [+-0.002514]
	2035	0.098463 [+-0.00333]	0.005746 [+-0.000576]	0.000207 [+-0.000008]	0.018409 [+-0.000525]	0.038094 [+-0.002437]
	2040	0.121449 [+-0.003141]	0.00441 [+-0.000528]	0.00025 [+-0.000007]	0.019535 [+-0.000485]	0.128044 [+-0.002318]
	2045	0.113539 [+-0.002941]	0.004896 [+-0.000479]	0.00003 [+-0.000007]	0.020797 [+-0.000445]	0.128616 [+-0.002147]
	2050	0.110008 [+-0.002735]	0.004508 [+-0.000429]	0.000229 [+-0.000006]	0.019551 [+-0.000407]	0.177423 [+-0.001976]
MCLI (annual, with no regain), relative to baseline	2015	0.075352 [+-0.004214]	0.004426 [+-0.000827]	-0.000046 [+-0.00001]	0.002053 [+-0.000734]	0.062141 [+-0.002667]
	2020	0.098396 [+-0.003922]	0.008356 [+-0.000747]	0.000313 [+-0.00001]	0.008561 [+-0.000663]	0.069336 [+-0.002727]
	2025	0.136139 [+-0.003689]	0.00672 [+-0.000681]	0.000427 [+-0.000009]	0.015437 [+-0.000607]	0.314762 [+-0.002601]
	2030	0.163525 [+-0.003504]	0.007779 [+-0.000626]	0.000258 [+-0.000008]	0.021474 [+-0.000564]	0.124981 [+-0.002512]
	2035	0.139109 [+-0.003327]	0.007296 [+-0.000576]	0.000329 [+-0.000008]	0.024016 [+-0.000524]	0.112507 [+-0.002435]
	2040	0.149837 [+-0.003139]	0.005774 [+-0.000528]	0.000225 [+-0.000007]	0.024171 [+-0.000484]	0.14695 [+-0.002317]
	2045	0.130262 [+-0.11701]	0.006842 [+-0.000479]	-0.000077 [+-0.000007]	0.024496 [+-0.000445]	0.154247 [+-0.002147]
	2050	0.11701 [+-0.002734]	0.005513 [+-0.000429]	0.000283 [+-0.000006]	0.022384 [+-0.000407]	0.192612 [+-0.001975]

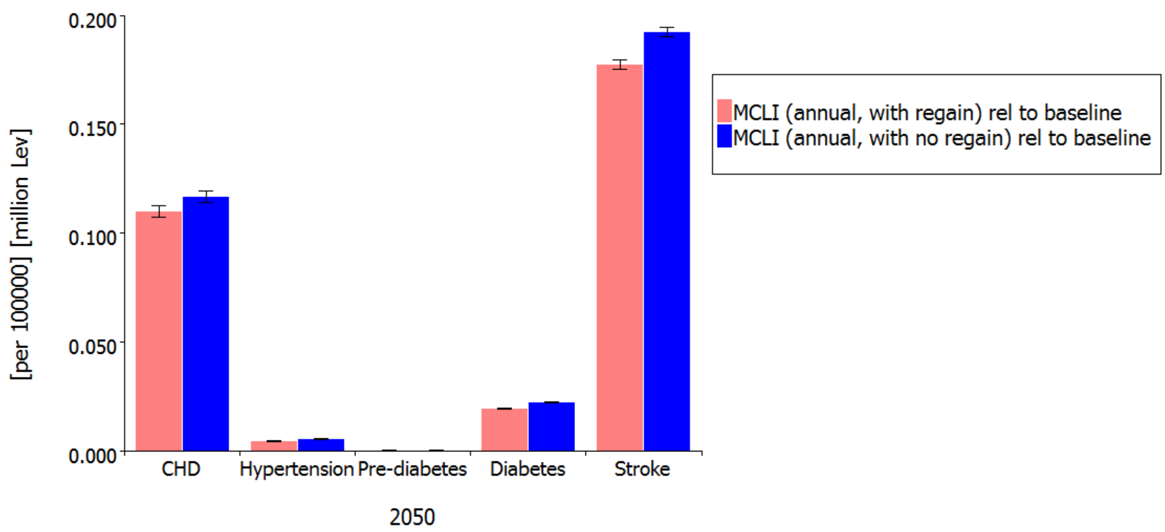


Figure 25. Direct healthcare costs (Lev millions) avoided (per 100,000), relative to baseline

Table 29. Indirect costs (Lev millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	0.20224 [+-0.010501]	0.003586 [+-0.001201]	0 [+-0]	0.000697 [+-0.000372]	0.105545 [+-0.005642]
	2020	0.171341 [+-0.00978]	0.008679 [+-0.001085]	0 [+-0]	0.001802 [+-0.000336]	0.092979 [+-0.005771]
	2025	0.23333 [+-0.009204]	0.007286 [+-0.000988]	0 [+-0]	0.004412 [+-0.000308]	0.571915 [+-0.005506]
	2030	0.280762 [+-0.008742]	0.009217 [+-0.000908]	0 [+-0]	0.007921 [+-0.000286]	0.206764 [+-0.005316]
	2035	0.245407 [+-0.008302]	0.008337 [+-0.000837]	0 [+-0]	0.009338 [+-0.000267]	0.080566 [+-0.005156]
	2040	0.302704 [+-0.00783]	0.006398 [+-0.000766]	0 [+-0]	0.009909 [+-0.000246]	0.270798 [+-0.004904]
	2045	0.282993 [+-0.007331]	0.007104 [+-0.000695]	0 [+-0]	0.010549 [+-0.000226]	0.272018 [+-0.004542]
	2050	0.274189 [+-0.006817]	0.006541 [+-0.000623]	0 [+-0]	0.009916 [+-0.000206]	0.375237 [+-0.004179]
MCLI (annual, with no regain), relative to baseline	2015	0.187813 [+-0.010503]	0.006422 [+-0.0012]	0 [+-0]	0.001041 [+-0.000372]	0.131424 [+-0.005641]
	2020	0.245239 [+-0.009774]	0.012125 [+-0.001085]	0 [+-0]	0.004342 [+-0.000336]	0.146645 [+-0.005769]
	2025	0.339333 [+-0.009195]	0.00975 [+-0.000988]	0 [+-0]	0.00783 [+-0.000308]	0.665695 [+-0.005502]
	2030	0.407578 [+-0.008731]	0.011287 [+-0.000908]	0 [+-0]	0.010892 [+-0.000286]	0.264328 [+-0.005314]
	2035	0.346718 [+-0.008294]	0.010586 [+-0.000837]	0 [+-0]	0.012181 [+-0.000266]	0.237946 [+-0.005148]
	2040	0.373466 [+-0.007824]	0.008377 [+-0.000766]	0 [+-0]	0.01226 [+-0.000246]	0.310783 [+-0.004902]
	2045	0.324673 [+-0.291641]	0.009928 [+-0.000694]	0 [+-0]	0.012425 [+-0.000226]	0.326225 [+-0.00454]
	2050	0.291641 [+-0.006816]	0.008 [+-0.000623]	0 [+-0]	0.011353 [+-0.000206]	0.407356 [+-0.004178]

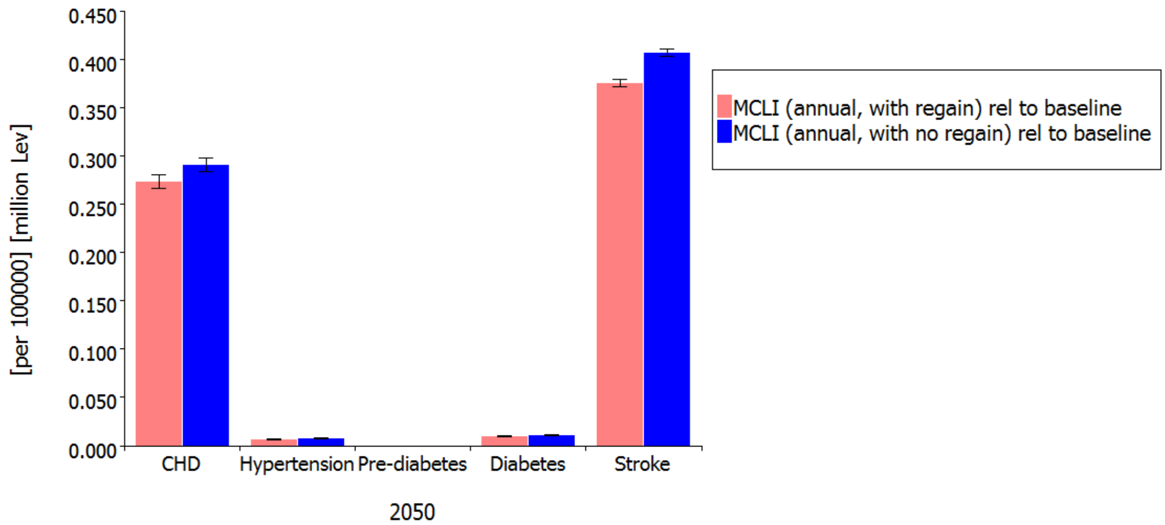


Figure 26. Indirect costs (Lev millions) avoided (per 100,000), relative to baseline

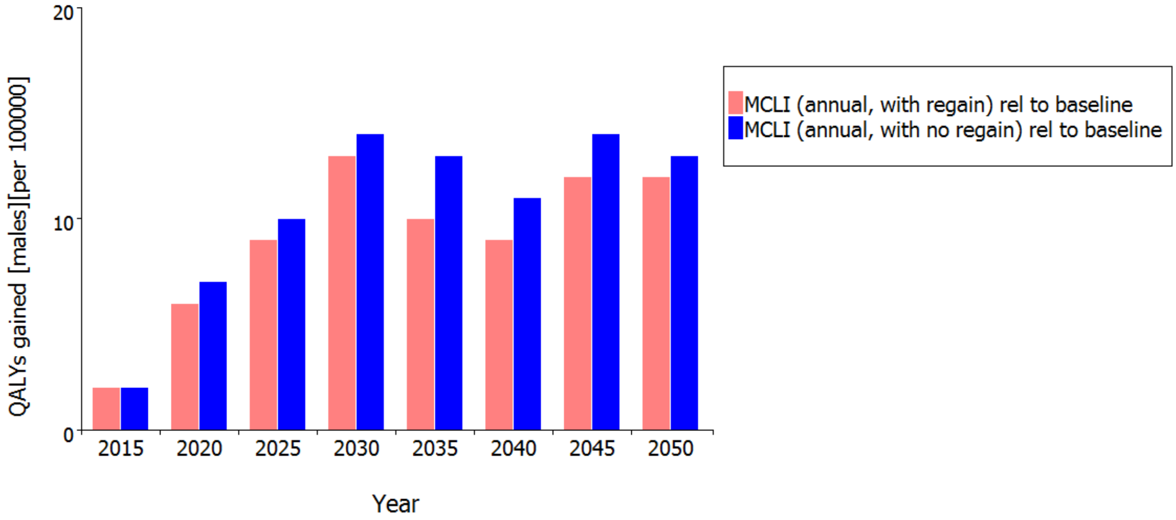


Figure 27. QALYS gained (per 100,000), relative to baseline (males)

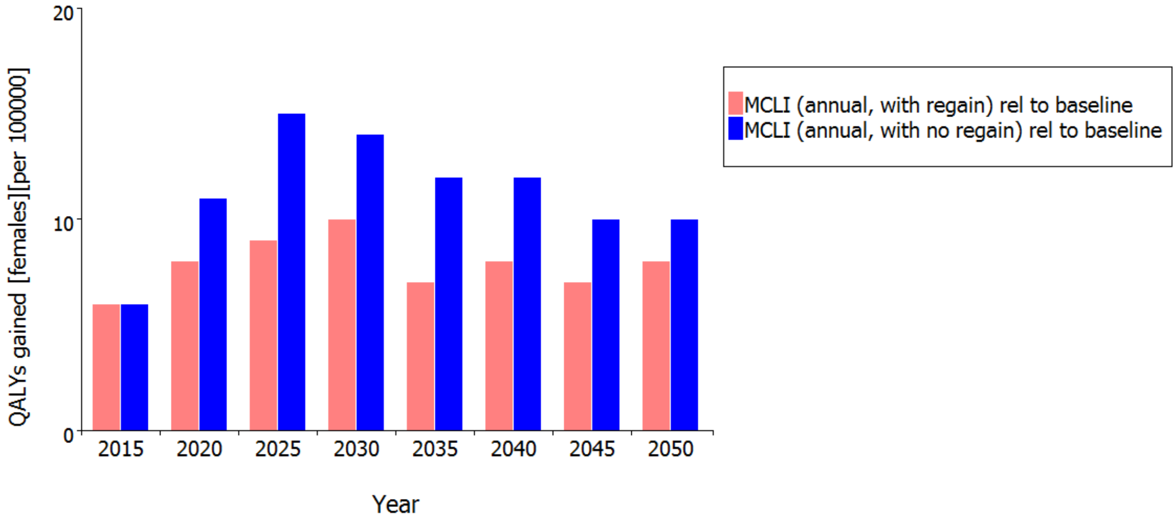


Figure 28. QALYS gained (per 100,000), relative to baseline (females)

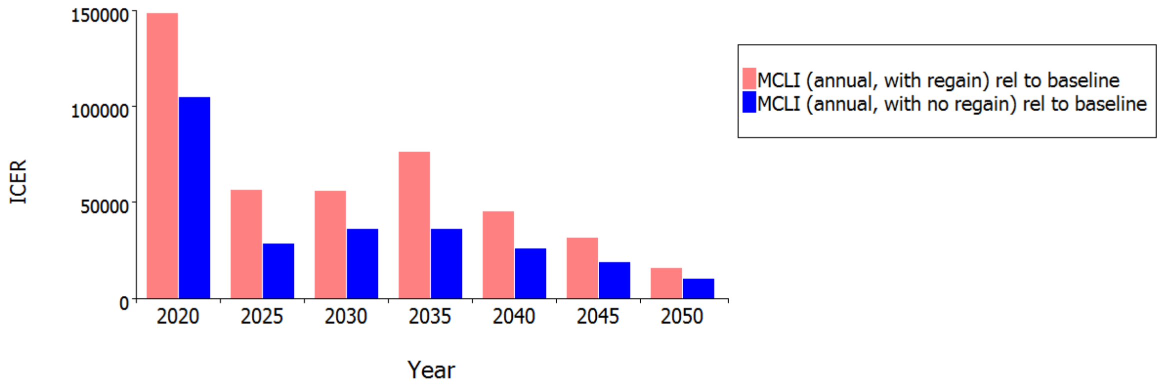


Figure 29. ICER

Sugar sweetened beverages (SSB)tax interventions

Impact on disease incidence and prevalence

Due to the small BMI drop, 100 million simulations were run to provide more accurate results. Table 30 presents the incidence cases per 100,000 of the baseline (no intervention) and SSB intervention scenarios. Incidence is predicted to increase across all diseases over time in both scenarios – SSB does not appear to impact incidence cases over time. However, results from the cumulative incidence cases outputs reveal that SSB does indeed decrease the rate at which incidence cases occur over time (though the impact is marginal). Table 31 presents the cumulative (2015 to 2050) incidence cases per 100,000 of the baseline (no intervention) and SSB scenarios. Cumulative incidence is expected to be lower across all diseases in the SSB scenario relative to baseline.

Table 32 and Figure 30 present the cumulative incidence cases avoided for the SSB intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The SSB scenario is predicted to reduce the cumulative incidence across all diseases, whereby the largest effect is expected to be observed for stroke (23 per 100,000) followed by pre-diabetes and hypertension (22 per 100,000 for both diseases).

Table 33 and Figure 31 present the prevalence cases avoided for the SSB scenario relative to baseline – presented in terms of 100,000 population. Results indicate that SSB intervention scenario would result in lower prevalence of every modelled disease when compared to the baseline scenario. The largest prevalence cases avoided per 100,000 can be observed for hypertension (13 per 100,000).

Table 30. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	499 [+-1]	628 [+-2]	699 [+-2]	326 [+-1]	308 [+-1]
	2020	521 [+-1]	628 [+-2]	726 [+-2]	340 [+-1]	321 [+-1]
	2025	549 [+-1]	639 [+-2]	758 [+-2]	356 [+-1]	337 [+-1]
	2030	578 [+-2]	662 [+-2]	787 [+-2]	372 [+-1]	360 [+-1]
	2035	610 [+-2]	682 [+-2]	814 [+-2]	389 [+-1]	381 [+-1]
	2040	640 [+-2]	681 [+-2]	832 [+-2]	404 [+-1]	397 [+-1]
	2045	658 [+-2]	670 [+-2]	834 [+-2]	416 [+-1]	409 [+-1]
	2050	670 [+-2]	648 [+-2]	841 [+-2]	427 [+-1]	423 [+-1]
SSB tax	2015	499 [+-1]	628 [+-2]	699 [+-2]	326 [+-1]	308 [+-1]
	2020	520 [+-1]	627 [+-2]	725 [+-2]	339 [+-1]	321 [+-1]
	2025	549 [+-1]	639 [+-2]	757 [+-2]	355 [+-1]	337 [+-1]
	2030	578 [+-2]	661 [+-2]	786 [+-2]	371 [+-1]	360 [+-1]
	2035	609 [+-2]	682 [+-2]	814 [+-2]	388 [+-1]	381 [+-1]
	2040	639 [+-2]	680 [+-2]	832 [+-2]	403 [+-1]	397 [+-1]
	2045	658 [+-2]	669 [+-2]	833 [+-2]	415 [+-1]	409 [+-1]
	2050	669 [+-2]	647 [+-2]	841 [+-2]	427 [+-1]	423 [+-1]

Table 31. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	499 [+-1]	628 [+-2]	699 [+-2]	326 [+-1]	308 [+-1]
	2020	3100 [+-3]	3810 [+-4]	4321 [+-4]	2021 [+-3]	1908 [+-3]
	2025	5921 [+-5]	7141 [+-5]	8223 [+-6]	3854 [+-4]	3638 [+-4]
	2030	9024 [+-6]	10734 [+-6]	12476 [+-7]	5865 [+-5]	5564 [+-5]
	2035	12472 [+-7]	14645 [+-7]	17127 [+-8]	8078 [+-6]	7718 [+-6]
	2040	16272 [+-8]	18817 [+-8]	22151 [+-9]	10494 [+-7]	10082 [+-6]
	2045	20390 [+-9]	23182 [+-9]	27496 [+-10]	13111 [+-7]	12642 [+-7]
	2050	24826 [+-10]	27710 [+-10]	33182 [+-11]	15939 [+-8]	15419 [+-8]
SSB tax	2015	499 [+-1]	628 [+-2]	699 [+-2]	326 [+-1]	308 [+-1]
	2020	3098 [+-3]	3806 [+-4]	4318 [+-4]	2019 [+-3]	1908 [+-3]
	2025	5918 [+-5]	7136 [+-5]	8217 [+-6]	3849 [+-4]	3637 [+-4]
	2030	9019 [+-6]	10725 [+-6]	12466 [+-7]	5857 [+-5]	5563 [+-5]
	2035	12463 [+-7]	14633 [+-7]	17114 [+-8]	8066 [+-6]	7716 [+-6]
	2040	16260 [+-8]	18802 [+-8]	22134 [+-9]	10479 [+-7]	10078 [+-6]
	2045	20375 [+-9]	23164 [+-9]	27475 [+-10]	13091 [+-7]	12638 [+-7]
	2050	24807 [+-10]	27688 [+-10]	33159 [+-11]	15917 [+-8]	15413 [+-8]

Table 32. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0 [+-1]	0 [+-3]	0 [+-3]	0 [+-1]	0 [+-1]
	2020	2 [+-4]	4 [+-6]	3 [+-6]	2 [+-4]	0 [+-4]
	2025	3 [+-7]	5 [+-7]	6 [+-8]	5 [+-6]	1 [+-6]
	2030	5 [+-8]	9 [+-8]	10 [+-10]	8 [+-7]	1 [+-7]
	2035	9 [+-10]	12 [+-10]	13 [+-11]	12 [+-8]	2 [+-8]
	2040	12 [+-11]	15 [+-11]	17 [+-13]	15 [+-10]	4 [+-8]
	2045	15 [+-13]	18 [+-13]	21 [+-14]	20 [+-10]	4 [+-10]
	2050	19 [+-14]	22 [+-14]	23 [+-16]	22 [+-11]	6 [+-11]

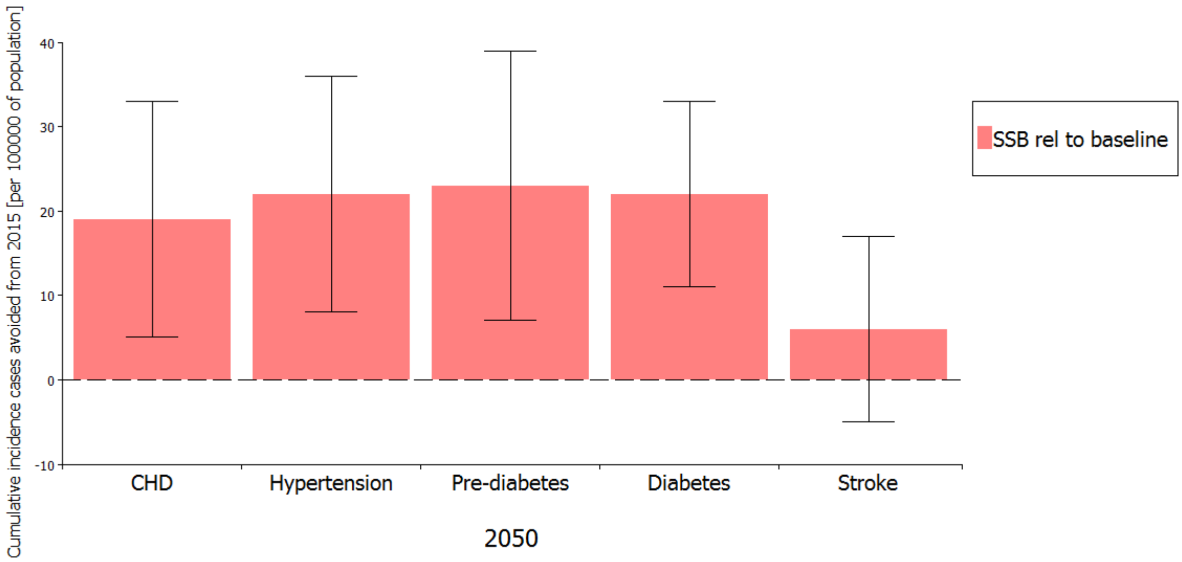


Figure 30. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 33. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0 [+-7]	-1 [+-11]	0 [+-4]	0 [+-7]	0 [+-3]
	2020	2 [+-7]	2 [+-11]	1 [+-4]	1 [+-7]	1 [+-3]
	2025	2 [+-7]	5 [+-11]	1 [+-4]	4 [+-8]	0 [+-4]
	2030	4 [+-8]	7 [+-11]	1 [+-4]	6 [+-8]	0 [+-4]
	2035	5 [+-8]	8 [+-11]	2 [+-4]	8 [+-8]	0 [+-4]
	2040	8 [+-8]	10 [+-13]	2 [+-4]	10 [+-8]	1 [+-4]
	2045	8 [+-8]	12 [+-13]	1 [+-4]	11 [+-8]	0 [+-4]
	2050	9 [+-10]	13 [+-13]	1 [+-4]	12 [+-10]	1 [+-4]

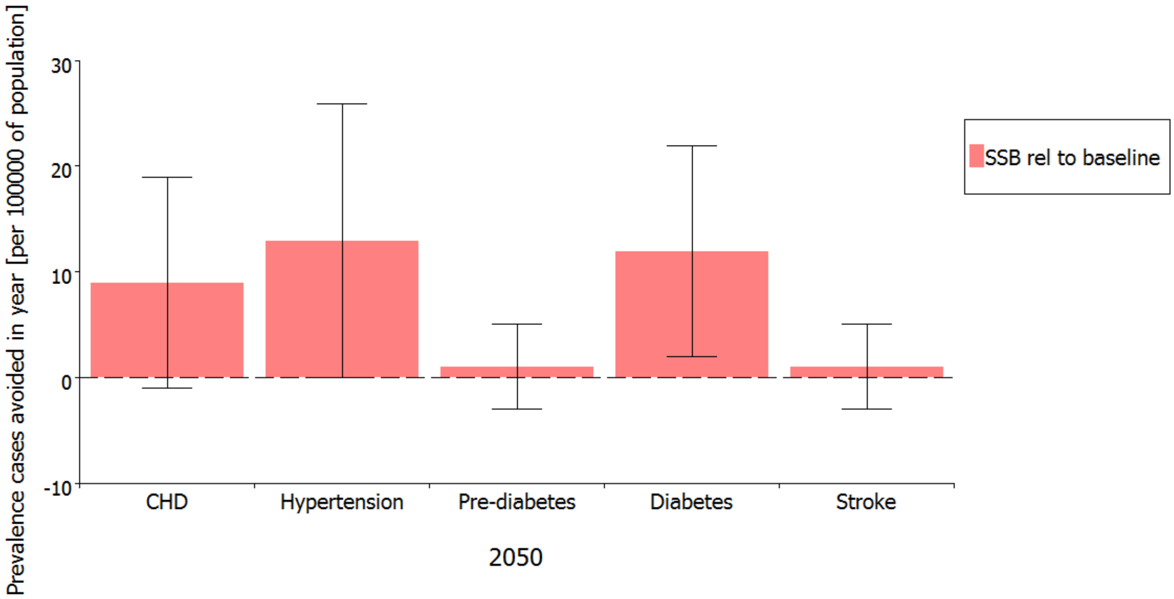


Figure 31. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Figure 32 and Table 34 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with an SSB tax, relative to the baseline. The graph reveals that the largest direct healthcare cost *avoided* are expected to occur in CHD (0.02 million Lev per 100,000 population in 2050).

Figure 33 and Table 35 presents the indirect costs that can be *avoided* (per 100,000 population) with an SSB tax, relative to the baseline. The graph reveals that the largest indirect cost *avoided* is expected to occur in CHD (0.05 million Lev per 100,000 population in 2050).

Figure 34 and Figure 35 present the QALYs that can be *gained* (per 100,000 population) with an SSB tax, relative to the baseline. For both males and females, the SSB tax intervention is expected to lead to increasing gains in QALYs between 2015 and 2030, and then remain steady thereafter.

In Figure 36, the negative ICER values (which in this case happens to be comprised of *positive* 'QALYs gained' values in the dominator and *negative* 'costs avoided' values in the numerator) indicates that the SSB tax intervention is cost effective (the SSB tax intervention scenario *dominates* the baseline scenario).

Table 34. Direct healthcare costs (Lev millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0.002136 [+-0.002983]	-0.000124 [+-0.000585]	0.000029 [+-0.000007]	-0.000217 [+-0.000519]	0.006767 [+-0.001886]
	2020	0.00687 [+-0.002778]	0.000548 [+-0.000529]	0.000174 [+-0.000007]	0.001006 [+-0.000468]	0.004307 [+-0.001925]
	2025	0.010532 [+-0.002617]	0.000927 [+-0.000482]	0.00017 [+-0.000007]	0.002579 [+-0.00043]	0.007877 [+-0.001844]
	2030	0.015791 [+-0.002485]	0.001245 [+-0.000443]	0.000129 [+-0.000006]	0.003519 [+-0.0004]	0.006493 [+-0.001778]
	2035	0.018314 [+-0.002362]	0.001391 [+-0.000409]	0.000114 [+-0.000006]	0.004108 [+-0.000372]	0.016594 [+-0.001727]
	2040	0.020044 [+-0.002228]	0.001469 [+-0.000373]	0.000082 [+-0.000006]	0.004523 [+-0.000344]	0.018818 [+-0.001643]
	2045	0.019022 [+-0.002088]	0.001477 [+-0.000339]	0.000061 [+-0.000004]	0.0044 [+-0.000316]	0.012241 [+-0.001523]
	2050	0.019564 [+-0.001943]	0.001412 [+-0.000304]	0.000027 [+-0.000004]	0.003828 [+-0.000288]	0.015491 [+-0.001399]

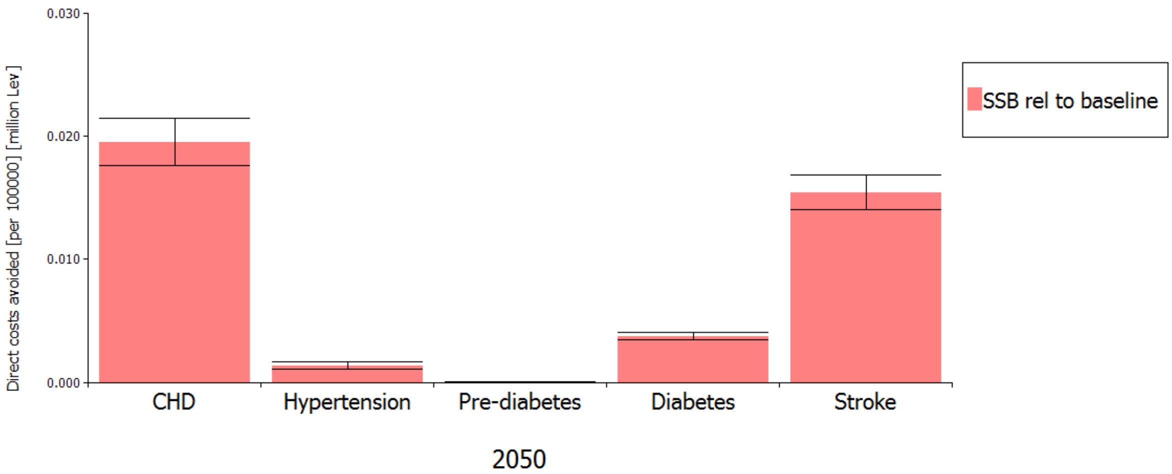


Figure 32. Direct healthcare costs (Lev millions) avoided (per 100,000), relative to baseline

Table 35. Indirect costs (Lev millions) avoided (per 100,000) relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0.005318 [+-0.007433]	-0.000179 [+-0.00085]	0 [+-0]	-0.00011 [+-0.000263]	0.01432 [+-0.003988]
	2020	0.01712 [+-0.006924]	0.000796 [+-0.000768]	0 [+-0]	0.00051 [+-0.000238]	0.009102 [+-0.004072]
	2025	0.026253 [+-0.006521]	0.001345 [+-0.000699]	0 [+-0]	0.001308 [+-0.000218]	0.016663 [+-0.003901]
	2030	0.03936 [+-0.006195]	0.001807 [+-0.000642]	0 [+-0]	0.001785 [+-0.000203]	0.013733 [+-0.00376]
	2035	0.045647 [+-0.005886]	0.002019 [+-0.000593]	0 [+-0]	0.002083 [+-0.000189]	0.035095 [+-0.003653]
	2040	0.049957 [+-0.005554]	0.002132 [+-0.000542]	0 [+-0]	0.002295 [+-0.000174]	0.039795 [+-0.003474]
	2045	0.047405 [+-0.005204]	0.002144 [+-0.000492]	0 [+-0]	0.002231 [+-0.00016]	0.025894 [+-0.003221]
	2050	0.048756 [+-0.004843]	0.002049 [+-0.000441]	0 [+-0]	0.001941 [+-0.000146]	0.032761 [+-0.00296]

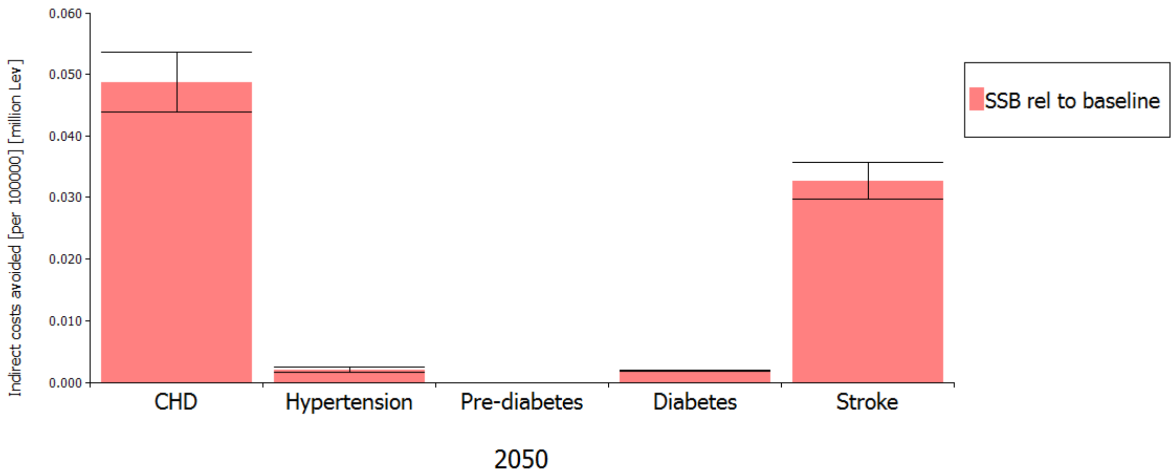


Figure 33. Indirect costs (Lev millions) avoided (per 100,000), relative to baseline

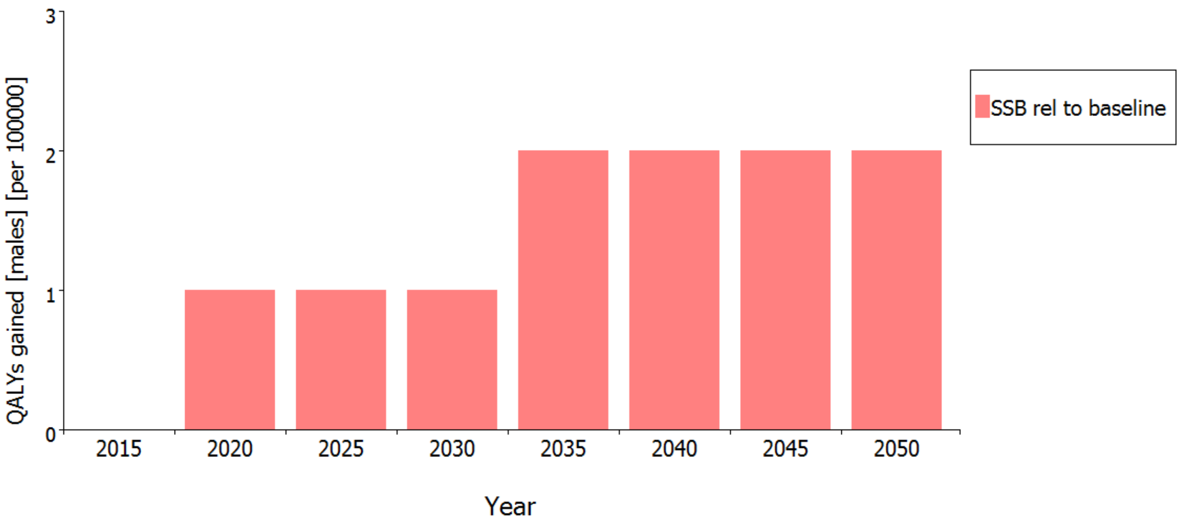


Figure 34. QALYS gained (per 100,000), relative to baseline (males)

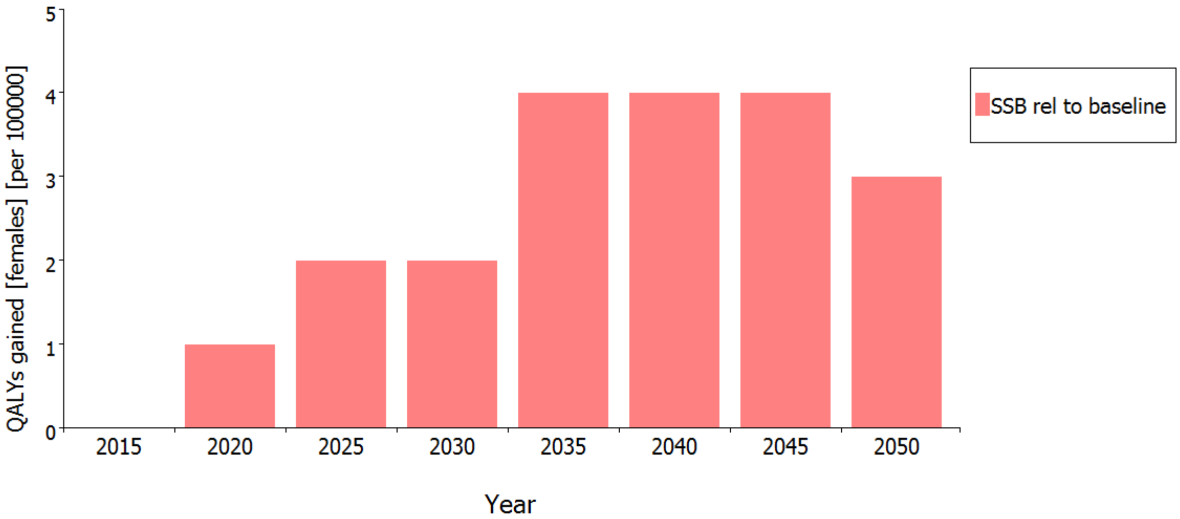


Figure 35. QALYS gained (per 100,000), relative to baseline (females)

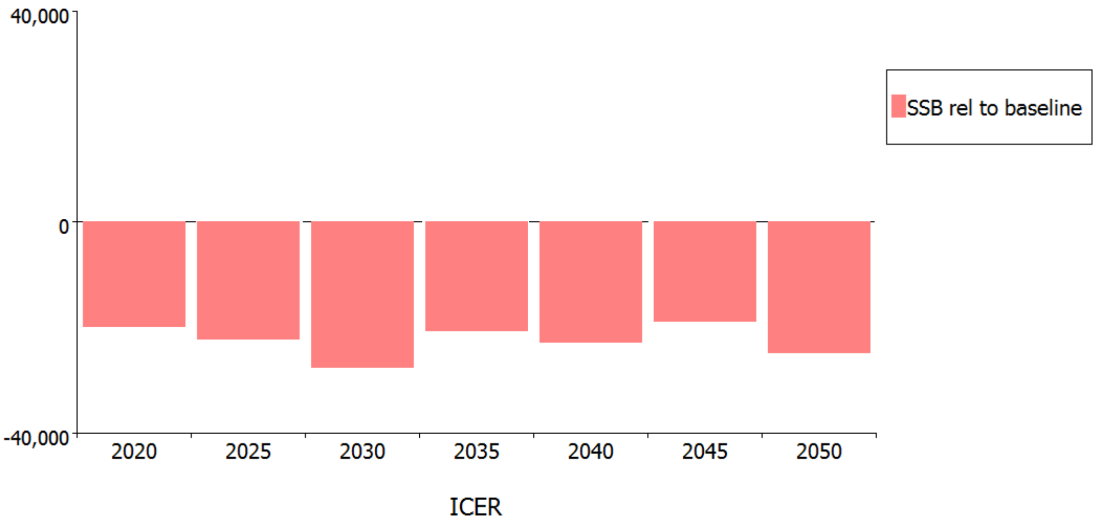


Figure 36. ICER

Smoking intervention results

Smoking cessation services (SCS)

Table 36. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59% (Finland proxy)
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	429 лв (Netherlands proxy)

* as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Impact on disease incidence and prevalence

Table 37 presents the incidence cases per 100,000 for the baseline (no intervention) and SCS intervention scenarios. Incidence cases increase over time across all diseases except hypertension. The smoking cessation intervention does appear to be effective in reducing the projected incidence cases over time.

Table 38 presents the cumulative (2015 to 2050) incidence cases per 100,000 of the baseline (no intervention) and SCS intervention scenarios. Cumulative incidence is expected to be lower across all diseases in the SCS intervention scenario relative to baseline.

Table 39 and Figure 37 present the cumulative incidence cases avoided for the SCS intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The intervention would have its largest effect on COPD and stroke with 2,272 per 100,000 and 2,247 per 100,000 incidence cases avoided in 2050, respectively. The effect on other diseases is also marked, and ranges from 508 per 100,000 incidence cases avoided for CHD to 606 per 100,000 cases avoided for lung cancer.

Table 40 and Figure 38 present the prevalence cases avoided for the SCS intervention scenario relative to baseline – presented in terms of per 100,000 (the table presents data for all years whilst the figure presents projections for the year 2050 only). A smoking cessation intervention as modelled would have the desired effect on the prevalence of all diseases except for hypertension. The intervention would have its largest effect on COPD with 1,205 per 100,000 prevalence cases avoided in 2050, followed by stroke with 595 per 100,000 prevalence cases avoided in 2050.

Table 37. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	509 [+-1]	525 [+-1]	678 [+-2]	51 [+-0]	303 [+-1]
	2020	551 [+-1]	570 [+-1]	683 [+-2]	62 [+-0]	337 [+-1]
	2025	599 [+-2]	629 [+-2]	696 [+-2]	72 [+-1]	368 [+-1]
	2030	649 [+-2]	694 [+-2]	718 [+-2]	83 [+-1]	410 [+-1]
	2035	690 [+-2]	756 [+-2]	731 [+-2]	92 [+-1]	445 [+-1]
	2040	722 [+-2]	806 [+-2]	718 [+-2]	101 [+-1]	475 [+-1]
	2045	738 [+-2]	842 [+-2]	693 [+-2]	110 [+-1]	498 [+-2]
	2050	741 [+-2]	859 [+-2]	656 [+-2]	115 [+-1]	519 [+-2]
SCS	2015	510 [+-1]	524 [+-1]	678 [+-2]	52 [+-0]	302 [+-1]
	2020	549 [+-1]	565 [+-1]	680 [+-2]	60 [+-0]	328 [+-1]
	2025	593 [+-2]	612 [+-2]	693 [+-2]	67 [+-1]	344 [+-1]
	2030	639 [+-2]	660 [+-2]	710 [+-2]	73 [+-1]	370 [+-1]
	2035	680 [+-2]	698 [+-2]	719 [+-2]	77 [+-1]	384 [+-1]
	2040	711 [+-2]	722 [+-2]	704 [+-2]	80 [+-1]	394 [+-1]
	2045	729 [+-2]	739 [+-2]	678 [+-2]	82 [+-1]	398 [+-1]
	2050	736 [+-2]	747 [+-2]	638 [+-2]	83 [+-1]	405 [+-1]

Table 38. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung caner	Stroke
Baseline	2015	509 [+-1]	525 [+-1]	678 [+-2]	51 [+-0]	303 [+-1]
	2020	3220 [+-3]	3327 [+-4]	4119 [+-4]	345 [+-1]	1950 [+-3]
	2025	6259 [+-5]	6505 [+-5]	7744 [+-5]	701 [+-2]	3817 [+-4]
	2030	9713 [+-6]	10177 [+-6]	11666 [+-7]	1130 [+-2]	5977 [+-5]
	2035	13619 [+-7]	14399 [+-7]	15928 [+-8]	1635 [+-3]	8463 [+-6]
	2040	17936 [+-8]	19150 [+-8]	20437 [+-9]	2217 [+-3]	11256 [+-7]
	2045	22623 [+-9]	24391 [+-9]	25105 [+-10]	2879 [+-4]	14345 [+-8]
	2050	27633 [+-10]	30079 [+-10]	29901 [+-10]	3615 [+-4]	17735 [+-9]
SCS	2015	510 [+-1]	524 [+-1]	678 [+-2]	52 [+-0]	302 [+-1]
	2020	3215 [+-3]	3310 [+-4]	4116 [+-4]	340 [+-1]	1928 [+-3]
	2025	6233 [+-5]	6423 [+-5]	7725 [+-5]	678 [+-2]	3707 [+-4]
	2030	9645 [+-6]	9946 [+-6]	11610 [+-7]	1064 [+-2]	5688 [+-5]
	2035	13474 [+-7]	13892 [+-7]	15796 [+-8]	1497 [+-3]	7878 [+-6]
	2040	17690 [+-8]	18211 [+-8]	20192 [+-9]	1972 [+-3]	10252 [+-7]
	2045	22252 [+-9]	22858 [+-9]	24706 [+-9]	2484 [+-3]	12786 [+-7]
	2050	27125 [+-10]	27807 [+-10]	29295 [+-10]	3030 [+-4]	15488 [+-8]

Table 39. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	-1 [+-1]	1 [+-1]	0 [+-3]	-1 [+-0]	1 [+-1]
	2020	5 [+-4]	17 [+-6]	3 [+-6]	5 [+-1]	22 [+-4]
	2025	26 [+-7]	82 [+-7]	19 [+-7]	23 [+-3]	110 [+-6]
	2030	68 [+-8]	231 [+-8]	56 [+-10]	66 [+-3]	289 [+-7]
	2035	145 [+-10]	507 [+-10]	132 [+-11]	138 [+-4]	585 [+-8]
	2040	246 [+-11]	939 [+-11]	245 [+-13]	245 [+-4]	1004 [+-10]
	2045	371 [+-13]	1533 [+-13]	399 [+-13]	395 [+-5]	1559 [+-11]
	2050	508 [+-14]	2272 [+-14]	606 [+-14]	585 [+-6]	2247 [+-12]

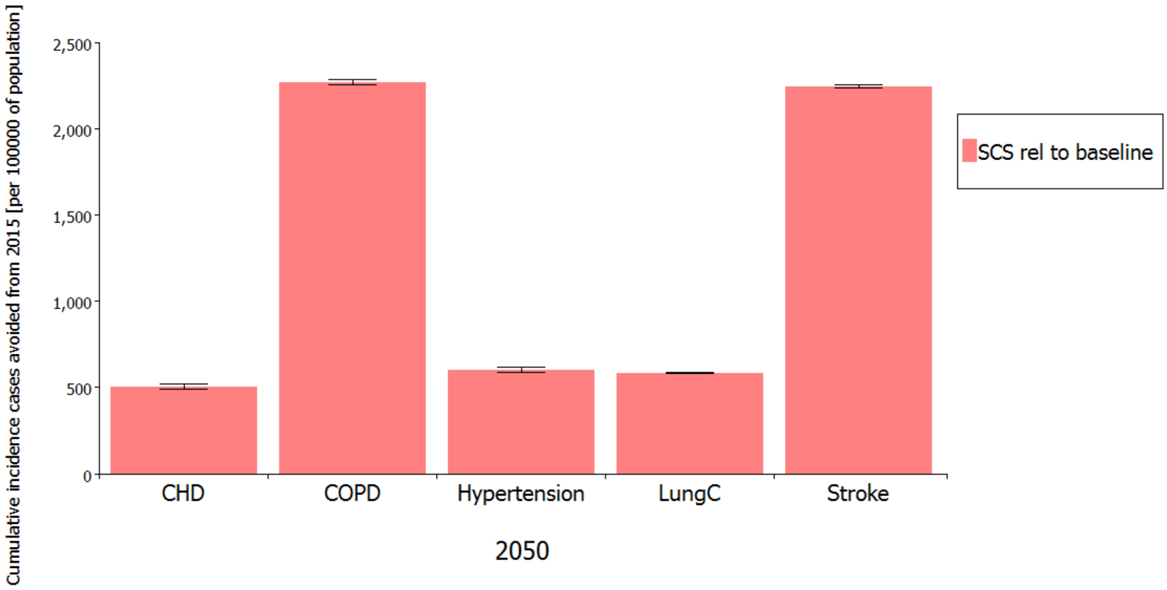


Figure 37 Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 40. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	LungC	Stroke
SCS relative to baseline	2015	6 [+-7]	-1 [+-8]	7 [+-11]	0 [+-1]	3 [+-3]
	2020	6 [+-7]	13 [+-8]	4 [+-11]	4 [+-1]	20 [+-3]
	2025	18 [+-7]	61 [+-10]	7 [+-11]	9 [+-1]	83 [+-4]
	2030	34 [+-8]	159 [+-10]	10 [+-11]	19 [+-1]	180 [+-4]
	2035	59 [+-8]	342 [+-11]	17 [+-13]	30 [+-1]	303 [+-4]
	2040	70 [+-9]	595 [+-11]	10 [+-13]	42 [+-1]	417 [+-4]
	2045	58 [+-10]	903 [+-11]	-18 [+-13]	58 [+-1]	520 [+-4]
	2050	8 [+-10]	1205 [+-12]	-67 [+-13]	69 [+-1]	595 [+-5]

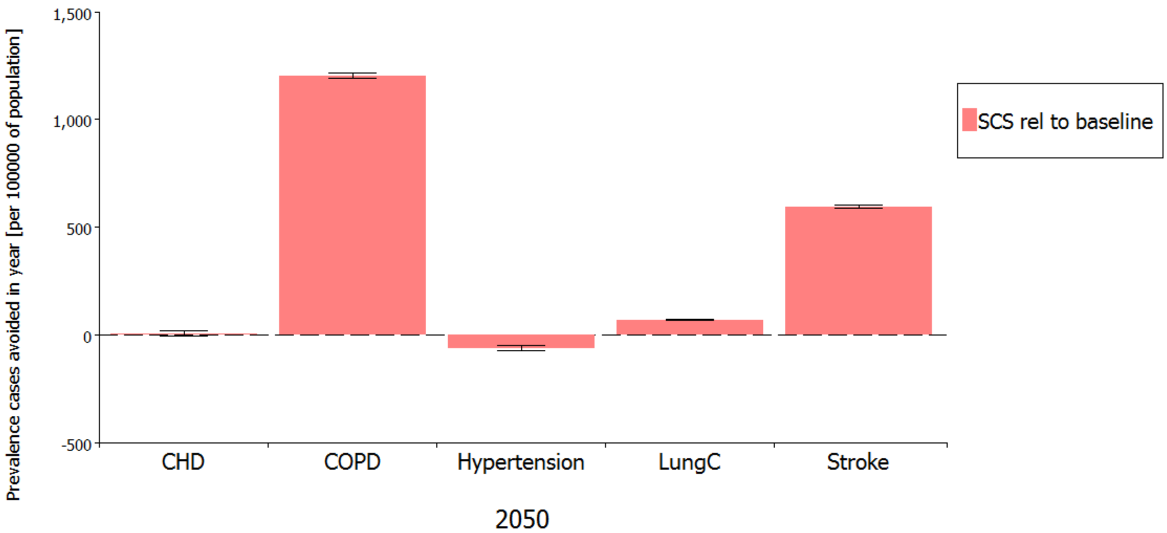


Figure 38. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Figure 39 and Table 41 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with a SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* are expected to occur in stroke (9.17 million Lev per 100,000 population in 2050).

Figure 40 and Table 42 presents the indirect costs that can be avoided (per 100,000 population) with an SCS intervention, relative to the baseline. The graph reveals that largest indirect costs *avoided* is expected to occur in stroke (19 million Lev per 100,000 population in 2050).

Figure 41 and Figure 42 present the QALYs that can be *gained* (per 100,000 population) with an SCS intervention, relative to the baseline. For both males and females, an SCS intervention does appear to be effective in increasing the gains in QALYs over time. 388 QALYs per 100,000 population and 378 QALYs per 100,000 population are expected to be gained in 2050 alone for males and females, respectively.

In Figure 43, the negative ICER values (which in this case is comprised of *positive* 'QALYs gained' values in the dominator and *negative* 'costs avoided' values in the numerator) indicates that the SCS intervention is cost effective (the SCS intervention scenario dominates the baseline scenario). The positive ICER values in 2020 (which is comprised of a *positive* 'QALY gained' value in the denominator and a *positive* 'costs avoided' value in the numerator) indicates that the SCS intervention *may* or *may not* be cost effective, depending on what cost effectiveness threshold value is chosen in Bulgaria.

Table 41. Direct healthcare costs (Lev millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	0.031914 [+-0.002846]	-0.001402 [+-0.002246]	0.001947 [+-0.000636]	0.000021 [+-0]	0.162514 [+-0.001762]
	2020	0.028763 [+-0.002756]	0.024544 [+-0.002142]	0.000966 [+-0.00058]	0.000526 [+-0]	0.752586 [+-0.001968]
	2025	0.077747 [+-0.002708]	0.099449 [+-0.00207]	0.001491 [+-0.000532]	0.001225 [+-0]	2.690815 [+-0.001985]
	2030	0.126556 [+-0.002691]	0.224674 [+-0.002022]	0.002033 [+-0.00049]	0.002138 [+-0]	5.027927 [+-0.001973]
	2035	0.187428 [+-0.002664]	0.417364 [+-0.001967]	0.002948 [+-0.000451]	0.002954 [+-0]	7.279373 [+-0.001938]
	2040	0.193491 [+-0.002594]	0.627279 [+-0.001884]	0.001504 [+-0.000411]	0.00359 [+-0]	8.651905 [+-0.001848]
	2045	0.136656 [+-0.002486]	0.821939 [+-0.001777]	-0.002298 [+-0.00037]	0.004235 [+-0]	9.301521 [+-0.001725]
	2050	0.016516 [+-0.002336]	0.946021 [+-0.001648]	-0.007304 [+-0.000327]	0.004362 [+-0]	9.166691 [+-0.001589]

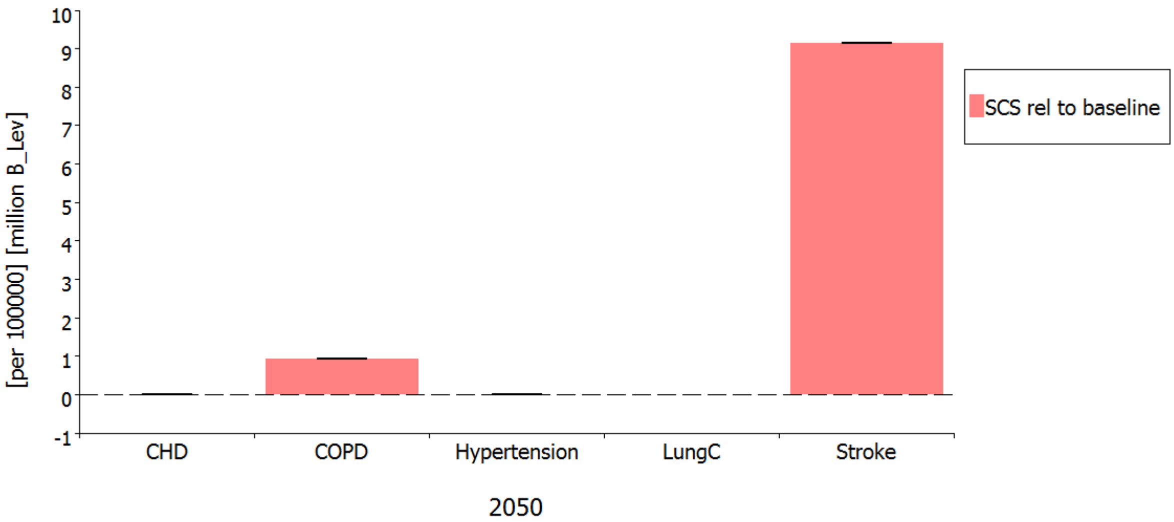


Figure 39. Direct healthcare costs (Lev millions) avoided (per 100,000), relative to baseline

Table 42. Indirect costs (Lev millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	0.079552 [+-0.007094]	-0.006798 [+-0.010894]	0.002824 [+-0.000923]	0.00011 [+-0]	0.343704 [+-0.003727]
	2020	0.071686 [+-0.00687]	0.119019 [+-0.010387]	0.001401 [+-0.000841]	0.002812 [+-0.000001]	1.59166 [+-0.004161]
	2025	0.193787 [+-0.006749]	0.482254 [+-0.010041]	0.002163 [+-0.000771]	0.006547 [+-0.000001]	5.690865 [+-0.004197]
	2030	0.315437 [+-0.006708]	1.0895 [+-0.009808]	0.002949 [+-0.000711]	0.011426 [+-0.000001]	10.633675 [+-0.004173]
	2035	0.467155 [+-0.006638]	2.023903 [+-0.009539]	0.004279 [+-0.000654]	0.015787 [+-0.000001]	15.395294 [+-0.004098]
	2040	0.482269 [+-0.006464]	3.04184 [+-0.009138]	0.002182 [+-0.000596]	0.019188 [+-0.000001]	18.298096 [+-0.003909]
	2045	0.340614 [+-0.006196]	3.985786 [+-0.008616]	-0.003335 [+-0.000537]	0.022632 [+-0.000001]	19.671982 [+-0.003649]
	2050	0.041164 [+-0.00582]	4.587494 [+-0.007993]	-0.010599 [+-0.000475]	0.023316 [+-0.000001]	19.386826 [+-0.003361]

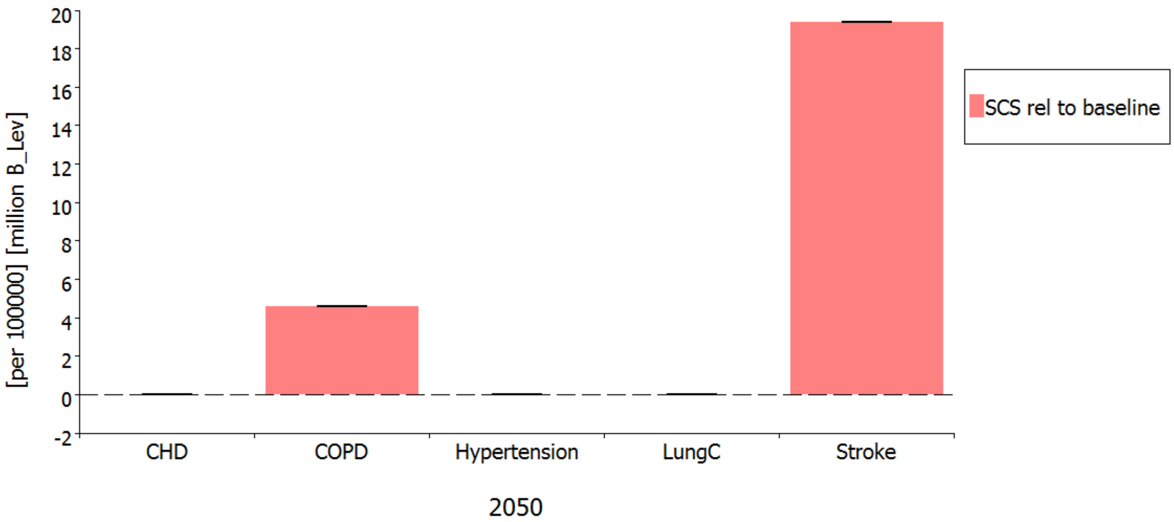


Figure 40. Indirect costs (Lev millions) avoided (per 100,000), relative to baseline

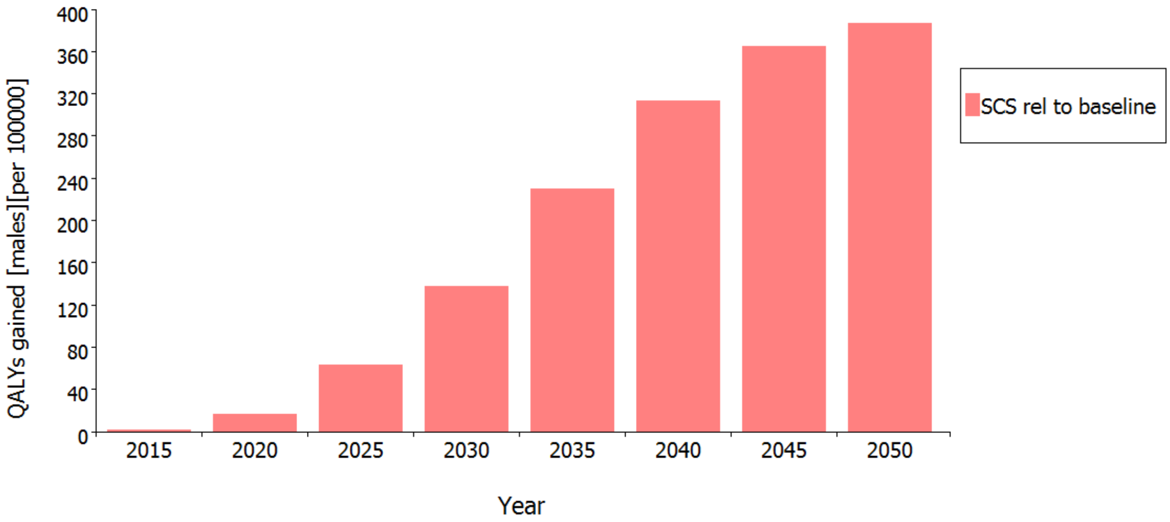


Figure 41. QALYS gained (per 100,000), relative to baseline (males)

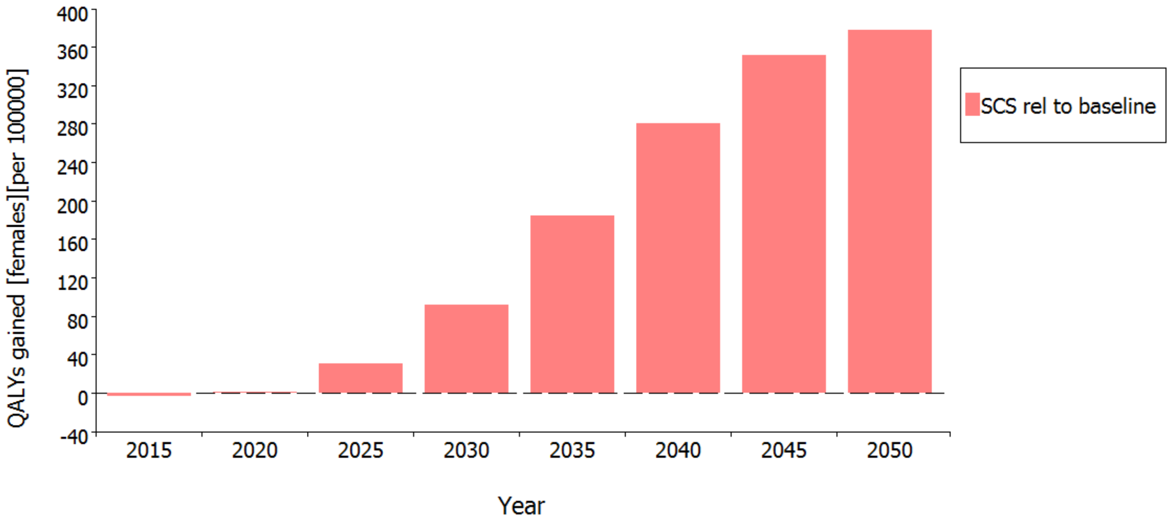


Figure 42. QALYS gained (per 100,000), relative to baseline (females)

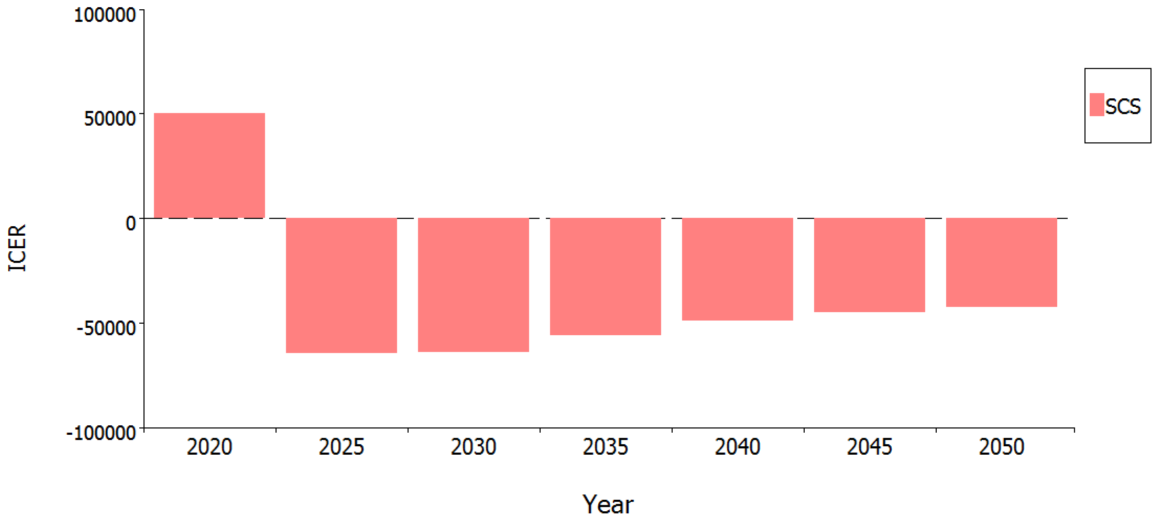


Figure 43. ICER

Finland

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m^2) are presented in Table 43 and for smoking prevalence by age and sex are presented in Table 44. Data were also collected by personal communication where possible.

Data were also collected by education level and income group where available in order to explore future prevalence of each risk factor by sub-groups.

Table 43. References used in the model for BMI prevalence

Reference	Year	Sample size		Age group	Measured/ Self-reported	National/ Regional
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 1998	1998	1,689	1,816	15-64	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 1999	1999	1,523	1,801	15-64	Self-reported	National
WHO; Raitarki et al, Distribution and determinants of serum high-sensitive C-reactive protein [1]	2001	1,026	1,193	20-39	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 2002 [1]	2002	1,462	1,757	15-64	Self-reported	National
WHO ; Helakorpi et al, Health behaviour among Finnish adult population, 2003 [1]	2003	1,516	1,819	15-64	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 2004 [1]	2004	1,520	1,805	15-64	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 2005 [1]	2005	1,500	1,727	15-64	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 2006 [1]	2006	1,450	1,761	15-64	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 2007 [1]	2007	1,397	1,789	15-64	Self-reported	National
WHO; Helakorpi et al, Health behaviour among Finnish adult population, 2008 [1]	2008	1,346	1,776	15-64	Self-reported	National
Helakorpi et al, Health behaviour among Finnish adult population, 2009 [1]	2009	1,240	1,620	15-64	Self-reported	National
Helakorpi et al, Health behaviour among	2010	1,221	1,539	15-64	Self-reported	National

Finnish adult population, 2010 [1]						
Helakorpi et al, Health behaviour among Finnish adult population, 2011 [1]	2011	1,181	1,565	15-64	Self-reported	National
Helakorpi et al, Health behaviour among Finnish adult population, 2012 [1]	2012	1,093	1,456	15-64	Self-reported	National
Helakorpi et al, Health behaviour among Finnish adult population, 2013 [1]	2013	1,080	1,411	15-64	Self-reported	National
Helakorpi et al, Health behaviour among Finnish adult population, 2014	2014	1,109	1,469	15-64	Self-reported	National

[1] Surveys used in BMI projections by education level

Table 44. Table of references used in the model for smoking prevalence

Reference	Year	Sample size	Age-group	National/Regional
Helakorpi et al, Health behaviour among Finnish adult population	2001 to 2013 (annual surveys)	Ranges from 3,372 to 4,180	20-64	National

Disease data

Disease data sources are detailed in appendix A2. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. Diabetes statistics for Sweden (as proxy) and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, Appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using incidence and mortality data (see technical appendix B4 for details). Hypertension incidence was calculated within the programme using prevalence data. Dutch data were used as proxy for direct costs of COPD, hypertension and pre-diabetes; for indirect costs for diabetes and hypertension and for utility weights for CHD, COPD and stroke accounting for exchange rates and purchasing price parities. UK data was used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Finland was one of the few countries where we could explore multi-stage COPD since we were provided access with the Finland 2000/2011 dataset. This dataset was analysed to obtain prevalence of COPD by stage and estimate relative risks by smoking status. This has been described in more detail in appendix B2.

Intervention data

Table 45 and MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. *Greece proxy (converted to Bulgarian Lev)

Table 46 present the country specific input data for the interventions.

Table 45. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (Euro)
Baseline	None	-	-
MCLI regain	1.6	100	110
MCLI no regain	1.6	0	110
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. *Greece proxy (converted to Bulgarian Lev)

Table 46. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59%
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 248 (Norway proxy)

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Section 2: Risk factor projections to 2050

BMI projections by age and sex

Table 47 presents the prevalence of normal weight, over-weight and obese (according to BMI) in the adult population by sex. Overall, in both Finnish men and women, obesity prevalence is projected to increase reaching 30% and 26% respectively by 2050. Overweight prevalence is projected to decline marginally. The proportion of healthy weight men and women is projected to decline over the next 35 years.

Figure 44 to Figure 48 present BMI-group projections to 2050 for males 20-69 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. Data from WHO annual surveys (1998 to 2014) were used as a proxy for the Finnish population.

The increase in obesity prevalence described above is expected among men across age groups. Among men 40 to 49 years old, obesity prevalence could surpass 40% by 2050. The proportion of healthy weight men is predicted to decline across age groups.

Figure 49 to Figure 53 present the BMI-group projections to 2050 for females 20-69 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence is expected amongst women 40-69 years and could exceed 35% by 2050 (Figure 51 to Figure 53); obesity prevalence is predicted to remain stable in 20 to 39 year old women (Figure 49 and Figure 50). Overweight prevalence is projected to remain stable in the 20-29 age group, increase amongst 30-49 year olds, and decline amongst women 50-69 years of age. The proportion of healthy weight women is predicted to decline in most age groups.

Table 47. Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI
2015	39.0	5.3	43.0	5.8	18.0	4.7	52.0	5.1	31.0	5.1	18.0	4.4	45.0	5.2	37.0	5.4	18.0	4.6
2020	38.0	7.8	43.0	8.5	20.0	6.8	51.0	7.5	30.0	7.3	19.0	6.3	44.0	7.6	36.0	7.9	19.0	6.6
2025	37.0	10.4	42.0	11.3	21.0	9.0	50.0	9.9	30.0	9.7	20.0	8.3	43.0	10.2	36.0	10.5	20.0	8.7
2030	36.0	13.1	42.0	14.1	23.0	11.2	49.0	12.4	30.0	12.1	21.0	10.3	43.0	12.8	36.0	13.1	22.0	10.8
2035	34.0	15.7	41.0	16.9	24.0	13.4	48.0	15.0	30.0	14.6	22.0	12.4	42.0	15.4	35.0	15.8	23.0	12.9
2040	33.0	18.4	41.0	19.8	26.0	15.7	47.0	17.5	29.0	17.0	23.0	14.4	41.0	18.0	35.0	18.5	25.0	15.1
2045	32.0	21.1	40.0	22.7	28.0	17.9	47.0	20.0	29.0	19.5	24.0	16.4	39.0	20.6	34.0	21.1	26.0	17.2
2050	31.0	23.8	40.0	25.6	30.0	20.2	46.0	22.6	29.0	21.9	26.0	18.5	38.0	23.2	34.0	23.8	28.0	19.3

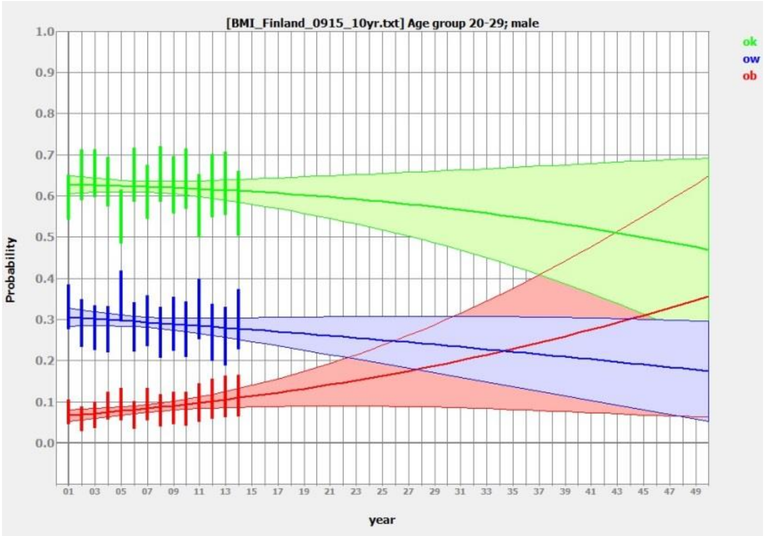


Figure 44. Projected BMI-group in 20-29 year old males

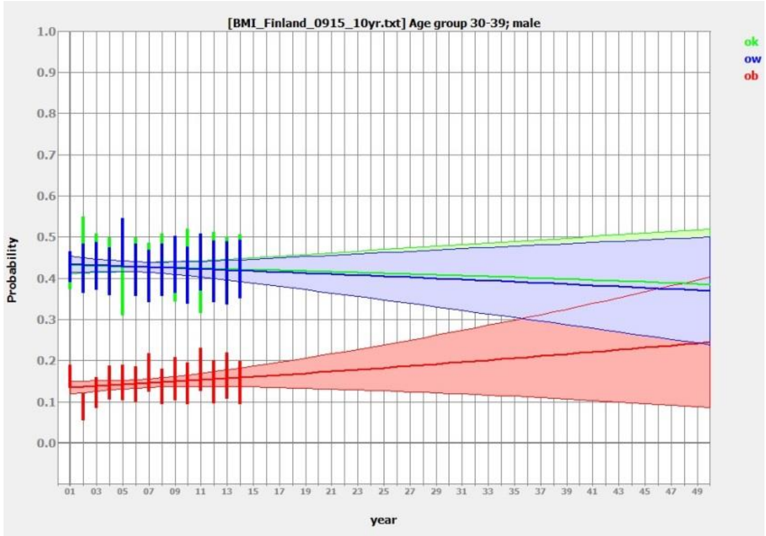


Figure 45. Projected BMI-group in 30-39 year old males

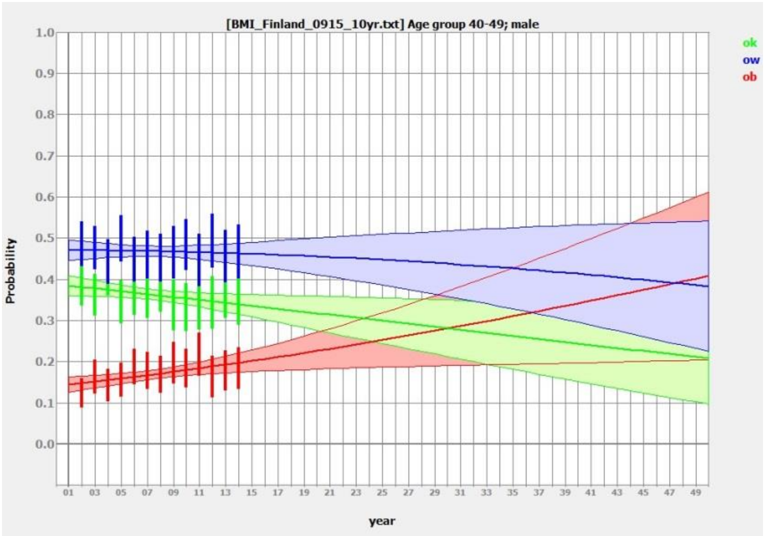


Figure 46. Projected BMI-group in 40-49 year old males

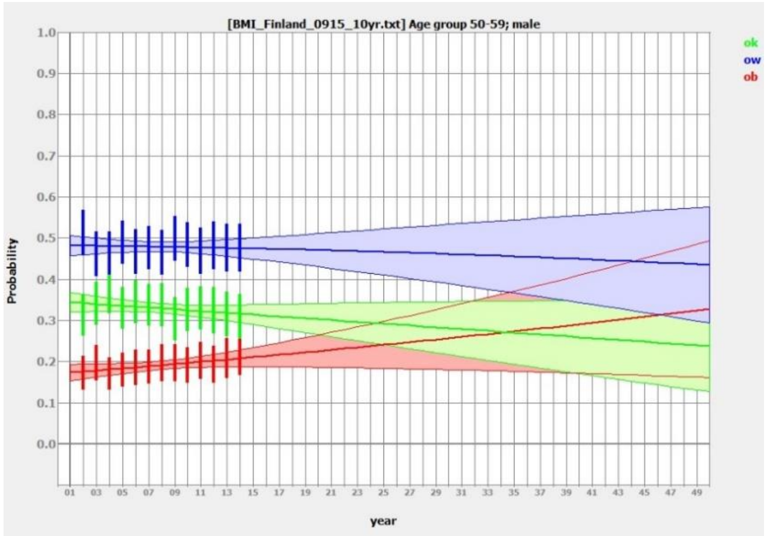


Figure 47. Projected BMI-group in 50-59 year old males

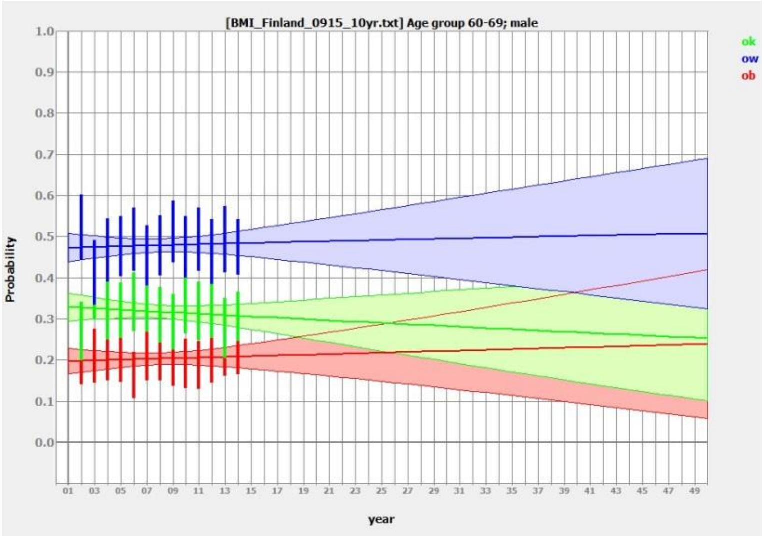


Figure 48. Projected BMI-group in 60-69 year old males

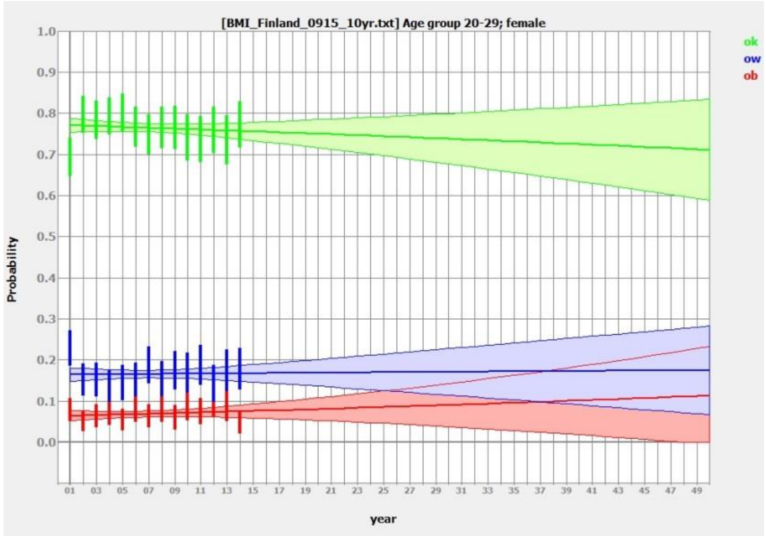


Figure 49. Projected BMI-group in 20-29 year old females

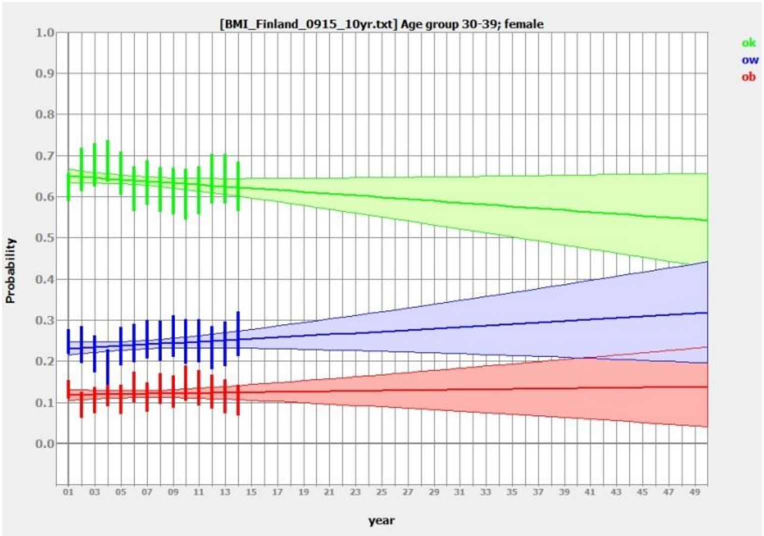


Figure 50. Projected BMI-group in 30-39 year old females

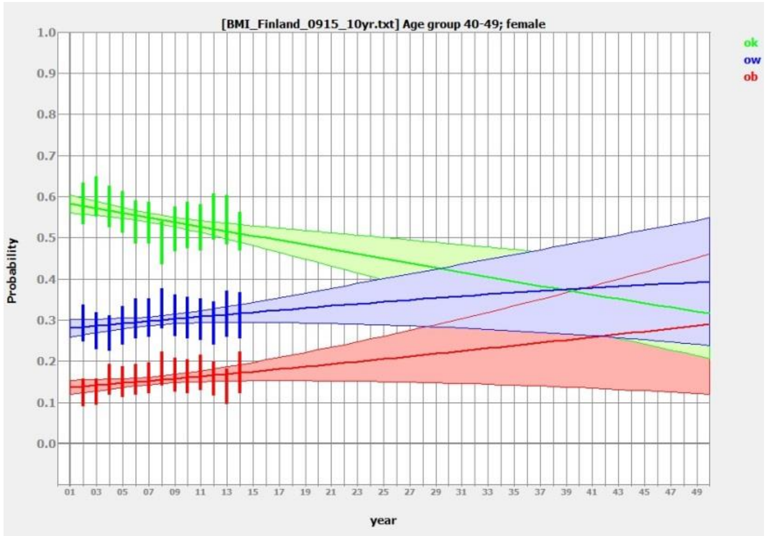


Figure 51. Projected BMI-group in 40-49 year old females

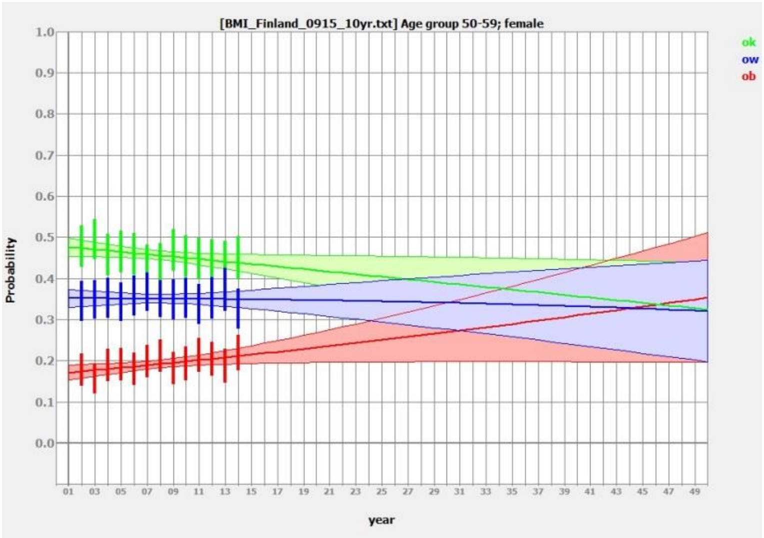


Figure 52. Projected BMI-group in 50-59 year old females

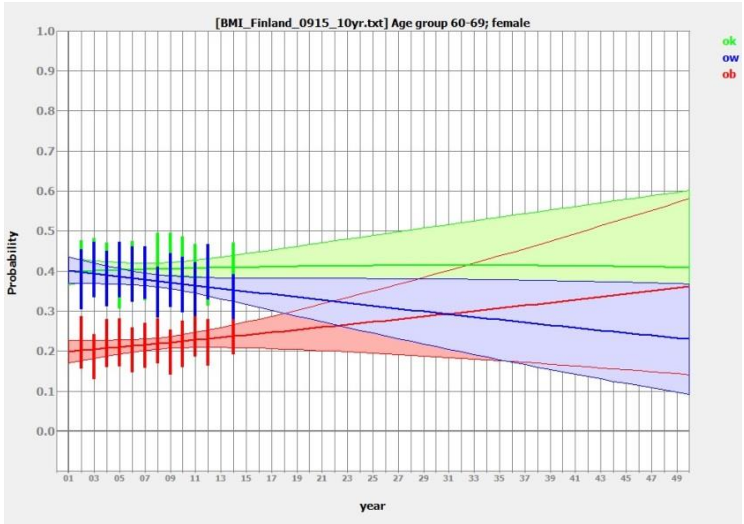


Figure 53. Projected BMI-group in 60-69 year old females

BMI projections by education level

Education was divided into two groups: 1) below tertiary education 2) tertiary education and above. Tertiary education was defined as 'post-secondary education'.

Males

Historically, overweight prevalence has been higher in men with tertiary education compared to men with less than tertiary education (Figure 54). Projections suggest that overweight prevalence will decrease slightly among men with tertiary education and remain stable among men with less than tertiary education. Overweight prevalence is not predicted to be significantly different in the two education groups in the future to 2050, indicating minimal inequality between groups (Figure 54

Figure 54 and appendix E3).

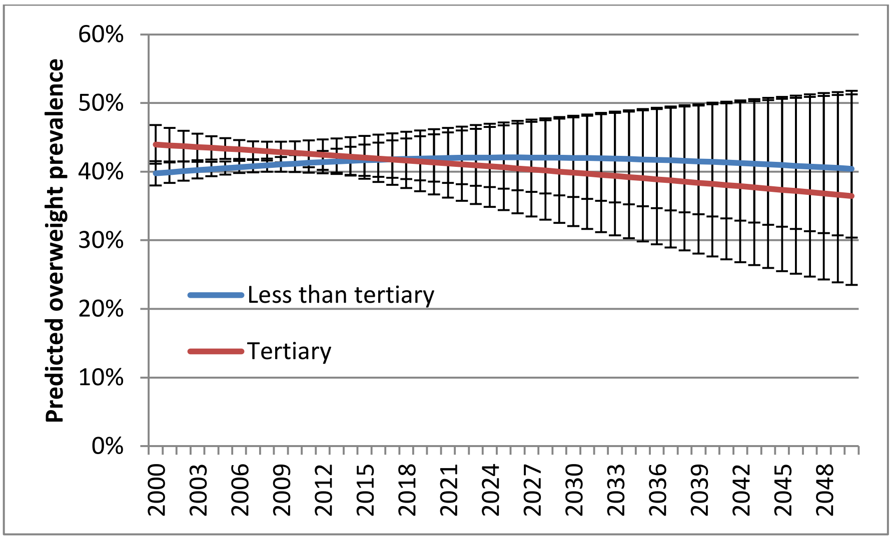


Figure 54. Overweight prevalence by education level among males

Obesity is predicted to increase in both education groups, and at a faster rate among less educated Finnish men than those with at least tertiary level education (Figure 55 & Appendix E3). By 2050 men with less than tertiary education are projected to have an obesity prevalence of 42% compared to 26% amongst men with tertiary education. The projections indicate widening inequalities in obesity over the next 35 years. However, error bars widen and overlap between education groups from 2016, so more data are needed to determine the significance of these trends, and the extent of absolute and relative inequalities over time.

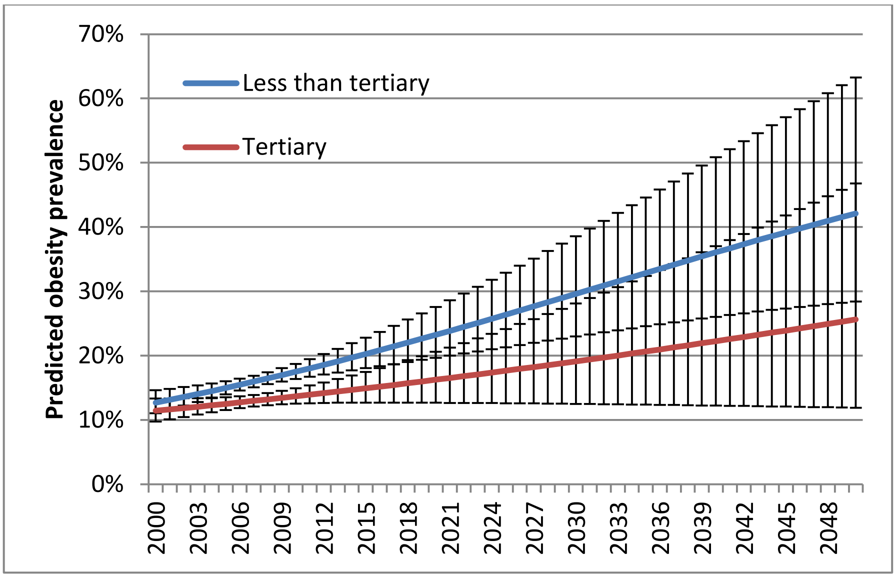


Figure 55. Obesity prevalence by education level among males

Females

Historically, there have been significant inequalities in overweight prevalence among Finnish women where a greater proportion of women with lower education levels were overweight compared to women with tertiary education (Figure 56). Overweight is predicted to increase in both education groups but at a faster rate amongst the more educated thereby narrowing inequalities from 2025. However, error bars overlap and more data are needed to determine the significance of this trend.

Obesity prevalence is predicted to increase in both women with tertiary education and those with less than tertiary education (Figure 57). Relative inequalities are projected to decline due to a slightly faster rate of increase in obesity among more educated groups, although as error bars overlap between groups more data are needed to determine the significance of this finding. Absolute inequalities are predicted to remain stable over the next 35 years (Figure 57 and appendix E3).

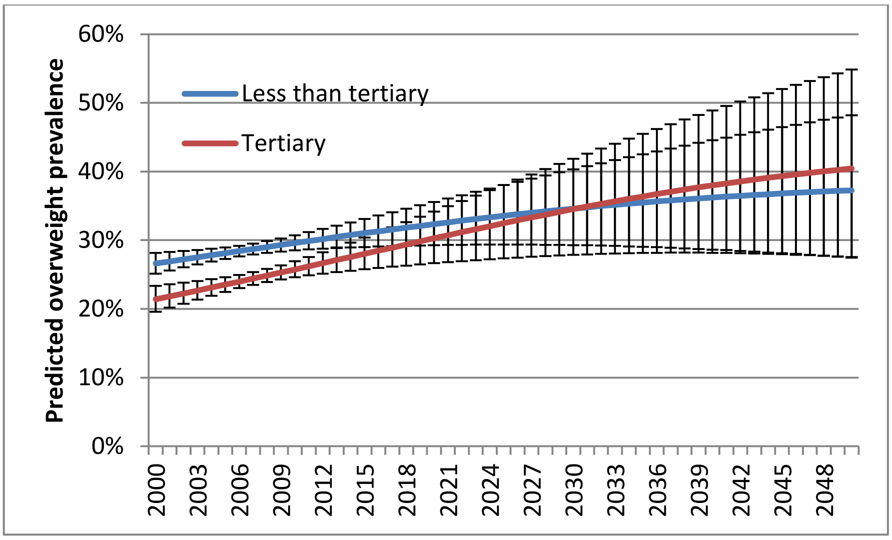


Figure 56. Overweight prevalence by education level among women

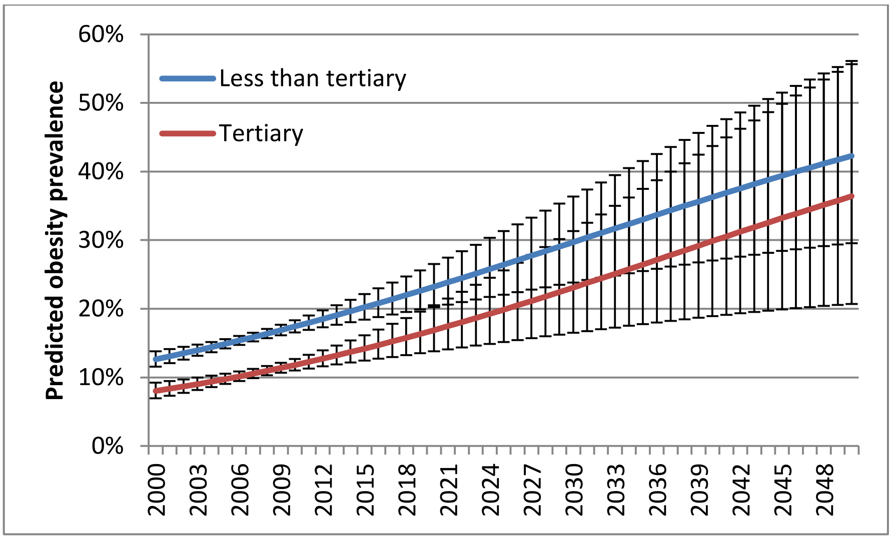


Figure 57. Obesity prevalence by education level among women

Smoking projections by sex and age group

Table 48 presents smoking prevalence projections to 2050 for males and females aged 20 to 100. Smoking prevalence is projected to decline in both males and females. Based on these projections smoking prevalence could decline to 13% by 2050.

The decline in smoking prevalence among men is expected across all age groups (Figure 58 to Figure 62). The largest change is projected among 20 to 49 year old males in whom the prevalence of smoking will decline from approximately 40% in 2000 to less than 10% in 2050

The prevalence of female smokers is expected to decrease in all age groups with the exception of 60-69 year olds (Figure 63 to Figure 67). The largest decrease in smoking prevalence is predicted for 20--39 year old women (Figure 63 and Figure 64).

Table 48. Smoker prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	**Non-smokers**	**+/- 95% CI**	**Smokers**	**+/- 95% CL**	**Non-smokers**	**+/- 95% CI**	**Smokers**	**+/- 95% CI**	**Non-smokers**	**+/- 95% CI**	**Smokers**	**+/- 95% CI**
2015	73.0	4.7	27.0	4.7	81.0	3.6	19.0	3.6	77.0	4.2	23.0	4.2
2020	76.0	2.5	24.0	2.5	83.0	1.9	17.0	1.9	79.0	2.2	21.0	2.2
2025	78.0	2.8	22.0	2.8	84.0	2.2	16.0	2.2	81.0	2.5	19.0	2.5
2030	80.0	5.2	20.0	5.2	85.0	4.0	15.0	4.0	82.0	4.7	18.0	4.7
2035	82.0	8.1	18.0	8.1	86.0	6.2	14.0	6.2	84.0	7.2	16.0	7.2
2040	83.0	11.0	17.0	11.0	86.0	8.4	14.0	8.4	85.0	9.7	15.0	9.7
2045	85.0	13.9	15.0	13.9	87.0	10.6	13.0	10.6	86.0	12.4	14.0	12.4
2050	86.0	16.9	14.0	16.9	88.0	12.8	12.0	12.8	87.0	15.0	13.0	15.0

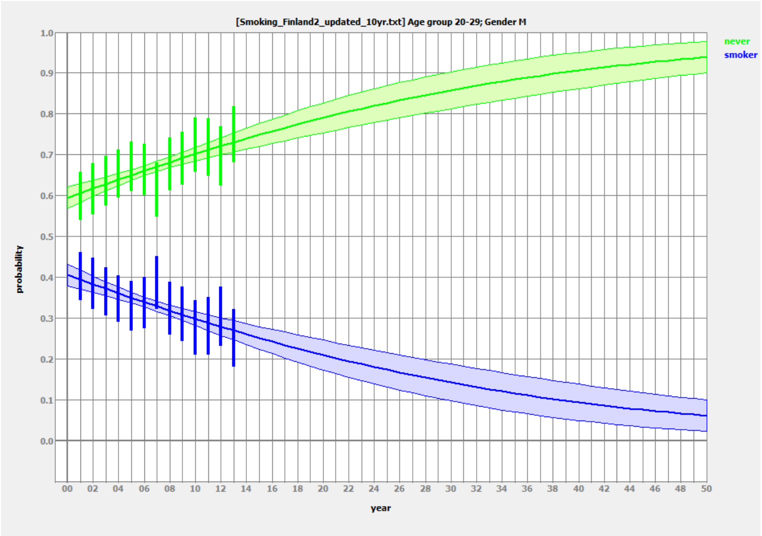


Figure 58. Smoking prevalence projections among males aged 20 to 29

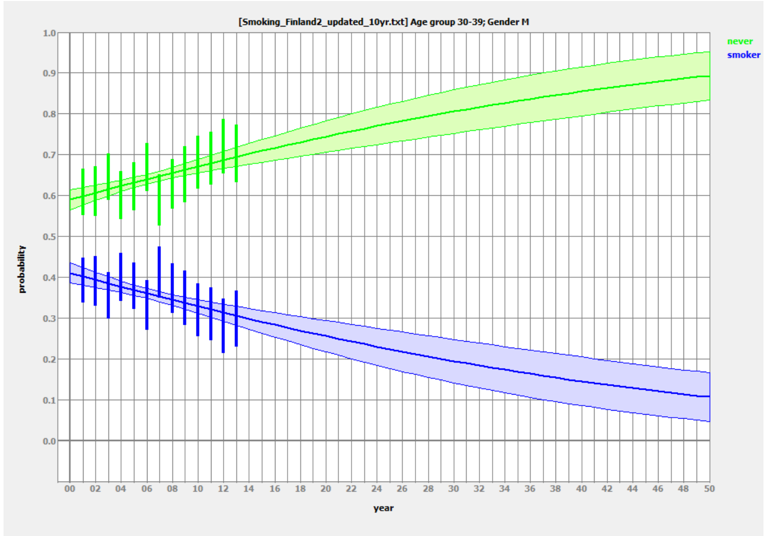


Figure 59. Smoking prevalence projections among males aged 30 to 39

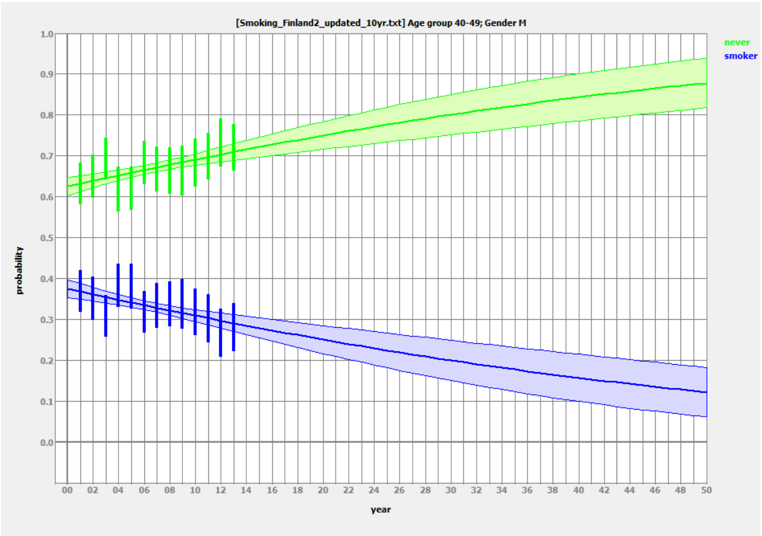


Figure 60. Smoking prevalence projections among males aged 40 to 49

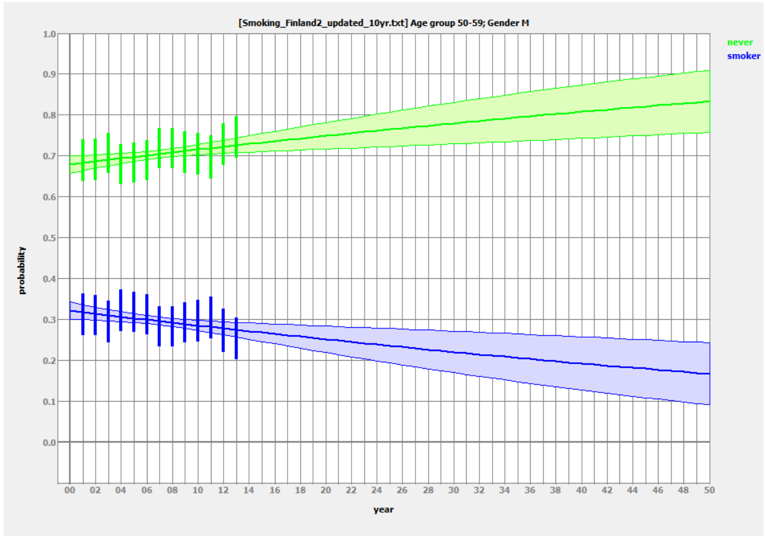


Figure 61. Smoking prevalence projections among males aged 50 to 59

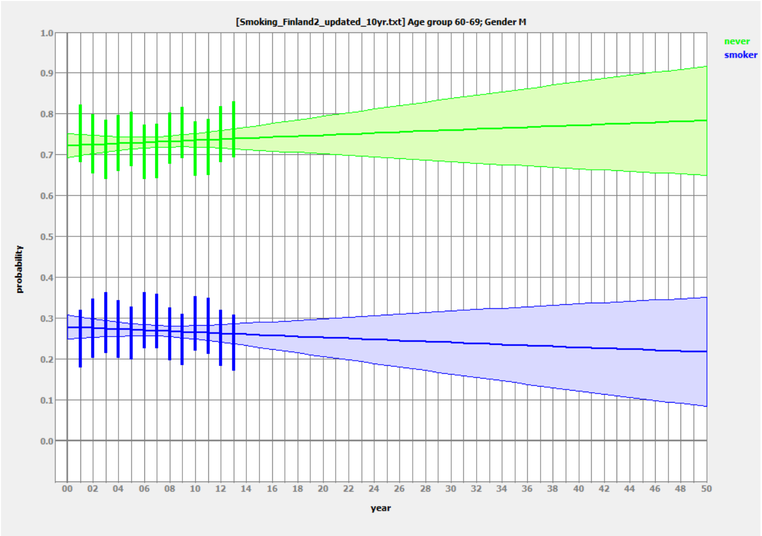


Figure 62. Smoking prevalence projections among males aged 60 to 69

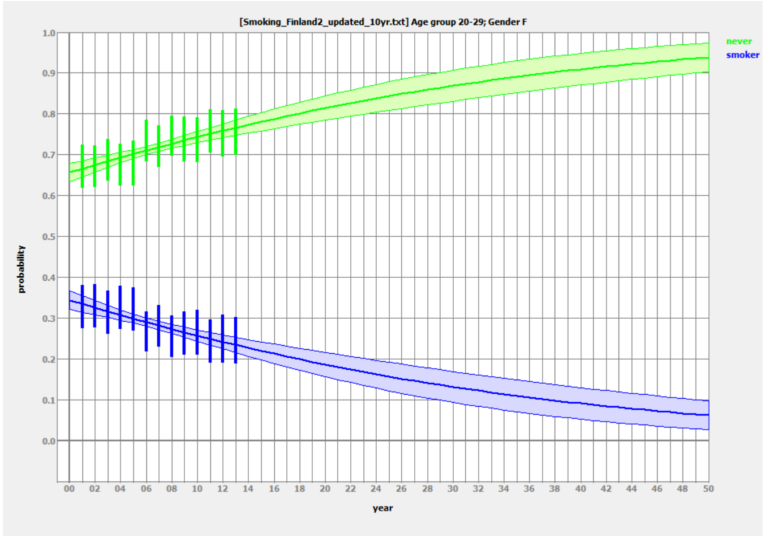


Figure 63. Smoking prevalence projections among females aged 20 to 29

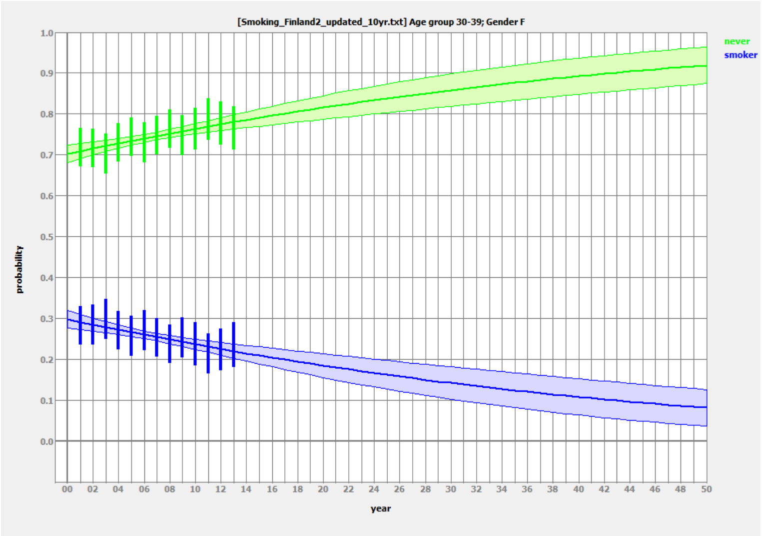


Figure 64. Smoking prevalence projections among females aged 30 to 39

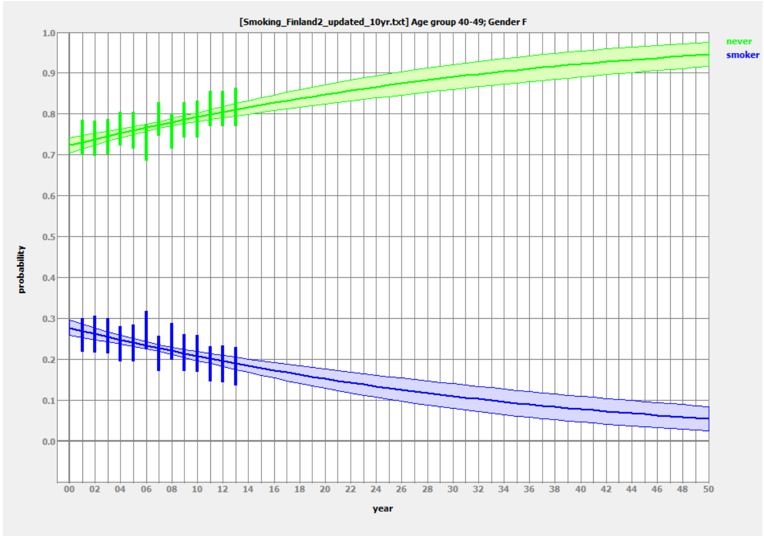


Figure 65. Smoking prevalence projections among females aged 40 to 49

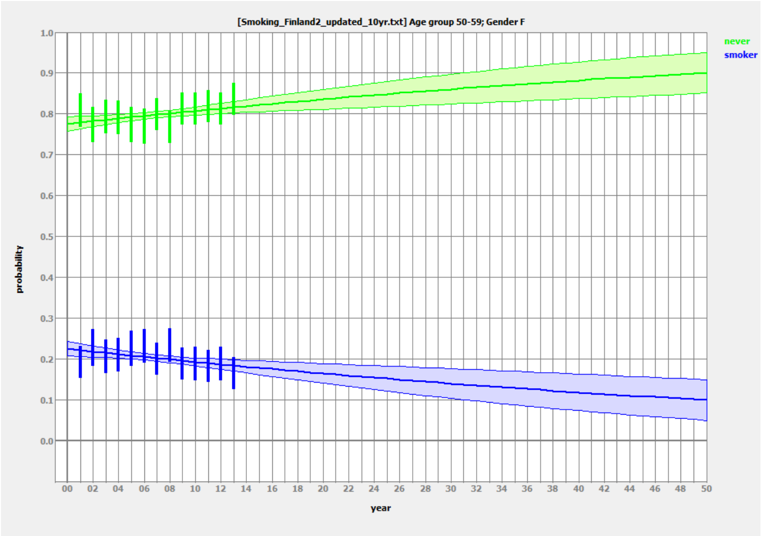


Figure 66. Smoking prevalence projections among females aged 50 to 59

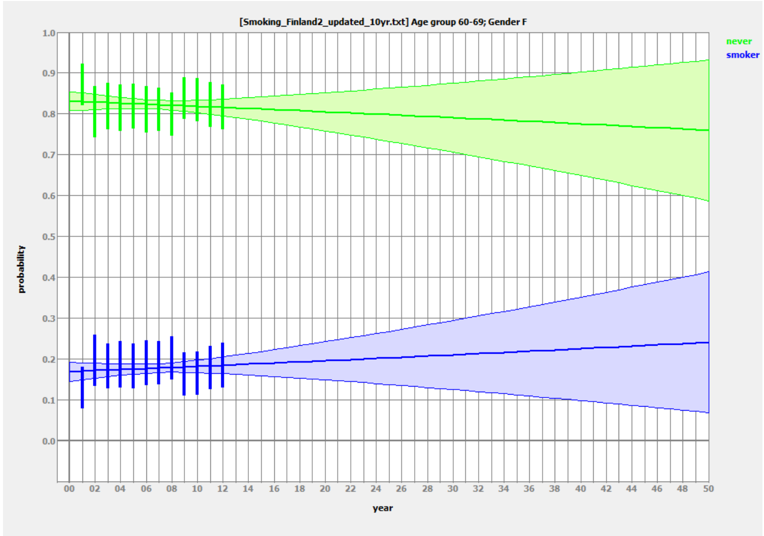


Figure 67. Smoking prevalence projections among females aged 60 to 69

Smoking projections by education level

Males

Men with less than tertiary education, defined as lower than degree level, smoke significantly more than men educated to degree level or above (Figure 68). In 2010smoking prevalence was 50% higher among men with less than tertiary education compared to men with tertiary education (appendix E3). Although smoking prevalence is projected to decline in both groups, relative inequalities are projected to increase slightly (Figure 68 and appendix E3). Absolute inequalities in smoking prevalence are projected to decrease from an estimated 11% difference in 2002 to 7% difference by 2050 as shown in Figure 68.

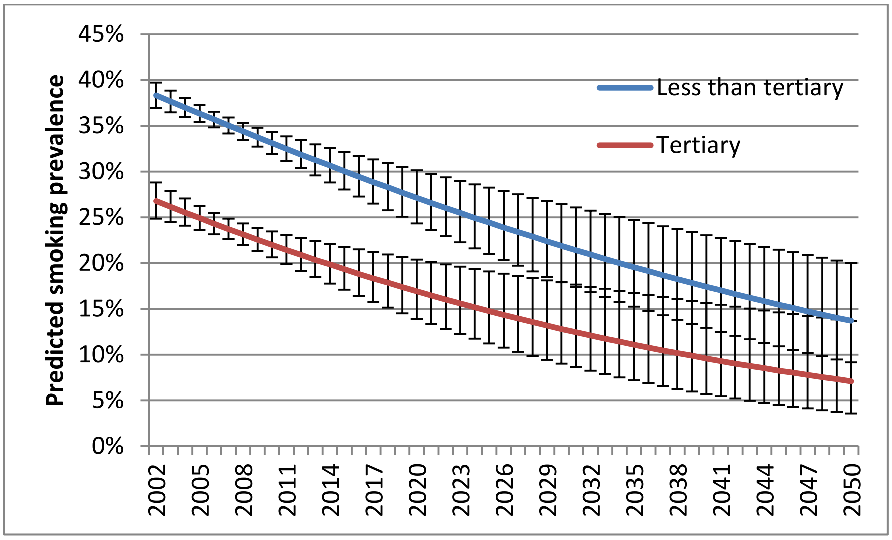


Figure 68. Smoking prevalence projections by education level among males

Females

A similar pattern of inequalities is projected among women by differing levels of education. In 2010 smoking prevalence among women with less than tertiary education was around 56% higher than it was among women with tertiary education (Figure 69 and appendix E3). It is projected that by 2050, smoking prevalence will be twice as high in women with less than tertiary compared to women with tertiary education (appendix E3). Smoking prevalence is projected to decrease in both education groups. Relative inequalities are predicted to increase but absolute inequalities are projected to decrease (Figure 69 and appendix E3).

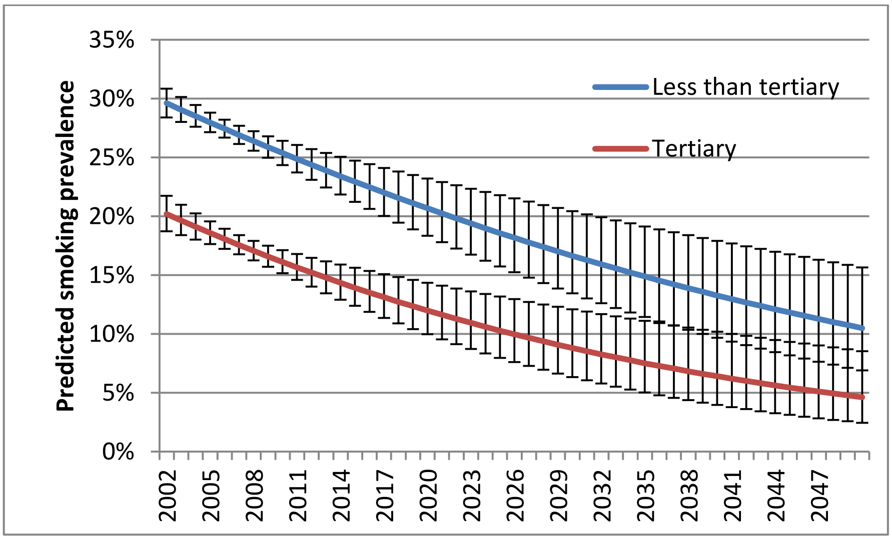


Figure 69. Smoking prevalence projections by education level among females

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

This section outlines the results of the microsimulation. The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 49. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

The BMI interventions tested and related input data are presented in Table 49.

Table 49. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (€)
Baseline	None	-	-
MCLI regain	1.6	100	110
MCLI no regain	1.6	0	110
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. *Greece proxy (converted to Bulgarian Lev)

Multi-component lifestyle interventions

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain –** these results are presented in appendix E1.

Impact on disease incidence and prevalence

Table 50 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and each intervention scenario. For each disease, incidence cases increase over time, but the interventions are effective in reducing incidence over time. Table 51 presents the cumulative incidence cases per 100,000 to 2050 for baseline and each intervention, and Table 52 and Figure 70 present the cumulative incidence cases *avoided* per 100,000 for baseline and each intervention. Each table/figure indicates that both MCLI interventions would result in a lower cumulative incidence of all diseases by 2050 compared to baseline. For example, MCLI (no regain) would result in the avoidance of 314 cumulative incidence cases of prediabetes per 100,000 relative to baseline by 2050. Even when MCLI is modelled with weight regain there is a positive effect, with the avoidance of 306, 289 and 170 cumulative incidence cases of prediabetes, hypertension and type 2 diabetes per 100,000 respectively.

Table 53 and Figure 71 present the prevalence cases avoided for each intervention relative to baseline, per 100,000. Both figures indicate that both MCLI intervention would result in a reduced number of prevalence cases per 100,000 compared to baseline for all diseases by 2050, and for each five year increment from 2020 to 2050. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for hypertension (213/100,000 and 231/100,000 for MCLI regain and no-regain scenarios respectively), followed by diabetes (103/100,000 and 119/100,000 respectively).

Table 50. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	213 [+-1]	450 [+-2]	530 [+-2]	179 [+-1]	231 [+-1]
	2020	240 [+-1]	439 [+-2]	534 [+-2]	185 [+-1]	256 [+-1]
	2025	256 [+-1]	435 [+-2]	542 [+-2]	190 [+-1]	272 [+-1]
	2030	279 [+-1]	433 [+-2]	549 [+-2]	195 [+-1]	293 [+-1]
	2035	294 [+-2]	442 [+-2]	552 [+-2]	200 [+-1]	307 [+-2]
	2040	315 [+-2]	462 [+-2]	563 [+-2]	203 [+-1]	319 [+-2]
	2045	315 [+-2]	466 [+-2]	565 [+-2]	208 [+-1]	322 [+-2]
	2050	315 [+-2]	472 [+-2]	569 [+-2]	212 [+-1]	318 [+-2]
MCLI (annual, with regain)	2015	212 [+-1]	448 [+-2]	529 [+-2]	181 [+-1]	232 [+-1]
	2020	237 [+-1]	437 [+-2]	530 [+-2]	183 [+-1]	254 [+-1]
	2025	253 [+-1]	428 [+-2]	534 [+-2]	186 [+-1]	270 [+-1]
	2030	275 [+-1]	426 [+-2]	542 [+-2]	189 [+-1]	292 [+-1]
	2035	290 [+-2]	433 [+-2]	544 [+-2]	195 [+-1]	305 [+-2]
	2040	309 [+-2]	450 [+-2]	553 [+-2]	198 [+-1]	318 [+-2]
	2045	313 [+-2]	455 [+-2]	557 [+-2]	201 [+-1]	320 [+-2]
	2050	307 [+-2]	460 [+-2]	557 [+-2]	205 [+-1]	315 [+-2]
MCLI (annual, with no regain)	2015	212 [+-1]	448 [+-2]	529 [+-2]	181 [+-1]	232 [+-1]
	2020	235 [+-1]	432 [+-2]	529 [+-2]	181 [+-1]	254 [+-1]
	2025	250 [+-1]	426 [+-2]	534 [+-2]	185 [+-1]	269 [+-1]
	2030	273 [+-1]	424 [+-2]	542 [+-2]	188 [+-1]	291 [+-1]
	2035	288 [+-1]	433 [+-2]	543 [+-2]	193 [+-1]	304 [+-2]
	2040	308 [+-2]	449 [+-2]	553 [+-2]	197 [+-1]	318 [+-2]
	2045	311 [+-2]	455 [+-2]	557 [+-2]	201 [+-1]	320 [+-2]
	2050	306 [+-2]	461 [+-2]	559 [+-2]	205 [+-1]	315 [+-2]

Table 51. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	213 [+-1]	450 [+-2]	530 [+-2]	179 [+-1]	231 [+-1]
	2020	1367 [+-3]	2658 [+-4]	3188 [+-5]	1091 [+-3]	1466 [+-3]
	2025	2626 [+-4]	4840 [+-6]	5884 [+-6]	2031 [+-4]	2800 [+-5]
	2030	4006 [+-5]	7048 [+-7]	8664 [+-8]	3009 [+-5]	4251 [+-6]
	2035	5513 [+-6]	9346 [+-8]	11548 [+-9]	4043 [+-5]	5824 [+-7]
	2040	7166 [+-7]	11801 [+-9]	14580 [+-10]	5139 [+-6]	7521 [+-7]
	2045	8912 [+-8]	14386 [+-10]	17735 [+-11]	6291 [+-7]	9302 [+-8]
	2050	10688 [+-9]	17052 [+-11]	20960 [+-12]	7481 [+-8]	11102 [+-9]
MCLI (annual, with regain)	2015	212 [+-1]	448 [+-2]	529 [+-2]	181 [+-1]	232 [+-1]
	2020	1357 [+-3]	2644 [+-4]	3169 [+-5]	1087 [+-3]	1463 [+-3]
	2025	2602 [+-4]	4801 [+-6]	5838 [+-6]	2013 [+-4]	2790 [+-5]
	2030	3959 [+-5]	6974 [+-7]	8577 [+-8]	2971 [+-5]	4234 [+-6]
	2035	5443 [+-6]	9227 [+-8]	11414 [+-9]	3981 [+-5]	5798 [+-7]
	2040	7069 [+-7]	11629 [+-9]	14387 [+-10]	5043 [+-6]	7483 [+-7]
	2045	8791 [+-8]	14158 [+-10]	17489 [+-11]	6159 [+-7]	9253 [+-8]
	2050	10536 [+-9]	16763 [+-11]	20654 [+-12]	7311 [+-7]	11044 [+-9]
MCLI (annual, with no regain)	2015	212 [+-1]	448 [+-2]	529 [+-2]	181 [+-1]	232 [+-1]
	2020	1350 [+-3]	2634 [+-4]	3166 [+-5]	1083 [+-3]	1461 [+-3]
	2025	2583 [+-4]	4773 [+-6]	5829 [+-6]	2000 [+-4]	2783 [+-5]
	2030	3927 [+-5]	6936 [+-7]	8565 [+-8]	2950 [+-5]	4220 [+-6]
	2035	5399 [+-6]	9181 [+-8]	11403 [+-9]	3952 [+-5]	5780 [+-7]
	2040	7013 [+-7]	11577 [+-9]	14375 [+-10]	5011 [+-6]	7465 [+-7]
	2045	8725 [+-8]	14104 [+-10]	17477 [+-11]	6122 [+-7]	9233 [+-8]
	2050	10461 [+-9]	16709 [+-11]	20646 [+-12]	7271 [+-7]	11023 [+-9]

Table 52. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain)	2015	1 [+-1]	2 [+-3]	1 [+-3]	-2 [+-1]	-1 [+-1]
	2020	10 [+-4]	14 [+-6]	19 [+-7]	4 [+-4]	3 [+-4]
	2025	24 [+-6]	39 [+-8]	46 [+-8]	18 [+-6]	10 [+-7]
	2030	47 [+-7]	74 [+-10]	87 [+-11]	38 [+-7]	17 [+-8]
	2035	70 [+-8]	119 [+-11]	134 [+-13]	62 [+-7]	26 [+-10]
	2040	97 [+-10]	172 [+-13]	193 [+-14]	96 [+-8]	38 [+-10]
	2045	121 [+-11]	228 [+-14]	246 [+-16]	132 [+-10]	49 [+-11]
	2050	152 [+-13]	289 [+-16]	306 [+-17]	170 [+-11]	58 [+-13]
MCLI (annual, with no regain)	2015	1 [+-1]	2 [+-3]	1 [+-3]	-2 [+-1]	-1 [+-1]
	2020	17 [+-4]	24 [+-6]	22 [+-7]	8 [+-4]	5 [+-4]
	2025	43 [+-6]	67 [+-8]	55 [+-8]	31 [+-6]	17 [+-7]
	2030	79 [+-7]	112 [+-10]	99 [+-11]	59 [+-7]	31 [+-8]
	2035	114 [+-8]	165 [+-11]	145 [+-13]	91 [+-7]	44 [+-10]
	2040	153 [+-10]	224 [+-13]	205 [+-14]	128 [+-8]	56 [+-10]
	2045	187 [+-11]	282 [+-14]	258 [+-16]	169 [+-10]	69 [+-11]
	2050	227 [+-13]	343 [+-16]	314 [+-17]	210 [+-11]	79 [+-13]

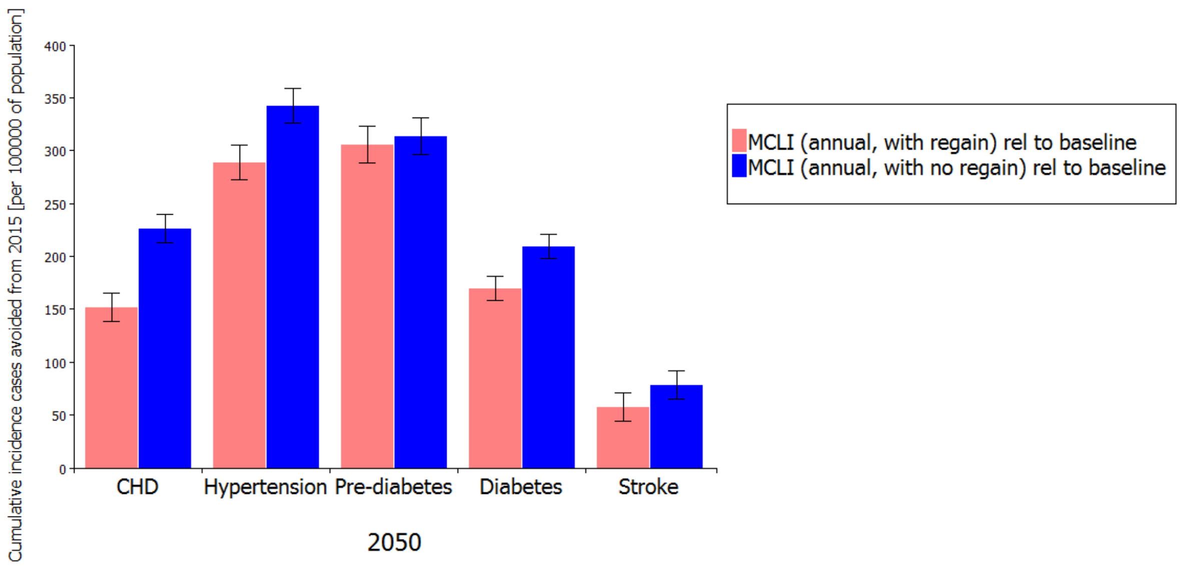


Figure 70. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 53. Prevalence cases avoided (per 100 000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	0 [+-3]	0 [+-14]	-4 [+-8]	0 [+-7]	-1 [+-6]
	2020	4 [+-3]	11 [+-14]	10 [+-8]	1 [+-8]	1 [+-6]
	2025	6 [+-3]	32 [+-14]	24 [+-8]	12 [+-8]	5 [+-6]
	2030	11 [+-3]	57 [+-14]	37 [+-8]	25 [+-8]	9 [+-6]
	2035	13 [+-3]	90 [+-14]	51 [+-8]	43 [+-8]	14 [+-6]
	2040	14 [+-4]	133 [+-16]	65 [+-8]	63 [+-8]	16 [+-7]
	2045	12 [+-4]	171 [+-16]	63 [+-9]	82 [+-8]	16 [+-7]
	2050	18 [+-4]	213 [+-16]	69 [+-10]	103 [+-8]	18 [+-7]
MCLI (annual, with no regain) relative to baseline	2015	-1 [+-3]	-4 [+-14]	-4 [+-8]	-2 [+-7]	-1 [+-6]
	2020	7 [+-3]	18 [+-14]	11 [+-8]	5 [+-8]	3 [+-6]
	2025	13 [+-3]	54 [+-14]	28 [+-8]	24 [+-8]	11 [+-6]
	2030	18 [+-3]	85 [+-14]	42 [+-8]	38 [+-8]	17 [+-6]
	2035	19 [+-3]	118 [+-14]	51 [+-8]	60 [+-8]	20 [+-6]
	2040	19 [+-4]	160 [+-16]	66 [+-8]	80 [+-8]	17 [+-7]
	2045	15 [+-4]	195 [+-16]	63 [+-9]	101 [+-8]	18 [+-7]
	2050	21 [+-4]	231 [+-16]	66 [+-10]	119 [+-8]	19 [+-7]

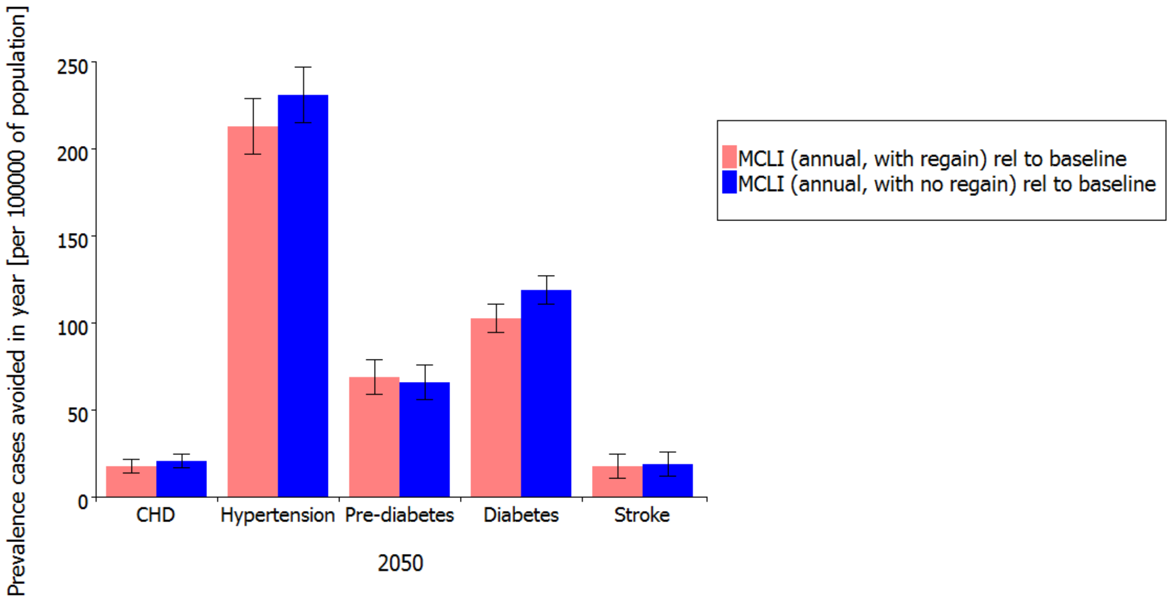


Figure 71. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 54 and Figure 72 present the direct health-care costs that can be avoided (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* are expected to occur in stroke for both MCLI interventions (€0.20m and €0.19m per 100,000 population in 2050 for the *MCLI (no weight regain)* and *MCLI (weight regain)* scenarios, respectively).

Table 55 and Figure 73 present the indirect costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect cost *avoided* is expected to occur in diabetes for both MCLI interventions (€0.08m and €0.07m per 100,000 population in 2050 for the *MCLI (no weight regain)* and *MCLI (weight regain)* scenarios, respectively).

Figure 74 and Figure 75 present the QALYs gained (per 100,000) for each intervention relative to baseline for males and females respectively between 2020 and 2050. For males, the MCLI weight regain scenario results in consistent increases in QALYs gained (relative to baseline) for each 5 year increment from 2025; QALYs gained peak at ~ 59/100,000 in this scenario. Similarly, the MCLI no weight regain scenario results in consistent increases in QALYs gained (compared to baseline) for each five year increment but from 2020 and where QALYs gained peak at 65/100,000; QALYs gained are higher for this scenario than the MCLI regain scenario for all years as expected. For females, QALYs gained (per 100,000) increase consistently from 2020 for each five year increment for both intervention scenarios. Again, the MCLI no weight regain scenario results in more QALYs gained (relative to baseline) compared to the MCLI weight regain scenario in all years except 2050 when it peaks in both scenarios at 42/100,000.

In Figure 76, the positive ICER values in this case happens to be comprised of positive 'QALY gained' values in the denominator and positive 'cost avoided' values in the numerator. A cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. However, since no cost effectiveness thresholds have been assigned in this project, we cannot determine for certain whether or not this set of interventions is cost effective.

Table 54. Direct healthcare cost (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	0.000951 [+-0.000068]	-0.000078 [+-0.000511]	-0.000359 [+-0.000042]	-0.000133 [+-0.001201]	-0.010551 [+-0.003195]
	2020	0.013086 [+-0.000074]	0.002132 [+-0.000454]	0.000833 [+-0.000037]	0.005518 [+-0.001107]	0.027061 [+-0.003264]
	2025	0.016092 [+-0.000072]	0.005418 [+-0.0004]	0.001729 [+-0.000033]	0.036533 [+-0.001009]	0.109406 [+-0.00318]
	2030	0.027781 [+-0.000069]	0.008345 [+-0.000353]	0.002232 [+-0.000028]	0.063151 [+-0.000913]	0.166962 [+-0.003037]
	2035	0.029285 [+-0.000062]	0.011387 [+-0.00031]	0.002647 [+-0.000025]	0.092278 [+-0.000822]	0.232887 [+-0.002816]
	2040	0.028118 [+-0.000056]	0.014531 [+-0.000274]	0.002926 [+-0.000022]	0.118196 [+-0.000736]	0.214279 [+-0.002546]
	2045	0.019487 [+-0.00005]	0.016123 [+-0.000242]	0.002444 [+-0.00002]	0.132512 [+-0.000653]	0.198376 [+-0.00224]
	2050	0.024606 [+-0.000043]	0.017338 [+-0.000214]	0.00231 [+-0.000017]	0.143766 [+-0.000579]	0.190231 [+-0.001919]
Scenario	**Year**	**CHD**	**Hypertension**	**Pre-diabetes**	**Diabetes**	**Stroke**
MCLI (annual, with no regain), relative to baseline	2015	-0.002392 [+-0.000068]	-0.000893 [+-0.000511]	-0.00044 [+-0.000042]	-0.006472 [+-0.001201]	-0.014366 [+-0.003195]
	2020	0.022963 [+-0.000074]	0.003466 [+-0.000453]	0.000908 [+-0.000037]	0.018136 [+-0.001107]	0.084091 [+-0.003261]
	2025	0.036428 [+-0.000071]	0.009094 [+-0.0004]	0.002007 [+-0.000033]	0.069254 [+-0.001007]	0.245651 [+-0.003174]
	2030	0.045649 [+-0.000068]	0.012393 [+-0.000352]	0.002531 [+-0.000028]	0.095673 [+-0.000911]	0.317619 [+-0.00303]
	2035	0.041564 [+-0.000062]	0.014882 [+-0.00031]	0.002658 [+-0.000025]	0.129682 [+-0.00082]	0.333046 [+-0.002811]
	2040	0.036474 [+-0.000056]	0.01743 [+-0.000274]	0.002944 [+-0.000022]	0.150324 [+-0.000734]	0.23983 [+-0.002545]
	2045	0.025278 [+-0.028575]	0.018415 [+-0.000242]	0.002416 [+-0.00002]	0.163924 [+-0.000652]	0.218224 [+-0.002239]
	2050	0.028575 [+-0.000043]	0.018802 [+-0.000214]	0.002213 [+-0.000017]	0.166515 [+-0.000578]	0.198689 [+-0.001918]

Table 55. Indirect Cost avoided for MCLI

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	0.000661 [+-]0.000048]	-0.000038 [+-]0.000245]	0 [+-]0]	-0.000067 [+-]0.00061]	-0.00409 [+-]0.001239]
	2020	0.009095 [+-]0.000052]	0.001024 [+-]0.000218]	0 [+-]0]	0.002796 [+-]0.000561]	0.010496 [+-]0.001266]
	2025	0.011185 [+-]0.00005]	0.002603 [+-]0.000192]	0 [+-]0]	0.018516 [+-]0.000511]	0.042425 [+-]0.001233]
	2030	0.019308 [+-]0.000047]	0.004008 [+-]0.000169]	0 [+-]0]	0.032007 [+-]0.000462]	0.064745 [+-]0.001178]
	2035	0.020353 [+-]0.000043]	0.00547 [+-]0.000149]	0 [+-]0]	0.046769 [+-]0.000417]	0.090309 [+-]0.001092]
	2040	0.019543 [+-]0.000039]	0.00698 [+-]0.000132]	0 [+-]0]	0.059905 [+-]0.000373]	0.083096 [+-]0.000987]
	2045	0.013544 [+-]0.000035]	0.007744 [+-]0.000117]	0 [+-]0]	0.067161 [+-]0.000331]	0.076927 [+-]0.000869]
	2050	0.017102 [+-]0.00003]	0.008328 [+-]0.000103]	0 [+-]0]	0.072865 [+-]0.000293]	0.073769 [+-]0.000744]
MCLI (annual, with no regain), relative to baseline	2015	-0.00166 [+-]0.000048]	-0.000429 [+-]0.000245]	0 [+-]0]	-0.00328 [+-]0.00061]	-0.00557 [+-]0.001239]
	2020	0.015959 [+-]0.000052]	0.001665 [+-]0.000218]	0 [+-]0]	0.009192 [+-]0.000561]	0.03261 [+-]0.001264]
	2025	0.025319 [+-]0.00005]	0.004368 [+-]0.000192]	0 [+-]0]	0.035099 [+-]0.00051]	0.095261 [+-]0.00123]
	2030	0.031727 [+-]0.000047]	0.005952 [+-]0.000169]	0 [+-]0]	0.04849 [+-]0.000461]	0.123167 [+-]0.001175]
	2035	0.028888 [+-]0.000043]	0.007148 [+-]0.000149]	0 [+-]0]	0.065727 [+-]0.000416]	0.12915 [+-]0.00109]
	2040	0.02535 [+-]0.000039]	0.008373 [+-]0.000132]	0 [+-]0]	0.076189 [+-]0.000372]	0.093002 [+-]0.000987]
	2045	0.017568 [+-]0.019861]	0.008845 [+-]0.000116]	0 [+-]0]	0.083082 [+-]0.00033]	0.084624 [+-]0.000868]
	2050	-0.00166 [+-]0.000048]	-0.000429 [+-]0.000245]	0 [+-]0]	-0.00328 [+-]0.00061]	-0.00557 [+-]0.001239]

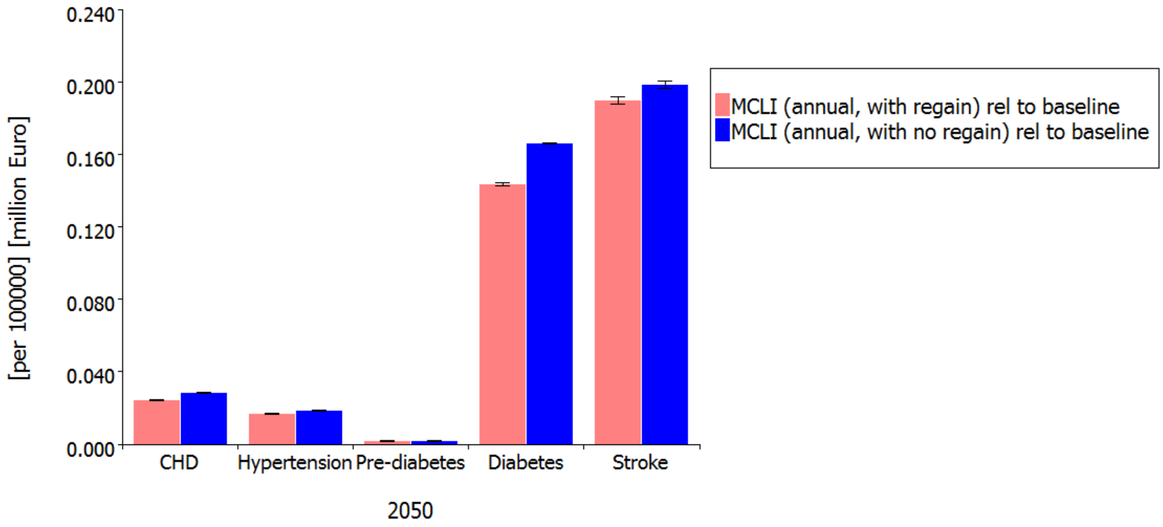


Figure 72. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

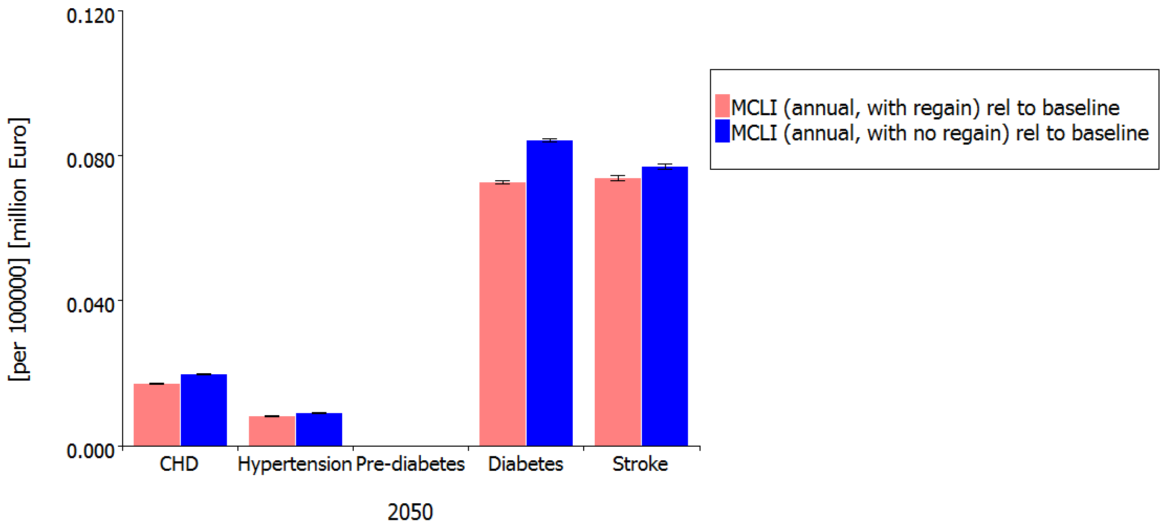


Figure 73. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

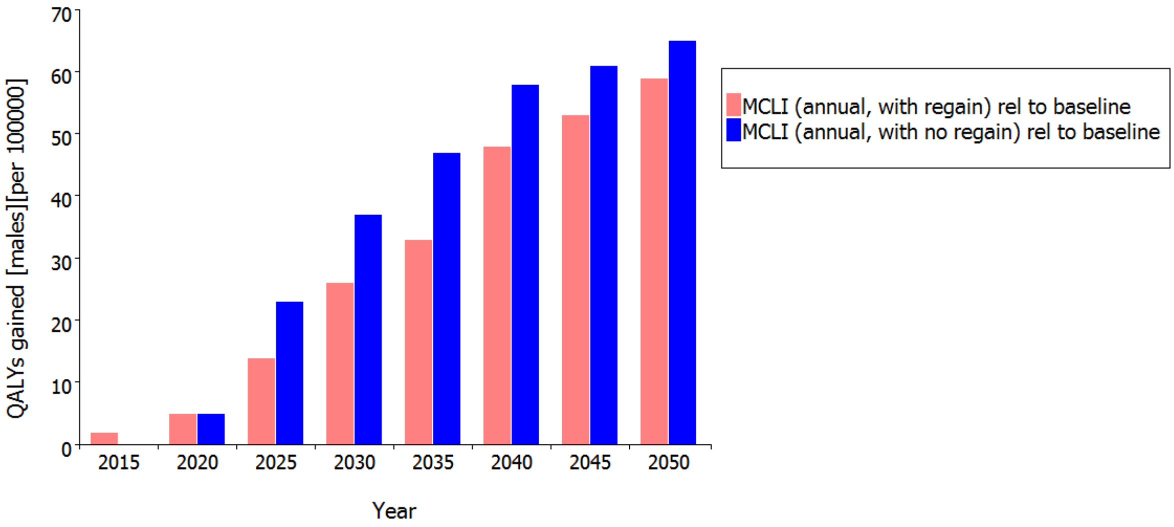


Figure 74. QALYS gained (per 100,000) relative to baseline (males)

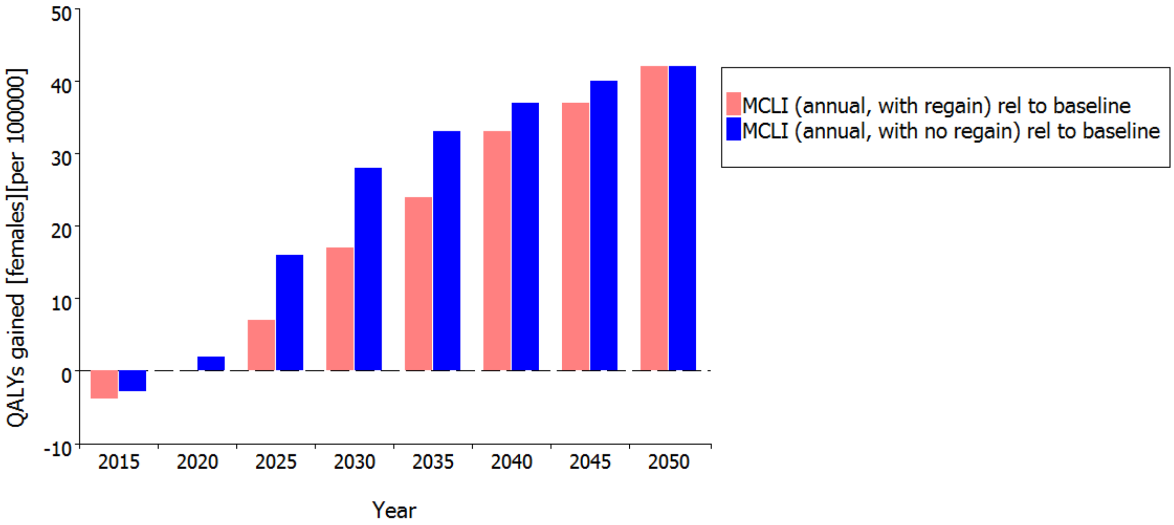


Figure 75. QALYs gained (per 100,000) relative to baseline (females)

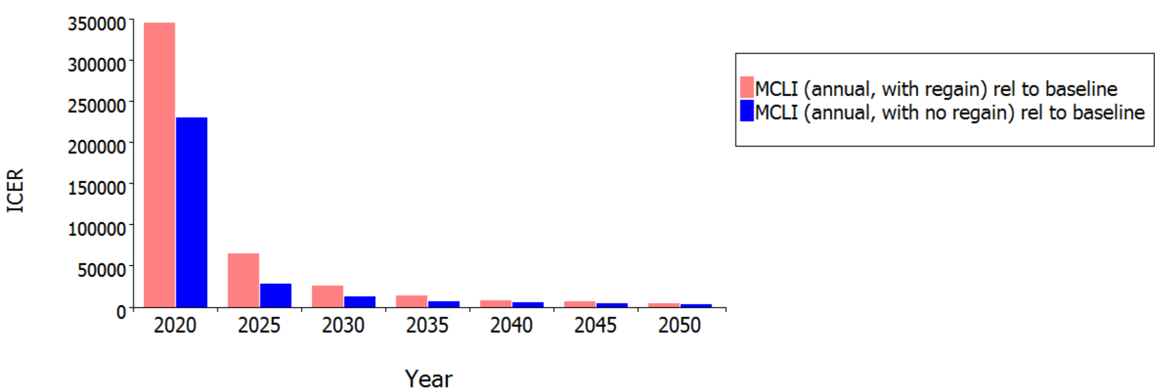


Figure 76. ICER

Sugar sweetened beverages (SSBs) tax intervention

Due to the small BMI drop, 100 million simulations were run to provide more accurate results. Table 56 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenario. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios.

The SSB scenario results in fewer cumulative cases across all diseases per 100,000 in 2050 compared to baseline (Table 57). The largest impact is on pre-diabetes with 14/100,000 cases avoided compared to baseline followed by hypertension with 9/100,000 cases avoided compared to baseline by 2050 (Table 58 and Figure 77). However, as can be seen in Figure 77 the 95% CI of these estimates are large. Cumulative cases avoided are only statistically significant for pre-diabetes and marginally for diabetes.

Table 59 and Figure 78 present the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. The SSB scenario is predicted to have a small impact on prevalence compared to baseline which is not statistically significant for any disease as can be seen in Figure 78.

Table 56. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	213 [+-1]	448 [+-1]	529 [+-1]	179 [+-1]	231 [+-1]
	2020	239 [+-1]	438 [+-1]	533 [+-1]	183 [+-1]	255 [+-1]
	2025	256 [+-1]	434 [+-1]	541 [+-1]	188 [+-1]	271 [+-1]
	2030	279 [+-1]	432 [+-1]	547 [+-1]	193 [+-1]	293 [+-1]
	2035	294 [+-1]	440 [+-1]	551 [+-1]	200 [+-1]	306 [+-1]
	2040	314 [+-1]	459 [+-1]	562 [+-1]	203 [+-1]	320 [+-1]
	2045	316 [+-1]	465 [+-1]	565 [+-2]	208 [+-1]	321 [+-1]
	2050	315 [+-1]	470 [+-1]	567 [+-2]	211 [+-1]	317 [+-1]
SSB tax	2015	213 [+-1]	448 [+-1]	529 [+-1]	179 [+-1]	231 [+-1]
	2020	239 [+-1]	437 [+-1]	532 [+-1]	183 [+-1]	255 [+-1]
	2025	256 [+-1]	434 [+-1]	540 [+-1]	188 [+-1]	271 [+-1]
	2030	279 [+-1]	432 [+-1]	547 [+-1]	193 [+-1]	292 [+-1]
	2035	294 [+-1]	440 [+-1]	551 [+-1]	199 [+-1]	306 [+-1]
	2040	314 [+-1]	459 [+-1]	562 [+-1]	203 [+-1]	320 [+-1]
	2045	316 [+-1]	465 [+-1]	565 [+-2]	207 [+-1]	321 [+-1]
	2050	315 [+-1]	470 [+-1]	567 [+-2]	211 [+-1]	317 [+-1]

Table 57. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	213 [+-1]	448 [+-1]	529 [+-1]	179 [+-1]	231 [+-1]
	2020	1364 [+-2]	2650 [+-3]	3180 [+-3]	1086 [+-2]	1466 [+-2]
	2025	2621 [+-3]	4825 [+-4]	5872 [+-5]	2021 [+-3]	2797 [+-3]
	2030	3999 [+-4]	7024 [+-5]	8648 [+-6]	2995 [+-3]	4248 [+-4]
	2035	5505 [+-4]	9312 [+-6]	11526 [+-6]	4025 [+-4]	5820 [+-5]
	2040	7156 [+-5]	11756 [+-6]	14549 [+-7]	5117 [+-4]	7517 [+-5]
	2045	8903 [+-6]	14334 [+-7]	17700 [+-8]	6264 [+-5]	9298 [+-6]
	2050	10680 [+-6]	16989 [+-8]	20921 [+-8]	7450 [+-5]	11098 [+-6]
SSB tax	2015	213 [+-1]	448 [+-1]	529 [+-1]	179 [+-1]	231 [+-1]
	2020	1364 [+-2]	2648 [+-3]	3177 [+-3]	1086 [+-2]	1466 [+-2]
	2025	2620 [+-3]	4821 [+-4]	5867 [+-5]	2020 [+-3]	2796 [+-3]
	2030	3998 [+-4]	7019 [+-5]	8640 [+-6]	2992 [+-3]	4247 [+-4]
	2035	5502 [+-4]	9305 [+-6]	11516 [+-6]	4021 [+-4]	5819 [+-5]
	2040	7153 [+-5]	11748 [+-6]	14538 [+-7]	5111 [+-4]	7516 [+-5]
	2045	8899 [+-6]	14325 [+-7]	17687 [+-8]	6258 [+-5]	9296 [+-6]
	2050	10676 [+-6]	16980 [+-8]	20907 [+-8]	7443 [+-5]	11096 [+-6]

Table 58. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0 [+-1]	0 [+-1]	0 [+-1]	0 [+-1]	0 [+-1]
	2020	0 [+-3]	2 [+-4]	3 [+-4]	0 [+-3]	0 [+-3]
	2025	1 [+-4]	4 [+-6]	5 [+-7]	1 [+-4]	1 [+-4]
	2030	1 [+-6]	5 [+-7]	8 [+-8]	3 [+-4]	1 [+-6]
	2035	3 [+-6]	7 [+-8]	10 [+-8]	4 [+-6]	1 [+-7]
	2040	3 [+-7]	8 [+-8]	11 [+-10]	6 [+-6]	1 [+-7]
	2045	4 [+-8]	9 [+-10]	13 [+-11]	6 [+-7]	2 [+-8]
	2050	4 [+-8]	9 [+-11]	14 [+-11]	7 [+-7]	2 [+-8]

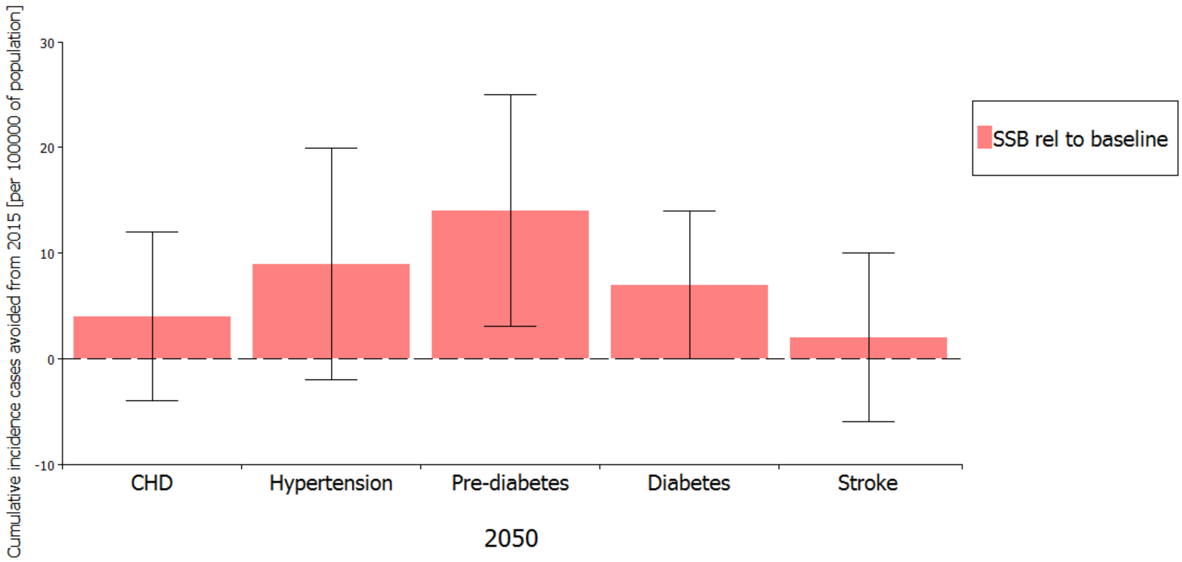


Figure 77. Cumulative incidence cases avoided (per 100,000) relative to baseline

Table 59. Prevalence cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0 [+-1]	0 [+-10]	1 [+-6]	0 [+-6]	1 [+-4]
	2020	0 [+-3]	3 [+-10]	2 [+-6]	1 [+-6]	0 [+-4]
	2025	1 [+-3]	4 [+-10]	3 [+-6]	1 [+-6]	0 [+-4]
	2030	1 [+-3]	5 [+-10]	3 [+-6]	2 [+-6]	1 [+-4]
	2035	0 [+-3]	5 [+-10]	4 [+-6]	3 [+-6]	1 [+-4]
	2040	1 [+-3]	6 [+-10]	4 [+-7]	4 [+-6]	1 [+-4]
	2045	1 [+-3]	7 [+-11]	3 [+-7]	3 [+-6]	0 [+-4]
	2050	1 [+-3]	6 [+-11]	2 [+-7]	3 [+-6]	0 [+-4]

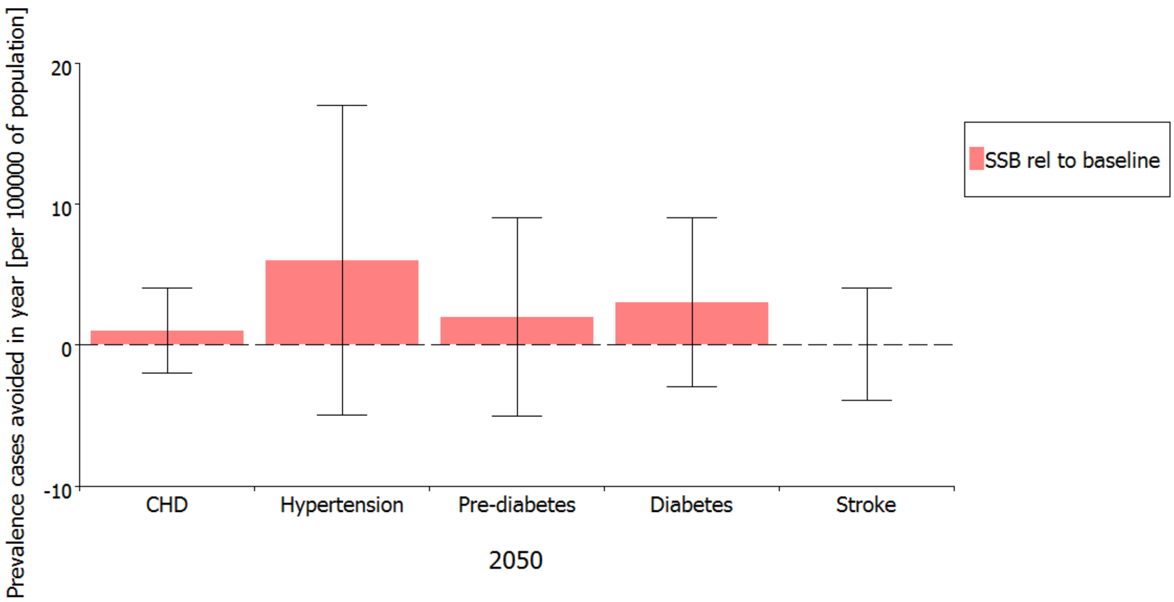


Figure 78. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 60 and Figure 79 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with an SSB intervention, relative to the baseline. The graph largest direct healthcare costs *avoided* is expected to occur in stroke (€0.01m per 100,000 population in 2050) and diabetes (€0.01m per 100,000 population in 2050).

Table 61 and Figure 80 presents the indirect costs that can be *avoided* (per 100,000 population) with an SSB intervention, relative to the baseline. The graph largest indirect costs *avoided* is expected to occur in stroke (€0.003m per 100,000 population in 2050) and diabetes (€0.003m per 100,000 population in 2050).

Figure 81 and Figure 82 present the QALYs that can be *gained* (per 100,000 population) with the SSB intervention, relative to the baseline. For both males and females, the QALYs gained remain stable between 1 and 2 per 100,000 population, relative to the baseline.

In Figure 83, the negative ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SSB tax intervention is expected to be cost effective (the MCLI intervention scenarios *dominate* the baseline scenario).

Table 60. Direct healthcare costs (€ millions) avoided (per 100,000) relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0.000361 [+-]0.000048]	0.000099 [+-]0.000359]	0.000023 [+-]0.00003]	-0.00021 [+-]0.000843]	0.003639 [+-]0.002257]
	2020	0.000671 [+-]0.000052]	0.000452 [+-]0.00032]	0.000183 [+-]0.000025]	0.002019 [+-]0.000776]	0.005749 [+-]0.002309]
	2025	0.001252 [+-]0.000051]	0.000661 [+-]0.000281]	0.000233 [+-]0.000023]	0.00448 [+-]0.000709]	0.009098 [+-]0.002249]
	2030	0.000885 [+-]0.000048]	0.000713 [+-]0.000249]	0.000207 [+-]0.00002]	0.006131 [+-]0.000643]	0.011089 [+-]0.002149]
	2035	0.000773 [+-]0.000044]	0.000746 [+-]0.000219]	0.000183 [+-]0.000017]	0.006681 [+-]0.000581]	0.011517 [+-]0.001995]
	2040	0.001077 [+-]0.00004]	0.000744 [+-]0.000194]	0.000142 [+-]0.000016]	0.007013 [+-]0.000521]	0.006603 [+-]0.001809]
	2045	0.000767 [+-]0.000035]	0.000677 [+-]0.000171]	0.000114 [+-]0.000014]	0.006243 [+-]0.000465]	0.007462 [+-]0.00159]
	2050	0.000915 [+-]0.000031]	0.000558 [+-]0.000151]	0.00008 [+-]0.000013]	0.005549 [+-]0.000413]	0.007418 [+-]0.001362]

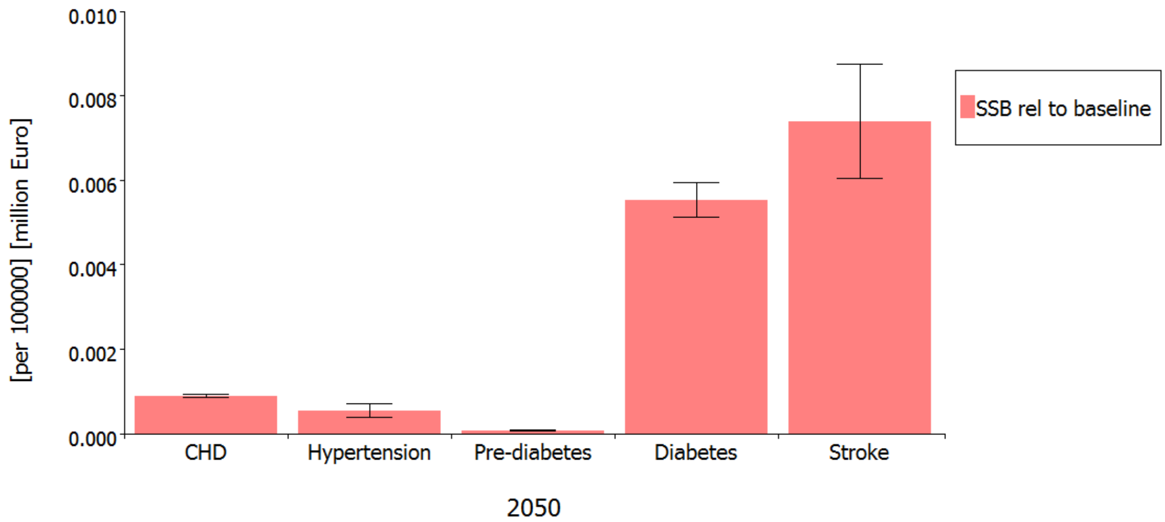


Figure 79. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 61. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0.00025 [+-]0.000034]	0.000048 [+-]0.000173]	0 [+-]0]	-0.00011 [+-]0.000427]	0.001411 [+-]0.000875]
	2020	0.000466 [+-]0.000037]	0.000218 [+-]0.000153]	0 [+-]0]	0.001023 [+-]0.000393]	0.00223 [+-]0.000895]
	2025	0.00087 [+-]0.000035]	0.000317 [+-]0.000136]	0 [+-]0]	0.00227 [+-]0.000359]	0.003527 [+-]0.000873]
	2030	0.000615 [+-]0.000034]	0.000343 [+-]0.000119]	0 [+-]0]	0.003107 [+-]0.000326]	0.004301 [+-]0.000833]
	2035	0.000537 [+-]0.000031]	0.000359 [+-]0.000105]	0 [+-]0]	0.003386 [+-]0.000294]	0.004467 [+-]0.000774]
	2040	0.000748 [+-]0.000028]	0.000357 [+-]0.000093]	0 [+-]0]	0.003555 [+-]0.000264]	0.002562 [+-]0.000701]
	2045	0.000533 [+-]0.000025]	0.000326 [+-]0.000082]	0 [+-]0]	0.003164 [+-]0.000235]	0.002892 [+-]0.000617]
	2050	0.000636 [+-]0.000021]	0.000268 [+-]0.000073]	0 [+-]0]	0.002812 [+-]0.000209]	0.002876 [+-]0.000528]

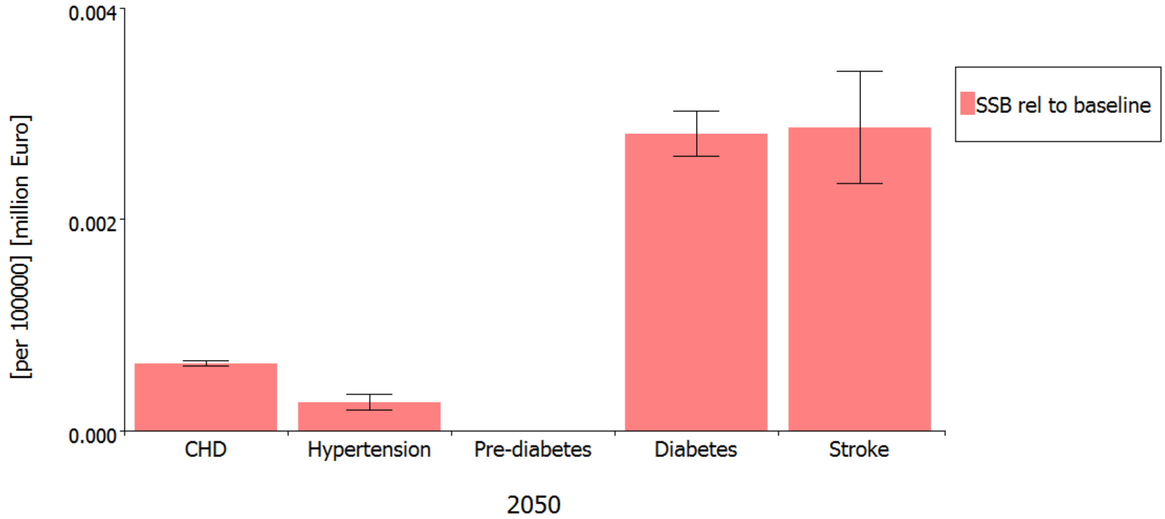


Figure 80. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

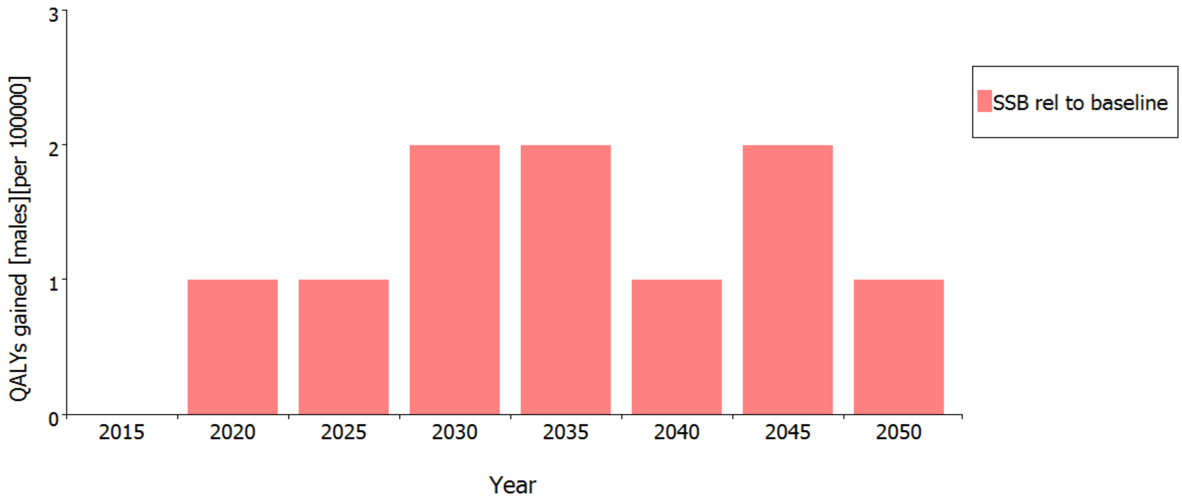


Figure 81. QALYS gained (per 100,000), relative to baseline (males)

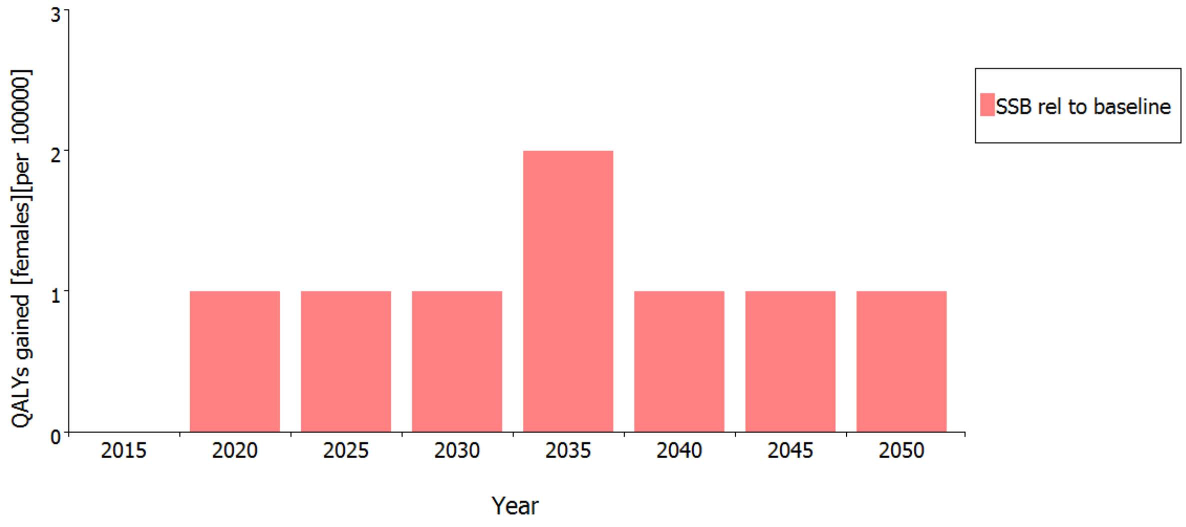


Figure 82. QALYs gained (per 100,000) relative to baseline (females)

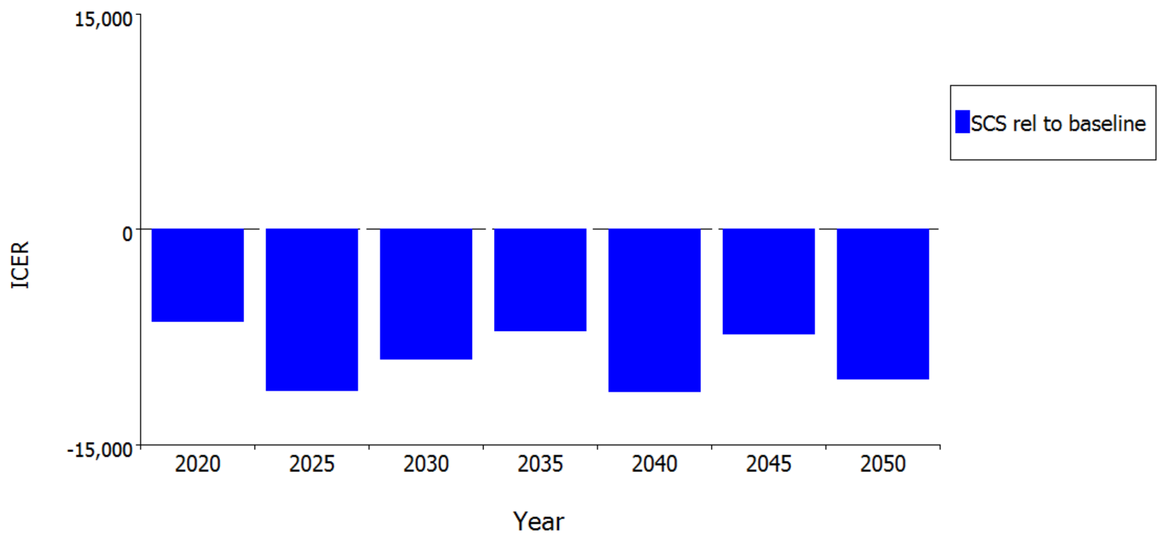


Figure 83. ICER

Smoking intervention results

This section presents the results of the smoking cessation services intervention followed by the results of the hypothetical treatment for COPD which acts on individuals in stage 3+ COPD moving to stage 2. Input data for SCS is presented in Table 62.

A multi-stage COPD model was available for Finland so results for COPD stage 1, 2 and 3+ are presented. A hypothetical treatment scenario was also modelled and the assumptions of this intervention are presented in Table 63.

Table 62. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59%
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 248 (Norway proxy)

Table 63. COPD treatment intervention input data

Parameter	Assumption
Who is treated and for how long?	COPD stage 3+ patients get the treatment, for the rest of their life as an add-on to existing treatment.
Age of those treated	There is no minimum age.
Costs of treatment	**€680** per case/year
Probability of remission	If a COPD patient is in stage 3 in the first year of their treatment, they have a probability of remission to stage 2. This one-off probability is estimated to be **0.121**.
Relative risk of moving from stage 3+ to stage 2	The RR of going from the Moderate to Severe disease stage is **0.90**.

Smoking cessation services (SCS)

Impact on disease incidence and prevalence

Table 64 presents the incidence cases per 100,000 to 2050 for baseline and each scenario. Incidence cases increase for CHD and stroke, slightly increase for COPD stages and decrease for hypertension. There is little change for lung cancer. These results are discussed further in the discussion, appendix E8 and E9. Table 65 (2015 to 2050) cumulative incidence cases per 100,000 of the baseline (no intervention) and SCS intervention scenarios. Cumulative incidence is expected to be lower across all diseases in the SCS intervention scenario relative to baseline. Table 66 and Figure 84 present the cumulative incidence cases *avoided* for the SCS intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The intervention would have its largest effect on stroke and Lung cancer with 935 and 253 cumulative incidence cases *avoided* per 100,000 in 2050, respectively.

Table 67 and Figure 85 presents the prevalence cases avoided for the SCS intervention scenario relative to baseline – presented in terms of per 100,000 (the table presents data for all years while the figure presents projections for the year 2050 only). A smoking cessation intervention is predicted to result in the avoidance of 325 cases of stroke and 29 cases of Lung cancer. However, no effect is found for CHD, COPD stage 2 and hypertension.

Table 64. Incidence cases (per 100,000)

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung cancer	Stroke
Baseline	2015	108 [+-1]	41 [+-0]	6 [+-0]	214 [+-1]	474 [+-1]	43 [+-0]	226 [+-1]
	2020	111 [+-1]	45 [+-0]	7 [+-0]	236 [+-1]	449 [+-1]	46 [+-0]	246 [+-1]
	2025	113 [+-1]	47 [+-0]	8 [+-0]	251 [+-1]	431 [+-1]	47 [+-0]	260 [+-1]
	2030	113 [+-1]	49 [+-0]	9 [+-0]	269 [+-1]	418 [+-1]	48 [+-0]	275 [+-1]
	2035	113 [+-1]	50 [+-0]	9 [+-0]	282 [+-1]	415 [+-1]	47 [+-0]	286 [+-1]
	2040	111 [+-1]	50 [+-0]	9 [+-0]	295 [+-1]	421 [+-1]	46 [+-0]	297 [+-1]
	2045	109 [+-1]	49 [+-0]	9 [+-0]	293 [+-1]	416 [+-1]	45 [+-0]	295 [+-1]
	2050	109 [+-1]	48 [+-0]	8 [+-0]	285 [+-1]	411 [+-1]	43 [+-0]	289 [+-1]
SCS	2015	108 [+-1]	42 [+-0]	6 [+-0]	214 [+-1]	473 [+-1]	43 [+-0]	226 [+-1]
	2020	111 [+-1]	45 [+-0]	7 [+-0]	235 [+-1]	447 [+-1]	44 [+-0]	240 [+-1]
	2025	111 [+-1]	47 [+-0]	8 [+-0]	250 [+-1]	430 [+-1]	43 [+-0]	244 [+-1]
	2030	110 [+-1]	49 [+-0]	8 [+-0]	269 [+-1]	417 [+-1]	42 [+-0]	250 [+-1]
	2035	110 [+-1]	49 [+-0]	8 [+-0]	281 [+-1]	412 [+-1]	39 [+-0]	253 [+-1]
	2040	107 [+-1]	49 [+-0]	8 [+-0]	295 [+-1]	418 [+-1]	36 [+-0]	261 [+-1]
	2045	105 [+-1]	48 [+-0]	8 [+-0]	295 [+-1]	412 [+-1]	33 [+-0]	259 [+-1]
	2050	104 [+-1]	47 [+-0]	8 [+-0]	288 [+-1]	407 [+-1]	31 [+-0]	254 [+-1]

Table 65. Cumulative incidence cases (per 100,000)

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung cancer	Stroke
Baseline	2015	108 [+-1]	41 [+-0]	6 [+-0]	214 [+-1]	474 [+-1]	43 [+-0]	226 [+-1]
	2020	658 [+-2]	259 [+-1]	40 [+-0]	1358 [+-2]	2754 [+-3]	264 [+-1]	1425 [+-2]
	2025	1221 [+-2]	492 [+-1]	79 [+-1]	2593 [+-3]	4941 [+-4]	499 [+-1]	2703 [+-3]
	2030	1798 [+-3]	738 [+-2]	121 [+-1]	3928 [+-4]	7098 [+-5]	741 [+-2]	4077 [+-4]
	2035	2390 [+-3]	997 [+-2]	166 [+-1]	5375 [+-4]	9282 [+-6]	991 [+-2]	5550 [+-5]
	2040	2995 [+-3]	1265 [+-2]	213 [+-1]	6937 [+-5]	11555 [+-6]	1244 [+-2]	7130 [+-5]
	2045	3612 [+-4]	1538 [+-2]	261 [+-1]	8567 [+-6]	13894 [+-7]	1498 [+-2]	8771 [+-6]
	2050	4235 [+-4]	1813 [+-3]	309 [+-1]	10194 [+-6]	16252 [+-7]	1750 [+-3]	10418 [+-6]
SCS	2015	108 [+-1]	42 [+-0]	6 [+-0]	214 [+-1]	473 [+-1]	43 [+-0]	226 [+-1]
	2020	657 [+-2]	259 [+-1]	41 [+-0]	1357 [+-2]	2749 [+-3]	262 [+-1]	1410 [+-2]
	2025	1214 [+-2]	491 [+-1]	79 [+-1]	2588 [+-3]	4934 [+-4]	482 [+-1]	2628 [+-3]
	2030	1777 [+-3]	736 [+-2]	120 [+-1]	3921 [+-4]	7080 [+-5]	699 [+-2]	3888 [+-4]
	2035	2352 [+-3]	991 [+-2]	163 [+-1]	5360 [+-4]	9250 [+-6]	909 [+-2]	5208 [+-4]
	2040	2935 [+-3]	1254 [+-2]	207 [+-1]	6915 [+-5]	11503 [+-6]	1113 [+-2]	6600 [+-5]
	2045	3527 [+-4]	1522 [+-2]	252 [+-1]	8543 [+-6]	13821 [+-7]	1309 [+-2]	8038 [+-5]
	2050	4124 [+-4]	1790 [+-3]	296 [+-1]	10177 [+-6]	16152 [+-7]	1497 [+-2]	9483 [+-6]

Table 66. Cumulative incidence cases avoided (per 100,000) relative to baseline

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	0 [+-1]	-1 [+-0]	0 [+-0]	0 [+-1]	1 [+-1]	0 [+-0]	0 [+-1]
	2020	1 [+-3]	0 [+-1]	-1 [+-0]	1 [+-3]	5 [+-4]	2 [+-1]	15 [+-3]
	2025	7 [+-3]	1 [+-1]	0 [+-1]	5 [+-4]	7 [+-6]	17 [+-1]	75 [+-4]
	2030	21 [+-4]	2 [+-3]	1 [+-1]	7 [+-6]	18 [+-7]	42 [+-3]	189 [+-6]
	2035	38 [+-4]	6 [+-3]	3 [+-1]	15 [+-6]	32 [+-8]	82 [+-3]	342 [+-6]
	2040	60 [+-4]	11 [+-3]	6 [+-1]	22 [+-7]	52 [+-8]	131 [+-3]	530 [+-7]
	2045	85 [+-6]	16 [+-3]	9 [+-1]	24 [+-8]	73 [+-10]	189 [+-3]	733 [+-8]
	2050	111 [+-6]	23 [+-4]	13 [+-1]	17 [+-8]	100 [+-10]	253 [+-4]	935 [+-8]

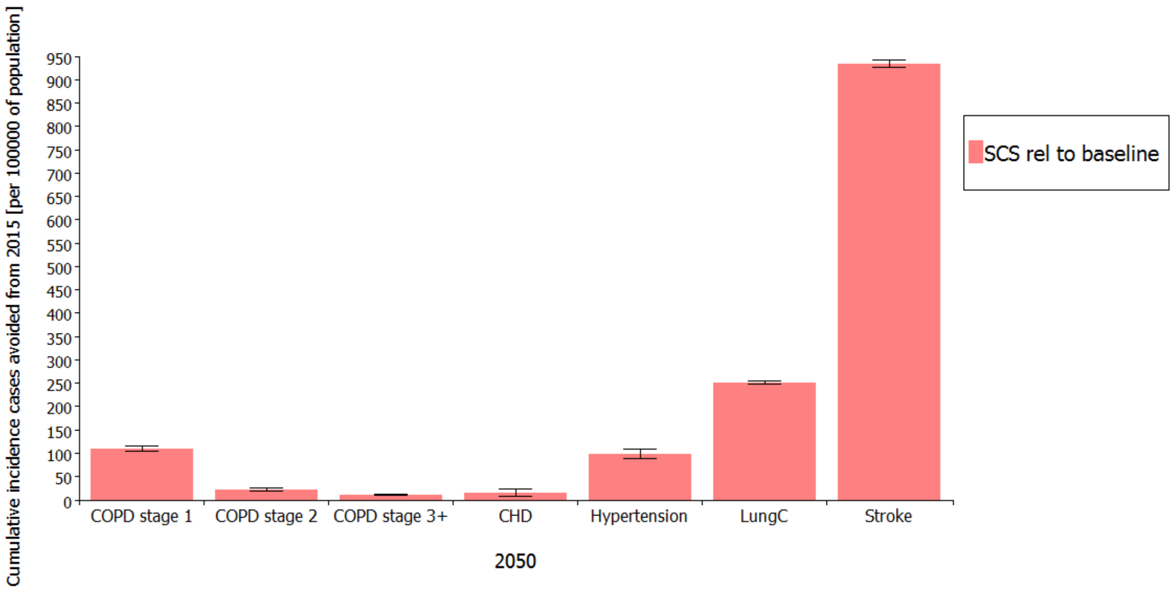


Figure 84. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 67. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	2 [+-4]	0 [+-1]	0 [+-0]	0 [+-1]	2 [+-10]	0 [+-1]	-3 [+-4]
	2020	2 [+-4]	0 [+-1]	0 [+-0]	2 [+-3]	6 [+-10]	1 [+-1]	12 [+-4]
	2025	7 [+-4]	1 [+-1]	0 [+-0]	4 [+-3]	6 [+-10]	7 [+-1]	59 [+-4]
	2030	17 [+-4]	1 [+-1]	1 [+-1]	2 [+-3]	9 [+-10]	14 [+-1]	131 [+-4]
	2035	25 [+-4]	0 [+-1]	2 [+-1]	5 [+-3]	6 [+-10]	19 [+-1]	209 [+-4]
	2040	35 [+-4]	-2 [+-3]	3 [+-1]	4 [+-3]	0 [+-11]	24 [+-1]	272 [+-4]
	2045	41 [+-4]	-2 [+-3]	4 [+-1]	1 [+-3]	-5 [+-11]	27 [+-1]	313 [+-4]
	2050	46 [+-4]	-1 [+-3]	5 [+-1]	-1 [+-3]	-10 [+-11]	29 [+-1]	325 [+-4]

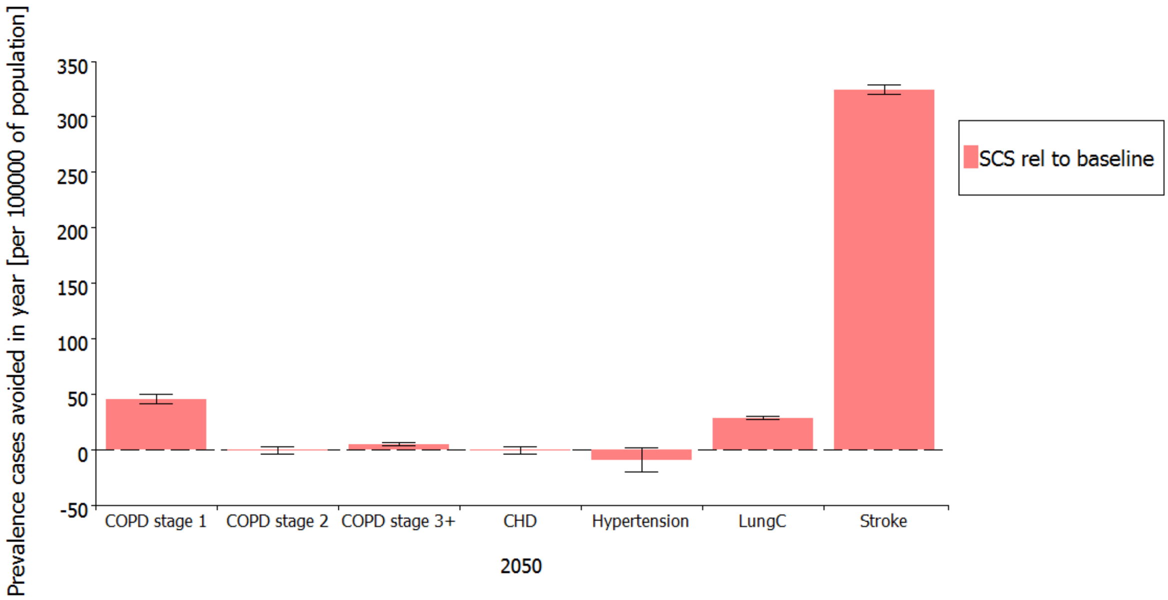


Figure 85. Prevalence cases avoided (per 100,000) relative to baseline

Impact on costs, QALYs and ICERs

Table 68 and Figure 86 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in stroke (€3.45million per 100,000 population in 2050).

Figure 87 and Table 69 presents the indirect costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to occur in stroke (€1.34million per 100,000 population in 2050).

Figure 88 and Figure 89 presents the QALYs that can be *gained* (per 100,000 population) with the SCS intervention, relative to the baseline. For both males and females, an SCS intervention does appear to be effective in increasing gains in QALYs over time.

In Figure 90, the negative ICER values (which in this case are comprised of *positive* 'QALYs gained' values in the dominator and *negative* 'costs avoided' values in the numerator) indicates that the SCS intervention is cost effective (the SCS intervention scenario *dominates* the baseline scenario).

Table 68. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung Cancer	stroke
SCS relative to baseline	2015	0.001038 [+-0.000042]	-0.000942 [+-0.000014]	-0.000152 [+-0.000001]	0.001469 [+-0.000048]	0.000484 [+-0.000389]	0.00043 [+-0.000001]	-0.10032 [+-0.002171]
	2020	0.000979 [+-0.000038]	0.00057 [+-0.000014]	-0.001334 [+-0.000001]	0.006388 [+-0.000051]	0.001182 [+-0.000346]	0.002536 [+-0.000001]	0.305908 [+-0.002196]
	2025	0.004065 [+-0.000034]	0.001477 [+-0.000013]	0.000067 [+-0.000001]	0.012036 [+-0.000049]	0.001013 [+-0.000304]	0.009302 [+-0.000001]	1.298496 [+-0.002088]
	2030	0.007957 [+-0.00003]	0.000221 [+-0.000013]	0.002758 [+-0.000001]	0.007169 [+-0.000045]	0.001295 [+-0.000264]	0.015177 [+-0.000001]	2.507118 [+-0.001931]
	2035	0.00989 [+-0.000026]	-0.000066 [+-0.000011]	0.005727 [+-0.000001]	0.009599 [+-0.00004]	0.000719 [+-0.00023]	0.018455 [+-0.000001]	3.457329 [+-0.001731]
	2040	0.012062 [+-0.000023]	-0.000946 [+-0.00001]	0.006557 [+-0.000001]	0.008898 [+-0.000035]	-0.000046 [+-0.000199]	0.018966 [+-0.000001]	3.87537 [+-0.001525]
	2045	0.012224 [+-0.000019]	-0.000906 [+-0.000008]	0.008618 [+-0.000001]	0.00135 [+-0.00003]	-0.00047 [+-0.000173]	0.019339 [+-0.000001]	3.837788 [+-0.001306]
	2050	0.011925 [+-0.000016]	-0.000881 [+-0.000007]	0.008966 [+-0.000001]	-0.00113 [+-0.000025]	-0.00077 [+-0.000147]	0.017403 [+-0]	3.445856 [+-0.001093]

Table 69. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung Cancer	stroke
SCS relative to baseline	2015	0.010447 [+-0.00043]	-0.004039 [+-0.000058]	-0.000198 [+-0.000001]	0.001022 [+-0.000034]	0.000233 [+-0.000187]	0.000606 [+-0.000001]	-0.03891 [+-0.000842]
	2020	0.009854 [+-0.000387]	0.002445 [+-0.000058]	-0.001746 [+-0.000001]	0.004439 [+-0.000035]	0.000568 [+-0.000165]	0.003576 [+-0.000002]	0.118628 [+-0.000852]
	2025	0.040917 [+-0.000345]	0.006337 [+-0.000057]	0.000087 [+-0.000003]	0.008365 [+-0.000034]	0.000487 [+-0.000146]	0.013115 [+-0.000001]	0.50354 [+-0.00081]
	2030	0.080085 [+-0.000303]	0.000947 [+-0.000054]	0.003609 [+-0.000003]	0.004982 [+-0.000031]	0.000622 [+-0.000127]	0.021396 [+-0.000001]	0.972229 [+-0.000749]
	2035	0.099537 [+-0.000263]	-0.000284 [+-0.000049]	0.007494 [+-0.000002]	0.006671 [+-0.000028]	0.000346 [+-0.00011]	0.026018 [+-0.000001]	1.34071 [+-0.000671]
	2040	0.121395 [+-0.000226]	-0.004057 [+-0.000044]	0.00858 [+-0.000001]	0.006184 [+-0.000024]	-0.000022 [+-0.000096]	0.02674 [+-0.000001]	1.50282 [+-0.000591]
	2045	0.123025 [+-0.000192]	-0.003886 [+-0.000038]	0.011279 [+-0.000001]	0.000938 [+-0.000021]	-0.00023 [+-0.000082]	0.027265 [+-0.000001]	1.488245 [+-0.000507]
	2050	0.120013 [+-0.000161]	-0.003778 [+-0.000033]	0.011732 [+-0.000001]	-0.00078 [+-0.000017]	-0.00037 [+-0.000071]	0.024534 [+-0.000001]	1.336259 [+-0.000424]

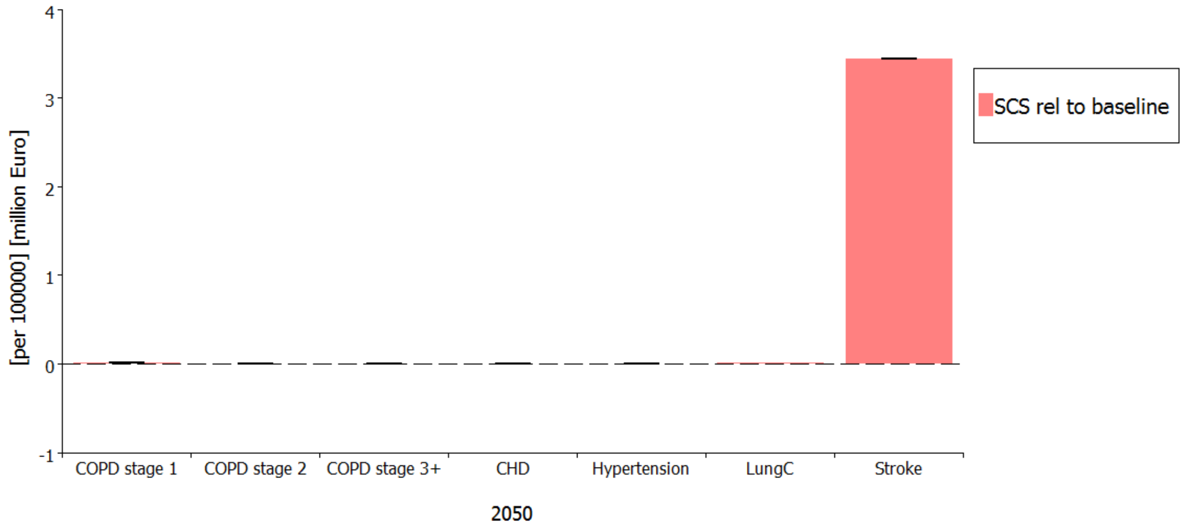


Figure 86. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

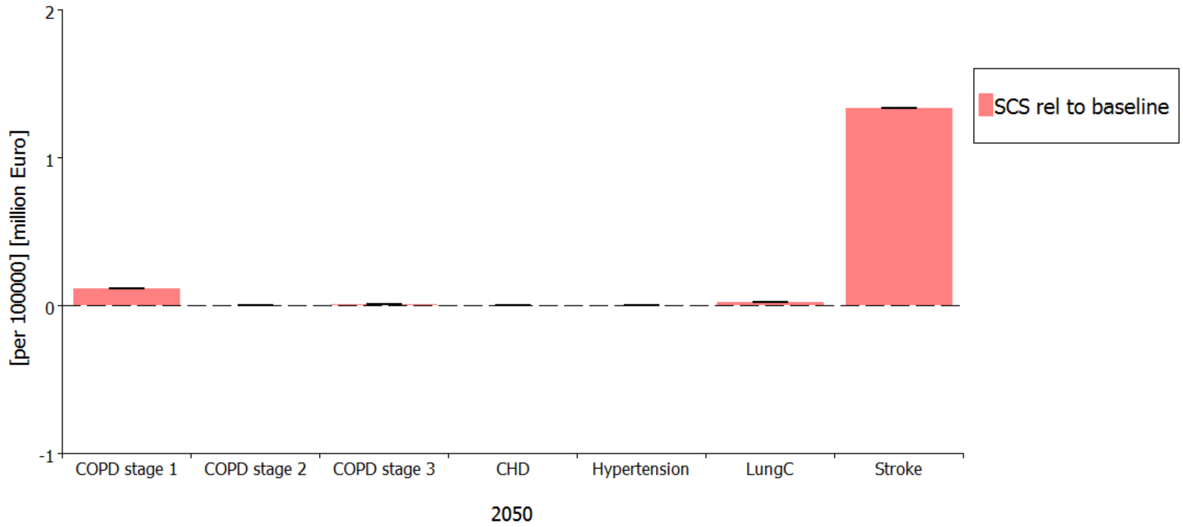


Figure 87. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

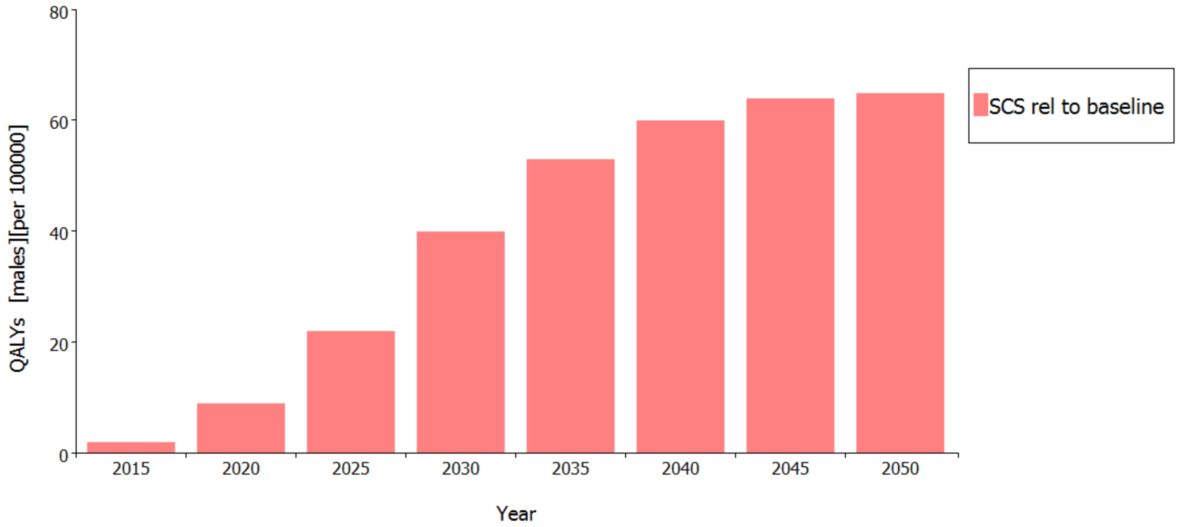


Figure 88. QALYS gained (per 100,000) relative to baseline (males)

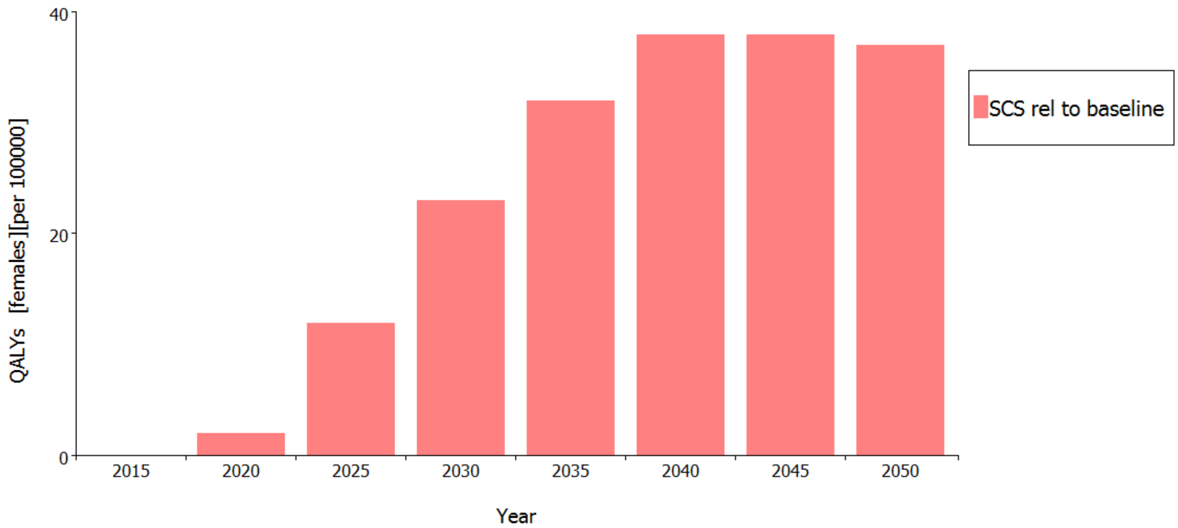


Figure 89. QALYS gained (per 100,000) relative to baseline (females)

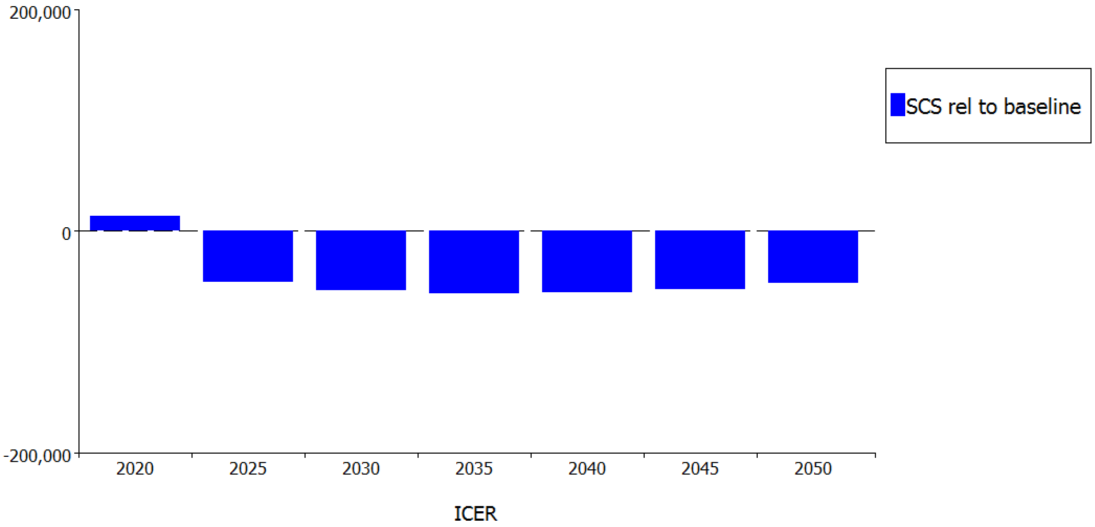


Figure 90. ICER

COPD treatment

Impact on disease incidence and prevalence

Table 70 presents the incidence cases per 100,000 for the baseline (no intervention) and COPD treatment intervention scenarios. Incidence cases increase slightly over time for COPD stage 2, increase for CHD and stroke and decrease for hypertension. There is little change for lung cancer. These results are discussed further in the discussion, appendix E8 and E9.

Table 72 and Figure 91 presents the cumulative incidence cases *avoided* for the COPD treatment relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The intervention did not have any significant effects on diseases other than COPD. For COPD cumulative incidence cases were shown to increase as a result of the intervention. However, this is because the treatment moves individuals back to stage 2 and reduces their risk of moving into stage 3. However, individuals can move forward again to stage 3 so are counted in this group again. Observing the prevalence gains is important (Figure 92).

This demonstrates that there are 27/100,000 prevalence cases avoided as a result of treating individuals in COPD stage 3+ who then move back to COPD stage2+ resulting in prevalence gains in this group. These results are described further in the discussion section.

Table 70. Incidence cases (per 100,000)

Scenario	Year	COPD Stage 1	COPD Stage 2	COPD Stage 3+	CHD	Hypertension	Lung Cancer	Stroke
Baseline	2015	108 [+-1]	41 [+-0]	6 [+-0]	214 [+-1]	474 [+-1]	43 [+-0]	226 [+-1]
	2020	111 [+-1]	45 [+-0]	7 [+-0]	236 [+-1]	448 [+-1]	45 [+-0]	246 [+-1]
	2025	113 [+-1]	48 [+-0]	8 [+-0]	251 [+-1]	431 [+-1]	47 [+-0]	260 [+-1]
	2030	114 [+-1]	49 [+-0]	9 [+-0]	270 [+-1]	419 [+-1]	48 [+-0]	275 [+-1]
	2035	113 [+-1]	50 [+-0]	9 [+-0]	283 [+-1]	415 [+-1]	48 [+-0]	287 [+-1]
	2040	111 [+-1]	50 [+-0]	9 [+-0]	296 [+-1]	421 [+-1]	46 [+-0]	299 [+-1]
	2045	110 [+-1]	49 [+-0]	9 [+-0]	295 [+-1]	415 [+-1]	45 [+-0]	297 [+-1]
	2050	109 [+-1]	48 [+-0]	8 [+-0]	287 [+-1]	411 [+-1]	43 [+-0]	290 [+-1]
COPD treatment	2015	108 [+-1]	45 [+-0]	6 [+-0]	213 [+-1]	474 [+-1]	43 [+-0]	226 [+-1]
	2020	111 [+-1]	49 [+-0]	7 [+-0]	236 [+-1]	448 [+-1]	46 [+-0]	246 [+-1]
	2025	113 [+-1]	51 [+-0]	8 [+-0]	252 [+-1]	431 [+-1]	47 [+-0]	260 [+-1]
	2030	114 [+-1]	53 [+-0]	9 [+-0]	270 [+-1]	419 [+-1]	48 [+-0]	275 [+-1]
	2035	113 [+-1]	54 [+-0]	9 [+-0]	284 [+-1]	414 [+-1]	48 [+-0]	287 [+-1]
	2040	111 [+-1]	54 [+-0]	10 [+-0]	296 [+-1]	421 [+-1]	47 [+-0]	299 [+-1]
	2045	110 [+-1]	53 [+-0]	9 [+-0]	295 [+-1]	415 [+-1]	45 [+-0]	297 [+-1]
	2050	109 [+-1]	53 [+-0]	9 [+-0]	287 [+-1]	411 [+-1]	44 [+-0]	290 [+-1]

Table 71. Cumulative incidence cases (per 100,000)

Scenario	Year	CODP Stage 1	COPD Stage 2	COPD Stage 3+	CHD	Hypertension	Lung Cancer	Stroke
Baseline	2015	108 [+-1]	41 [+-0]	6 [+-0]	214 [+-1]	474 [+-1]	43 [+-0]	226 [+-1]
	2020	657 [+-2]	260 [+-1]	41 [+-0]	1357 [+-2]	2752 [+-3]	264 [+-1]	1424 [+-2]
	2025	1221 [+-2]	492 [+-1]	79 [+-1]	2590 [+-3]	4938 [+-4]	497 [+-1]	2703 [+-3]
	2030	1797 [+-3]	739 [+-2]	121 [+-1]	3927 [+-4]	7091 [+-5]	740 [+-2]	4075 [+-4]
	2035	2389 [+-3]	997 [+-2]	166 [+-1]	5374 [+-4]	9271 [+-6]	991 [+-2]	5550 [+-5]
	2040	2994 [+-3]	1266 [+-2]	213 [+-1]	6938 [+-5]	11542 [+-6]	1244 [+-2]	7132 [+-5]
	2045	3611 [+-4]	1540 [+-2]	262 [+-1]	8568 [+-6]	13875 [+-7]	1499 [+-2]	8778 [+-6]
	2050	4235 [+-4]	1816 [+-3]	310 [+-1]	10200 [+-6]	16225 [+-7]	1751 [+-3]	10428 [+-6]
COPD treatment	2015	108 [+-1]	45 [+-0]	6 [+-0]	213 [+-1]	474 [+-1]	43 [+-0]	226 [+-1]
	2020	657 [+-2]	282 [+-1]	42 [+-0]	1357 [+-2]	2751 [+-3]	264 [+-1]	1424 [+-2]
	2025	1221 [+-2]	533 [+-1]	83 [+-1]	2591 [+-3]	4938 [+-4]	498 [+-1]	2703 [+-3]
	2030	1797 [+-3]	799 [+-2]	128 [+-1]	3927 [+-4]	7092 [+-5]	741 [+-2]	4075 [+-4]
	2035	2389 [+-3]	1079 [+-2]	176 [+-1]	5375 [+-4]	9271 [+-6]	991 [+-2]	5551 [+-5]
	2040	2993 [+-3]	1370 [+-2]	227 [+-1]	6938 [+-5]	11541 [+-6]	1246 [+-2]	7131 [+-5]
	2045	3610 [+-4]	1668 [+-3]	2 [+-1]	8569 [+-6]	13877 [+-7]	1501 [+-2]	8777 [+-6]
	2050	4235 [+-4]	1968 [+-3]	332 [+-1]	10203 [+-6]	16226 [+-7]	1753 [+-3]	10427 [+-6]

Table 72. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	COPD Stage 1	COPD Stage 2	COPD Stage 3+	CHD	Hypertension	Lung Cancer	Stroke
COPD treatment	2015	0 [+-1]	-4 [+-0]	0 [+-0]	1 [+-1]	0 [+-1]	0 [+-0]	0 [+-1]
	2020	0 [+-3]	-22 [+-1]	-1 [+-0]	0 [+-3]	1 [+-4]	0 [+-1]	0 [+-3]
	2025	0 [+-3]	-41 [+-1]	-4 [+-1]	-1 [+-4]	0 [+-6]	-1 [+-1]	0 [+-4]
	2030	0 [+-4]	-60 [+-3]	-7 [+-1]	0 [+-6]	-1 [+-7]	-1 [+-3]	0 [+-6]
	2035	0 [+-4]	-82 [+-3]	-10 [+-1]	-1 [+-6]	0 [+-8]	0 [+-3]	-1 [+-7]
	2040	1 [+-4]	-104 [+-3]	-14 [+-1]	0 [+-7]	1 [+-8]	-2 [+-3]	1 [+-7]
	2045	1 [+-6]	-128 [+-4]	-18 [+-1]	-1 [+-8]	-2 [+-10]	-2 [+-3]	1 [+-8]
	2050	0 [+-6]	-152 [+-4]	-22 [+-1]	-3 [+-8]	-1 [+-10]	-2 [+-4]	1 [+-8]

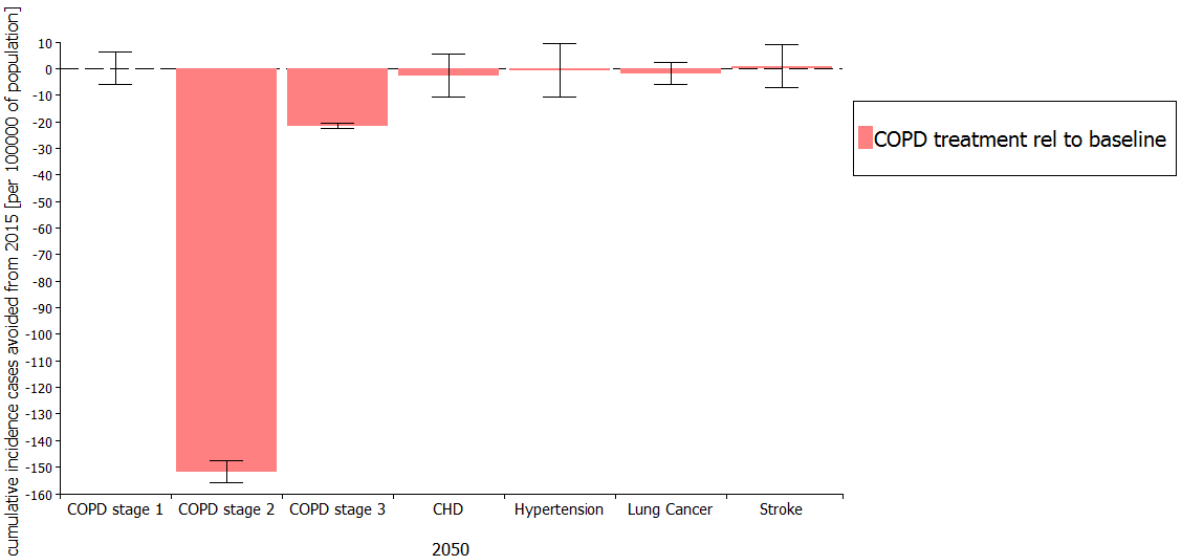


Figure 91. Cumulative incidence cases avoided (per 100,000) relative to baseline

Table 73. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	COPD Stage 1	COPD Stage 2	COPD Stage 3	CHD	Hypertension	Lung Cancer	Stroke
COPD treatment	2015	1 [+-4]	-5 [+-1]	4 [+-0]	1 [+-1]	-1 [+-10]	0 [+-1]	-1 [+-4]
	2020	0 [+-4]	-17 [+-1]	15 [+-0]	0 [+-3]	0 [+-10]	-1 [+-1]	0 [+-4]
	2025	0 [+-4]	-21 [+-1]	20 [+-0]	-1 [+-3]	0 [+-10]	0 [+-1]	-2 [+-4]
	2030	0 [+-4]	-25 [+-1]	24 [+-1]	0 [+-3]	-3 [+-10]	0 [+-1]	0 [+-4]
	2035	0 [+-4]	-28 [+-2]	27 [+-1]	0 [+-3]	1 [+-10]	0 [+-1]	-1 [+-4]
	2040	0 [+-4]	-29 [+-3]	27 [+-1]	0 [+-3]	2 [+-10]	-1 [+-1]	0 [+-4]
	2045	0 [+-4]	-30 [+-3]	27 [+-1]	0 [+-3]	0 [+-11]	0 [+-1]	0 [+-4]
	2050	-1 [+-4]	-29 [+-3]	27 [+-1]	-2 [+-3]	-1 [+-11]	0 [+-1]	0 [+-4]

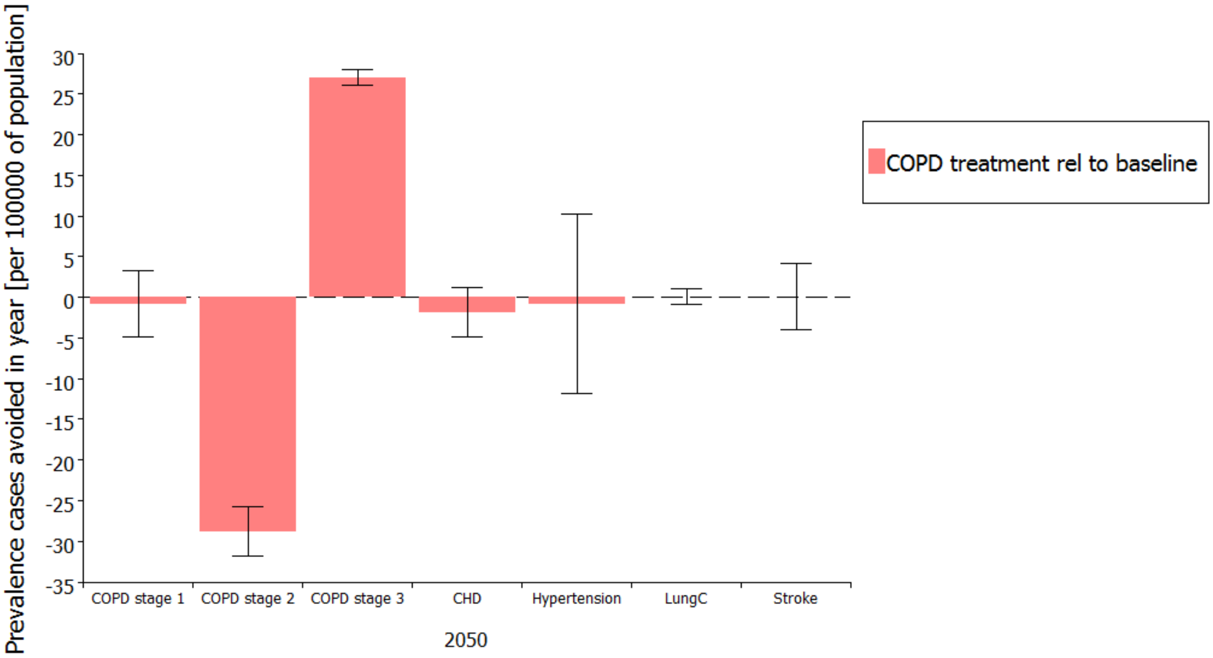


Figure 92. Prevalence cases (per 100,000), relative to baseline

Impact to costs, QALYs and ICERs

Table 74 and Figure 93 presents the direct healthcare costs that can be avoided (per 100,000 population) with the COPD treatment, relative to the baseline. The graph reveals that the direct healthcare costs *avoided* are expected to occur in stage 3+ COPD, reaching €0.054m per 100,000 population in 2050. However, this was coupled with an increase in costs for stage 2 COPD of €0.018m per 100,000 population in 2050. There were no costs avoided for the other diseases.

A similar pattern of results was found for indirect costs with the largest costs avoided for COPD stage 3 (€0.070m per 100,000 population in 2050) (Table 75 and Figure 94).

Figure 95 and Figure 96 present the QALYs that can be *gained* (per 100,000) with the COPD treatment, relative to the baseline. For both males and female, QALY gained are consistently small (<=1). Thus it was not possible to calculate an ICER for this scenario.

Table 74. Direct healthcare costs (€ millions) avoided (per 100,000) relative to baseline

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung cancer	Stroke
COPD treatment relative to baseline	2015	0.000705 [+-0.000042]	-0.00816 [+-0.000014]	0.020925 [+-0.000001]	0.000812 [+-0.000048]	-0.000152 [+-0.000389]	0.000212 [+-0.000001]	-0.01675 [+-0.00217]
	2020	0.000126 [+-0.000038]	-0.023892 [+-0.000014]	0.073345 [+-0.000001]	-0.001587 [+-0.000051]	-0.000073 [+-0.000346]	-0.00051 [+-0.000001]	-0.01026 [+-0.002208]
	2025	0.000081 [+-0.000034]	-0.027625 [+-0.000013]	0.08494 [+-0.000001]	-0.002452 [+-0.000049]	-0.000098 [+-0.000304]	-0.00011 [+-0.000001]	-0.03225 [+-0.002133]
	2030	0.000173 [+-0.00003]	-0.027617 [+-0.000013]	0.086617 [+-0.000001]	-0.00042 [+-0.000045]	-0.000369 [+-0.000266]	-0.00034 [+-0.000001]	-0.01061 [+-0.002012]
	2035	0.00024 [+-0.000027]	-0.026456 [+-0.000012]	0.081976 [+-0.000001]	-0.000402 [+-0.00004]	0.00006 [+-0.000231]	0.000114 [+-0.000001]	-0.01981 [+-0.001846]
	2040	-0.000069 [+-0.000023]	-0.023822 [+-0.000011]	0.073299 [+-0.000001]	-0.001272 [+-0.000035]	0.000151 [+-0.000199]	-0.00024 [+-0.000001]	-0.00012 [+-0.001653]
	2045	0.000001 [+-0.00002]	-0.020825 [+-0.000009]	0.063992 [+-0.000001]	-0.000198 [+-0.000031]	-0.000055 [+-0.000173]	-0.00018 [+-0.000001]	0.000494 [+-0.001435]
	2050	-0.000061 [+-0.000017]	-0.017705 [+-0.000008]	0.053824 [+-0.000001]	-0.001974 [+-0.000025]	-0.000091 [+-0.000148]	0.000137 [+-0]	-0.0018 [+-0.001209]

Table 75. Indirect costs (€ millions) avoided (per 100,000) relative to baseline

Scenario	Year	COPD stage 1	COPD stage 2	COPD stage 3+	CHD	Hypertension	Lung cancer	Stroke
COPD treatment relative to baseline	2015	0.007092 [+-0.000431]	-0.035005 [+-0.000059]	0.027383 [+-0.000001]	0.000565 [+-0.000034]	-0.000073 [+-0.000187]	0.000299 [+-0.000001]	-0.0065 [+-0.000841]
	2020	0.001266 [+-0.000389]	-0.102495 [+-0.000059]	0.09598 [+-0.000001]	-0.001103 [+-0.000035]	-0.000035 [+-0.000167]	-0.00073 [+-0.000003]	-0.00398 [+-0.000856]
	2025	0.000814 [+-0.000346]	-0.118506 [+-0.000058]	0.111153 [+-0.000002]	-0.001704 [+-0.000034]	-0.000047 [+-0.000146]	-0.00015 [+-0.000001]	-0.01251 [+-0.000827]
	2030	0.001746 [+-0.000305]	-0.118471 [+-0.000055]	0.113348 [+-0.000002]	-0.000292 [+-0.000031]	-0.000178 [+-0.000127]	-0.00047 [+-0.000001]	-0.00411 [+-0.000781]
	2035	0.002417 [+-0.000266]	-0.113487 [+-0.000051]	0.107274 [+-0.000002]	-0.000279 [+-0.000028]	0.000029 [+-0.00011]	0.000161 [+-0.000001]	-0.00768 [+-0.000716]
	2040	-0.0007 [+-0.000229]	-0.102193 [+-0.000046]	0.09592 [+-0.000001]	-0.000884 [+-0.000025]	0.000073 [+-0.000096]	-0.00034 [+-0.000001]	-0.000046 [+-0.000642]
	2045	0.000019 [+-0.000195]	-0.089332 [+-0.00004]	0.083742 [+-0.000001]	-0.000137 [+-0.000021]	-0.000027 [+-0.000083]	-0.00025 [+-0.000001]	0.000193 [+-0.000556]
	2050	-0.00062 [+-0.000165]	-0.075952 [+-0.000034]	0.070435 [+-0.000001]	-0.001372 [+-0.000017]	-0.000044 [+-0.000071]	0.000194 [+-0.000001]	-0.0007 [+-0.000469]

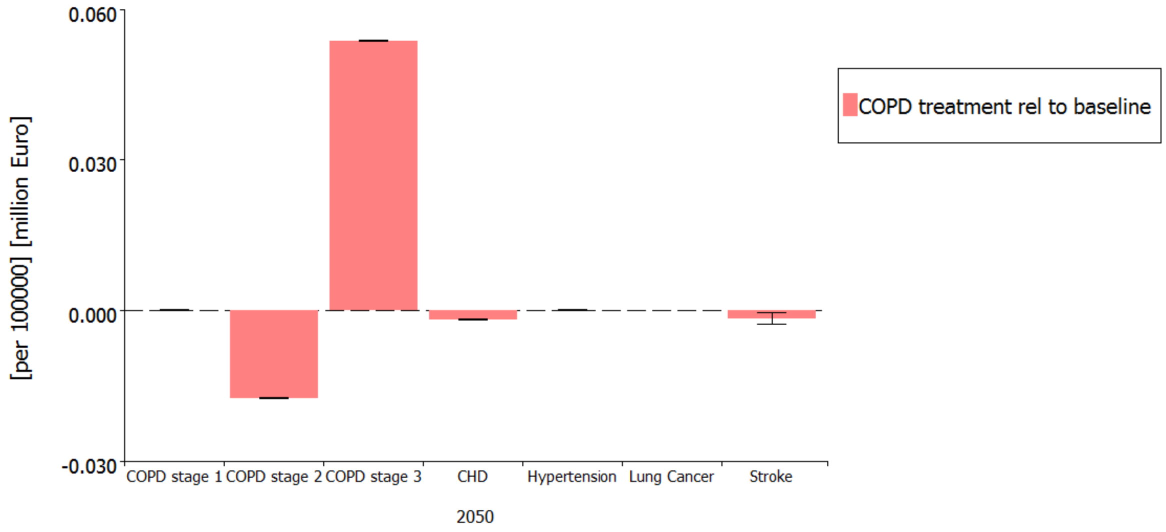


Figure 93. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

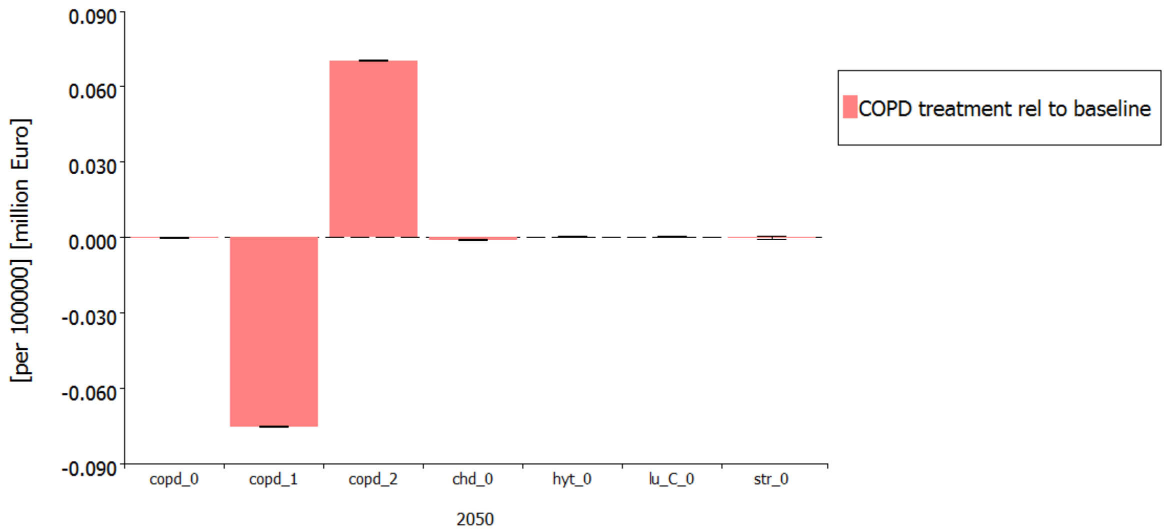


Figure 94. Indirect costs (€ millions) avoided (per 100,000) relative to baseline

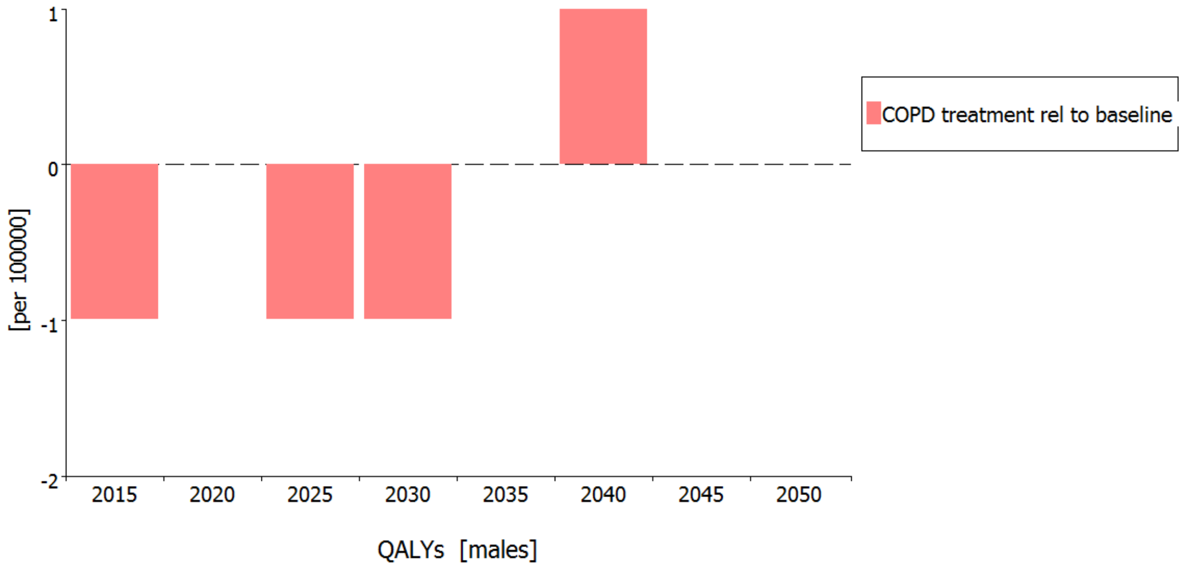


Figure 95. QALYS gained (per 100,000), relative to baseline (males)

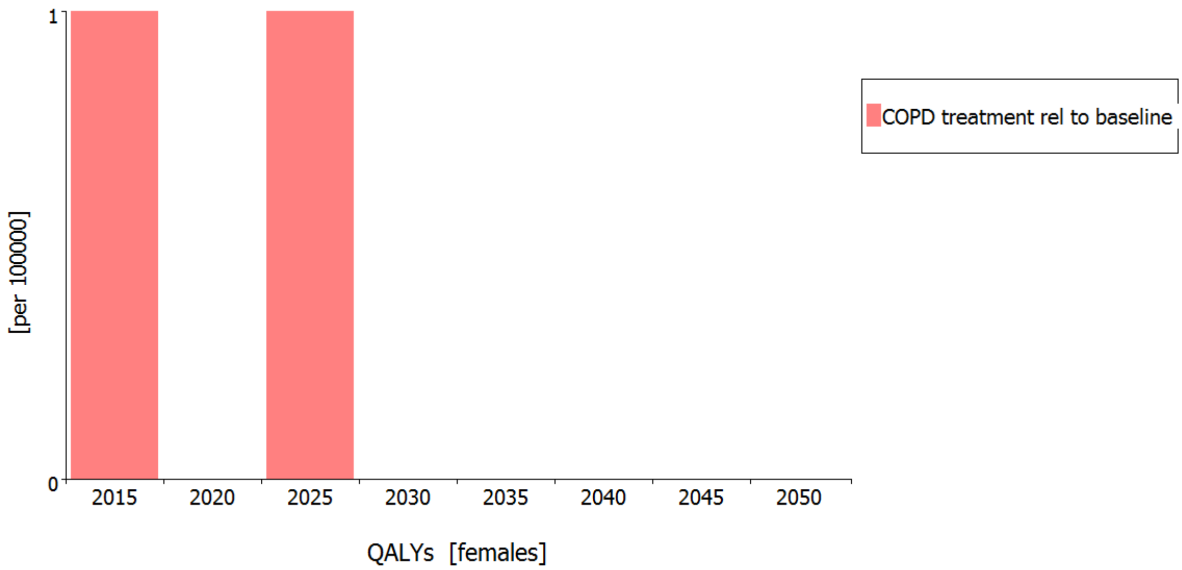


Figure 96. QALYS gained (per 100,000) relative to baseline (females)

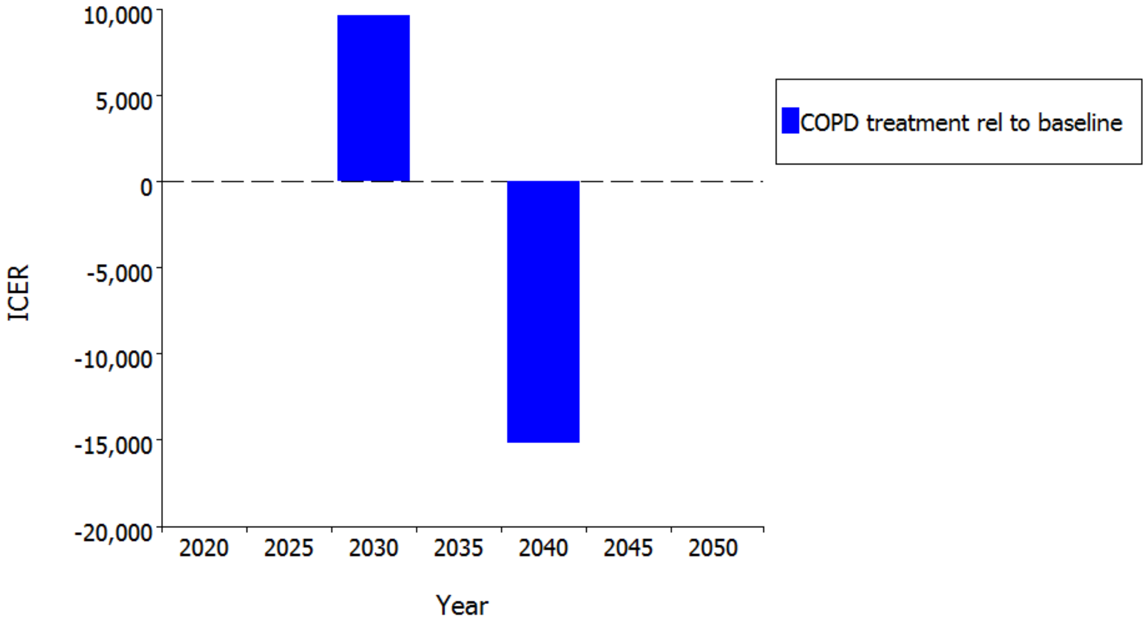


Figure 97. ICER

Greece

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m2) are presented in Table 76 and for smoking prevalence by age and sex are presented in Table 77. Data were also collected by personal communication where possible. Data were also collected by education level and income group where available in order to explore future prevalence of each risk factor by sub-groups.

Table 76. References used in the model for BMI prevalence

Reference	Year	Sample size M	Sample size F	Age group	Measured/ Self-reported	National/ Regional
Survey on Income & Living Conditions, Hellenic Statistical Authority, personal communication	1998	4,659,710	5,133,801	15-100	Self-reported	National
Survey on Income & Living Conditions, Hellenic Statistical Authority, personal communication	1999	4,428,897	4,912,742	15-100	Self-reported	National
Survey on Income & Living Conditions, Hellenic Statistical Authority, personal communication	2000	4,398,975	4,831,754	15-100	Self-reported	National
Survey on Income & Living Conditions, Hellenic Statistical Authority, personal communication	2001	4,360,600	4,867,626	15-100	Self-reported	National
WHO; Kapantais et al, 2004	2003	8,234	9,107	20-69	Self-reported	National
World Health Survey, 2003 [1]	2003	500	500	20-100	Self-reported	National
European Health Interview Survey, Eurostat [1]	2008	3,162	3,162	20-100	Self-reported	National
Survey on Income & Living Conditions, Hellenic Statistical Authority, personal communication	2009	4,369,422	4,618,038	15-100	Self-reported	National
Hellas Health I Survey Personal communication Filippo Fillipidis	2006	459	506	18+	Self-reported	National
Hellas Health II Survey Personal communication Filippo Fillipidis	2008	683	763	18+	Self-reported	National
Hellas Health III Survey, Personal communication Filippo Fillipidis	2010	492	487	18+	Self-reported	National

[1] Used for BMI projections by education level only.

Table 77. References used in the model for smoking prevalence

Reference	Year	Sample size	Age group	National/subnational
Pitsavos et al, 2008	1999	19,477	20-64	National
European Health Interview Survey	2009	4,260	20-100	National

Disease data

Disease data sources are detailed in appendix A3. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. For Greece, Lithuanian proxy data were used for CHD and COPD incidence and COPD prevalence (Pers comm V Kraucioniene). Diabetes statistics for Greece and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, Appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using prevalence and mortality data (see technical appendix B4 for details). Hypertension incidence was calculated within the programme using prevalence data. Dutch data were used as proxy for direct costs of COPD, hypertension and pre-diabetes; for indirect costs for diabetes and hypertension and for utility weights for CHD, COPD and stroke accounting for exchange rates and purchasing price parities (appendix E5). UK data was used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Intervention data

Table 78 and Table 79 presents the intervention input data for each of the interventions modelled:

Table 78. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (€)
Baseline	None	-	-
MCLI regain	0.6	100	175
MCLI no regain	0.6	0	175
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax

Table 79. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	65%
Accessibility of the intervention (%)	50%
Overall reach (%)	33%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	22%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€220

* as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Section 2: Risk factor projections to 2050

BMI projections by age and sex

Table 80 presents the prevalence of normal weight, over-weight and obese (according to BMI) in the adult population, by sex. Overall, in both Greek males and females, obesity prevalence is projected to increase reaching 78% and 66% respectively by 2050Overweight prevalence is projected to decline. The proportion of healthy weight males and females is projected to decline over the next 35 years.

Figure 98 to Figure 103 present BMI-group projections to 2050 for males 20-79 years (normal weight=<25 kg/m2, in green; overweight=25-29.9 kg/m2, in blue; obesity=≥30 kg/m2, in red) by 10-year age groups. Various data sources were used as a proxy for the Greek population: Survey on Income & Living Conditions (1998-2001 and 2009), WHO and World Health surveys (2003) the European Health Interview Survey (2008) and Hellas Health Surveys I-III (2006-2010). The increase in obesity prevalence described above is expected among males across all age groups. Among males 60 to 69 years old, obesity prevalence could reach 68% by 2050 (Figure 102). The proportion of healthy weight males is predicted to decline in all age groups.

Figure 104 to Figure 109 present the BMI-group projections to 2050 for females 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence is expected among all age groups. The largest increase is projected among 70 to 79 year olds in whom obesity prevalence could exceed 90% in 2050 (Figure 109). Overweight prevalence is projected to decline across age groups. The proportion of healthy weight females is predicted to decline in all age groups.

Table 80. Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI
2015	31.0	3.0	43.0	3.0	27.0	3.0	43.0	3.0	32.0	3.0	26.0	3.0	37.0	3.0	37.0	3.0	26.0	3.0
2020	27.0	4.1	39.0	4.1	34.0	4.0	39.0	4.1	29.0	4.1	32.0	4.0	33.0	4.1	34.0	4.1	33.0	4.0
2025	24.0	5.1	34.0	5.1	42.0	5.0	35.0	5.1	27.0	5.1	38.0	5.0	30.0	5.1	30.0	5.1	40.0	5.0
2030	21.0	6.2	29.0	6.2	50.0	6.1	32.0	6.2	24.0	6.2	45.0	6.1	26.0	6.2	26.0	6.2	47.0	6.1
2035	18.0	7.3	24.0	7.3	58.0	7.1	28.0	7.2	21.0	7.2	51.0	7.1	23.0	7.2	23.0	7.3	54.0	7.1
2040	15.0	8.3	20.0	8.3	66.0	8.2	25.0	8.3	19.0	8.3	57.0	8.2	20.0	8.3	19.0	8.3	61.0	8.2
2045	12.0	9.4	16.0	9.4	72.0	9.3	22.0	9.4	16.0	9.4	62.0	9.2	17.0	9.4	16.0	9.4	67.0	9.3
2050	10.0	10.5	12.0	10.5	78.0	10.3	19.0	10.5	14.0	10.5	66.0	10.3	15.0	10.5	13.0	10.5	72.0	10.3

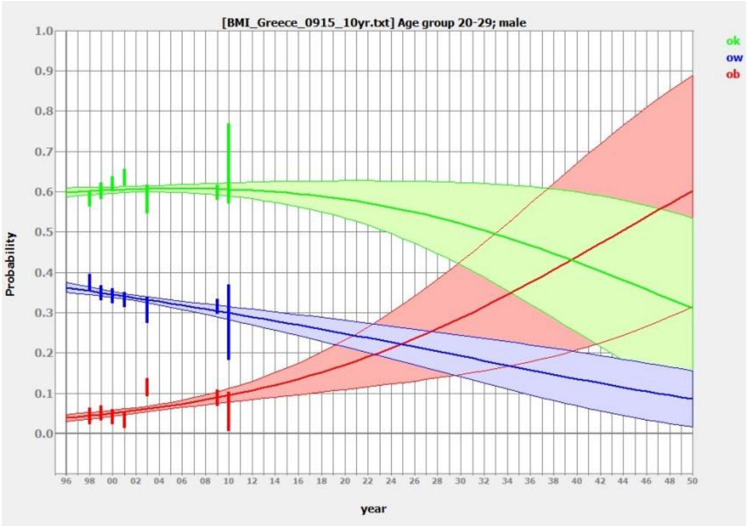


Figure 98. Projected BMI-group in 20-29 year old males

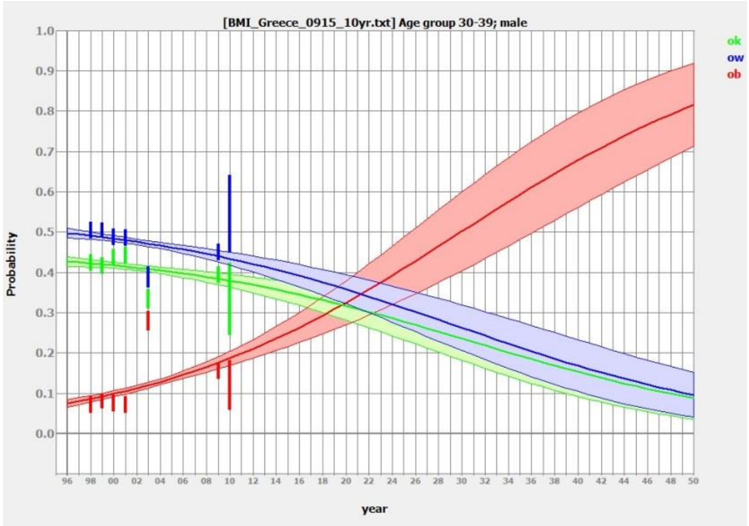


Figure 99. Projected BMI-group in 30-39 year old males

Figure 100. Projected BMI-group in 40-49 year old males

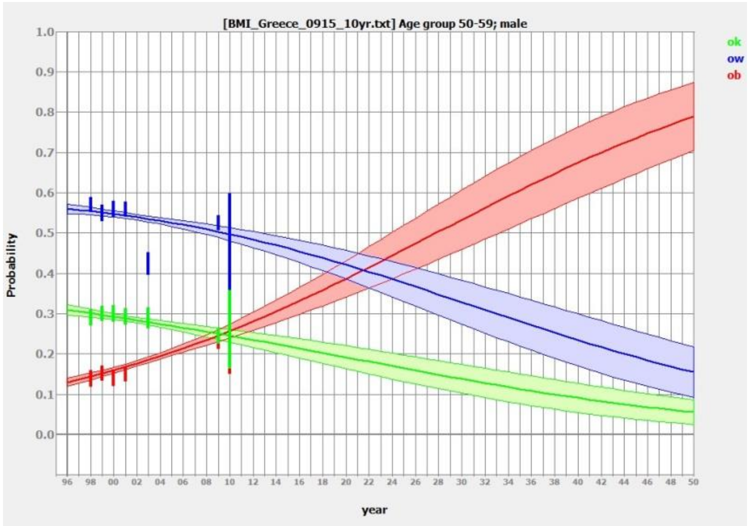


Figure 101. Projected BMI- group in 50-59 year old males

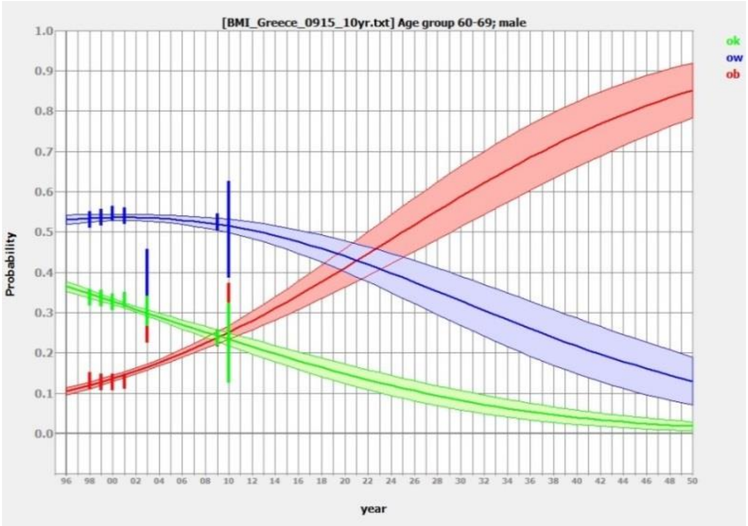


Figure 102. Projected BMI- group in 60-69 year old males

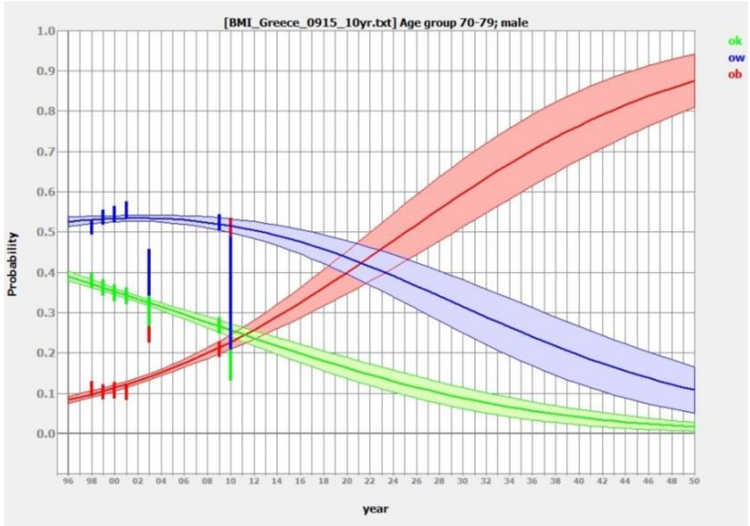


Figure 103. Projected BMI- group in 70-79 year old males

Figure 104. Projected BMI- group in 20-29 year old females

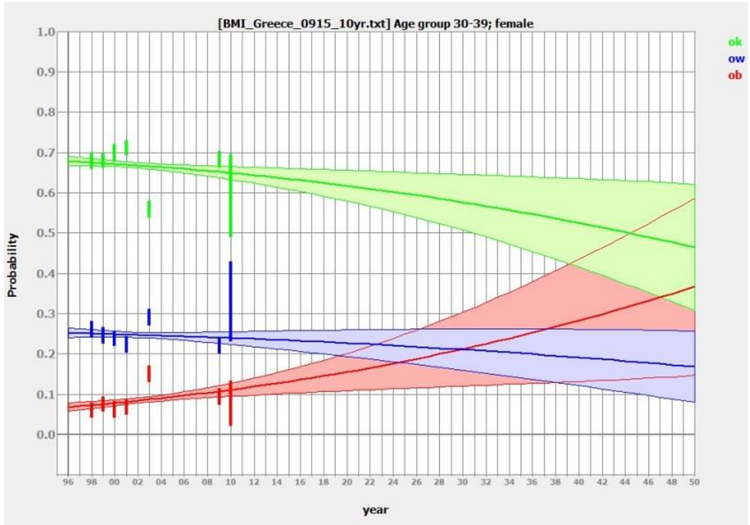


Figure 105. Projected BMI- group in 30-39 year old females

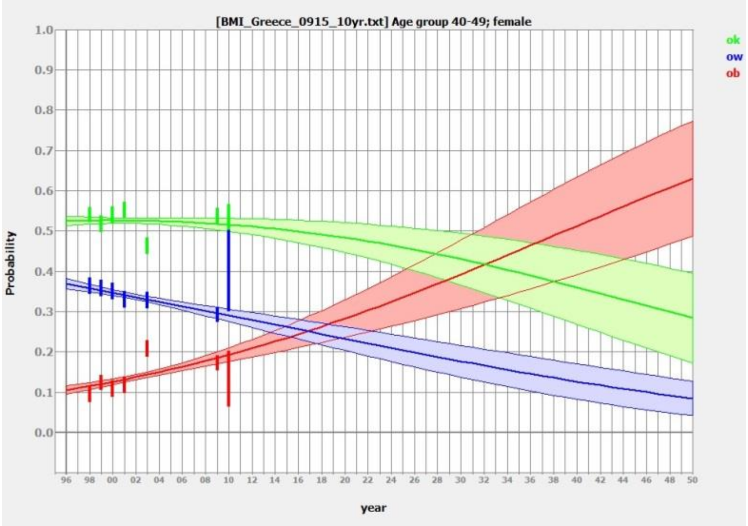


Figure 106. Projected BMI- group in 40-49 year old females

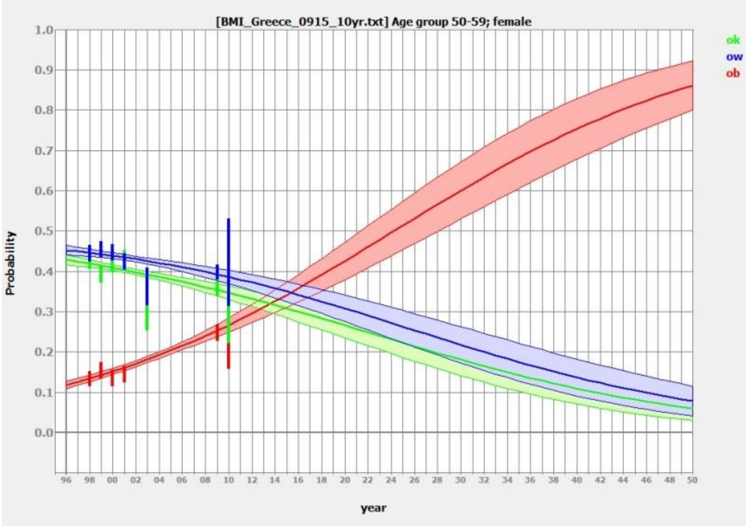


Figure 107. Projected BMI- group in 50-59 year old females

Figure 108. Projected BMI- group in 60-69 year old females

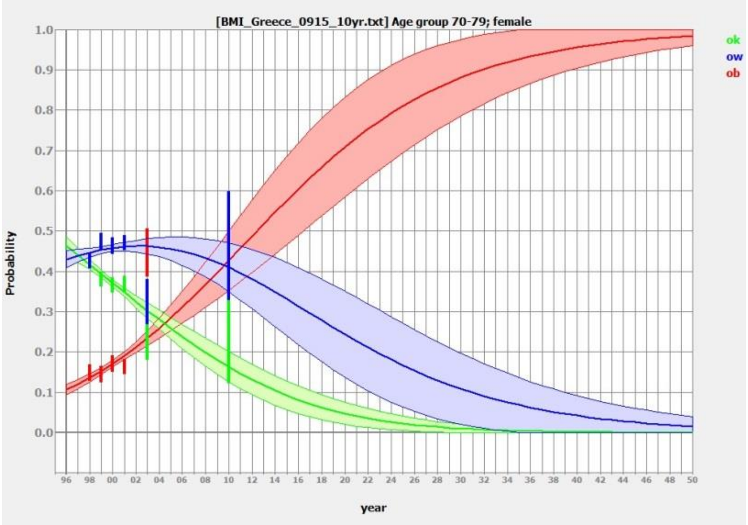


Figure 109. Projected BMI- group in 70-79 year old females

BMI projections by education level

Education was divided into two groups: 1) below tertiary education 2) tertiary education and above. Tertiary education was defined as 'post-secondary education'.

Greek projections for overweight and obesity by education level were estimated using the only two data points available (2003 and 2008 Eurostat data). For this reason the error around projections is large and conclusive statements about inequality trends cannot be made. This also explains apparent inconsistencies in projections by age and sex (which were based on more data points) compared to education and sex (which were based on just two data points).

Males

Historically overweight prevalence has been similar for males with less than tertiary education and males with at least tertiary education (Figure 110). From 2020 prevalence of overweight is predicted to diverge resulting in higher levels of overweight amongst lesser educated males (77%) compared to more educated males (52%) by 2050. However, error bars are extremely wide and overlap between groups for all years so the projections should be interpreted with caution. The reverse trend is projected for obesity, which is predicted to increase in both groups, but at a faster rate among tertiary educated males compared to males with less than tertiary education (Figure 111); again these findings should be viewed with caution given wide and overlapping error bars.

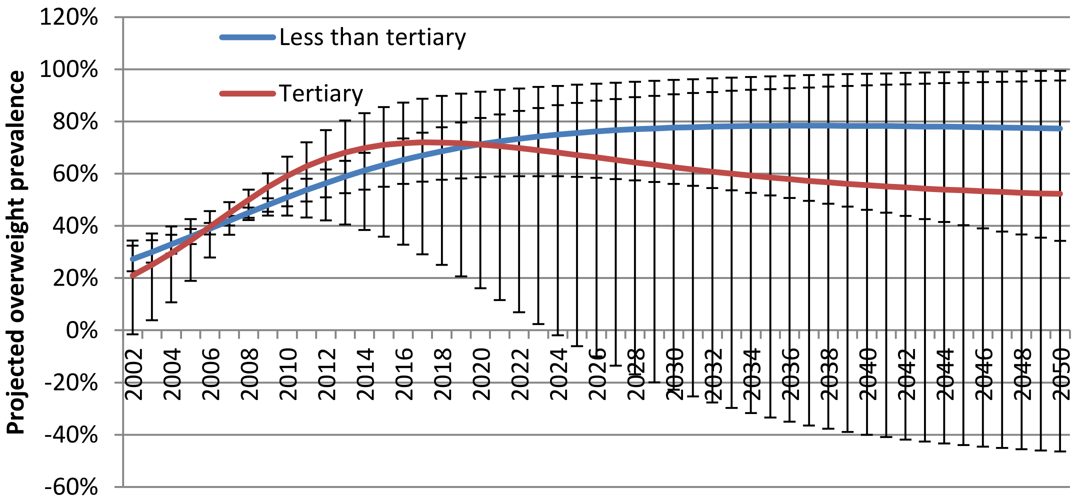


Figure 110. Overweight prevalence by education level among males

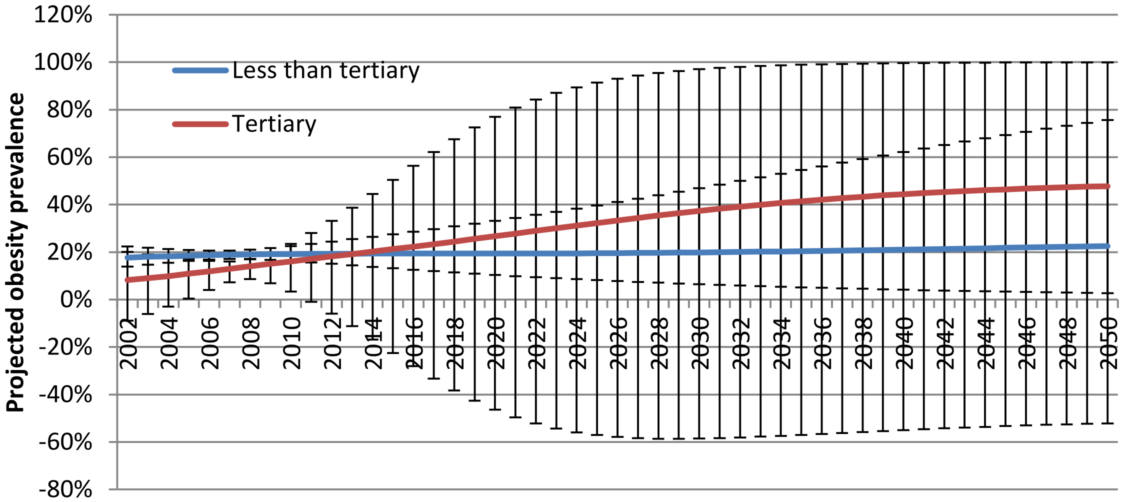


Figure 111. Obesity prevalence by education level among males

Females

Overweight prevalence appears to be decreasing in females with tertiary education and those with less than tertiary education, but is projected to decrease at a faster rate in the more educated group (Figure 112). Obesity prevalence has remained stable in both education groups in the period for which data are available, and is predicted to remain approximately stable for both groups to 2050 (Figure 113). However, again due to wide and overlapping error bars (caused by few data points) these findings should be viewed with caution.

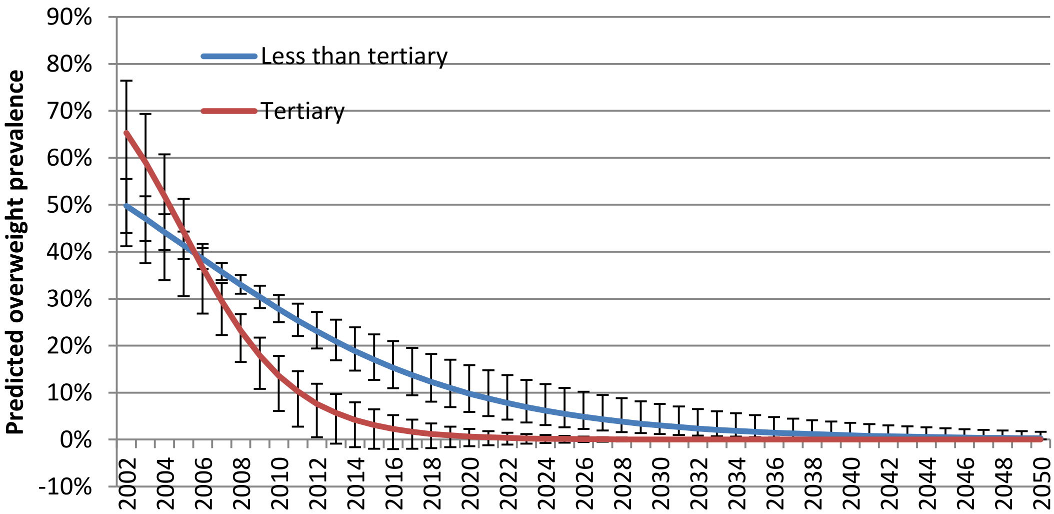


Figure 112. Overweight prevalence by education level among females

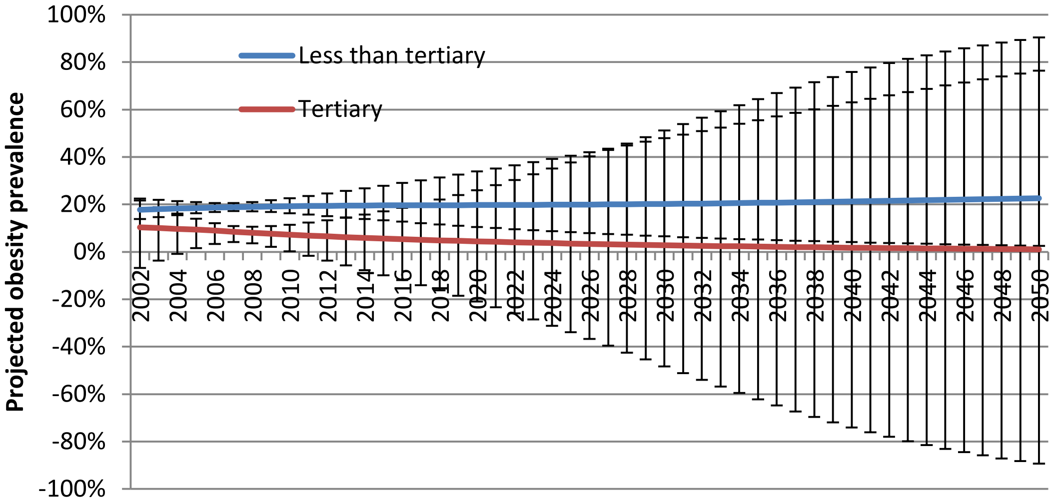


Figure 113. Obesity prevalence by education level among females

Smoking projections by sex and age group

Table 81presents smoking prevalence projections to 2050 for males and females aged 20 to 100. Smoking prevalence is projected to decline in males reaching 9% in 2050, but increase substantially in females reaching 54% over the same time period.

The decline in smoking prevalence is expected across all age groups among males (Figure 114 to Figure 118). The largest change is projected among 20 to 29 year old males in whom the prevalence of smoking will decline from approximately 80% in 1995 to less than 1% in 2050 (Figure 114). A mixed picture emerges for smoking projections amongst Greek females depending on age group (Figure 119 to Figure 123). Smoking prevalence amongst females 20-39 years is predicted to decline from approximately 50% to less than 10% between 1995 and 2050 (Figure 119 and Figure 120). Conversely, smoking prevalence is projected to increase in females in the 40-69 age groups, with a particularly steep increase for females 60-69 years from 5% in 1995 to more than 95% in 2050 (Figure 123).

Table 81. Smoker prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-
2015	67.0	6.3	33.0	6.3	65.0	4.1	35.0	4.1	66.0	5.3	34.0	5.3
2020	74.0	3.7	26.0	3.7	60.0	2.2	40.0	2.2	67.0	3.0	33.0	3.0
2025	79.0	4.4	21.0	4.4	56.0	3.8	44.0	3.8	67.0	4.1	33.0	4.1
2030	83.0	7.5	17.0	7.5	52.0	6.7	48.0	6.7	67.0	7.1	33.0	7.1
2035	86.0	11.1	14.0	11.1	49.0	9.8	51.0	9.8	67.0	10.5	33.0	10.5
2040	88.0	14.9	12.0	14.9	48.0	13.0	52.0	13.0	68.0	13.9	32.0	13.9
2045	90.0	18.7	10.0	18.7	47.0	16.2	53.0	16.2	68.0	17.5	32.0	17.5
2050	91.0	22.6	9.0	22.6	46.0	19.4	54.0	19.4	68.0	21.1	32.0	21.1

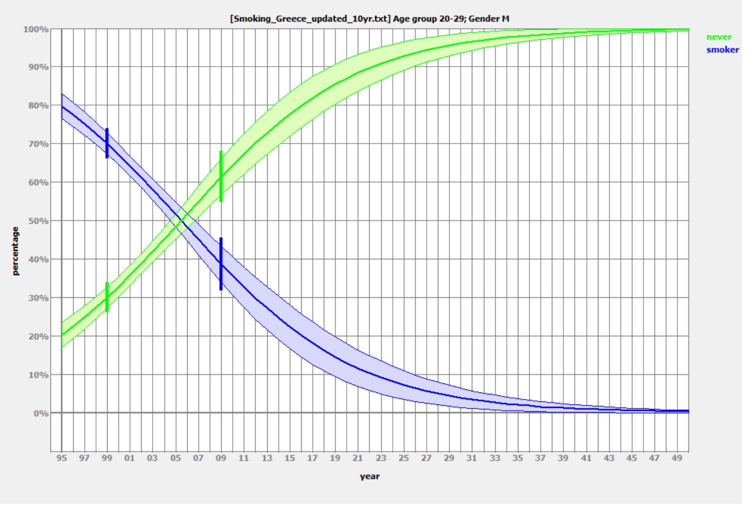


Figure 114. Smoking prevalence projections among males aged 20 to 29

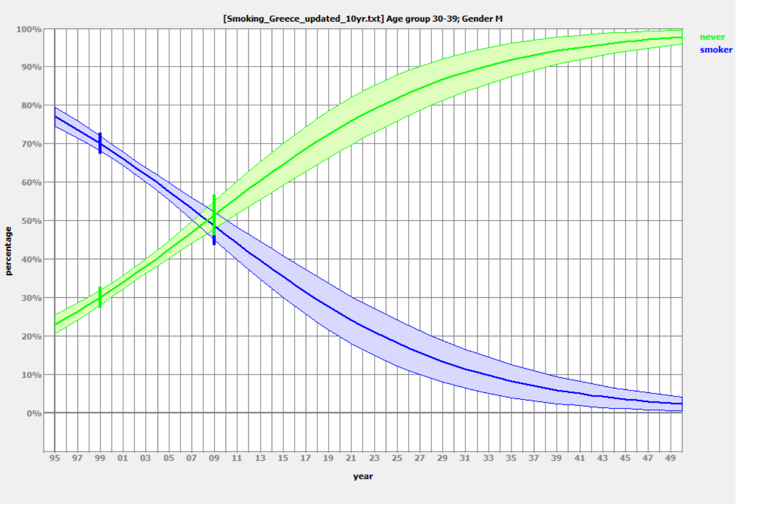


Figure 115. Smoking prevalence projections among males aged 30 to 39

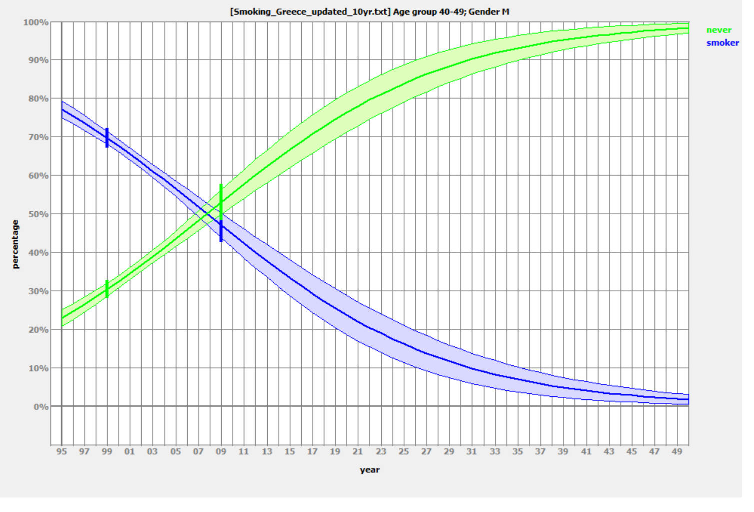


Figure 116. Smoking prevalence projections among males aged 40 to 49

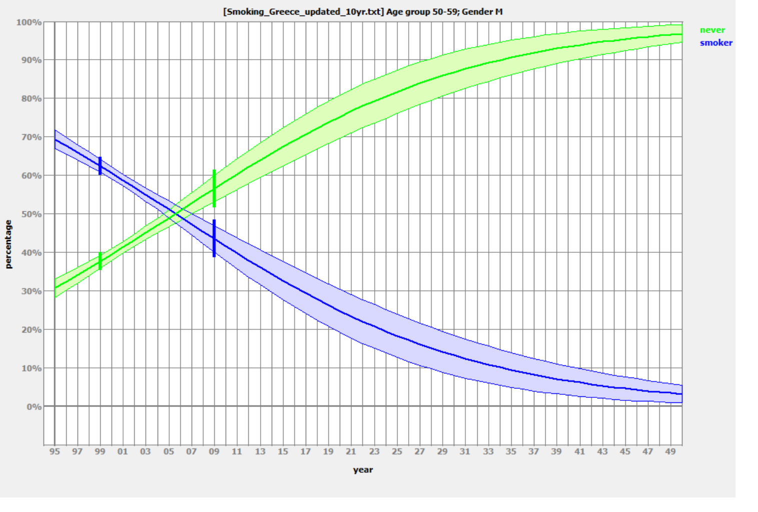


Figure 117. Smoking prevalence projections among males aged 50 to 59

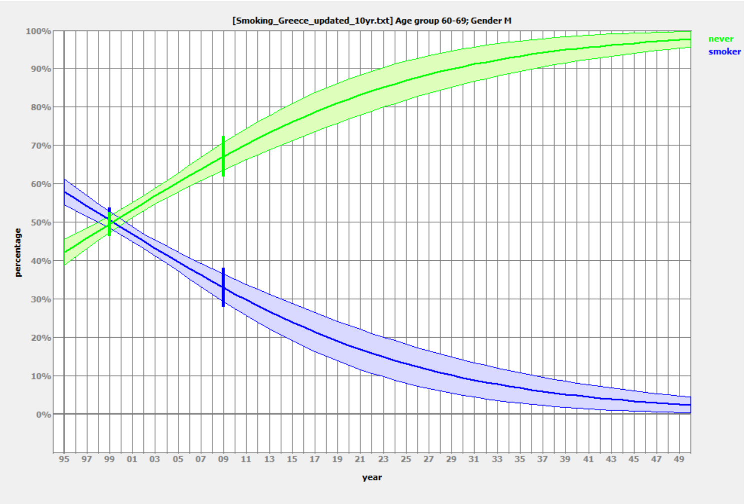


Figure 118. Smoking prevalence projections among males aged 60 to 69

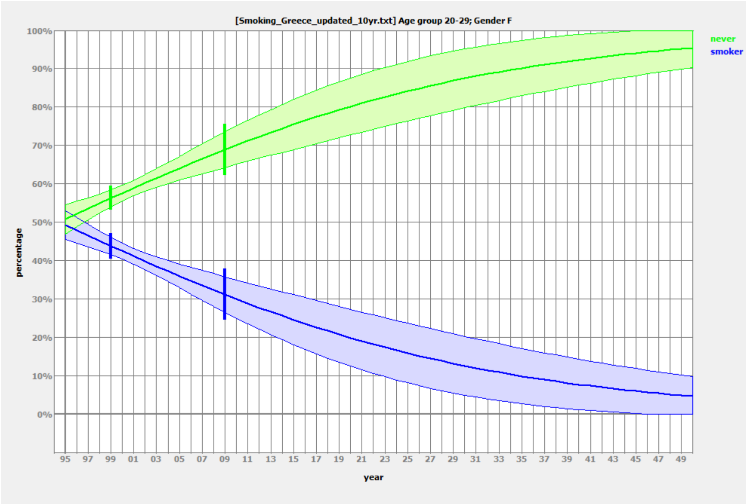


Figure 119. Smoking prevalence projections among females aged 20 to 29

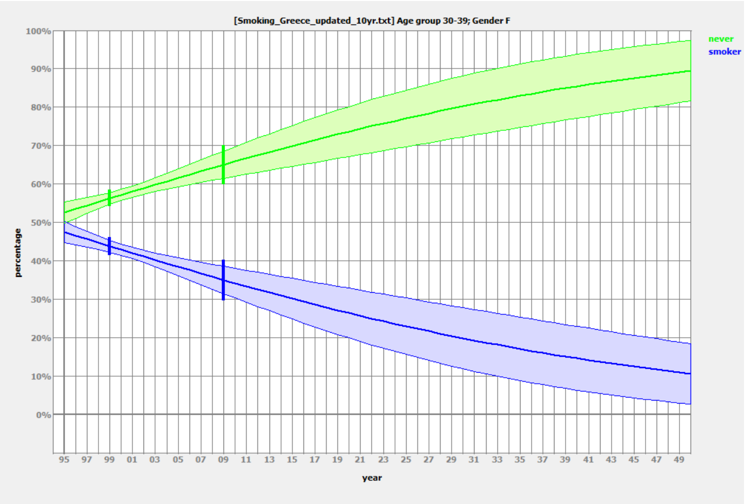


Figure 120. Smoking prevalence projections among females aged 30 to 39

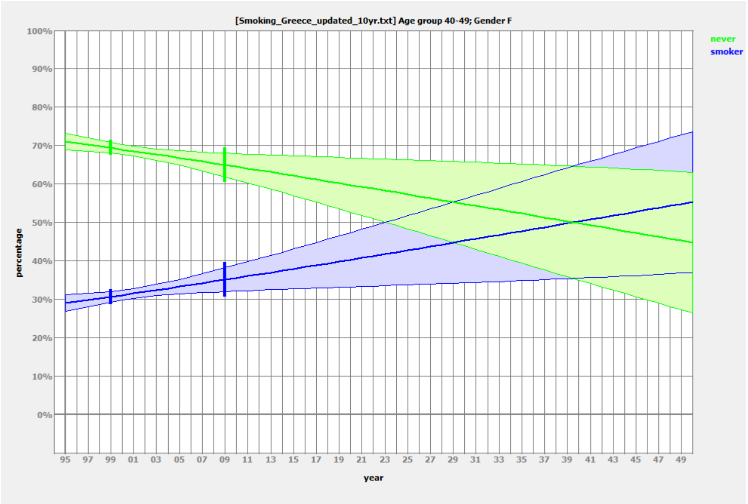


Figure 121. Smoking prevalence projections among females aged 40 to 49

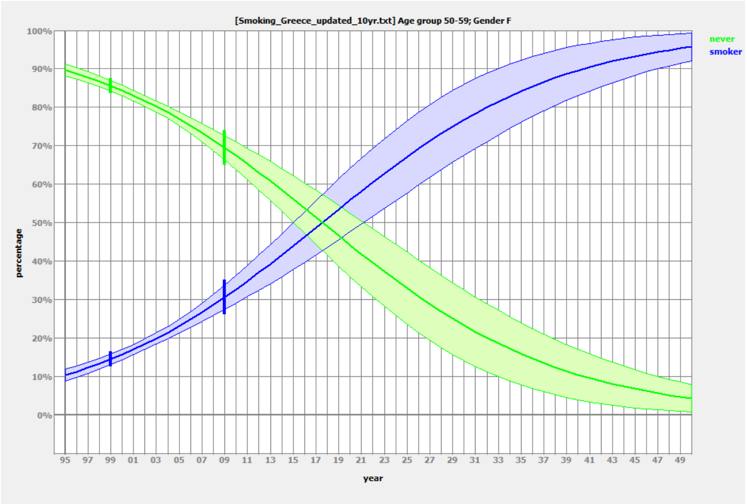


Figure 122. Smoking prevalence projections among females aged 50 to 59

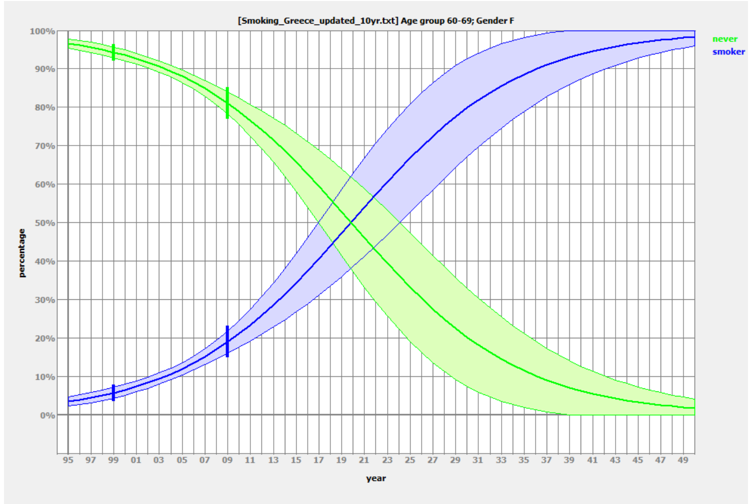


Figure 123. Smoking prevalence projections among females aged 60 to 69

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 82. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

Table 82. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (€)
Baseline	None	-	-
MCLI regain	0.6	100	175
MCLI no regain	0.6	0	175
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: sugar sweetened beverage tax

Multi-component lifestyle interventions (MCLI)

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of Section 3.

1. MCLI, annual, with regain
2. MCLI, annual, with no regain
3. MCLI, not annual, with no regain – these results are presented in Appendix E1.

Impact on disease incidence and prevalence

Table 83 presents the incidence cases per 100,000 to 2050 for baseline (no intervention) and each MCLI intervention scenario. Although the incidence cases increase over time for every disease and intervention scenario, the MCLI interventions do indeed decrease the rate at which incidence cases occur over time.

Table 84 presents the cumulative incidence cases per 100,000 to 2050 for every scenario including baseline.

Table 85 and Figure 124 present the cumulative incidence cases *avoided* for every intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). Results indicate that both variations of the MCLI intervention would result in lower cumulative incidences of every modelled disease when compared to the baseline scenario. For example, *MCLI (no regain)* would result in the avoidance of 385 cumulative incidence cases of CHD per 100,000 relative to baseline by 2050. Even with *MCLI (regain)*, positive impact can be observed, with avoidances of 325, 273 and 284 cumulative incidence cases of CHD, hypertension and type 2 diabetes per 100,000 respectively.

Table 86 and Figure 125 present the prevalence cases *avoided* for each intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). Results indicate that both variations of the MCLI intervention would result in lower prevalence of every modelled disease when compared to the baseline scenario. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for CHD (209 per 100,000 and 187 per 100,000 for *MCLI (regain)* and *MCLI (no regain)* scenarios, respectively) and type 2 diabetes (208 per 100,000 and 195 per 100,000 for *MCLI (regain)* and *MCLI (no regain)* scenarios, respectively).

Table 83. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	513 [+-2]	673 [+-2]	631 [+-2]	518 [+-2]	434 [+-2]
	2020	581 [+-2]	771 [+-2]	712 [+-2]	591 [+-2]	479 [+-2]
	2025	654 [+-2]	876 [+-3]	797 [+-2]	670 [+-2]	513 [+-2]
	2030	730 [+-2]	975 [+-3]	870 [+-3]	747 [+-2]	569 [+-2]
	2035	803 [+-3]	1046 [+-3]	924 [+-3]	810 [+-3]	621 [+-2]
	2040	861 [+-3]	1088 [+-3]	959 [+-3]	862 [+-3]	686 [+-2]
	2045	894 [+-3]	1093 [+-3]	979 [+-3]	902 [+-3]	736 [+-3]
	2050	907 [+-3]	1079 [+-3]	987 [+-3]	938 [+-3]	792 [+-3]
MCLI (annual, with regain)	2015	512 [+-2]	672 [+-2]	631 [+-2]	515 [+-2]	434 [+-2]
	2020	579 [+-2]	766 [+-2]	712 [+-2]	589 [+-2]	479 [+-2]
	2025	646 [+-2]	869 [+-3]	794 [+-2]	666 [+-2]	511 [+-2]
	2030	724 [+-2]	967 [+-3]	870 [+-3]	740 [+-2]	567 [+-2]
	2035	795 [+-3]	1040 [+-3]	923 [+-3]	804 [+-3]	619 [+-2]
	2040	850 [+-3]	1078 [+-3]	958 [+-3]	853 [+-3]	682 [+-2]
	2045	883 [+-3]	1083 [+-3]	977 [+-3]	890 [+-3]	734 [+-3]
	2050	898 [+-3]	1070 [+-3]	984 [+-3]	928 [+-3]	787 [+-3]
MCLI (annual, with no regain)	2015	512 [+-2]	672 [+-2]	631 [+-2]	515 [+-2]	434 [+-2]
	2020	575 [+-2]	763 [+-2]	710 [+-2]	585 [+-2]	478 [+-2]
	2025	643 [+-2]	867 [+-3]	792 [+-2]	662 [+-2]	510 [+-2]
	2030	720 [+-2]	966 [+-3]	871 [+-3]	739 [+-2]	567 [+-2]
	2035	794 [+-3]	1039 [+-3]	924 [+-3]	804 [+-3]	617 [+-2]
	2040	848 [+-3]	1080 [+-3]	959 [+-3]	852 [+-3]	681 [+-2]
	2045	883 [+-3]	1084 [+-3]	979 [+-3]	891 [+-3]	734 [+-3]
	2050	898 [+-3]	1072 [+-3]	985 [+-3]	929 [+-3]	787 [+-3]

Table 84. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	513 [+-2]	673 [+-2]	631 [+-2]	518 [+-2]	434 [+-2]
	2020	3294 [+-5]	4337 [+-6]	4041 [+-5]	3324 [+-5]	2758 [+-5]
	2025	6493 [+-7]	8603 [+-8]	7942 [+-8]	6586 [+-7]	5327 [+-6]
	2030	10192 [+-9]	13535 [+-10]	12380 [+-9]	10367 [+-9]	8222 [+-8]
	2035	14424 [+-10]	19086 [+-11]	17321 [+-11]	14651 [+-10]	11512 [+-9]
	2040	19179 [+-12]	25180 [+-13]	22721 [+-12]	19435 [+-12]	15264 [+-11]
	2045	24437 [+-13]	31740 [+-14]	28577 [+-13]	24727 [+-13]	19530 [+-12]
	2050	30202 [+-14]	38777 [+-15]	34956 [+-15]	30610 [+-14]	24379 [+-13]
MCLI (annual, with regain)	2015	512 [+-2]	672 [+-2]	631 [+-2]	515 [+-2]	434 [+-2]
	2020	3281 [+-5]	4323 [+-6]	4031 [+-5]	3311 [+-5]	2760 [+-5]
	2025	6458 [+-7]	8562 [+-8]	7921 [+-8]	6554 [+-7]	5319 [+-6]
	2030	10124 [+-9]	13462 [+-10]	12355 [+-9]	10301 [+-9]	8201 [+-8]
	2035	14305 [+-10]	18983 [+-11]	17283 [+-11]	14545 [+-10]	11472 [+-9]
	2040	19001 [+-11]	25027 [+-13]	22674 [+-12]	19281 [+-12]	15207 [+-11]
	2045	24190 [+-13]	31532 [+-14]	28521 [+-13]	24511 [+-13]	19443 [+-12]
	2050	29877 [+-14]	38504 [+-15]	34879 [+-15]	30326 [+-14]	24264 [+-13]
MCLI (annual, with no regain)	2015	512 [+-2]	672 [+-2]	631 [+-2]	515 [+-2]	434 [+-2]
	2020	3271 [+-5]	4315 [+-6]	4030 [+-5]	3304 [+-5]	2755 [+-5]
	2025	6429 [+-7]	8540 [+-8]	7917 [+-8]	6531 [+-7]	5311 [+-6]
	2030	10082 [+-9]	13427 [+-10]	12355 [+-9]	10268 [+-9]	8187 [+-8]
	2035	14256 [+-10]	18943 [+-11]	17288 [+-11]	14509 [+-10]	11453 [+-9]
	2040	18945 [+-11]	24990 [+-13]	22686 [+-12]	19241 [+-12]	15185 [+-11]
	2045	24130 [+-13]	31494 [+-14]	28541 [+-13]	24471 [+-13]	19420 [+-12]
	2050	29817 [+-14]	38468 [+-15]	34904 [+-15]	30289 [+-14]	24237 [+-13]

Table 85. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	1 [+-3]	1 [+-3]	0 [+-3]	3 [+-3]	0 [+-3]
	2020	13 [+-7]	14 [+-8]	10 [+-7]	13 [+-7]	-2 [+-7]
	2025	35 [+-10]	41 [+-11]	21 [+-11]	32 [+-10]	8 [+-8]
	2030	68 [+-13]	73 [+-14]	25 [+-13]	66 [+-13]	21 [+-11]
	2035	119 [+-14]	103 [+-16]	38 [+-16]	106 [+-14]	40 [+-13]
	2040	178 [+-16]	153 [+-18]	47 [+-17]	154 [+-17]	57 [+-16]
	2045	247 [+-18]	208 [+-20]	56 [+-18]	216 [+-18]	87 [+-17]
	2050	325 [+-20]	273 [+-21]	77 [+-21]	284 [+-20]	115 [+-18]
MCLI (annual, with no regain) relative to baseline	2015	1 [+-3]	1 [+-3]	0 [+-3]	3 [+-3]	0 [+-3]
	2020	23 [+-7]	22 [+-8]	11 [+-7]	20 [+-7]	3 [+-7]
	2025	64 [+-10]	63 [+-11]	25 [+-11]	55 [+-10]	16 [+-8]
	2030	110 [+-13]	108 [+-14]	25 [+-13]	99 [+-13]	35 [+-11]
	2035	168 [+-14]	143 [+-16]	33 [+-16]	142 [+-14]	59 [+-13]
	2040	234 [+-16]	190 [+-18]	35 [+-17]	194 [+-17]	79 [+-16]
	2045	307 [+-18]	246 [+-20]	36 [+-18]	256 [+-18]	110 [+-17]
	2050	385 [+-20]	309 [+-21]	52 [+-21]	321 [+-20]	142 [+-18]

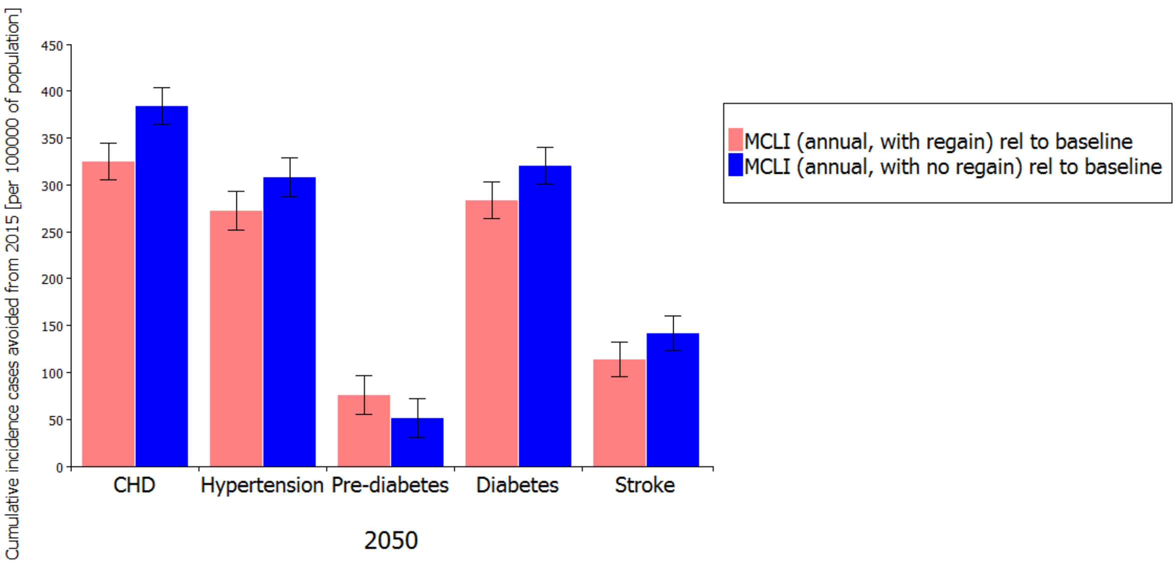


Figure 124. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 86. Prevalence cases avoided per 100,000, relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	16 [+-10]	14 [+-14]	1 [+-7]	7 [+-13]	5 [+-7]
	2020	18 [+-11]	21 [+-14]	3 [+-7]	15 [+-13]	-1 [+-8]
	2025	35 [+-11]	41 [+-16]	4 [+-8]	29 [+-14]	12 [+-8]
	2030	59 [+-13]	70 [+-16]	1 [+-8]	63 [+-14]	17 [+-8]
	2035	98 [+-13]	93 [+-17]	8 [+-8]	95 [+-16]	28 [+-10]
	2040	131 [+-14]	124 [+-18]	2 [+-8]	126 [+-17]	31 [+-10]
	2045	161 [+-14]	151 [+-18]	0 [+-8]	162 [+-17]	44 [+-11]
	2050	187 [+-16]	177 [+-20]	6 [+-10]	195 [+-18]	44 [+-11]
MCLI (annual, with no regain) relative to baseline	2015	19 [+-10]	10 [+-14]	3 [+-7]	5 [+-13]	7 [+-7]
	2020	33 [+-11]	26 [+-14]	5 [+-7]	21 [+-13]	4 [+-8]
	2025	63 [+-11]	59 [+-16]	6 [+-8]	50 [+-14]	17 [+-8]
	2030	94 [+-13]	97 [+-16]	-1 [+-8]	88 [+-14]	24 [+-8]
	2035	131 [+-13]	118 [+-17]	5 [+-8]	119 [+-16]	37 [+-10]
	2040	162 [+-14]	143 [+-18]	-3 [+-8]	149 [+-17]	39 [+-10]
	2045	190 [+-14]	166 [+-18]	-4 [+-8]	181 [+-17]	49 [+-11]
	2050	209 [+-16]	186 [+-20]	3 [+-10]	208 [+-18]	49 [+-11]

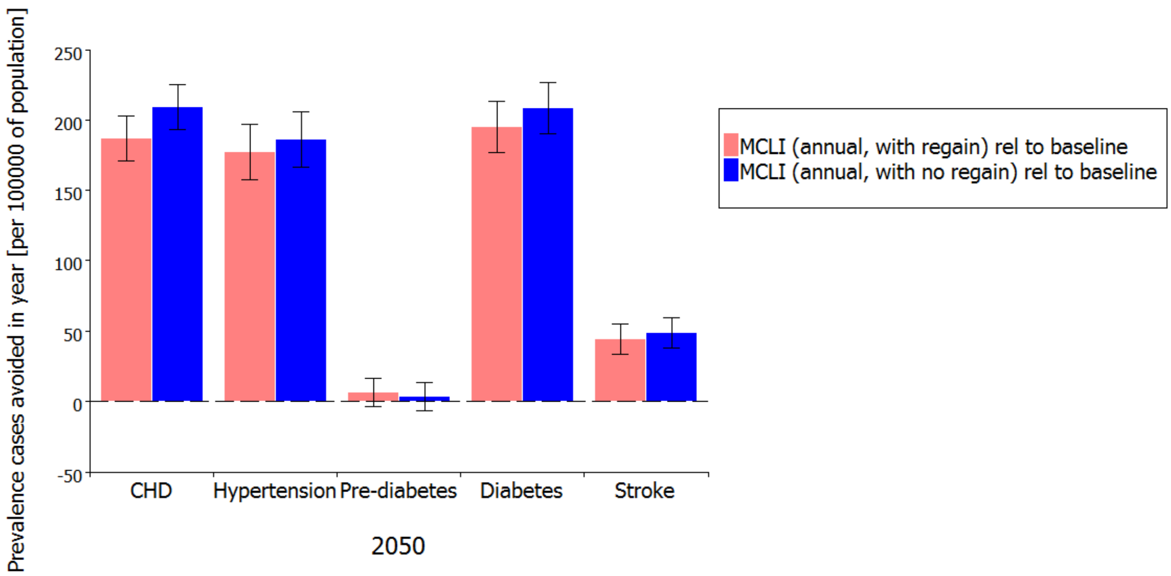


Figure 125. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Figure 126 and Table 87 present the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expect to occur in stroke for both MCLI interventions (€0.38 million and €0.34 million per 100,000 population for the *MCLI (weight no regain)* and *MCLI (weight regain)* scenarios, respectively).

Figure 127 and Table 88 present the indirect costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to occur in CHD for both MCLI interventions (€0.35 million and €0.32 million per 100,000 population for the *MCLI (weight no regain)* and *MCLI (weight regain)* scenarios, respectively).

Figure 128 and Figure 129 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the. For both males and females, both variations of the MCLI interventions appear to be effective in increasing gains in QALYs over time. For 2050 alone, 54 QALYs per 100,000 and 43 QALYs per 100,000 are expected to be gained for males and females, respectively.

In Figure 130, the positive ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both versions of the MCLI interventions may or may not be cost effective depending on what cost effectiveness threshold value is chosen in Finland. This is because a cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. However, since no cost effectiveness thresholds are currently not used in this country, we cannot categorically determine whether or not this set of interventions is cost effective. Over time, however, the ICER is expected to approach near zero, indicating that the interventions are likely to become cost effective.

Table 87. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	0.04418 [+-0.002331]	0.001861 [+-0.0003]	0.000091 [+-0.000017]	0.013184 [+-0.002919]	0.097481 [+-0.006295]
	2020	0.046621 [+-0.002271]	0.002414 [+-0.000284]	0.00014 [+-0.000016]	0.023403 [+-0.002754]	-0.029907 [+-0.006331]
	2025	0.07572 [+-0.002269]	0.004015 [+-0.000276]	0.000178 [+-0.000016]	0.038223 [+-0.002679]	0.181992 [+-0.006261]
	2030	0.109585 [+-0.002319]	0.005876 [+-0.000276]	0.000023 [+-0.000014]	0.070824 [+-0.002667]	0.235893 [+-0.006237]
	2035	0.155781 [+-0.002393]	0.006745 [+-0.000278]	0.00031 [+-0.000014]	0.093845 [+-0.002679]	0.334511 [+-0.006324]
	2040	0.179783 [+-0.002449]	0.00775 [+-0.000276]	0.000064 [+-0.000013]	0.106241 [+-0.002676]	0.327347 [+-0.006471]
	2045	0.191038 [+-0.002443]	0.008167 [+-0.000268]	0.000025 [+-0.000013]	0.118472 [+-0.002634]	0.394562 [+-0.006529]
	2050	0.19134 [+-0.002367]	0.008221 [+-0.000255]	0.000134 [+-0.000011]	0.122974 [+-0.002557]	0.3363 [+-0.006476]
MCLI (annual, with no regain) relative to baseline	2015	0.055021 [+-0.002331]	0.001351 [+-0.0003]	0.000172 [+-0.000017]	0.009212 [+-0.00292]	0.151108 [+-0.006292]
	2020	0.082138 [+-0.002268]	0.002966 [+-0.000284]	0.000269 [+-0.000016]	0.033051 [+-0.002753]	0.074829 [+-0.006325]
	2025	0.135771 [+-0.002264]	0.005709 [+-0.000276]	0.000307 [+-0.000016]	0.065699 [+-0.002676]	0.268677 [+-0.006257]
	2030	0.173267 [+-0.002313]	0.008191 [+-0.000276]	-0.000045 [+-0.000014]	0.100046 [+-0.002664]	0.338821 [+-0.00623]
	2035	0.209066 [+-0.002388]	0.008528 [+-0.000277]	0.0002 [+-0.000014]	0.116663 [+-0.002676]	0.443115 [+-0.006317]
	2040	0.222326 [+-0.002445]	0.008961 [+-0.000276]	-0.000084 [+-0.000013]	0.125877 [+-0.002674]	0.402283 [+-0.006466]
	2045	0.22508 [+-0.00244]	0.008989 [+-0.000268]	-0.000091 [+-0.000013]	0.132277 [+-0.002633]	0.438755 [+-0.006525]
	2050	0.213496 [+-0.002365]	0.008632 [+-0.000255]	0.000077 [+-0.000011]	0.130826 [+-0.002556]	0.375534 [+-0.006474]

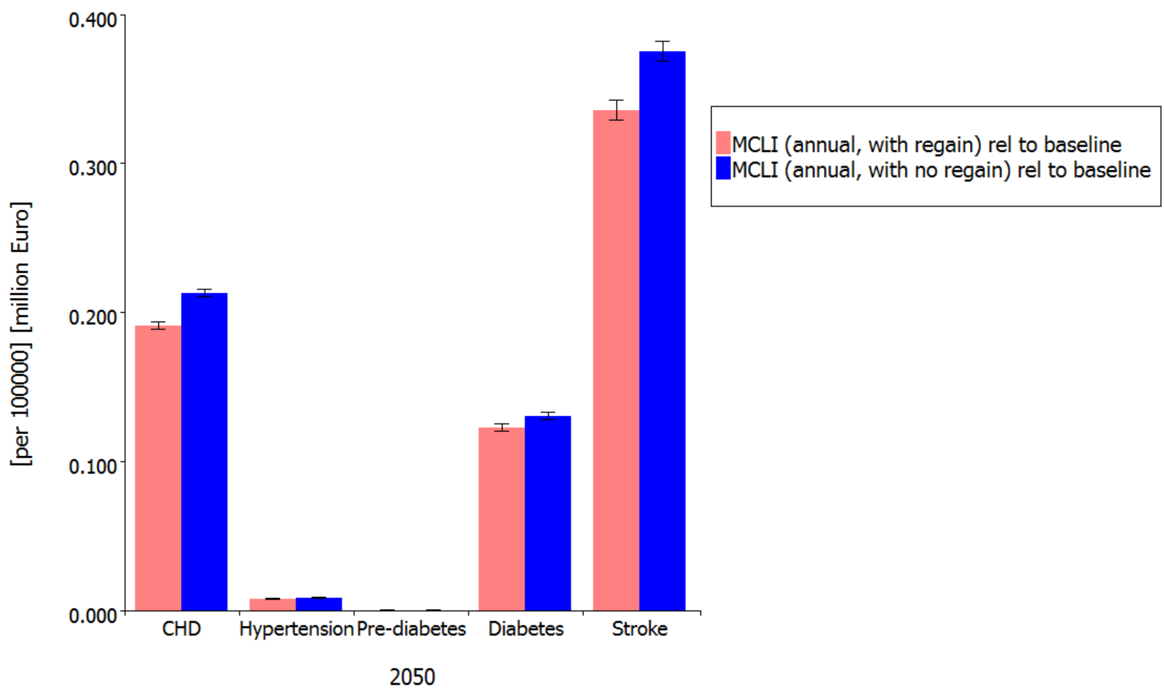


Figure 126. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 88. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	0.072708 [+-0.003837]	0.00142 [+-0.000229]	0 [+-0]	0.006683 [+-0.00148]	0.076332 [+-0.00493]
	2020	0.076733 [+-0.003737]	0.001844 [+-0.000216]	0 [+-0]	0.011863 [+-0.001396]	-0.023422 [+-0.004958]
	2025	0.124622 [+-0.003734]	0.003066 [+-0.000211]	0 [+-0]	0.019376 [+-0.001358]	0.142521 [+-0.004904]
	2030	0.180355 [+-0.003816]	0.004486 [+-0.000211]	0 [+-0]	0.035902 [+-0.001352]	0.184731 [+-0.004884]
	2035	0.256384 [+-0.003939]	0.005148 [+-0.000211]	0 [+-0]	0.047572 [+-0.001358]	0.261959 [+-0.004953]
	2040	0.295883 [+-0.004029]	0.005916 [+-0.00021]	0 [+-0]	0.053856 [+-0.001356]	0.256351 [+-0.005068]
	2045	0.314407 [+-0.00402]	0.006234 [+-0.000204]	0 [+-0]	0.060055 [+-0.001335]	0.30899 [+-0.005112]
	2050	0.314909 [+-0.003897]	0.006276 [+-0.000194]	0 [+-0]	0.062337 [+-0.001296]	0.263359 [+-0.005072]
MCLI (annual, with no regain) relative to baseline	2015	0.090549 [+-0.003835]	0.001031 [+-0.000229]	0 [+-0]	0.004669 [+-0.00148]	0.118332 [+-0.004927]
	2020	0.135185 [+-0.003732]	0.002265 [+-0.000216]	0 [+-0]	0.016754 [+-0.001396]	0.058601 [+-0.004953]
	2025	0.223454 [+-0.003726]	0.004358 [+-0.000211]	0 [+-0]	0.033305 [+-0.001357]	0.210407 [+-0.0049]
	2030	0.285162 [+-0.003807]	0.006253 [+-0.000211]	0 [+-0]	0.050714 [+-0.001351]	0.265331 [+-0.004878]
	2035	0.344082 [+-0.00393]	0.006509 [+-0.000211]	0 [+-0]	0.059139 [+-0.001357]	0.347012 [+-0.004947]
	2040	0.365902 [+-0.004023]	0.00684 [+-0.00021]	0 [+-0]	0.063809 [+-0.001355]	0.315037 [+-0.005064]
	2045	0.370434 [+-0.004014]	0.006862 [+-0.000204]	0 [+-0]	0.067053 [+-0.001334]	0.343597 [+-0.00511]
	2050	0.351374 [+-0.003893]	0.006589 [+-0.000194]	0 [+-0]	0.066317 [+-0.001295]	0.294086 [+-0.005069]

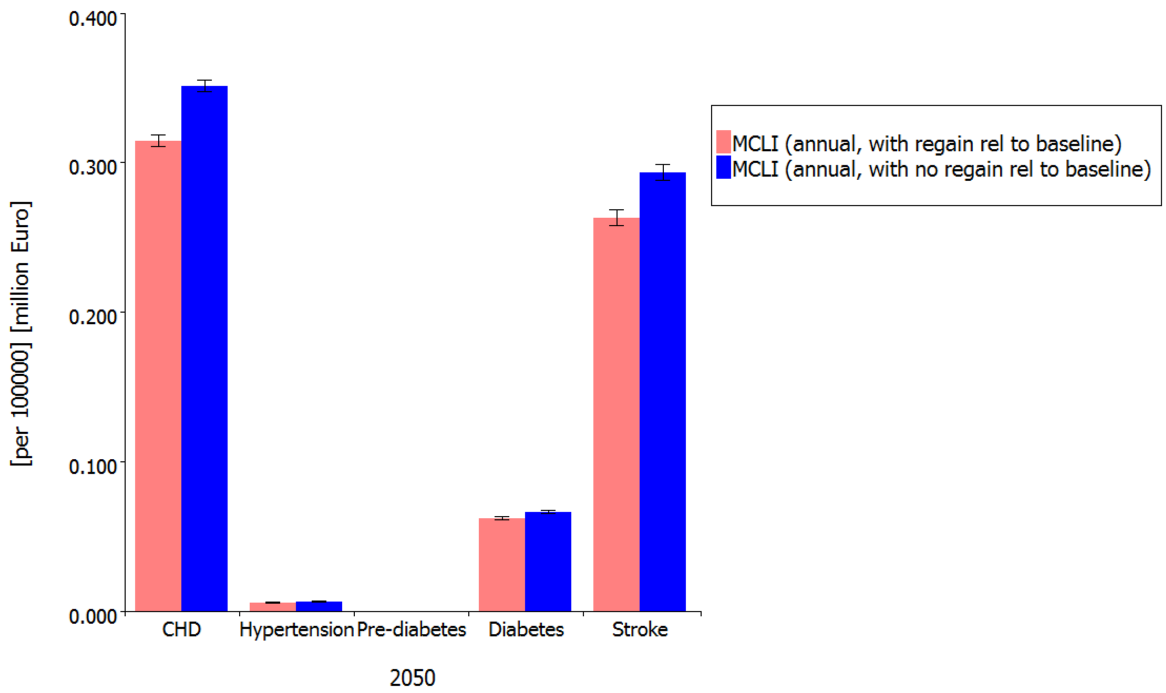


Figure 127. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

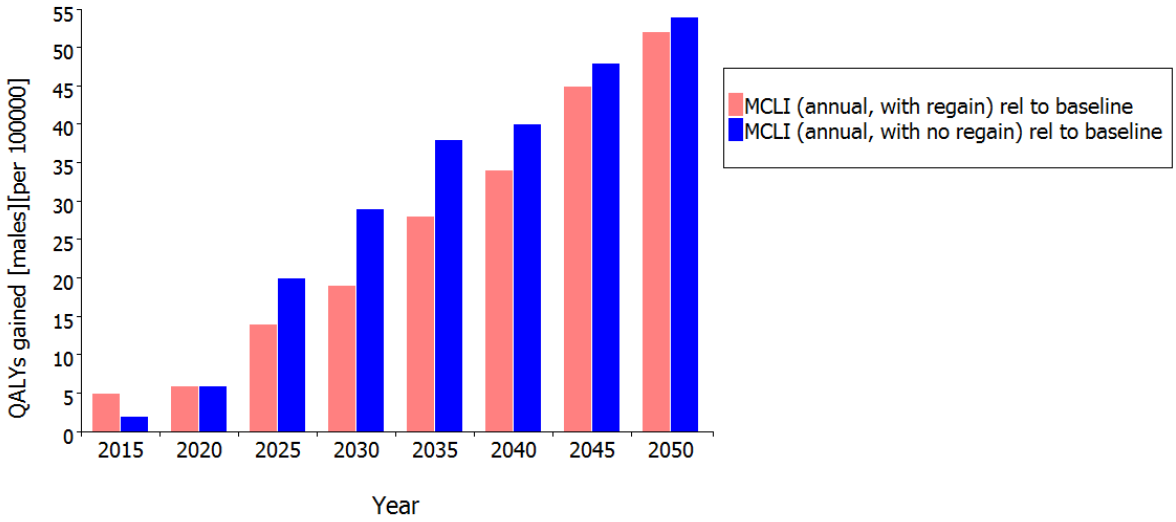


Figure 128. QALYS gained (per 100,000), relative to baseline (males)

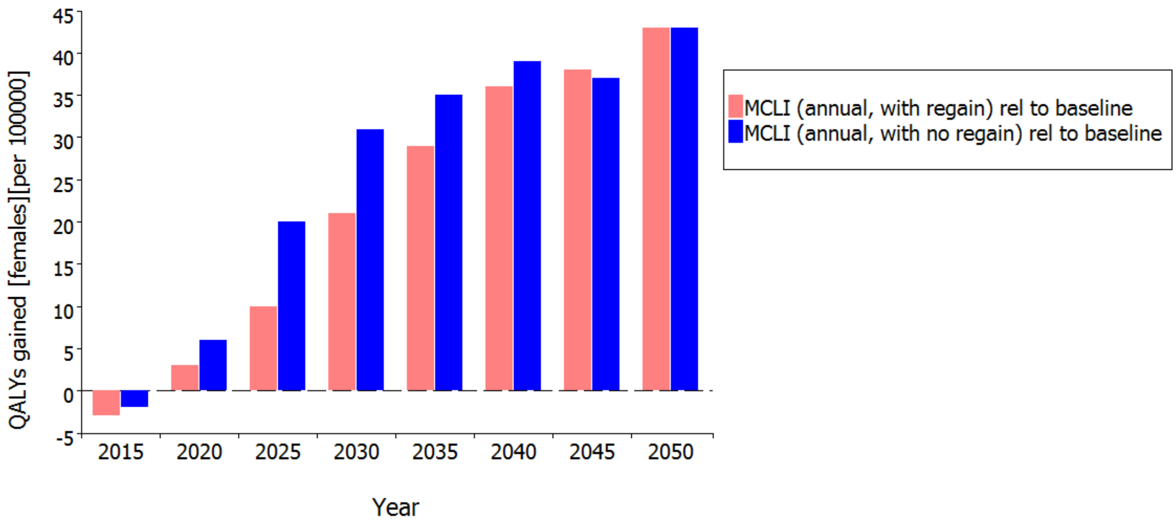


Figure 129. QALYS gained (per 100,000), relative to baseline (females)

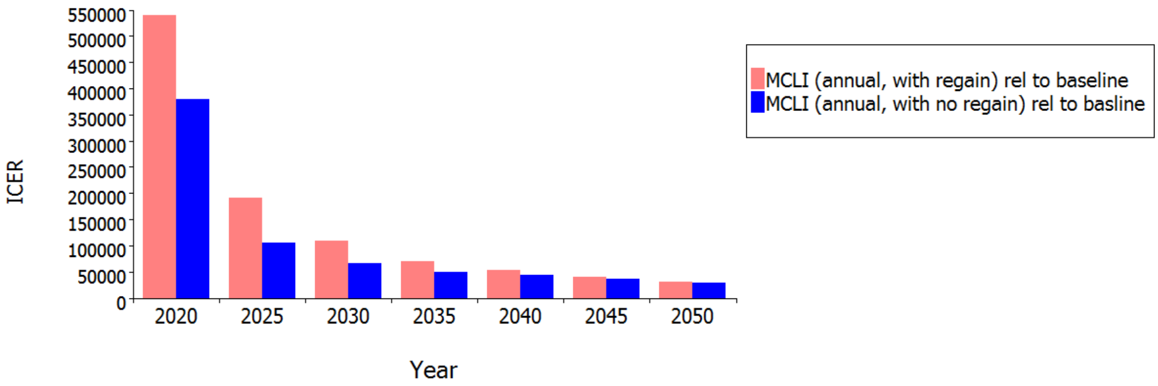


Figure 130. ICER

Sugar sweetened beverages (SSB) tax interventions

Impact on disease incidence and prevalence

Due to the small BMI drop, 100 million simulations were run to provide more accurate results. Table 89 presents the incidence cases per 100,000 of the baseline (no intervention) and SSB intervention scenarios. Incidence is predicted to increase across all diseases over time in both scenarios – SSB does not appear to impact incidence cases over time. However, results from the cumulative incidence cases outputs reveal that SSB does indeed decrease the rate at which incidence cases occur over time (though the impact is marginal).

Table 90 presents the cumulative (2015 to 2050) incidence cases per 100,000 of the baseline (no intervention) and SSB scenarios. Cumulative incidence is expected to be lower across all diseases in the SSB scenario relative to baseline.

Table 91 and Figure 131 present the cumulative incidence cases *avoided* for the SSB intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The SSB scenario is predicted to reduce the cumulative incidence across all diseases, whereby the largest effect is expected to be observed for CHD (23 per 100,000) followed by pre-diabetes (22 per 100,000).

Table 92 and Figure 132 present the prevalence cases *avoided* for the SSB scenario relative to baseline – presented in terms of 100,000 population. Results indicate that SSB intervention scenario would result in lower prevalence of every modelled disease when compared to the baseline scenario. The largest prevalence cases avoided per 100,000 can be observed for hypertension and diabetes (both 15 per 100,000).

Table 89. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	513 [+-1]	672 [+-2]	630 [+-2]	518 [+-1]	434 [+-1]
	2020	580 [+-1]	770 [+-2]	712 [+-2]	591 [+-2]	479 [+-1]
	2025	654 [+-2]	875 [+-2]	797 [+-2]	670 [+-2]	513 [+-1]
	2030	729 [+-2]	975 [+-2]	869 [+-2]	748 [+-2]	569 [+-2]
	2035	804 [+-2]	1047 [+-2]	924 [+-2]	810 [+-2]	620 [+-2]
	2040	861 [+-2]	1087 [+-2]	959 [+-2]	864 [+-2]	686 [+-2]
	2045	895 [+-2]	1093 [+-2]	979 [+-2]	900 [+-2]	737 [+-2]
	2050	909 [+-2]	1078 [+-2]	988 [+-2]	937 [+-2]	790 [+-2]
SSB tax	2015	513 [+-1]	672 [+-2]	629 [+-2]	518 [+-1]	434 [+-1]
	2020	580 [+-1]	769 [+-2]	712 [+-2]	590 [+-2]	479 [+-1]
	2025	654 [+-2]	875 [+-2]	797 [+-2]	669 [+-2]	513 [+-1]
	2030	729 [+-2]	975 [+-2]	869 [+-2]	747 [+-2]	568 [+-2]
	2035	804 [+-2]	1046 [+-2]	923 [+-2]	809 [+-2]	620 [+-2]
	2040	861 [+-2]	1087 [+-2]	959 [+-2]	863 [+-2]	686 [+-2]
	2045	894 [+-2]	1093 [+-2]	979 [+-2]	900 [+-2]	737 [+-2]
	2050	908 [+-2]	1078 [+-2]	988 [+-2]	937 [+-2]	790 [+-2]

Table 90. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	513 [+-1]	672 [+-2]	630 [+-2]	518 [+-1]	434 [+-1]
	2020	3294 [+-4]	4336 [+-4]	4040 [+-4]	3323 [+-4]	2760 [+-3]
	2025	6491 [+-5]	8600 [+-6]	7944 [+-5]	6585 [+-5]	5327 [+-4]
	2030	10190 [+-6]	13531 [+-7]	12381 [+-7]	10367 [+-6]	8220 [+-6]
	2035	14420 [+-7]	19084 [+-8]	17322 [+-8]	14652 [+-7]	11508 [+-6]
	2040	19175 [+-8]	25179 [+-9]	22722 [+-9]	19438 [+-8]	15259 [+-7]
	2045	24432 [+-9]	31737 [+-10]	28580 [+-10]	24728 [+-9]	19520 [+-8]
	2050	30196 [+-10]	38767 [+-11]	34954 [+-10]	30609 [+-10]	24364 [+-9]
SSB tax	2015	513 [+-1]	672 [+-2]	629 [+-2]	518 [+-1]	434 [+-1]
	2020	3292 [+-4]	4333 [+-4]	4036 [+-4]	3321 [+-4]	2760 [+-3]
	2025	6487 [+-5]	8593 [+-6]	7937 [+-5]	6580 [+-5]	5325 [+-4]
	2030	10184 [+-6]	13521 [+-7]	12371 [+-7]	10358 [+-6]	8217 [+-6]
	2035	14412 [+-7]	19071 [+-8]	17309 [+-8]	14640 [+-7]	11504 [+-6]
	2040	19164 [+-8]	25162 [+-9]	22707 [+-9]	19421 [+-8]	15254 [+-7]
	2045	24419 [+-9]	31717 [+-10]	28564 [+-10]	24710 [+-9]	19515 [+-8]
	2050	30179 [+-10]	38744 [+-11]	34936 [+-10]	30587 [+-10]	24357 [+-9]

Table 91. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0 [+-1]	0 [+-3]	1 [+-3]	0 [+-1]	0 [+-1]
	2020	2 [+-6]	3 [+-6]	4 [+-6]	2 [+-6]	0 [+-4]
	2025	4 [+-7]	7 [+-8]	7 [+-7]	5 [+-7]	2 [+-6]
	2030	6 [+-8]	10 [+-10]	10 [+-10]	9 [+-8]	3 [+-8]
	2035	8 [+-10]	13 [+-11]	13 [+-11]	12 [+-10]	4 [+-8]
	2040	11 [+-11]	17 [+-13]	15 [+-13]	17 [+-11]	5 [+-10]
	2045	13 [+-13]	20 [+-14]	16 [+-14]	18 [+-13]	5 [+-11]
	2050	17 [+-14]	23 [+-16]	18 [+-14]	22 [+-14]	7 [+-13]

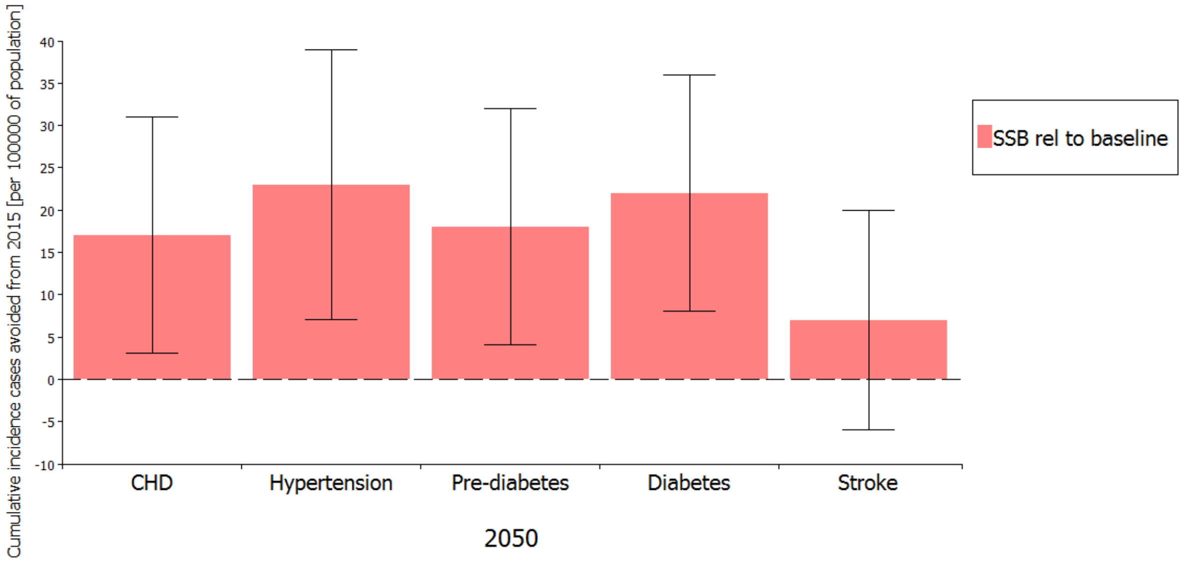


Figure 131. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 92. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0 [+-7]	0 [+-10]	0 [+-6]	1 [+-10]	1 [+-6]
	2020	2 [+-7]	3 [+-10]	1 [+-6]	3 [+-10]	2 [+-6]
	2025	3 [+-8]	6 [+-11]	2 [+-6]	5 [+-10]	1 [+-6]
	2030	5 [+-8]	9 [+-11]	2 [+-6]	8 [+-10]	2 [+-6]
	2035	5 [+-10]	11 [+-13]	1 [+-6]	10 [+-11]	1 [+-7]
	2040	6 [+-10]	13 [+-13]	1 [+-6]	13 [+-11]	1 [+-7]
	2045	7 [+-10]	14 [+-13]	2 [+-7]	13 [+-13]	2 [+-7]
	2050	9 [+-11]	15 [+-14]	1 [+-7]	15 [+-13]	2 [+-8]

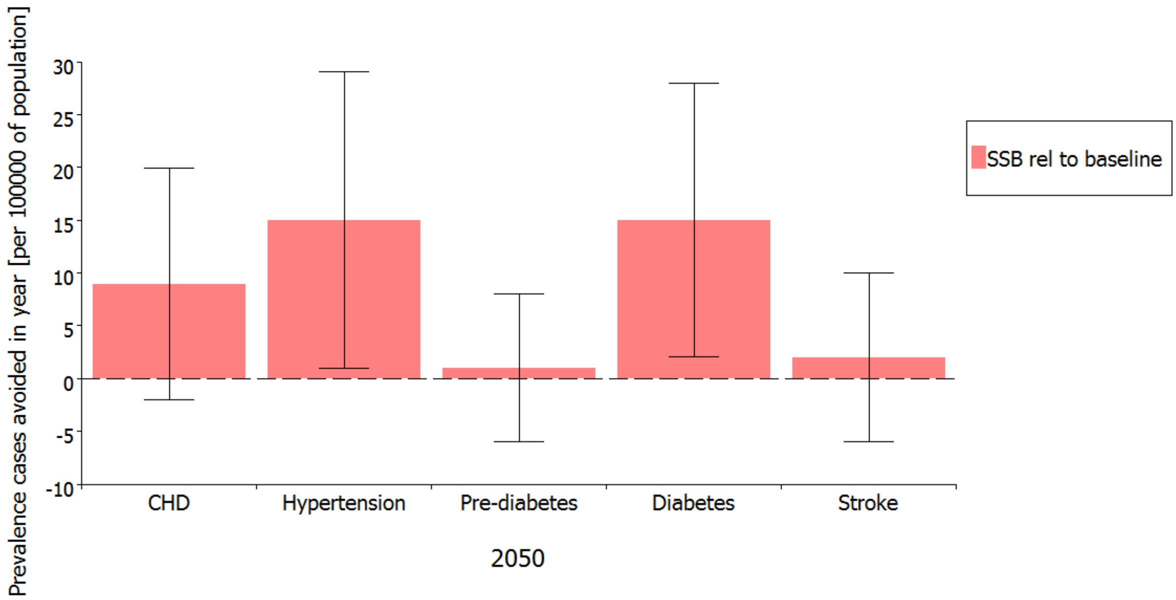


Figure 132. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Figure 133 and Table 93 present the direct healthcare costs that can be *avoided* (per 100,000 population) with the SSB tax intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to occur in stroke (€0.05 million per 100,000 population in 2050).

Figure 134 and Table 94 present the indirect costs that can be *avoided* (per 100,000 population) with the SSB tax intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to occur in CHD (€0.015 million per 100,000 population in 2050).

Figure 135 and Figure 136 present the QALYs that can be *gained* (per 100,000 population) with the SSB tax intervention, relative to the baseline. For both males and females, an SSB tax is projected to lead to increasing gains in QALYs over time. 2 QALYs per 100,000 and 3 QALYs per 100,000 are expected to be *gained* in 2050 for males and females, respectively.

In Figure 137, the negative ICER values (which in this case is comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SSB tax intervention is cost effective (the SSB tax intervention scenario *dominate* the baseline scenario).

Table 93. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0.000113 [+-0.001649]	0.00009 [+-0.000212]	-0.000019 [+-0.000011]	0.000927 [+-0.002063]	0.017349 [+-0.004451]
	2020	0.003534 [+-0.001607]	0.000376 [+-0.000201]	0.000087 [+-0.000011]	0.003363 [+-0.001947]	0.021042 [+-0.004475]
	2025	0.006966 [+-0.001607]	0.000611 [+-0.000196]	0.00009 [+-0.000011]	0.006092 [+-0.001896]	0.012535 [+-0.00443]
	2030	0.008419 [+-0.001645]	0.000726 [+-0.000195]	0.000074 [+-0.00001]	0.00906 [+-0.00189]	0.024002 [+-0.004417]
	2035	0.008718 [+-0.001702]	0.000755 [+-0.000197]	0.000063 [+-0.00001]	0.010065 [+-0.0019]	0.021179 [+-0.004486]
	2040	0.008696 [+-0.001743]	0.000761 [+-0.000195]	0.000041 [+-0.00001]	0.01046 [+-0.0019]	0.013199 [+-0.004591]
	2045	0.00848 [+-0.001742]	0.000738 [+-0.00019]	0.000053 [+-0.000008]	0.009516 [+-0.001872]	0.017929 [+-0.004633]
	2050	0.009011 [+-0.001689]	0.000687 [+-0.000181]	0.000021 [+-0.000007]	0.009393 [+-0.001818]	0.013416 [+-0.004594]
	2015	0.015316 [+-0.001648]	0.000606 [+-0.000212]	0.000113 [+-0.000011]	-0.003889 [+-0.002063]	0.053543 [+-0.00445]

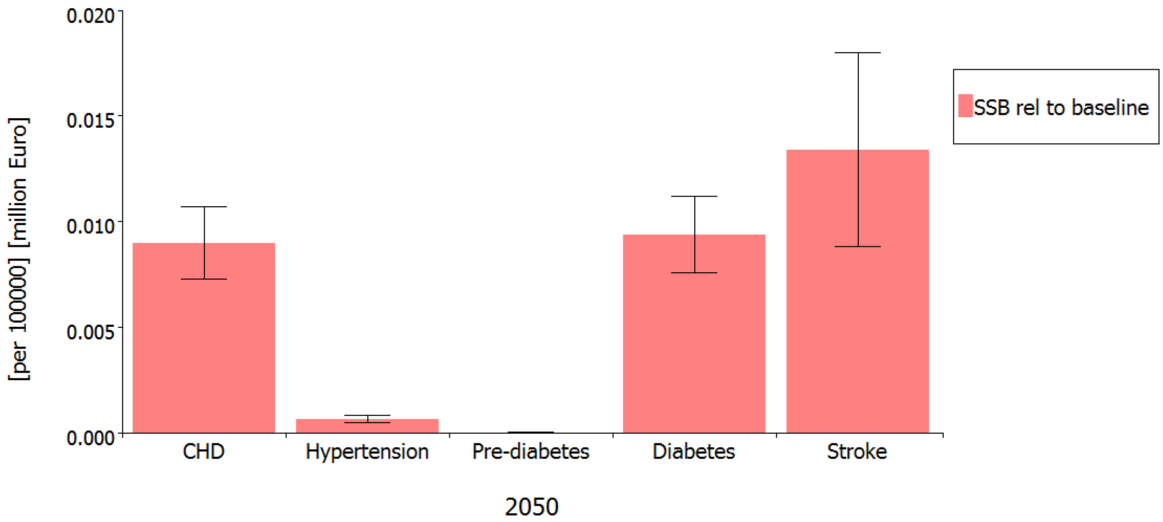


Figure 133. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 94. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB tax relative to baseline	2015	0.000183 [+-0.002714]	0.000069 [+-0.000161]	0 [+-0]	0.000469 [+-0.001046]	0.01358 [+-0.003485]
	2020	0.005821 [+-0.002645]	0.000287 [+-0.000153]	0 [+-0]	0.001703 [+-0.000987]	0.016476 [+-0.003505]
	2025	0.011463 [+-0.002645]	0.000466 [+-0.00015]	0 [+-0]	0.003088 [+-0.000961]	0.009811 [+-0.00347]
	2030	0.013859 [+-0.002708]	0.000555 [+-0.00015]	0 [+-0]	0.004592 [+-0.000958]	0.018799 [+-0.003458]
	2035	0.014351 [+-0.0028]	0.000576 [+-0.00015]	0 [+-0]	0.005101 [+-0.000963]	0.016579 [+-0.003512]
	2040	0.014307 [+-0.002869]	0.000581 [+-0.00015]	0 [+-0]	0.005301 [+-0.000963]	0.010338 [+-0.003596]
	2045	0.013956 [+-0.002865]	0.000564 [+-0.000146]	0 [+-0]	0.004823 [+-0.000949]	0.014038 [+-0.003628]
	2050	0.014832 [+-0.00278]	0.000524 [+-0.000138]	0 [+-0]	0.004761 [+-0.000921]	0.010506 [+-0.003598]

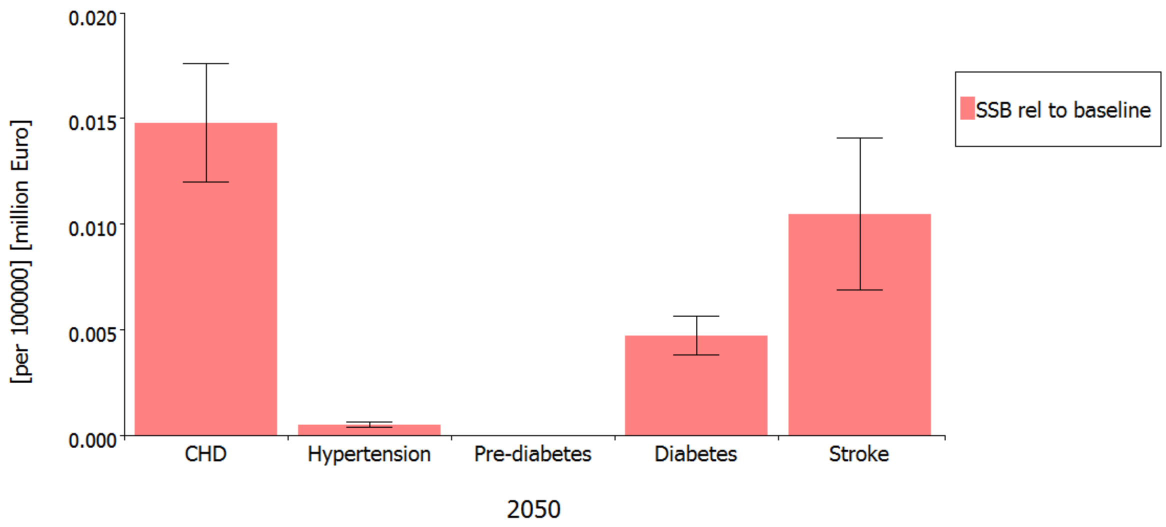


Figure 134. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

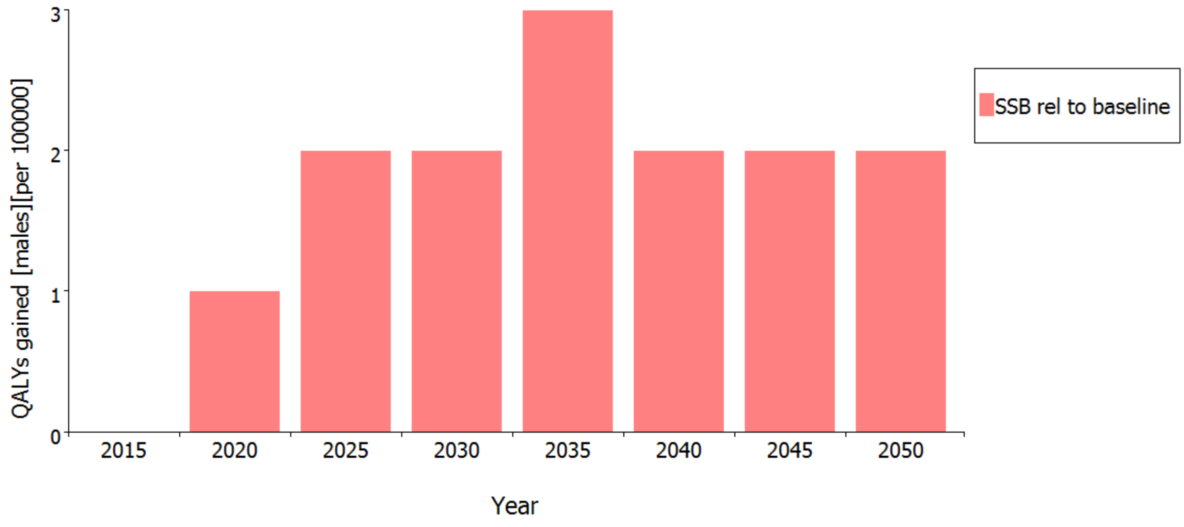


Figure 135. QALYS gained (per 100,000), relative to baseline (males)

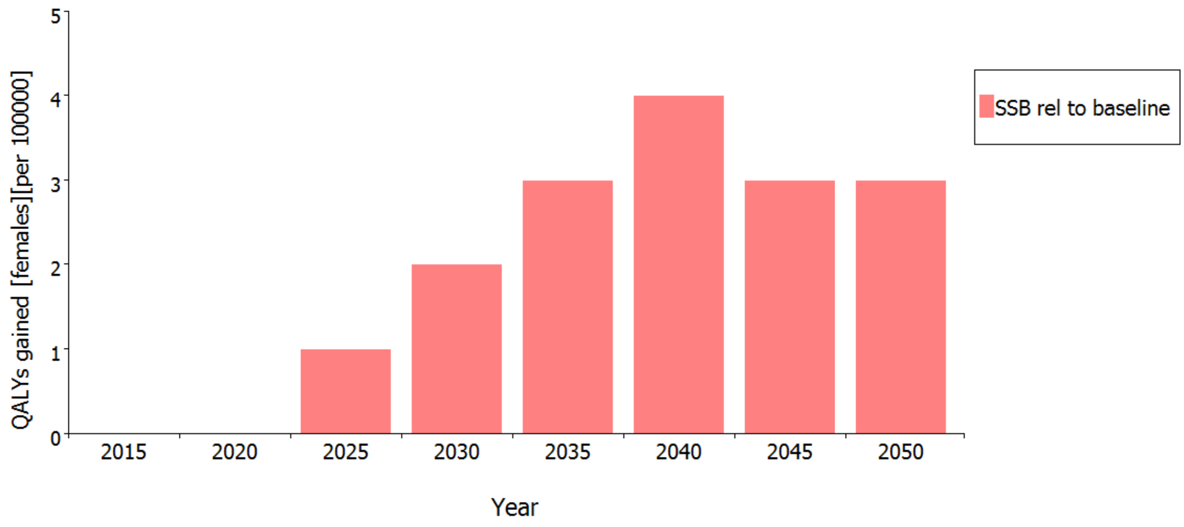


Figure 136. QALYS gained (per 100,000), relative to baseline (females)

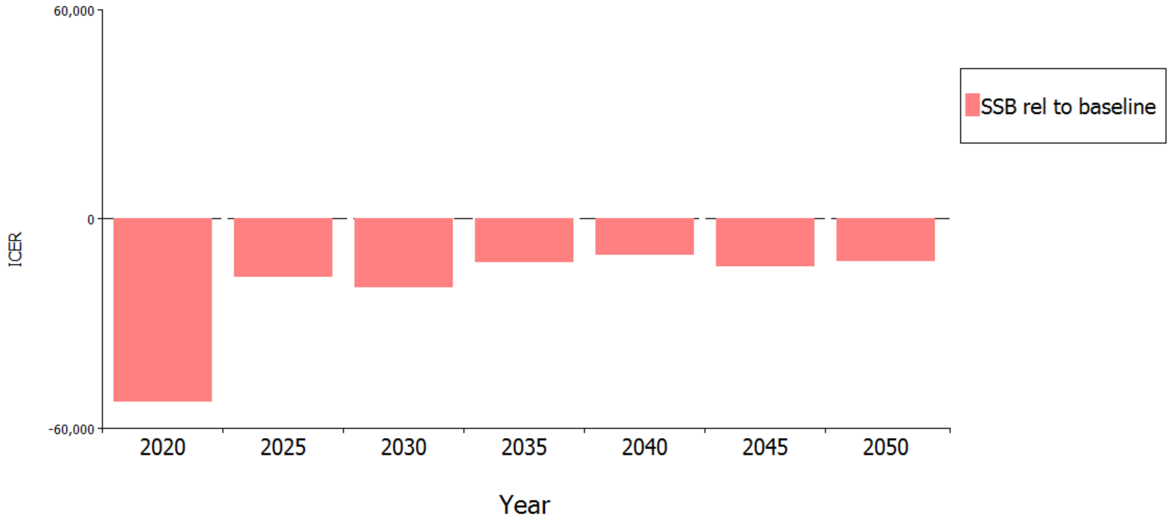


Figure 137. ICER

Smoking intervention results

Smoking cessation services (SCS)

Table 95. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	65%
Accessibility of the intervention (%)	50%
Overall reach (%)	33%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	22%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€220

* as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Impact on disease incidence and prevalence

Table 96 presents the incidence cases per 100,000 population of the baseline (no intervention) and SCS intervention scenarios. Incidence is predicted to increase across all diseases over time in both scenarios – SCS does appear to impact incidence cases over time. Results from the cumulative incidence cases outputs reveal that SCS does indeed decrease the rate at which incidence cases occur over time. Table 97 presents the cumulative (2015 to 2050) incidence cases per 100,000 population of the baseline (no intervention) and SCS scenarios. Cumulative incidence is expected to be lower across all diseases in the SSB scenario relative to baseline.

Table 98 and Figure 138 present the cumulative incidence cases *avoided* for the SCS intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The SCS intervention is predicted to reduce the cumulative incidence across all diseases, whereby the largest effect is expected to be observed for stroke (2,439 per 100,000) followed by COPD (1,631 per 100,000).

Table 99 present the prevalence cases *avoided* for the SCS intervention relative to baseline – presented in terms of 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). Results indicate that the SCS intervention would result in lower prevalence of every modelled disease when compared to the baseline scenario. The largest prevalence cases avoided per 100,000 can be observed for stroke (1,231 per 100,000) followed by COPD (1,023 per 100,000).

Table 96. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	510 [+-1]	526 [+-1]	705 [+-2]	57 [+-0]	428 [+-1]
	2020	557 [+-1]	576 [+-1]	738 [+-2]	65 [+-1]	489 [+-1]
	2025	612 [+-2]	630 [+-2]	780 [+-2]	73 [+-1]	532 [+-1]
	2030	666 [+-2]	681 [+-2]	817 [+-2]	81 [+-1]	595 [+-2]
	2035	720 [+-2]	720 [+-2]	839 [+-2]	89 [+-1]	645 [+-2]
	2040	757 [+-2]	740 [+-2]	841 [+-2]	95 [+-1]	708 [+-2]
	2045	780 [+-2]	762 [+-2]	826 [+-2]	100 [+-1]	754 [+-2]
	2050	778 [+-2]	771 [+-2]	806 [+-2]	103 [+-1]	799 [+-2]
SCS	2015	509 [+-1]	525 [+-1]	705 [+-2]	57 [+-0]	428 [+-1]
	2020	557 [+-1]	571 [+-1]	739 [+-2]	64 [+-0]	481 [+-1]
	2025	608 [+-2]	615 [+-2]	777 [+-2]	70 [+-1]	509 [+-1]
	2030	661 [+-2]	653 [+-2]	812 [+-2]	77 [+-1]	550 [+-1]
	2035	712 [+-2]	678 [+-2]	831 [+-2]	81 [+-1]	577 [+-2]
	2040	749 [+-2]	685 [+-2]	831 [+-2]	84 [+-1]	611 [+-2]
	2045	769 [+-2]	685 [+-2]	813 [+-2]	85 [+-1]	635 [+-2]
	2050	771 [+-2]	675 [+-2]	792 [+-2]	86 [+-1]	663 [+-2]

Table 97. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	510 [+-1]	526 [+-1]	705 [+-2]	57 [+-0]	428 [+-1]
	2020	3214 [+-3]	3312 [+-4]	4349 [+-4]	367 [+-1]	2778 [+-3]
	2025	6242 [+-5]	6437 [+-5]	8266 [+-5]	724 [+-2]	5422 [+-4]
	2030	9663 [+-6]	9946 [+-6]	12529 [+-7]	1136 [+-2]	8448 [+-6]
	2035	13507 [+-7]	13831 [+-7]	17128 [+-8]	1607 [+-3]	11880 [+-7]
	2040	17756 [+-8]	18037 [+-8]	21998 [+-9]	2133 [+-3]	15770 [+-8]
	2045	22393 [+-9]	22597 [+-9]	27109 [+-9]	2715 [+-3]	20138 [+-8]
	2050	27396 [+-10]	27552 [+-10]	32510 [+-10]	3361 [+-4]	25049 [+-9]
SCS	2015	509 [+-1]	525 [+-1]	705 [+-2]	57 [+-0]	428 [+-1]
	2020	3211 [+-3]	3303 [+-4]	4346 [+-4]	365 [+-1]	2759 [+-3]
	2025	6225 [+-5]	6371 [+-5]	8257 [+-5]	713 [+-2]	5327 [+-4]
	2030	9619 [+-6]	9761 [+-6]	12495 [+-7]	1104 [+-2]	8169 [+-5]
	2035	13417 [+-7]	13441 [+-7]	17039 [+-8]	1539 [+-3]	11290 [+-6]
	2040	17598 [+-8]	17362 [+-8]	21828 [+-9]	2010 [+-3]	14714 [+-7]
	2045	22143 [+-9]	21512 [+-9]	26829 [+-9]	2518 [+-3]	18464 [+-8]
	2050	27052 [+-10]	25921 [+-9]	32093 [+-10]	3068 [+-4]	22610 [+-9]

Table 98. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	1 [+-1]	1 [+-1]	0 [+-3]	0 [+-0]	0 [+-1]
	2020	3 [+-4]	9 [+-6]	3 [+-6]	2 [+-1]	19 [+-4]
	2025	17 [+-7]	66 [+-7]	9 [+-7]	11 [+-3]	95 [+-6]
	2030	44 [+-8]	185 [+-8]	34 [+-10]	32 [+-3]	279 [+-8]
	2035	90 [+-10]	390 [+-10]	89 [+-11]	68 [+-4]	590 [+-9]
	2040	158 [+-11]	675 [+-11]	170 [+-13]	123 [+-4]	1056 [+-11]
	2045	250 [+-13]	1085 [+-13]	280 [+-13]	197 [+-4]	1674 [+-11]
	2050	344 [+-14]	1631 [+-13]	417 [+-14]	293 [+-6]	2439 [+-13]

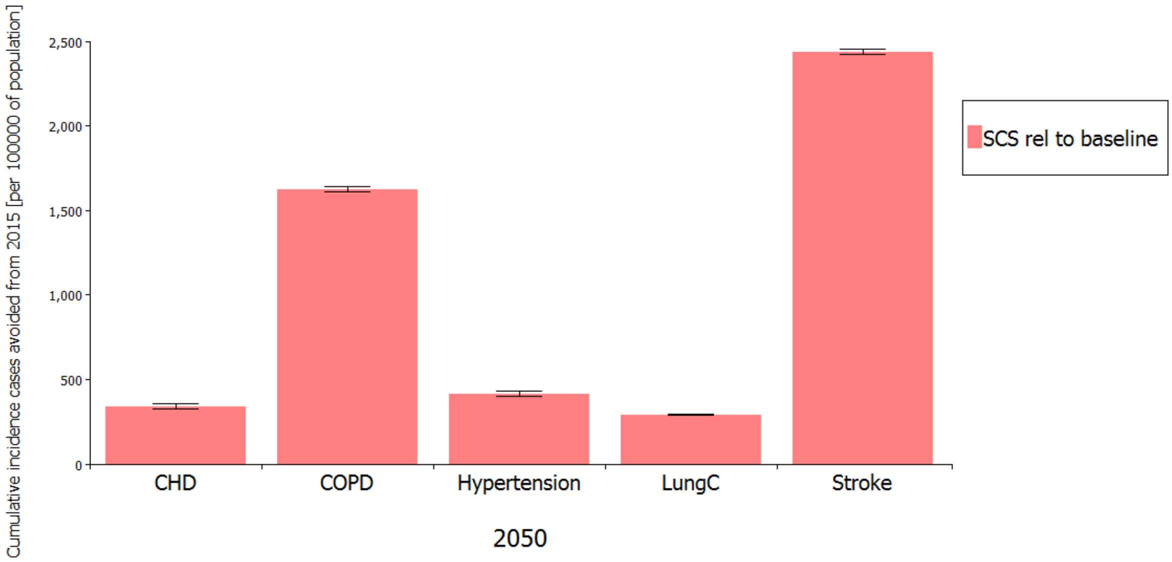


Figure 138. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 99. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	-1 [+-7]	-5 [+-8]	3 [+-10]	0 [+-1]	6 [+-6]
	2020	3 [+-7]	1 [+-10]	2 [+-10]	1 [+-1]	19 [+-6]
	2025	11 [+-8]	49 [+-10]	3 [+-11]	5 [+-1]	82 [+-6]
	2030	22 [+-8]	142 [+-10]	7 [+-11]	8 [+-1]	217 [+-6]
	2035	34 [+-8]	289 [+-11]	12 [+-11]	15 [+-1]	408 [+-7]
	2040	54 [+-10]	473 [+-11]	23 [+-13]	24 [+-1]	666 [+-7]
	2045	75 [+-10]	717 [+-11]	30 [+-13]	30 [+-1]	949 [+-7]
	2050	80 [+-10]	1023 [+-11]	39 [+-13]	36 [+-1]	1231 [+-8]

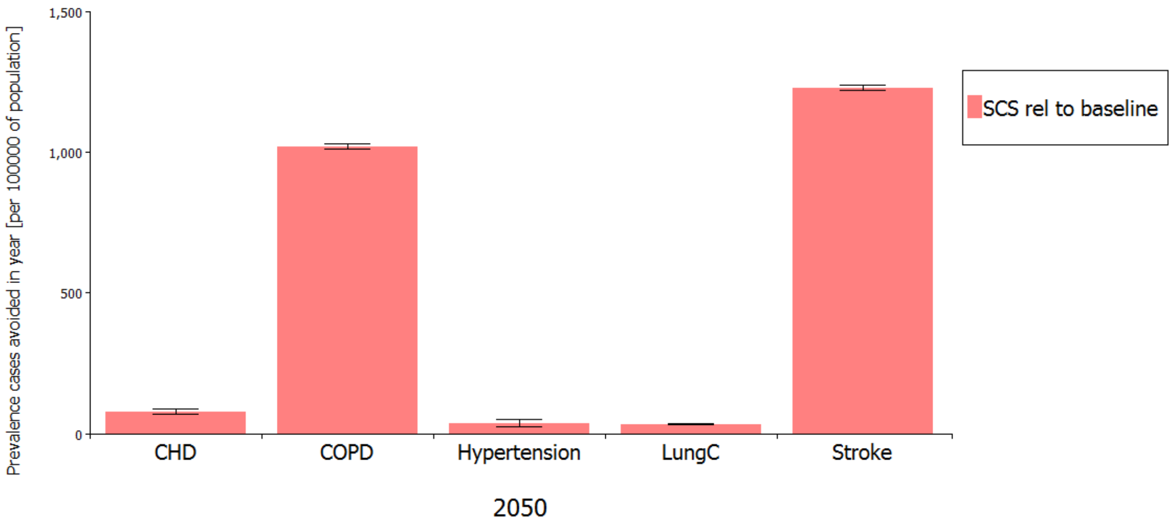


Figure 139. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 100 and Figure 140 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* are expected to occur in stroke (€9.46 million per 100,000 population in 2050).

Table 101 and Figure 141 presents the indirect costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to occur in stroke (€7.41 million per 100,000 population in 2050).

Figure 142 and Figure 143 present the QALYs that can be *gained* (per 100,000 population) with the SCS intervention, relative to the baseline. For both males and females, an SSB tax is projected to lead to increasing gains in QALYs over time. 160 QALYs per 100,000 and 450 QALYs per 100,000 are expected to be *gained* in 2050 for males and females, respectively.

In Figure 144, the negative ICER values (which in this case is comprised of *positive* 'QALYs gained' values in the dominator and *negative* 'costs avoided' values in the numerator) indicates that the SCS intervention is cost effective (the SSB tax intervention scenario *dominates* the baseline scenario). The ICER value in 2020 is caused by the small difference in QALYs between the SCS intervention and baseline scenario – likely explained by the fact that it takes time for this public health intervention to produce marked improvements in QALYs in the population. In effect, the intervention only starts becoming cost effective from 2025 onwards.

Table 100. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	-0.004181 [+-0.001515]	-0.006544 [+-0.001253]	0.0003 [+-0.000218]	0.000031 [+-0.000001]	0.115128 [+-0.003748]
	2020	0.005316 [+-0.001502]	0.001387 [+-0.00122]	0.000282 [+-0.000205]	0.001275 [+-0.000001]	0.355507 [+-0.004081]
	2025	0.022993 [+-0.001498]	0.043501 [+-0.001196]	0.000318 [+-0.000194]	0.003694 [+-0.000001]	1.322029 [+-0.004266]
	2030	0.040356 [+-0.001505]	0.109172 [+-0.001176]	0.000543 [+-0.000184]	0.005814 [+-0.000001]	3.013695 [+-0.00439]
	2035	0.053843 [+-0.001513]	0.191195 [+-0.001143]	0.000889 [+-0.000175]	0.008869 [+-0.000001]	4.876701 [+-0.004466]
	2040	0.073706 [+-0.0015]	0.270555 [+-0.00109]	0.001429 [+-0.000165]	0.011507 [+-0.000001]	6.871002 [+-0.004493]
	2045	0.088773 [+-0.001453]	0.353257 [+-0.001015]	0.001601 [+-0.000152]	0.012962 [+-0.000001]	8.452408 [+-0.004409]
	2050	0.0814 [+-0.001369]	0.434693 [+-0.00093]	0.001785 [+-0.000138]	0.013293 [+-0.000001]	9.460415 [+-0.004242]

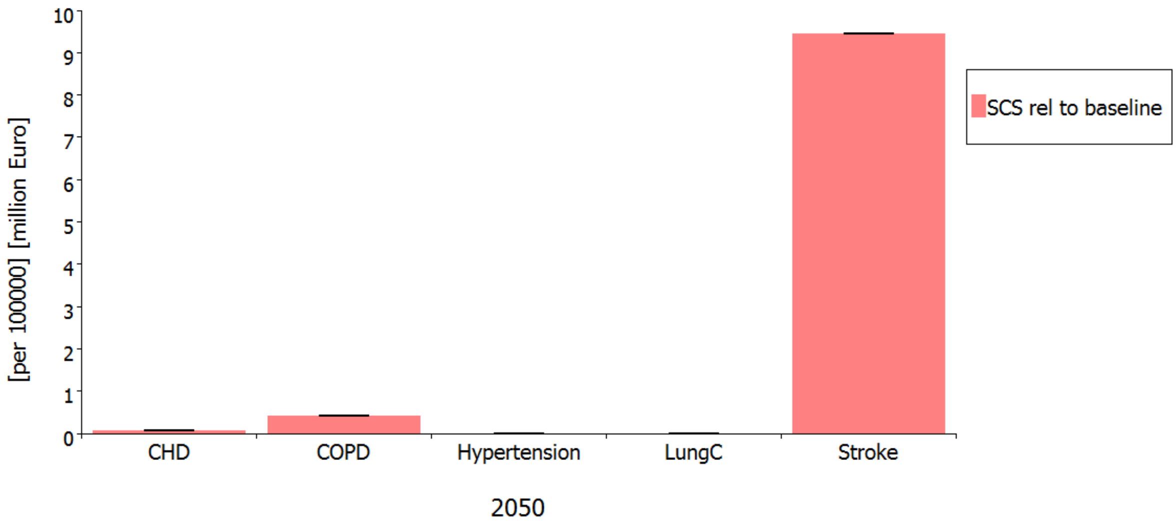


Figure 140. Direct healthcare costs (€ millions) avoided (per 100,000) relative to baseline

Table 101. Indirect costs (€ millions) avoided (per 100,000) relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	-0.006882 [+-0.002494]	-0.038223 [+-0.007319]	0.000228 [+-0.000165]	0.000082 [+-0.000001]	0.09016 [+-0.002935]
	2020	0.008747 [+-0.002472]	0.008095 [+-0.007126]	0.000216 [+-0.000156]	0.003374 [+-0.000003]	0.2784 [+-0.003196]
	2025	0.03784 [+-0.002464]	0.254089 [+-0.006988]	0.000243 [+-0.000147]	0.009772 [+-0.000003]	1.035301 [+-0.00334]
	2030	0.06642 [+-0.002476]	0.637688 [+-0.006868]	0.000414 [+-0.00014]	0.015381 [+-0.000003]	2.360054 [+-0.003438]
	2035	0.088615 [+-0.00249]	1.116798 [+-0.006681]	0.000679 [+-0.000134]	0.023463 [+-0.000004]	3.819 [+-0.003497]
	2040	0.121305 [+-0.002469]	1.580349 [+-0.006365]	0.001091 [+-0.000126]	0.030442 [+-0.000003]	5.38076 [+-0.003518]
	2045	0.146101 [+-0.00239]	2.063423 [+-0.005932]	0.001222 [+-0.000116]	0.03429 [+-0.000003]	6.619179 [+-0.003453]
	2050	0.133968 [+-0.002253]	2.539104 [+-0.005429]	0.001362 [+-0.000105]	0.035168 [+-0.000003]	7.408558 [+-0.003322]

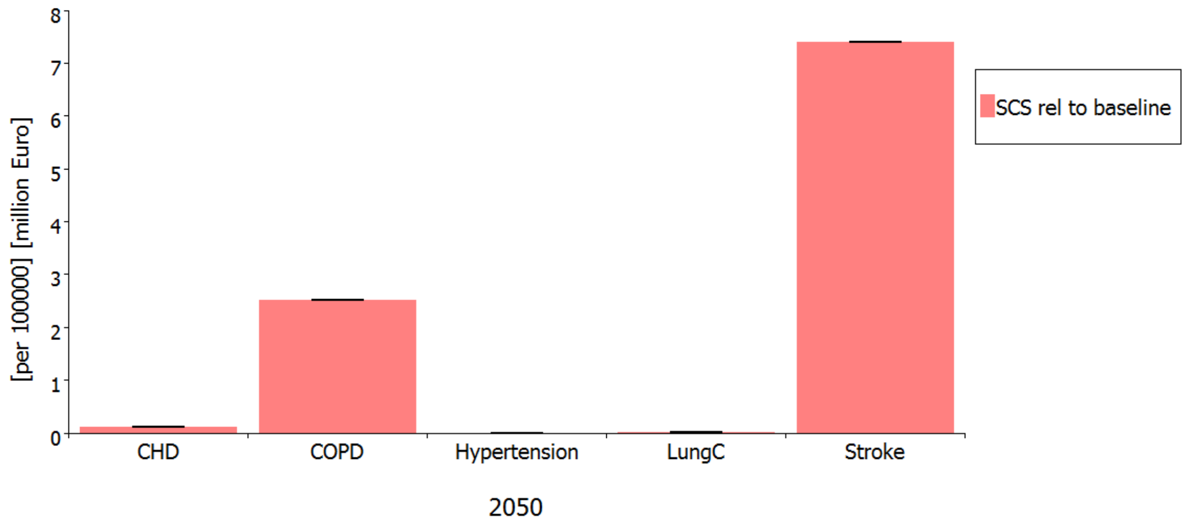


Figure 141. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

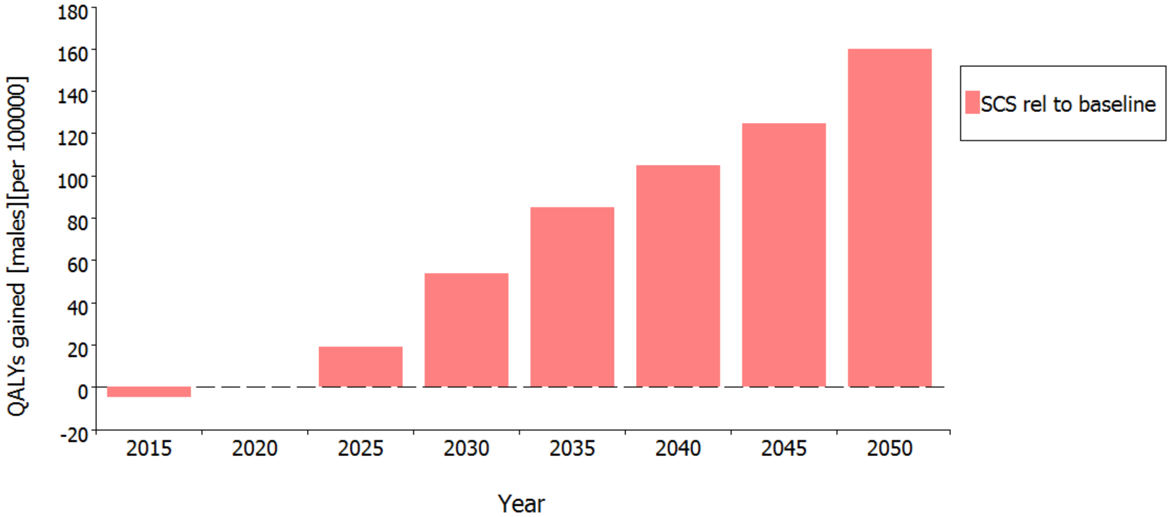


Figure 142. QALYS gained (per 100,000), relative to baseline (males)

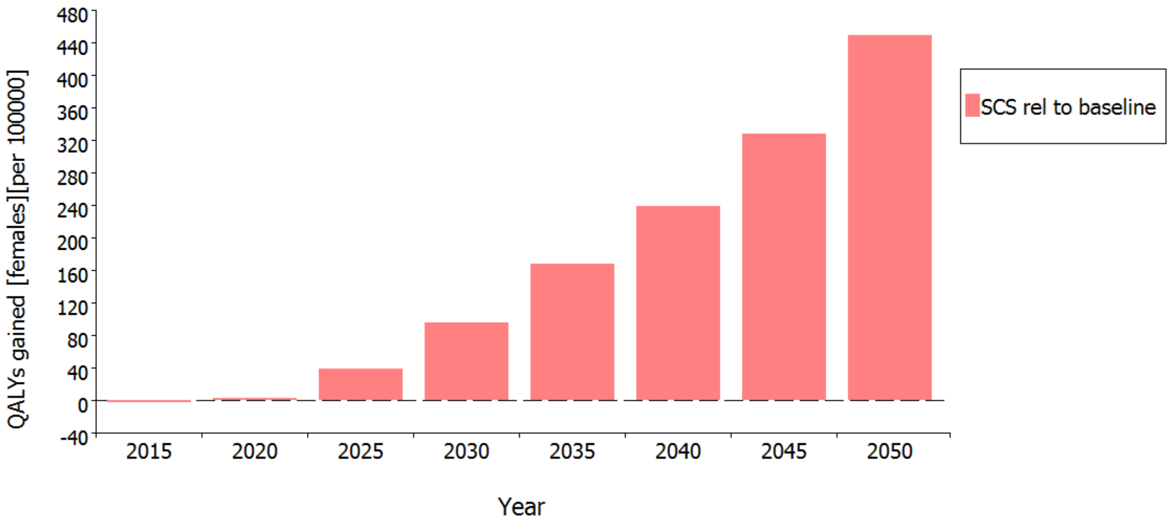


Figure 143. QALYS gained (per 100,000) relative to baseline (females)

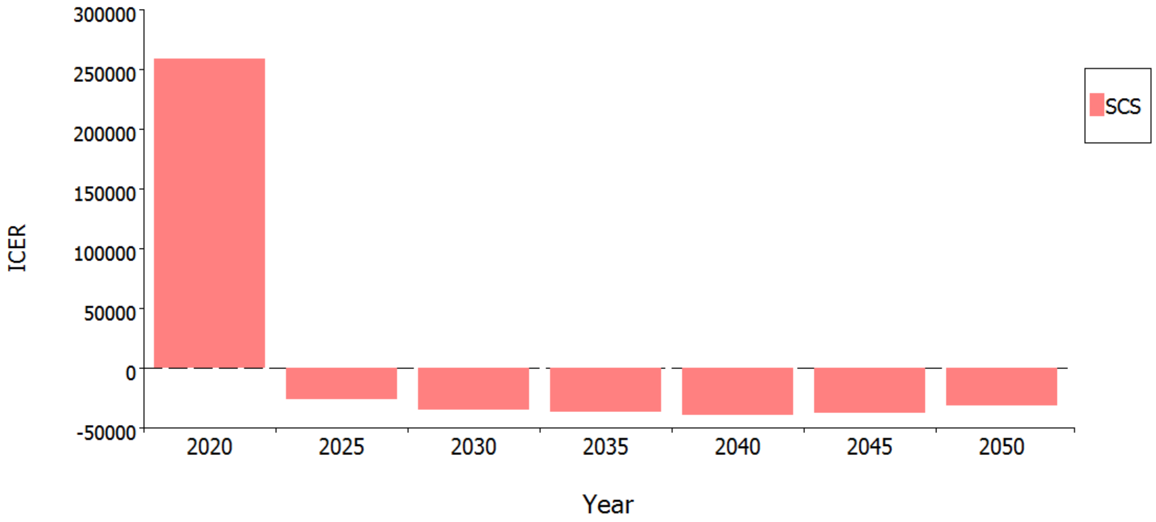


Figure 144. ICER

Lithuania

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m^2) are presented in Table 102 and for smoking prevalence by age and sex are presented in

Table 103. Data were also collected by personal communication where possible.

Data were also collected by education level and income group where available in order to explore future prevalence of each risk factor by sub-groups.

Table 102 References used in the model for BMI prevalence

Reference	Year	Sample size		Age group	Measured/ Self-reported	National/ Subnational
		M	F			
WHO; Grabauskas et al, 1998	1998	811	1044	20-64	Self-reported	National
WHO; Grabauskas et al, 2000	2000	989	1183	20-64	Self-reported	National
Grabauskas et al. Lithuanian health behaviour monitoring, 2002[1]	2002	1650	1027	20-64	Self-reported	National
Grabauskas et al. Health Behaviour among Lithuanian adult population, 2004[1]	2004	757	1009	20-64	Self-reported	National
Unpublished data obtained from Sigita Mačiuikienė	2005	3801	5707	15-100	Self-reported	National
Grabauskas et al. Health Behaviour among Lithuanian Adult Population, 2006[1]	2006	704	1001	20-64	Self-reported	National
Grabauskas et al, Health Behaviour among Lithuanian Adult Population, 2008[1]	2008	715	994	20-64	Self-reported	National
Grabauskas et al, Health Behaviour among Lithuanian Adult Population, 2010[1]	2010	578	1359	20-64	Self-reported	National
V. Kriaucioniene et al., The prevalence and trends of overweight and obesity among Lithuanian adults, 1994–2012, 2012[1]	2012	716	1064	20-64	Self-reported	National

[1] Datasets used for BMI by education projections

Table 103 References used in the model for smoking prevalence

Reference	Year	Sample size	Age group	National/ Subnational
Grabauskas et al. Health Behaviour among Lithuanian Adult Population, 2002	2002	1799	20-64	National
Grabauskas et al. Health Behaviour among Lithuanian Adult Population, 2006	2006	1526	20-64	National
Grabauskas et al. Health Behaviour among Lithuanian Adult Population, 2008	2008	1599	20-64	National
Grabauskas et al. Health Behaviour among Lithuanian Adult Population, 2010	2010	1788	20-64	National
Grabauskas et al. Health Behaviour among Lithuanian Adult Population, 2012	2012	1598	20-64	National

Disease data

Disease data sources are detailed in appendix A4. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. Lithuania provided a complete set of epidemiological data stratified by sex and age. Diabetes statistics for Lithuania and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, Appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using prevalence and mortality data (see technical appendix for details). Dutch data were used as proxy for direct costs of COPD, hypertension and pre-diabetes; for indirect costs for diabetes and hypertension and for utility weights for CHD and COPD accounting for exchange rates and purchasing price parities (appendix E5). UK data was used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Intervention data

Table 104 and Table 105 present the intervention input data for each of the interventions modelled:

Table 104 Assumptions for BMI intervention

Intervention	BMI reduction	% BMI regain	Cost of intervention (€)
Baseline	None	-	-
MCLI regain	0.6	100	118
MCLI no regain	0.6	0	118
SSB	0.01	0	0

Table 105 Assumptions for SCS

Variable	Value
Reach	
Willingness to quit smoking (%)	59%
Accessibility of the intervention (%)	50%
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 621

Section 2: Risk factor projections to 2050

BMI projections by age and sex

Table 106 presents the prevalence of normal weight, over-weight and obese (according to BMI) in the adult population by sex. Overall, obesity prevalence is projected to increase in Lithuanian males, and to a lesser extent in females, reaching 38% and 26% respectively by 2050. Overweight prevalence is projected to decline in males and females. The proportion of healthy weight men is projected to decline over the next 35 years, but is predicted to increase amongst females.

Figure 145 to Figure 150 present BMI-group projections to 2050 for males 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. National data from the Health Behaviour among Lithuanian Adult Population (2002-2012) were used as a proxy for the Lithuanian population. The increase in obesity prevalence described above is expected among men in most age groups. Among men 50 to 79 years old, obesity prevalence could exceed 40% by 2050. The proportion of healthy weight men is predicted to decline slightly or stabilise in most age groups, except in 20-29 year olds for whom healthy weight prevalence increases sharply.

Figure 151 to Figure 156 present the BMI-group projections to 2050 for females 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The predicted increase in obesity described above is marginal for Lithuanian females, and is predicted only amongst 70-79 year old females; for 20-29 year old obesity prevalence is low and is predicted to remain low. Overweight prevalence is projected to remain stable or decline across all age groups. The proportion of healthy weight females is predicted to stabilise or increase by 2050, with the steepest increase predicted for 30-59 year olds.

Table 106 Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI
2015	39.0	9.1	41.0	9.8	21.0	7.8	48.0	7.1	28.0	7.2	24.0	6.4	44.0	8.1	34.0	8.6	22.0	7.1
2020	38.0	13.3	40.0	14.3	22.0	11.4	50.0	10.4	26.0	10.7	24.0	9.5	44.0	11.9	32.0	12.6	23.0	10.5
2025	37.0	17.6	39.0	19.0	24.0	15.1	51.0	13.9	25.0	14.3	24.0	12.7	44.0	15.9	31.0	16.8	24.0	13.9
2030	35.0	21.9	38.0	23.7	27.0	18.8	52.0	17.4	23.0	17.9	25.0	15.9	44.0	19.8	30.0	21.0	26.0	17.4
2035	33.0	26.3	37.0	28.5	30.0	22.6	53.0	21.0	21.0	21.6	25.0	19.2	44.0	23.8	29.0	25.3	28.0	21.0
2040	30.0	30.7	36.0	33.3	34.0	26.3	54.0	24.5	20.0	25.2	25.0	22.5	44.0	27.8	27.0	29.5	29.0	24.5
2045	29.0	35.1	35.0	38.0	36.0	30.1	55.0	28.1	19.0	28.9	26.0	25.8	43.0	31.8	26.0	33.8	31.0	28.0
2050	27.0	39.6	34.0	42.8	38.0	33.9	56.0	31.7	17.0	32.6	26.0	29.1	43.0	35.8	25.0	38.1	32.0	31.6

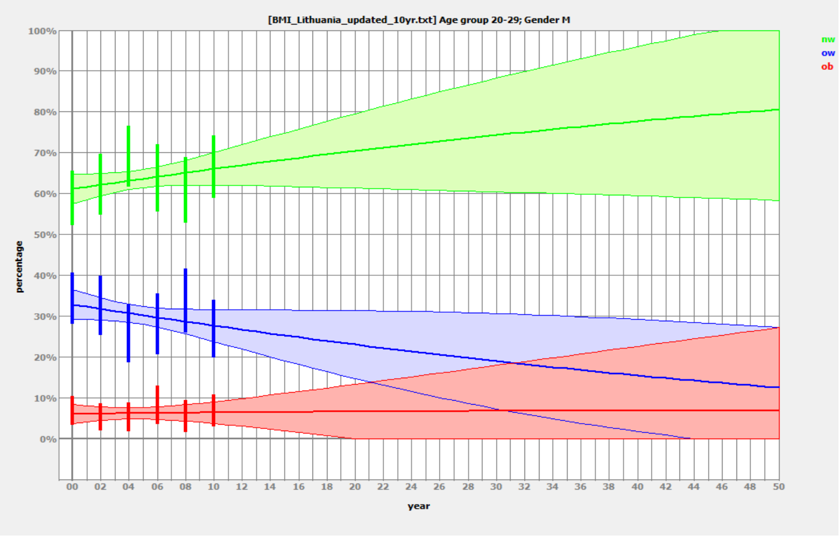


Figure 145 Projected BMI-group in 20-29 year old males

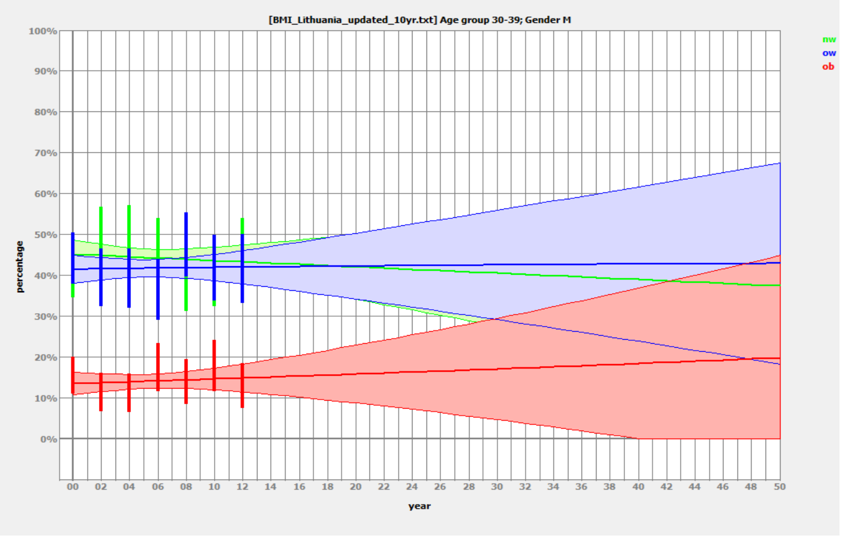


Figure 146 Projected BMI-group in 30-39 year old males

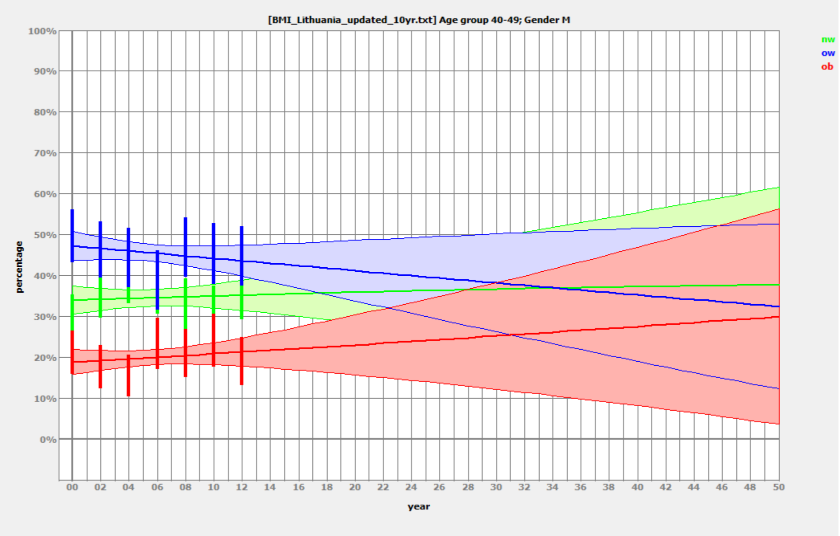


Figure 147 Projected BMI-group in 40-49 year old males

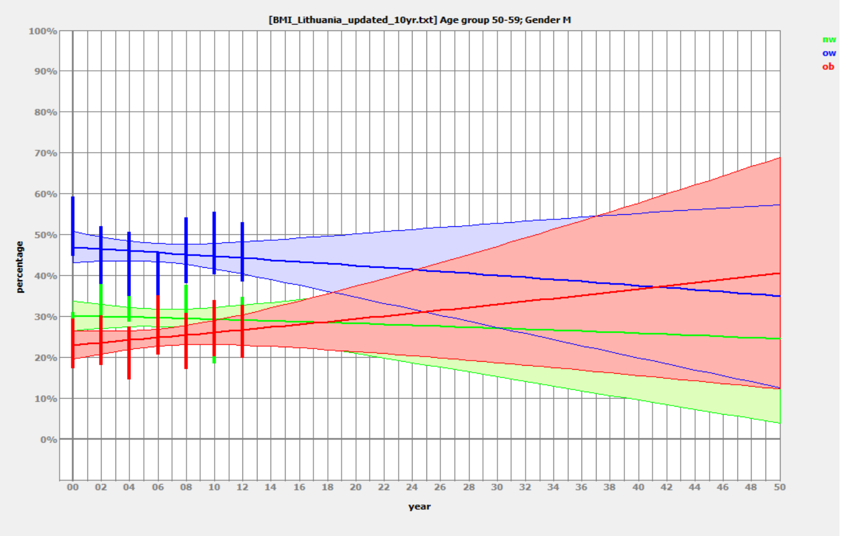


Figure 148 Projected BMI-group in 50-59 year old males

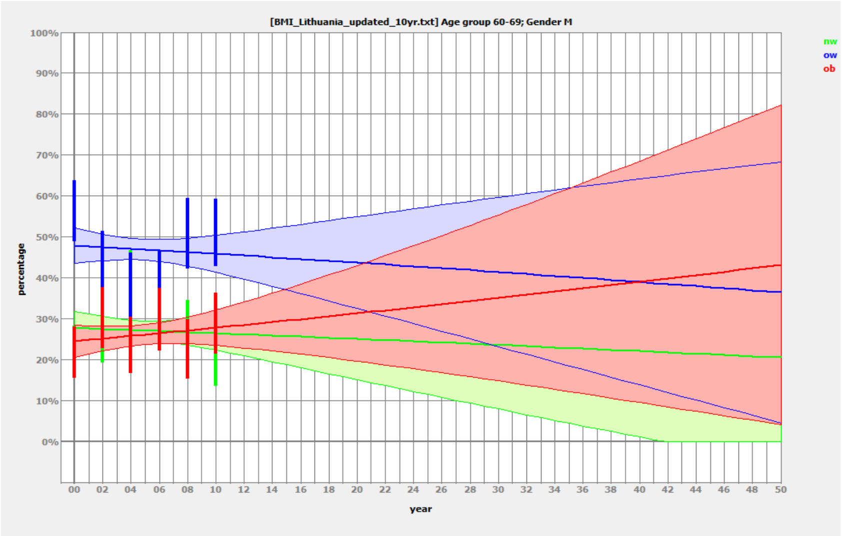


Figure 149 Projected BMI-group in 60-69 year old males

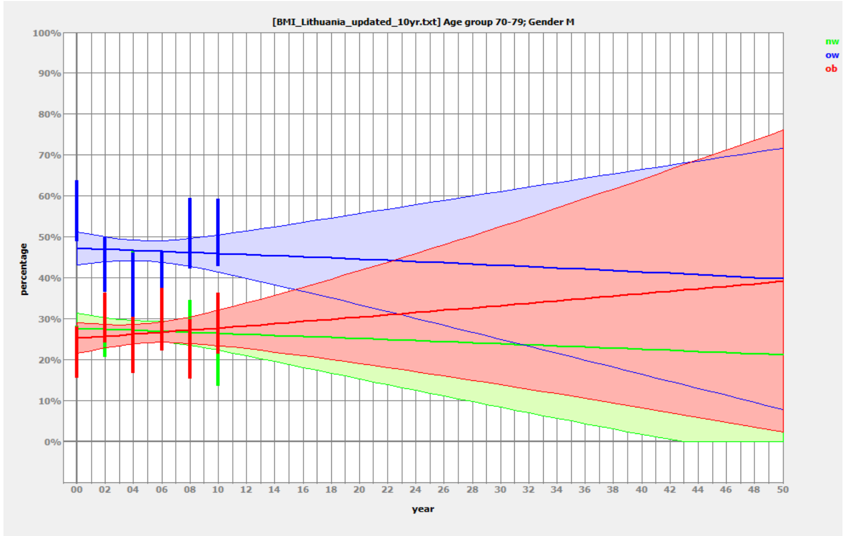


Figure 150 Projected BMI-group in 70-79 year old males

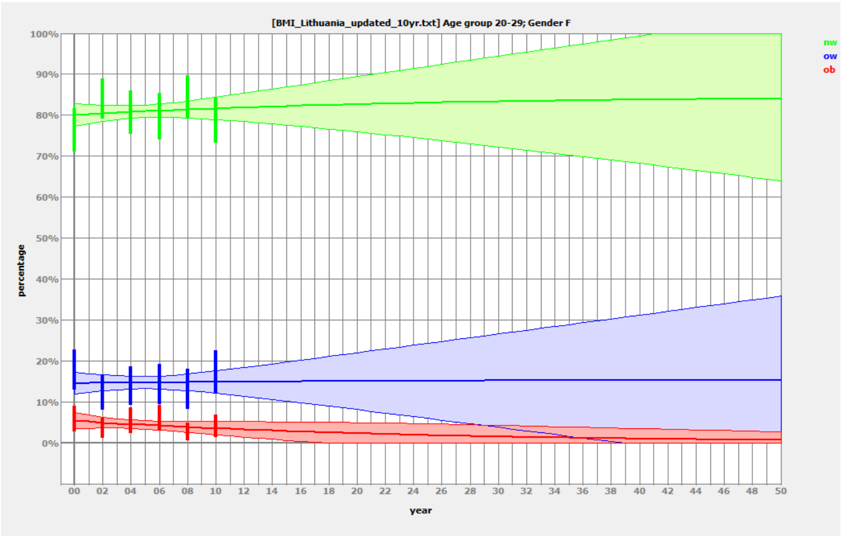


Figure 151 Projected BMI-group in 20-29 year old females

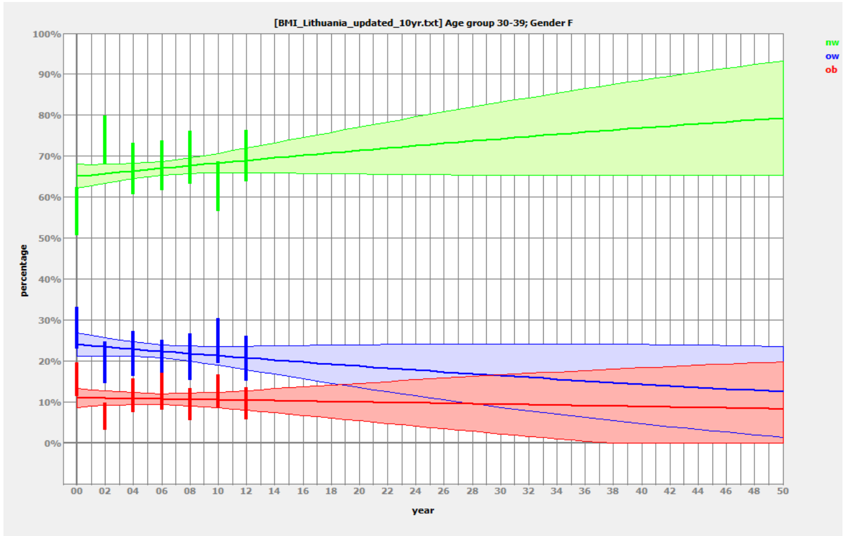


Figure 152 Projected BMI-group in 30-39 year old females

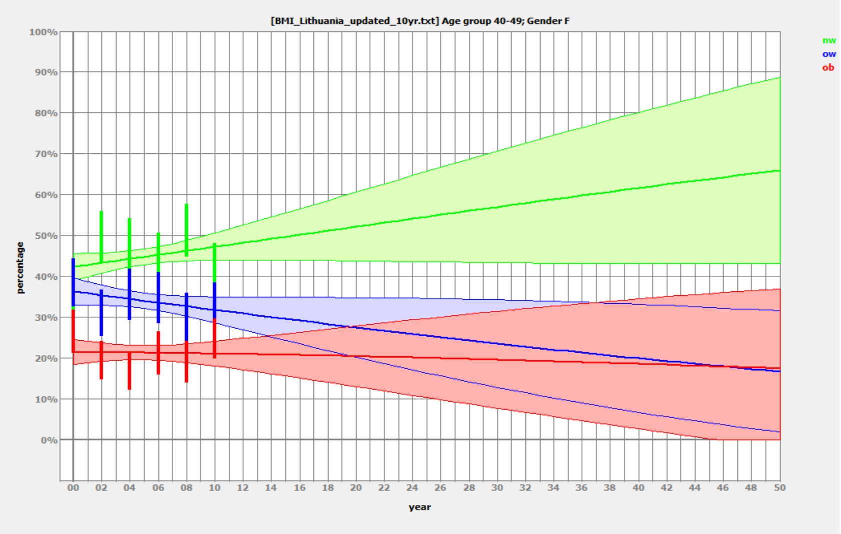


Figure 153 Projected BMI-group in 40-49 year old females

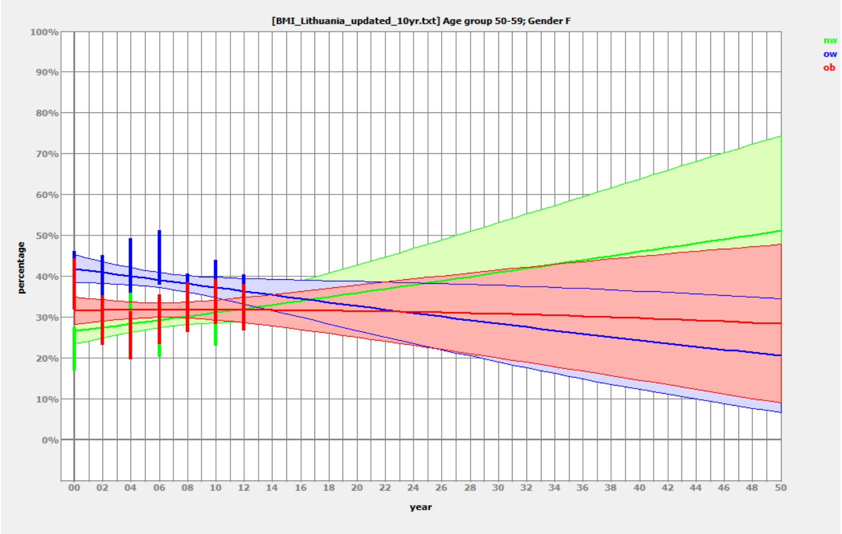


Figure 154 Projected BMI-group in 50-59 year old females

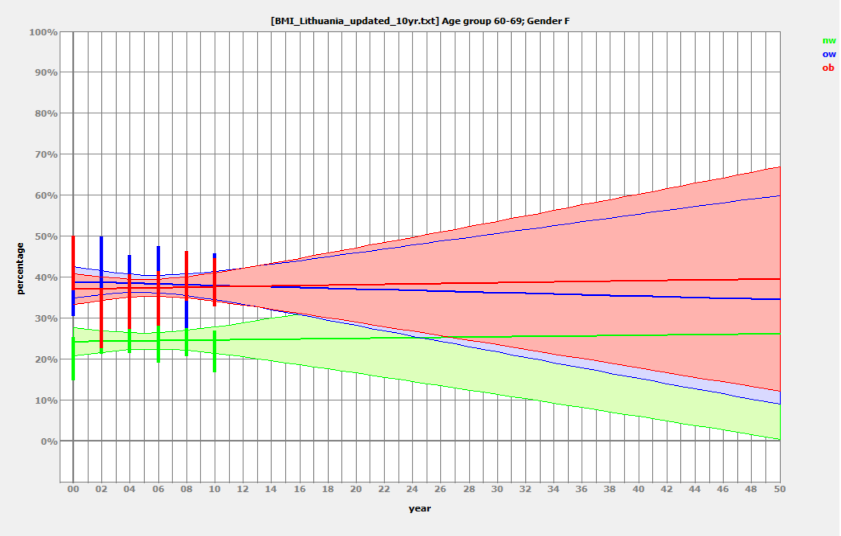


Figure 155 Projected BMI-group in 60-69 year old females

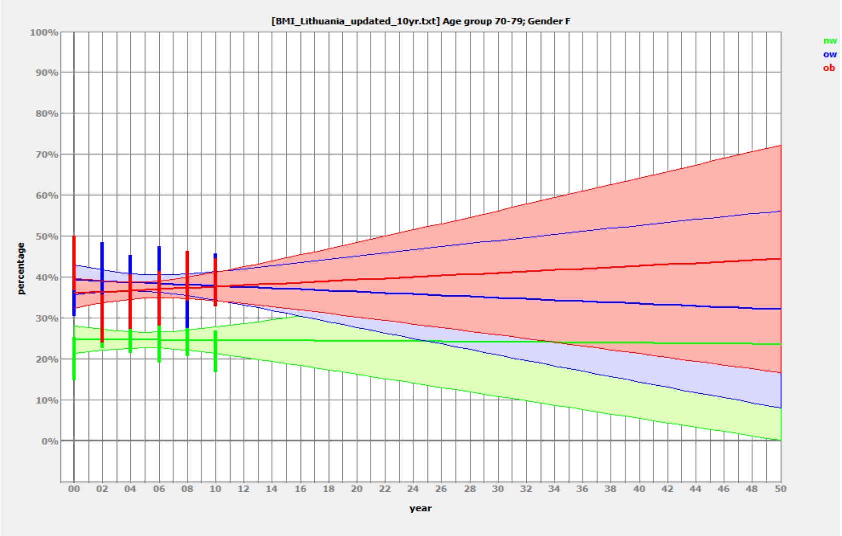


Figure 156 Projected BMI-group in 70-79 year old females

BMI projections by education level

Education was divided into two groups: 1) below tertiary education 2) tertiary education and above. Tertiary education was defined as 'post-secondary education'.

Males

Historically, overweight prevalence has been higher among men with tertiary education compared to men with less than tertiary education (Figure 157). However, the relationship between overweight prevalence and education level has changed since 2012 where males with less than tertiary education now have a higher overweight prevalence than males with at least tertiary level education. Figure 157 indicates that inequalities in overweight prevalence are predicted to increase over the next 25 to 30 years if trends go unchecked.

Inequalities in obesity are projected to remain similar for Lithuanian men with less than tertiary education and those with at least tertiary education (Figure 158; note overlap of error bars between education groups for all years). Full data presenting obesity prevalence by education group in Lithuanian males is shown in Appendix E4.

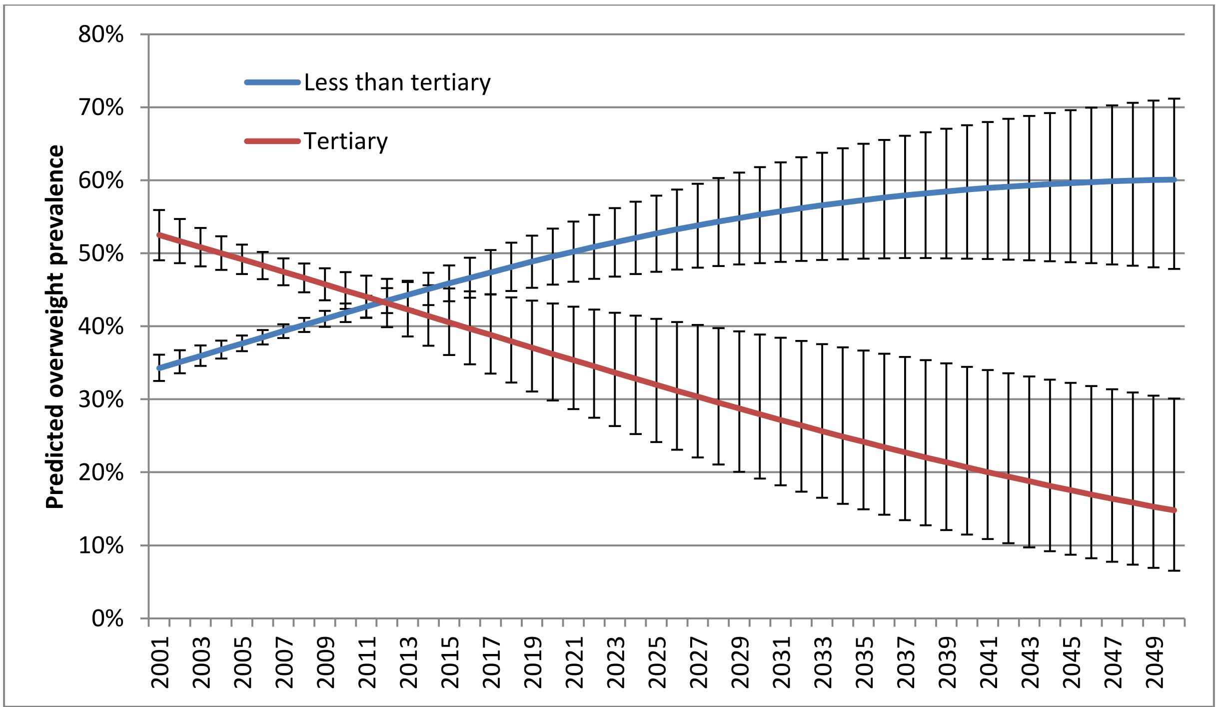


Figure 157 Overweight prevalence by education level among males

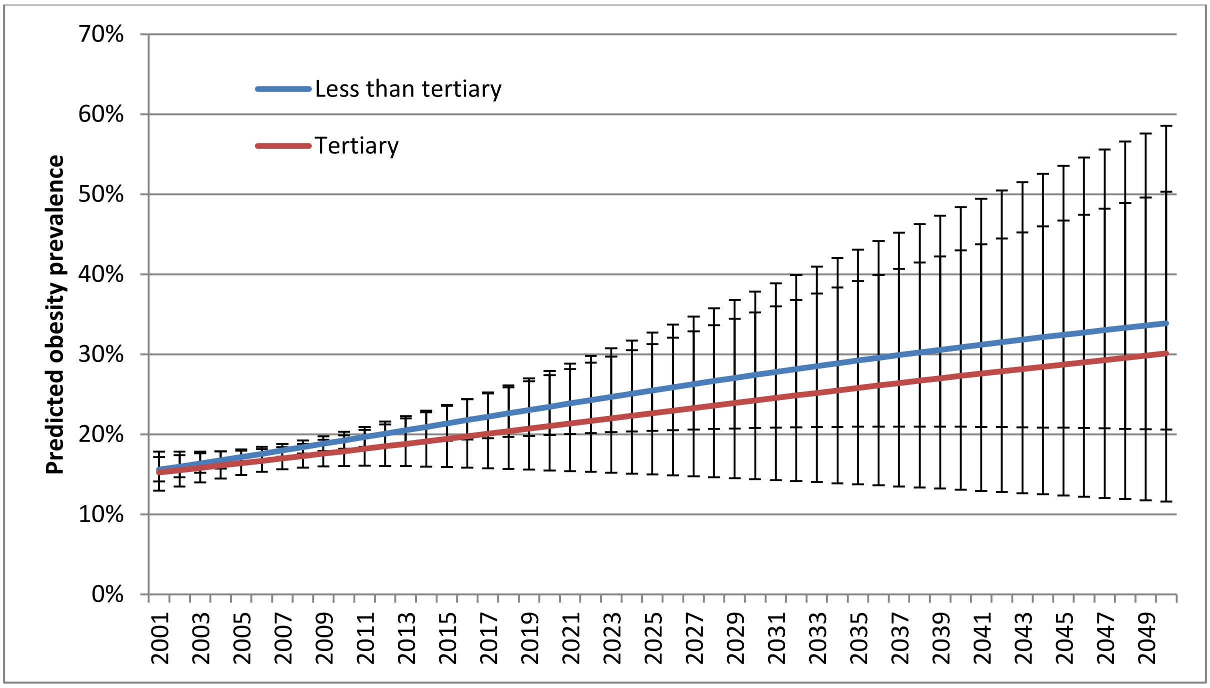


Figure 158 Obesity prevalence by education level among males

Females

Inequalities in overweight prevalence have been increasing for Lithuanian females with and without tertiary level education since 2001, and are projected to widen up to 2050 (Figure 159). However, there is overlap of error bars between education groups from 2030 so more data are necessary to determine the significance of this trend.

Obesity prevalence is predicted to increase very little among females with tertiary education, but will increase substantially among females with less than tertiary education (Figure 160). As a result of the stable obesity prevalence predicted for tertiary level educated females, and the steep increase in obesity prevalence for females with less than tertiary education, relative and absolute inequalities are projected to widen. By 2030 females in the lower education group are predicted to have a prevalence of obesity 3.4 times higher than females with tertiary education (Appendix E4 and Figure 160).

Fewer data points were available to project overweight and obesity by education level than for the age-stratified projections (see Table 102). For this reason, projections may vary slightly depending on the type of disaggregation reported.

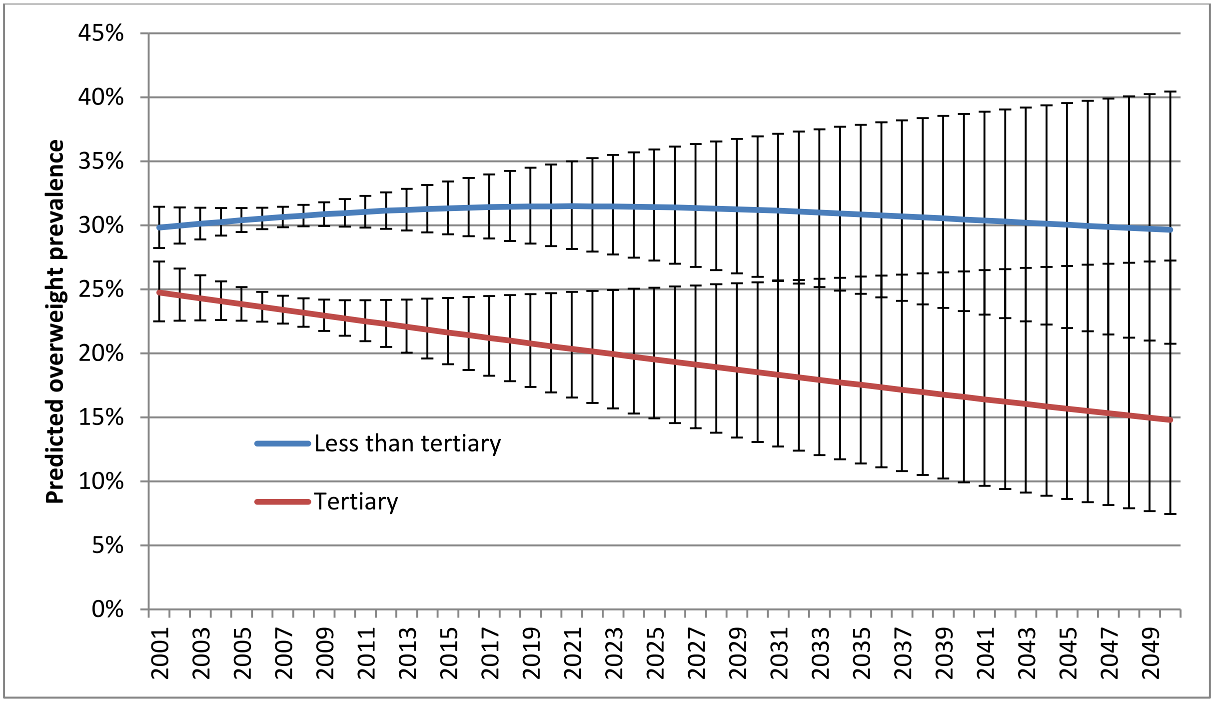


Figure 159 Overweight prevalence by education level among females

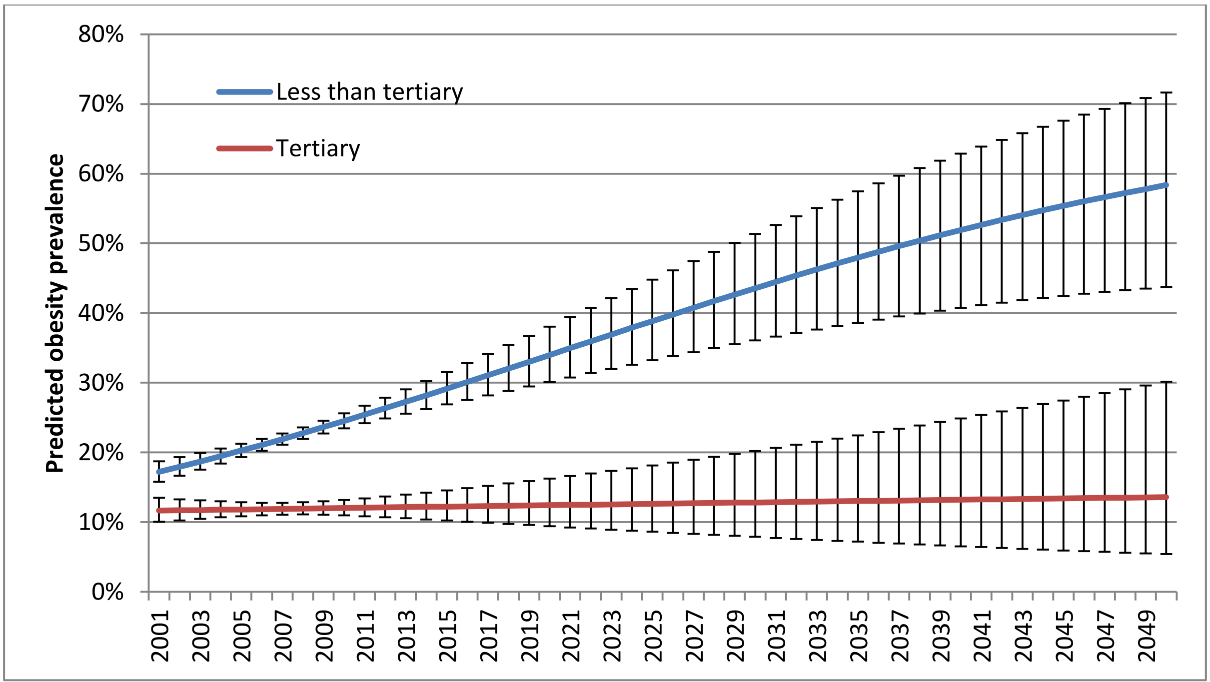


Figure 160 Obesity prevalence by education level among females

Smoking projections by sex and age group

Table 107 presents smoking prevalence projections to 2050 for males and females aged 20 to 100. Smoking prevalence is projected to increase by 2 percentage points to 35% in males, and to decrease by 10 percentage points to 20% in females by 2050.

Overall smoking prevalence among males is projected to remain stable at about 35%. However, as Figure 163 to Figure 165 show, among 40 to 79 year old males, smoking prevalence is projected to decline. In contrast, smoking prevalence is projected to increase among 20 to 29 year olds (Figure 161) and remain stable among 30 to 39 year olds (Figure 162).

Smoking prevalence among Lithuanian females is projected to decline overall (Table 107). The decline is projected among all age groups with the exception of the 60 to 69 year old age group (Figure 166 to Figure 170). Among 60 to 69 year old females smoking prevalence is projected to increase significantly surpassing 50%.

Table 107 Smoker prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both			
Year	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-
2015	67.0	15.3	33.0	15.3	70.0	9.1	30.0	9.1	69.0	12.6	31.0	12.6
2020	68.0	26.8	32.0	26.8	72.0	14.4	28.0	14.4	70.0	21.5	30.0	21.5
2025	68.0	38.5	32.0	38.5	74.0	20.0	26.0	20.0	71.0	30.7	29.0	30.7
2030	68.0	50.3	32.0	50.3	75.0	25.6	25.0	25.6	72.0	39.9	28.0	39.9
2035	67.0	62.2	33.0	62.2	77.0	31.2	23.0	31.2	72.0	49.2	28.0	49.2
2040	66.0	74.1	34.0	74.1	78.0	36.9	22.0	36.9	73.0	58.5	27.0	58.5
2045	66.0	85.9	34.0	85.9	79.0	42.5	21.0	42.5	73.0	67.8	27.0	67.8
2050	65.0	97.8	35.0	97.8	80.0	48.2	20.0	48.2	73.0	77.1	27.0	77.1

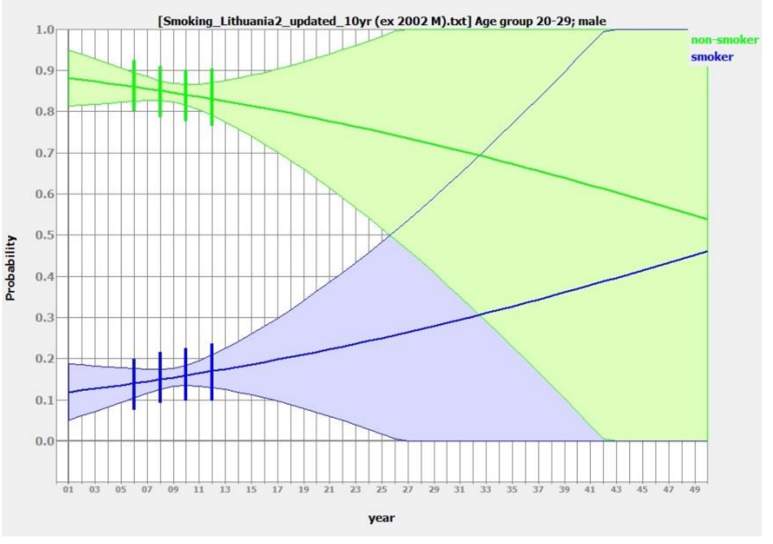


Figure 161 Smoking prevalence projections among males aged 20 to 29

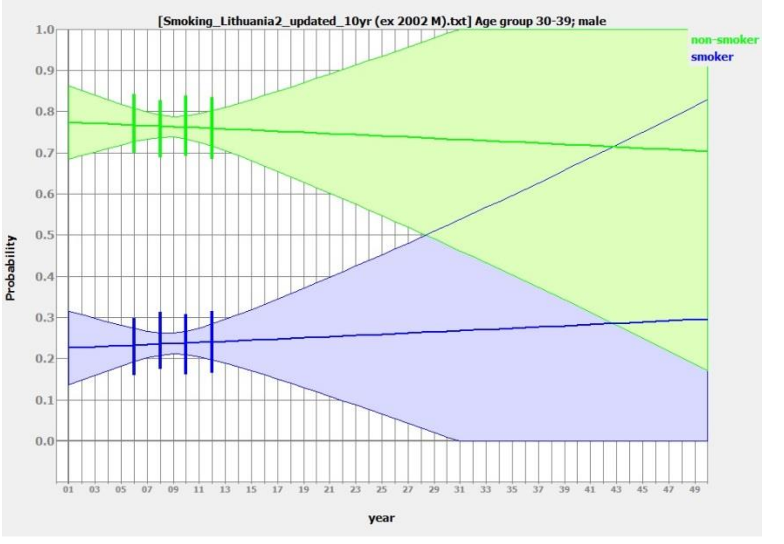


Figure 162 Smoking prevalence projections among males aged 30 to 39

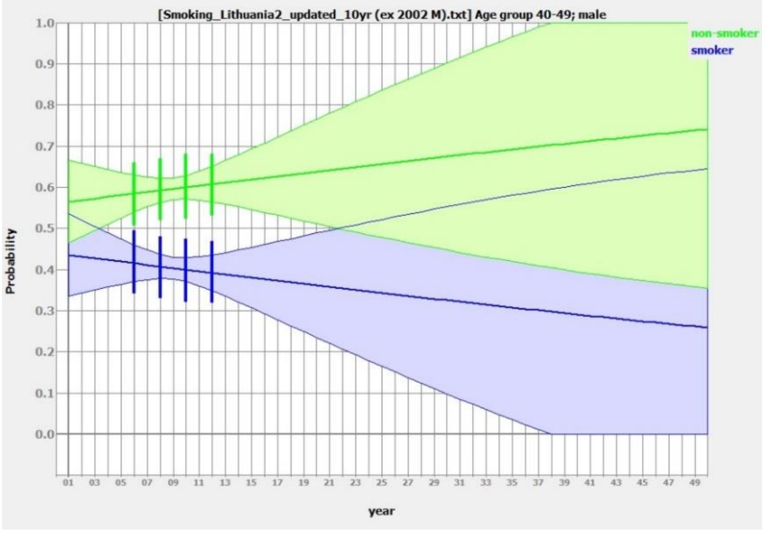


Figure 163 Smoking prevalence projections among males aged 40 to 49

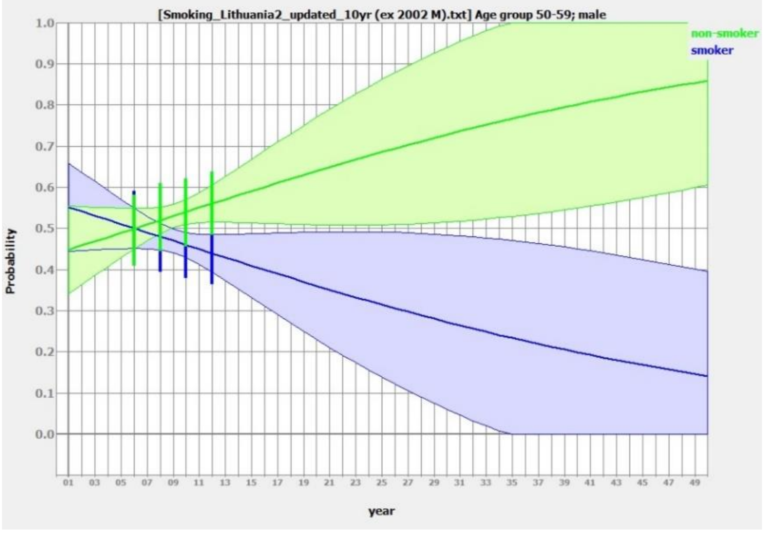


Figure 164 Smoking prevalence projections among males aged 50 to 59

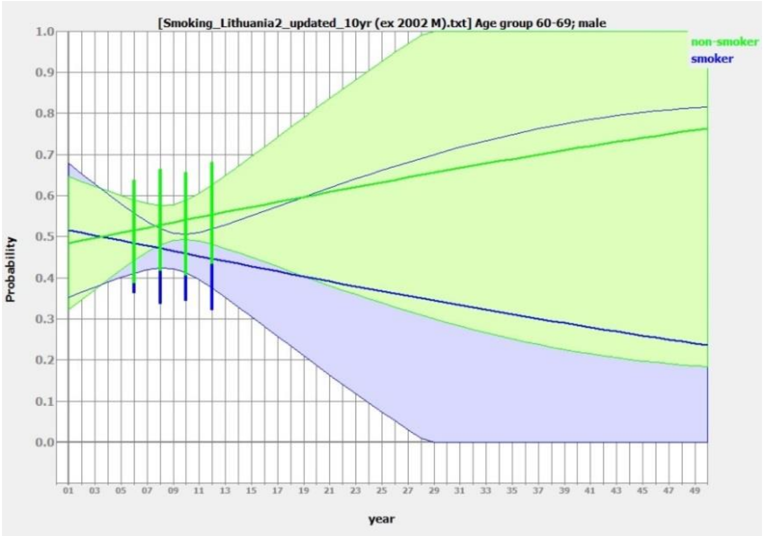


Figure 165 Smoking prevalence projections among males aged 60 to 69

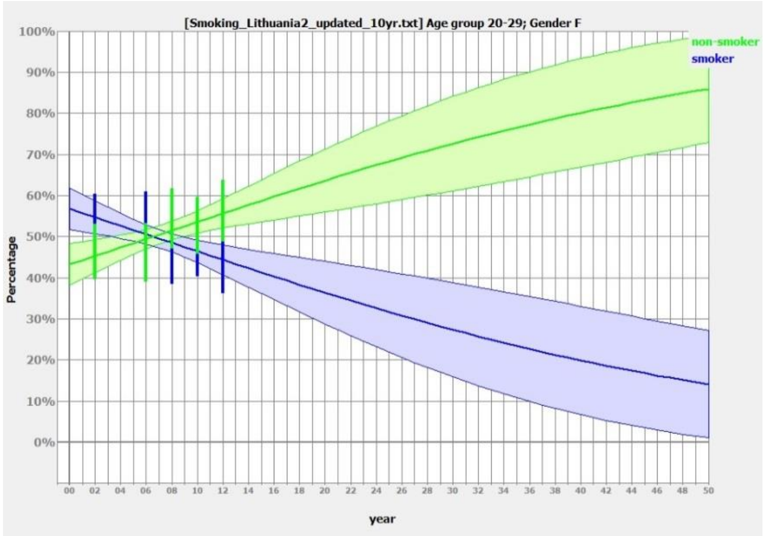


Figure 166 Smoking prevalence projections among females aged 20 to 29

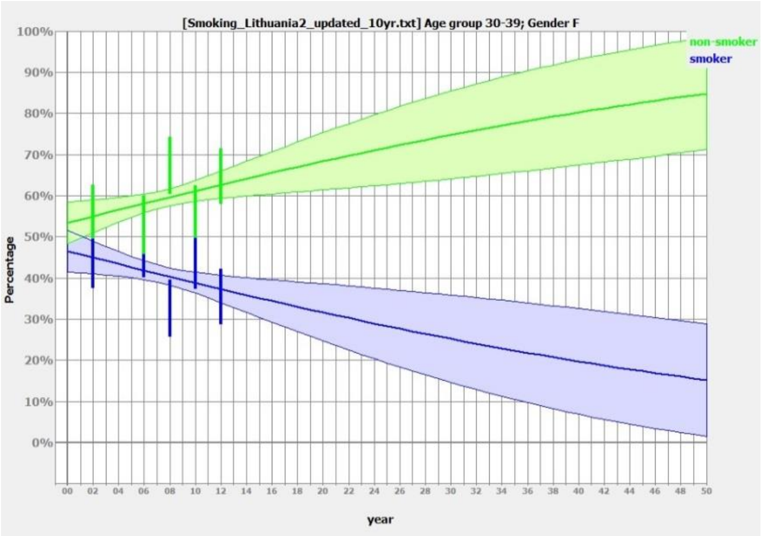


Figure 167 Smoking prevalence projections among females aged 30 to 39

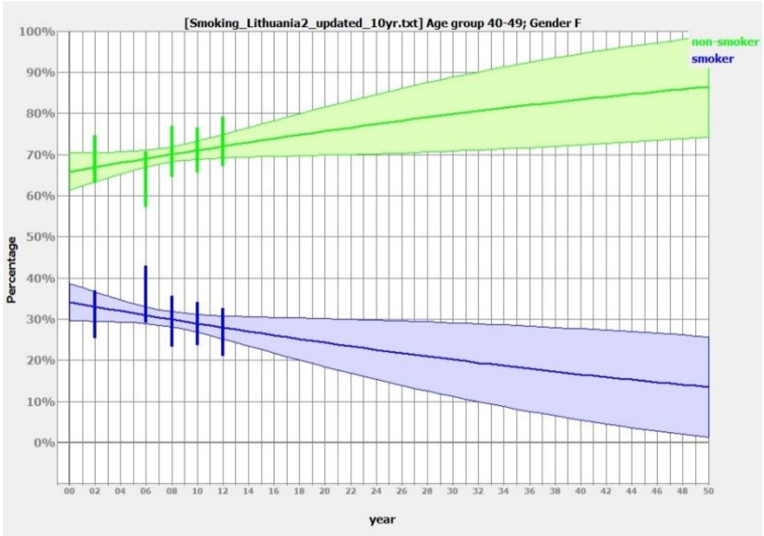


Figure 168 Smoking prevalence projections among females aged 40 to 49

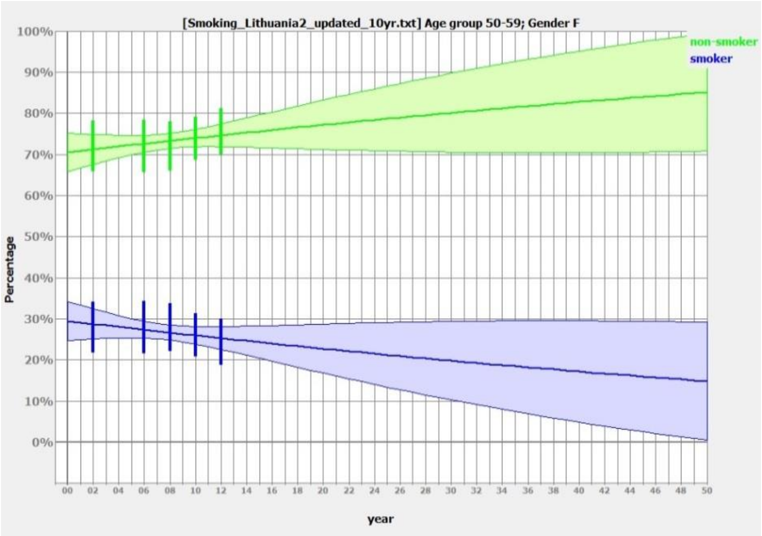


Figure 169 Smoking prevalence projections among females aged 50 to 59

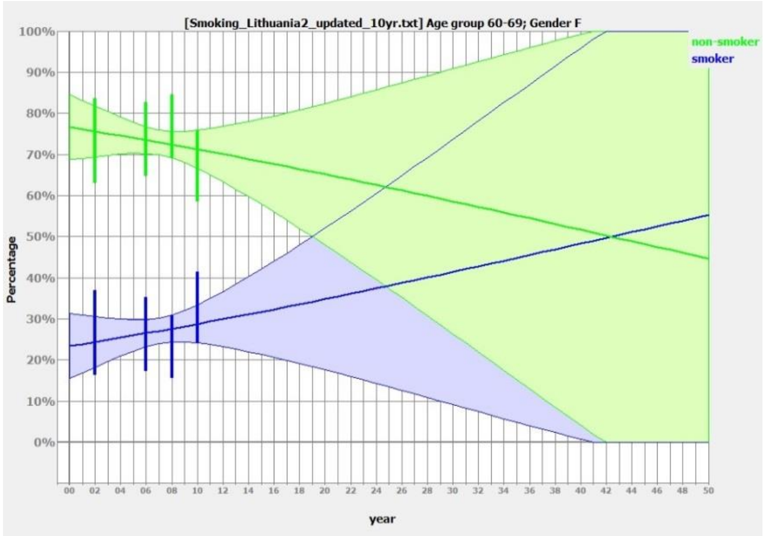


Figure 170 Smoking prevalence projections among females aged 60 to 69

Smoking projections by education level

Males

Men with less than tertiary education are more likely to smoke compared to those with tertiary education, although smoking prevalence is predicted to decline in both groups by 2050 (Figure 171). Relative inequalities in smoking prevalence are projected to increase (Appendix E4). Absolute declines are predicted to be larger among less educated males compared to more educated males, therefore absolute inequalities are likely to decline. From 2025 onwards error bars between education groups overlap, and so more data are necessary to determine the significance of these trends.

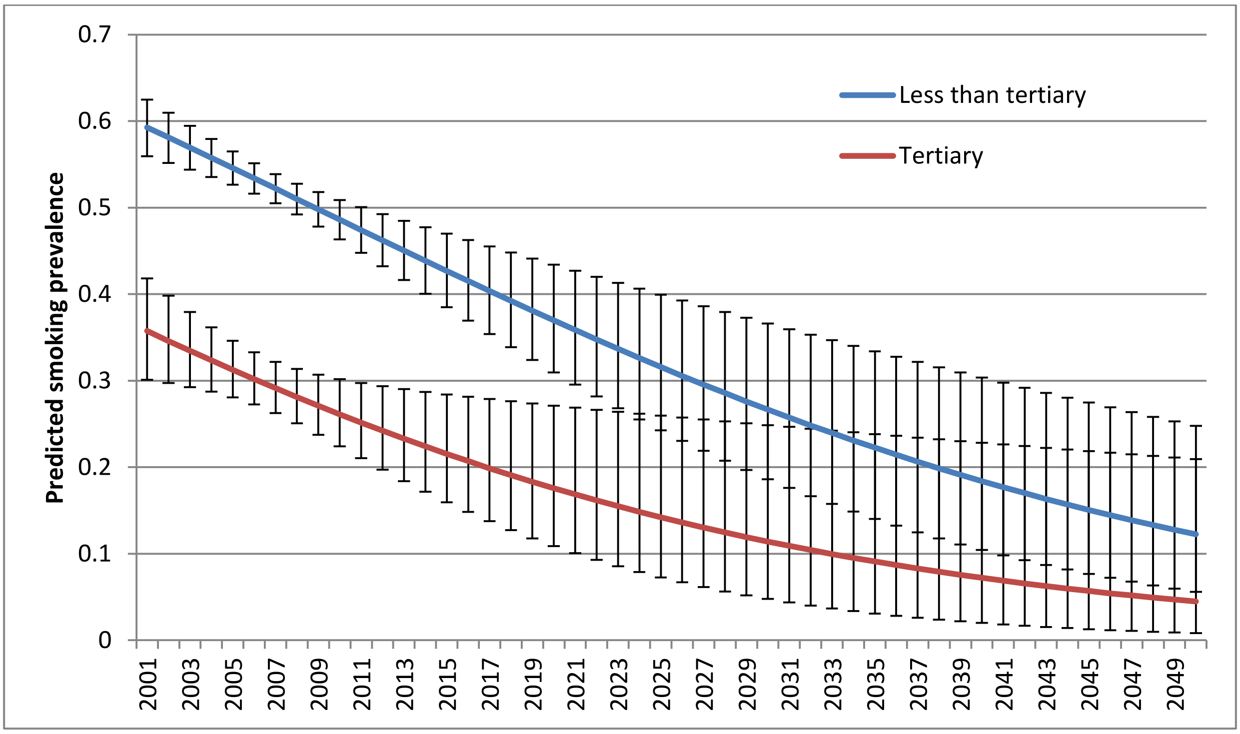


Figure 171 Smoking prevalence projections by education level among males

Females

Inequalities between females with differing levels of education have also been observed historically, and are projected to increase to 2050 whereby modest declines in smoking are predicted for lesser educated females and steep declines are predicted for more educated females (Figure 172). Absolute and relative inequalities in smoking prevalence among females by differing levels of education are predicted to increase over the next 35 years (Figure 172 and Appendix E4).However, confidence intervals are wide and overlap between the two education groups for all years so more data are necessary to determine the significance of these trends.

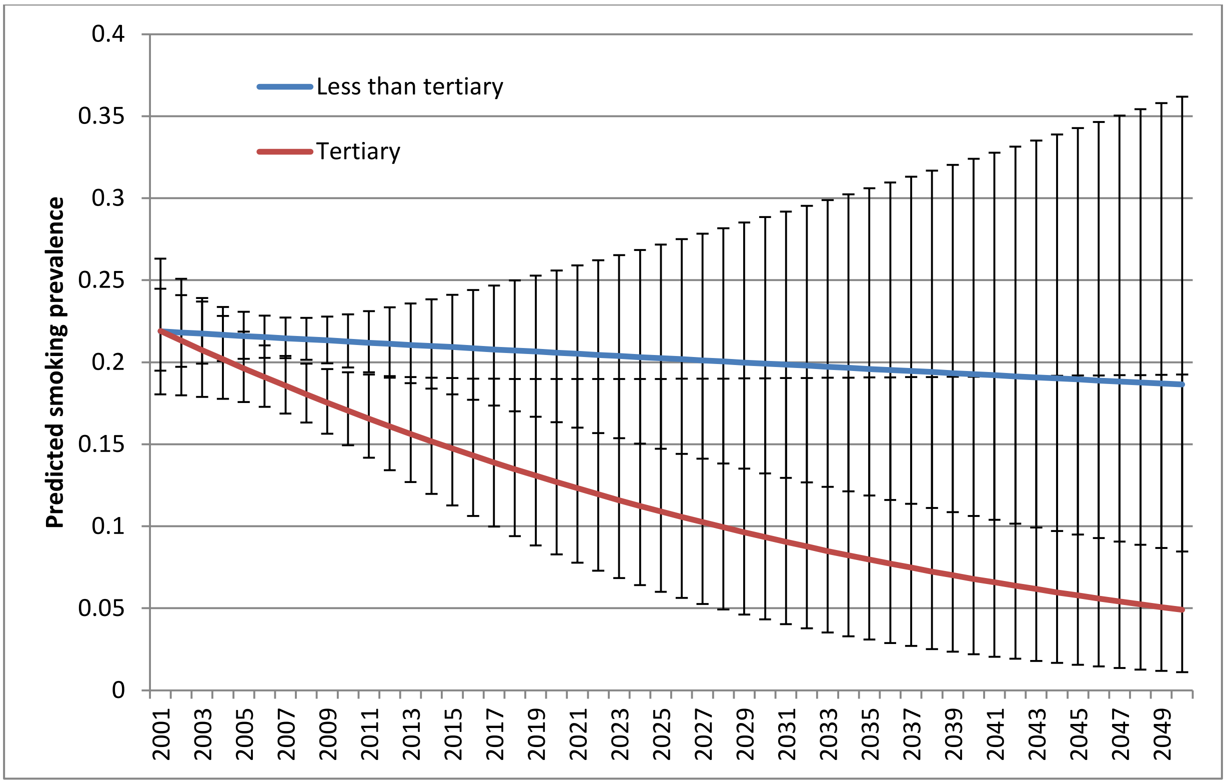


Figure 172 Smoking prevalence projections by education level among females

Section 3: Results of the microsimulation modelling and intervention testing

This section outlines the results of the microsimulation.

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 108. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.
Table 108 presents the assumptions for BMI intervention.

Table 108. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (€)
Baseline	None	-	-
MCLI regain	0.6	100	118
MCLI no regain	0.6	0	118
SSB	0.01	0	0

Multi-component lifestyle interventions (MCLI)

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain –** these results are presented in Appendix E1.

Impact on disease incidence and prevalence

Table 109 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and each intervention scenario. Incidence cases increase over time for all diseases except for hypertension, but the interventions are effective in reducing incidence over time.

Error! Reference source not found. presents the cumulative incidence cases per 100,000 to 2050 for baseline and each intervention. Both interventions result in fewer cumulative incidence for each disease relative to baseline by 2050.

Table 111 and Figure 173 present the cumulative incidence cases *avoided* per 100,000 for baseline and each intervention. Each table/figure indicates that both MCLI interventions would result in a lower cumulative incidence of all diseases by 2050 compared to baseline. For example, MCLI (no regain) would result in the avoidance of 165 cumulative incidence cases of hypertension per 100,000 relative to baseline by 2050 and 237 per 100,000 cases of CHD relative to baseline by 2050.

Even when MCLI is modelled with weight regain there is a positive effect, with the avoidance of 143, 178 and 91 cumulative incidence cases of hypertension, CHD and pre-diabetes per 100,000 respectively by 2050.

Table 112 and Figure 174 present the prevalence cases avoided for each intervention relative to baseline, per 100,000. Both figures indicate that both MCLI intervention would result in a reduced number of prevalence cases per 100,000 compared to baseline for all diseases by 2050, and for each five year increment from 2020 to 2050. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for hypertension (87/100,000 and 85/100,000 for MCLI no regain and regain scenarios, respectively), followed by CHD (75/100,000 and 67/100,000, respectively).

Table 109. Incidence cases (per 100,000)

Scenario	Year	Hypertension	CHD	Pre-diabetes	Diabetes	Stroke
Baseline	2015	665 [+-2]	479 [+-2]	507 [+-2]	165 [+-1]	291 [+-1]
	2020	655 [+-2]	510 [+-2]	508 [+-2]	171 [+-1]	314 [+-2]
	2025	622 [+-2]	533 [+-2]	505 [+-2]	175 [+-1]	330 [+-2]
	2030	616 [+-2]	551 [+-2]	504 [+-2]	180 [+-1]	346 [+-2]
	2035	644 [+-2]	576 [+-2]	519 [+-2]	185 [+-1]	365 [+-2]
	2040	659 [+-2]	604 [+-2]	528 [+-2]	192 [+-1]	385 [+-2]
	2045	652 [+-2]	631 [+-2]	538 [+-2]	197 [+-1]	405 [+-2]
	2050	620 [+-2]	656 [+-3]	536 [+-2]	201 [+-1]	418 [+-2]
MCLI (annual, with regain)	2015	666 [+-2]	480 [+-2]	504 [+-2]	165 [+-1]	292 [+-1]
	2020	654 [+-2]	508 [+-2]	507 [+-2]	172 [+-1]	313 [+-2]
	2025	620 [+-2]	530 [+-2]	502 [+-2]	175 [+-1]	329 [+-2]
	2030	615 [+-2]	549 [+-2]	504 [+-2]	180 [+-1]	345 [+-2]
	2035	642 [+-2]	570 [+-2]	515 [+-2]	184 [+-1]	364 [+-2]
	2040	653 [+-2]	596 [+-2]	526 [+-2]	188 [+-1]	384 [+-2]
	2045	646 [+-2]	626 [+-2]	532 [+-2]	195 [+-1]	403 [+-2]
	2050	614 [+-2]	649 [+-2]	533 [+-2]	198 [+-1]	417 [+-2]
MCLI (annual, with no regain)	2015	666 [+-2]	479 [+-2]	505 [+-2]	165 [+-1]	292 [+-1]
	2020	652 [+-2]	504 [+-2]	506 [+-2]	171 [+-1]	313 [+-2]
	2025	619 [+-2]	526 [+-2]	502 [+-2]	174 [+-1]	329 [+-2]
	2030	614 [+-2]	547 [+-2]	504 [+-2]	179 [+-1]	345 [+-2]
	2035	641 [+-2]	569 [+-2]	515 [+-2]	184 [+-1]	364 [+-2]
	2040	652 [+-2]	596 [+-2]	526 [+-2]	189 [+-1]	384 [+-2]
	2045	646 [+-2]	625 [+-2]	532 [+-2]	194 [+-1]	403 [+-2]
	2050	614 [+-2]	648 [+-2]	533 [+-2]	197 [+-1]	418 [+-2]

Table 110 Cumulative incidence cases (per 100,000)

Scenario	Year	Hypertension	CHD	Pre-diabetes	Diabetes	Stroke
	2015	665 [+-2]	479 [+-2]	507 [+-2]	165 [+-1]	291 [+-1]
	2020	3977 [+-5]	2991 [+-5]	3058 [+-5]	1016 [+-3]	1837 [+-4]
	2025	7254 [+-7]	5687 [+-7]	5665 [+-6]	1912 [+-4]	3509 [+-5]
Baseline	2030	10599 [+-9]	8610 [+-8]	8385 [+-8]	2872 [+-5]	5336 [+-6]
	2035	14218 [+-10]	11818 [+-9]	11305 [+-9]	3911 [+-6]	7357 [+-8]
	2040	18145 [+-11]	15331 [+-11]	14459 [+-10]	5038 [+-6]	9592 [+-9]
	2045	22276 [+-13]	19160 [+-12]	17810 [+-12]	6249 [+-7]	12034 [+-10]
	2050	26527 [+-14]	23329 [+-13]	21362 [+-13]	7546 [+-8]	14686 [+-11]
	2015	666 [+-2]	480 [+-2]	504 [+-2]	165 [+-1]	292 [+-1]
	2020	3976 [+-5]	2986 [+-5]	3055 [+-5]	1014 [+-3]	1832 [+-4]
	2025	7242 [+-7]	5673 [+-6]	5654 [+-6]	1907 [+-4]	3498 [+-5]
MCLI (annual, with regain)	2030	10572 [+-9]	8575 [+-8]	8363 [+-8]	2861 [+-5]	5319 [+-6]
	2035	14169 [+-10]	11750 [+-9]	11269 [+-9]	3894 [+-6]	7336 [+-8]
	2040	18070 [+-11]	15232 [+-11]	14405 [+-10]	5007 [+-6]	9563 [+-9]
	2045	22166 [+-13]	19026 [+-12]	17741 [+-12]	6206 [+-7]	11999 [+-10]
	2050	26384 [+-14]	23151 [+-13]	21271 [+-13]	7490 [+-8]	14643 [+-11]
	2015	666 [+-2]	479 [+-2]	505 [+-2]	165 [+-1]	292 [+-1]
	2020	3972 [+-5]	2977 [+-5]	3054 [+-5]	1011 [+-3]	1831 [+-4]
	2025	7231 [+-7]	5647 [+-6]	5650 [+-6]	1901 [+-4]	3494 [+-5]
MCLI (annual, with no regain)	2030	10555 [+-9]	8540 [+-8]	8357 [+-8]	2850 [+-5]	5313 [+-6]
	2035	14148 [+-10]	11706 [+-9]	11265 [+-9]	3881 [+-6]	7325 [+-8]
	2040	18048 [+-11]	15182 [+-11]	14403 [+-10]	4995 [+-6]	9552 [+-9]
	2045	22145 [+-13]	18971 [+-12]	17735 [+-12]	6190 [+-7]	11987 [+-10]
	2050	26362 [+-14]	23092 [+-13]	21266 [+-13]	7473 [+-8]	14632 [+-11]

Table 111. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	Hypertension	CHD	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain)	2015	-1 [+-3]	-1 [+-3]	3 [+-3]	0 [+-1]	-1 [+-1]
	2020	1 [+-7]	5 [+-7]	3 [+-7]	2 [+-4]	5 [+-6]
	2025	12 [+-10]	14 [+-9]	11 [+-8]	5 [+-6]	11 [+-7]
	2030	27 [+-13]	35 [+-11]	22 [+-11]	11 [+-7]	17 [+-8]
	2035	49 [+-14]	68 [+-13]	36 [+-13]	17 [+-8]	21 [+-11]
	2040	75 [+-16]	99 [+-16]	54 [+-14]	31 [+-8]	29 [+-13]
	2045	110 [+-18]	134 [+-17]	69 [+-17]	43 [+-10]	35 [+-14]
	2050	143 [+-20]	178 [+-18]	91 [+-18]	56 [+-11]	43 [+-16]
MCLI (annual, with no regain)	2015	-1 [+-3]	0 [+-3]	2 [+-3]	0 [+-1]	-1 [+-1]
	2020	5 [+-7]	14 [+-7]	4 [+-7]	5 [+-4]	6 [+-6]
	2025	23 [+-10]	40 [+-9]	15 [+-8]	11 [+-6]	15 [+-7]
	2030	44 [+-13]	70 [+-11]	28 [+-11]	22 [+-7]	23 [+-8]
	2035	70 [+-14]	112 [+-13]	40 [+-13]	30 [+-8]	32 [+-11]
	2040	97 [+-16]	149 [+-16]	56 [+-14]	43 [+-8]	40 [+-13]
	2045	131 [+-18]	189 [+-17]	75 [+-17]	59 [+-10]	47 [+-14]
	2050	165 [+-20]	237 [+-18]	96 [+-18]	73 [+-11]	54 [+-16]

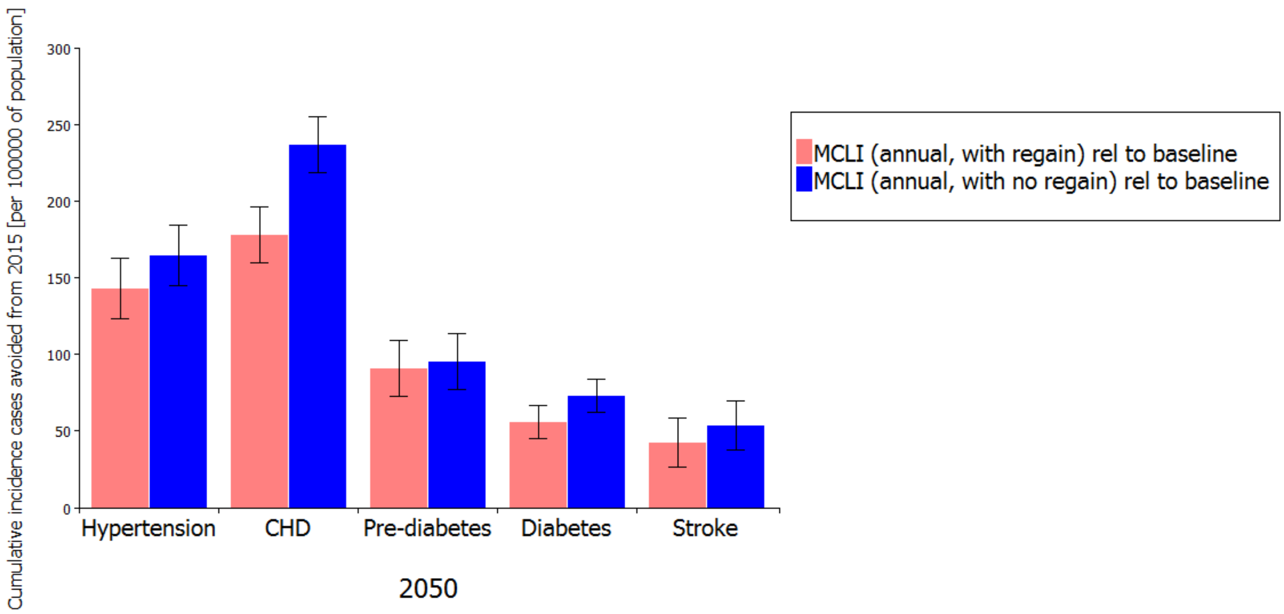


Figure 173 Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 112 Prevalence cases avoided in year (per 100,000)

Scenario	Year	Hypertension	CHD	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	0 [+-16]	-3 [+-8]	-2 [+-9]	-8 [+-7]	-3 [+-6]
	2020	2 [+-17]	4 [+-8]	0 [+-10]	-8 [+-7]	-1 [+-6]
	2025	11 [+-17]	9 [+-8]	1 [+-10]	-5 [+-7]	4 [+-6]
	2030	21 [+-17]	28 [+-10]	8 [+-10]	0 [+-7]	4 [+-6]
	2035	34 [+-17]	46 [+-10]	16 [+-10]	5 [+-8]	3 [+-7]
	2040	50 [+-18]	56 [+-10]	19 [+-10]	16 [+-8]	6 [+-7]
	2045	67 [+-18]	59 [+-10]	18 [+-10]	24 [+-8]	8 [+-7]
	2050	85 [+-18]	67 [+-11]	24 [+-10]	30 [+-8]	9 [+-7]
MCLI (annual, with no regain) relative to baseline	2015	0 [+-16]	-6 [+-8]	-1 [+-9]	-6 [+-7]	-5 [+-6]
	2020	8 [+-17]	13 [+-8]	1 [+-10]	-4 [+-7]	0 [+-6]
	2025	23 [+-17]	31 [+-8]	4 [+-10]	2 [+-7]	5 [+-6]
	2030	34 [+-17]	49 [+-10]	9 [+-10]	7 [+-7]	6 [+-6]
	2035	45 [+-17]	64 [+-10]	16 [+-10]	11 [+-8]	5 [+-7]
	2040	57 [+-18]	71 [+-10]	20 [+-10]	19 [+-8]	7 [+-7]
	2045	69 [+-18]	69 [+-10]	19 [+-10]	27 [+-8]	8 [+-7]
	2050	87 [+-18]	75 [+-11]	25 [+-10]	33 [+-8]	8 [+-7]

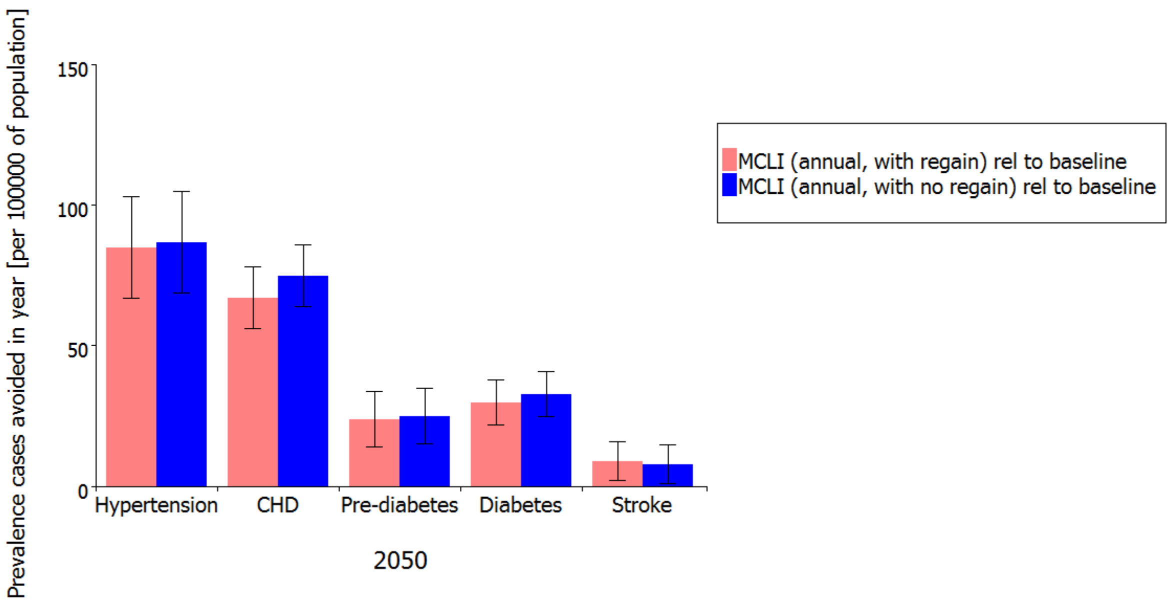


Figure 174. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYS and ICERs

Table 113 and Figure 175 present the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in CHD for both MCLI interventions, (€0.041 and 0.037 million per 100,000 population for the *MCLI (no weight regain)* and *MCLI (weight regain)* scenarios, respectively).

Table 114 and Figure 176 present the indirect costs that can be avoided (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to occur in CHD for both MCLI interventions (€0.106m and €0.095m per 100,000 population for the *MCLI (no weight regain)* and *MCLI (weight regain)* scenarios, respectively).

Figure 177 and Figure 178 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the baseline. For both males and females, the both variations of the MCLI interventions are expected to lead to increasing gains in QALYs over time.

In Figure 179, the positive ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both versions of the MCLI scenarios may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Lithuania. This is because a cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. However, since no cost effectiveness thresholds are currently not used in this country, we cannot categorically determine whether or not this set of interventions is cost effective. Over time, however, the ICER is expected to approach near zero, indicating that the interventions are likely to become cost effective. The negative ICER value for *MCLI (weight regain)* scenario in 2020 (which in this case happens to be comprised of *negative* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that this intervention is expected to not be cost effective in 2020.

Table 113 Direct healthcare cost (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	Hypertension	CHD	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	-0.00014 [+-0.000547]	-0.008129 [+-0.001143]	-0.000105 [+-0.000035]	-0.00666 [+-0.000197]	-0.08197 [+-0.002153]
	2020	0.000171 [+-0.000449]	0.009753 [+-0.001018]	-0.000007 [+-0.000028]	-0.00519 [+-0.000165]	-0.01519 [+-0.002092]
	2025	0.000999 [+-0.000366]	0.016583 [+-0.00087]	0.000062 [+-0.000023]	-0.00239 [+-0.000137]	0.050602 [+-0.00185]
	2030	0.001589 [+-0.000298]	0.04038 [+-0.000738]	0.00024 [+-0.000018]	0.000287 [+-0.000115]	0.043066 [+-0.001589]
	2035	0.002083 [+-0.000245]	0.052198 [+-0.000629]	0.000412 [+-0.000014]	0.001622 [+-0.000096]	0.021795 [+-0.001368]
	2040	0.002333 [+-0.000204]	0.049575 [+-0.000537]	0.000355 [+-0.000011]	0.003972 [+-0.000081]	0.040874 [+-0.001184]
	2045	0.002468 [+-0.000168]	0.040626 [+-0.000455]	0.000271 [+-0.00001]	0.004689 [+-0.000068]	0.041364 [+-0.001032]
	2050	0.002435 [+-0.000136]	0.036757 [+-0.000382]	0.000287 [+-0.000007]	0.004443 [+-0.000056]	0.036193 [+-0.000885]
MCLI (annual, with no regain), relative to baseline	2015	-0.000005 [+-0.000547]	-0.01715 [+-0.001144]	-0.00008 [+-0.000035]	-0.00536 [+-0.000197]	-0.12289 [+-0.002155]
	2020	0.001006 [+-0.000449]	0.029398 [+-0.001016]	0.000018 [+-0.000028]	-0.00258 [+-0.000165]	-0.00065 [+-0.002092]
	2025	0.002178 [+-0.000366]	0.05652 [+-0.000868]	0.000178 [+-0.000023]	0.001002 [+-0.000136]	0.071573 [+-0.001849]
	2030	0.002536 [+-0.000298]	0.07117 [+-0.000736]	0.000278 [+-0.000018]	0.003073 [+-0.000114]	0.061863 [+-0.001588]
	2035	0.002699 [+-0.000245]	0.071804 [+-0.000627]	0.000403 [+-0.000014]	0.003249 [+-0.000096]	0.040314 [+-0.001367]
	2040	0.002666 [+-0.000204]	0.062775 [+-0.000535]	0.000383 [+-0.000011]	0.004632 [+-0.000081]	0.049866 [+-0.001184]
	2045	0.002568 [+-0.002499]	0.047515 [+-0.000455]	0.000292 [+-0.00001]	0.005175 [+-0.000068]	0.041754 [+-0.001032]
	2050	0.002499 [+-0.000136]	0.040789 [+-0.000382]	0.000302 [+-0.000007]	0.004884 [+-0.000056]	0.031212 [+-0.000885]

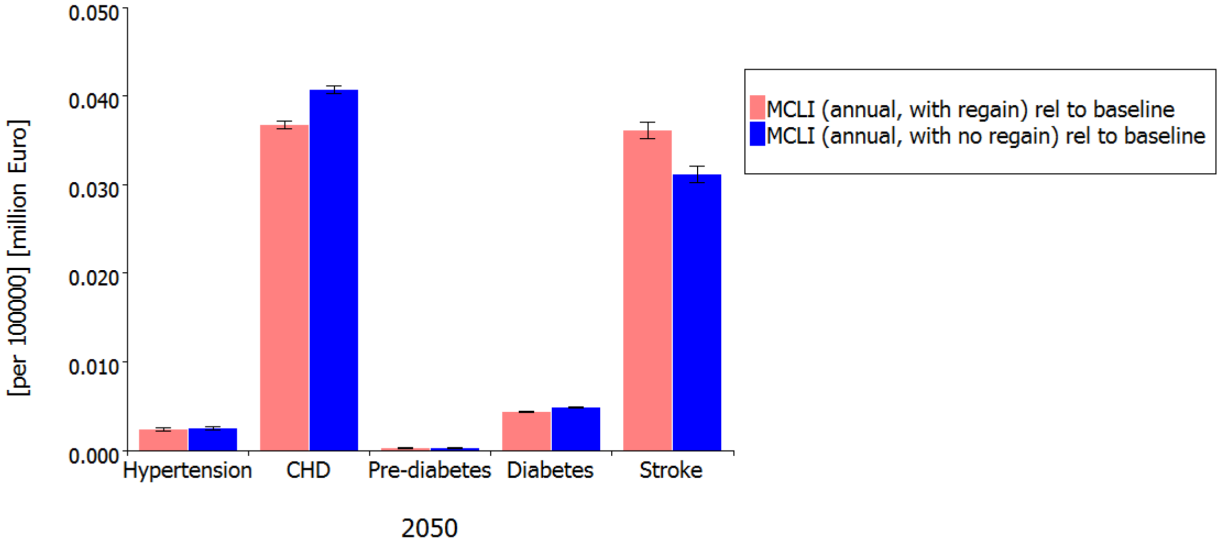


Figure 175. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 114. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	Hypertension	CHD	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	-0.00022 [+-0.000871]	-0.021034 [+-0.002959]	0 [+-0]	-0.00338 [+-0.0001]	-0.13769 [+-0.003617]
	2020	0.000271 [+-0.000714]	0.025238 [+-0.002632]	0 [+-0]	-0.00263 [+-0.000083]	-0.02552 [+-0.003514]
	2025	0.001589 [+-0.000581]	0.042915 [+-0.002251]	0 [+-0]	-0.00121 [+-0.000069]	0.084999 [+-0.003108]
	2030	0.002527 [+-0.000474]	0.104492 [+-0.00191]	0 [+-0]	0.000145 [+-0.000058]	0.072342 [+-0.002669]
	2035	0.003315 [+-0.000391]	0.135075 [+-0.001628]	0 [+-0]	0.000822 [+-0.000048]	0.03661 [+-0.002296]
	2040	0.003712 [+-0.000323]	0.128284 [+-0.001388]	0 [+-0]	0.002013 [+-0.000041]	0.068661 [+-0.001991]
	2045	0.003927 [+-0.000267]	0.105125 [+-0.001177]	0 [+-0]	0.002375 [+-0.000034]	0.069479 [+-0.001734]
	2050	0.003873 [+-0.000217]	0.095114 [+-0.000989]	0 [+-0]	0.00225 [+-0.000028]	0.060795 [+-0.001486]
MCLI (annual, with no regain), relative to baseline	2015	-0.000008 [+-0.000871]	-0.044376 [+-0.002961]	0 [+-0]	-0.00272 [+-0.0001]	-0.20642 [+-0.00362]
	2020	0.001601 [+-0.000714]	0.076071 [+-0.002628]	0 [+-0]	-0.0013 [+-0.000083]	-0.0011 [+-0.003513]
	2025	0.003466 [+-0.000581]	0.146254 [+-0.002244]	0 [+-0]	0.000507 [+-0.000069]	0.120224 [+-0.003106]
	2030	0.004036 [+-0.000474]	0.184164 [+-0.001905]	0 [+-0]	0.001556 [+-0.000058]	0.103912 [+-0.002668]
	2035	0.004294 [+-0.000391]	0.185804 [+-0.001624]	0 [+-0]	0.001646 [+-0.000048]	0.067719 [+-0.002295]
	2040	0.004243 [+-0.000323]	0.162441 [+-0.001385]	0 [+-0]	0.002347 [+-0.000041]	0.083763 [+-0.001989]
	2045	0.004086 [+-0.003975]	0.122953 [+-0.001175]	0 [+-0]	0.002621 [+-0.000034]	0.070135 [+-0.001734]
	2050	0.003975 [+-0.000217]	0.105548 [+-0.000989]	0 [+-0]	0.002474 [+-0.000028]	0.052427 [+-0.001486]

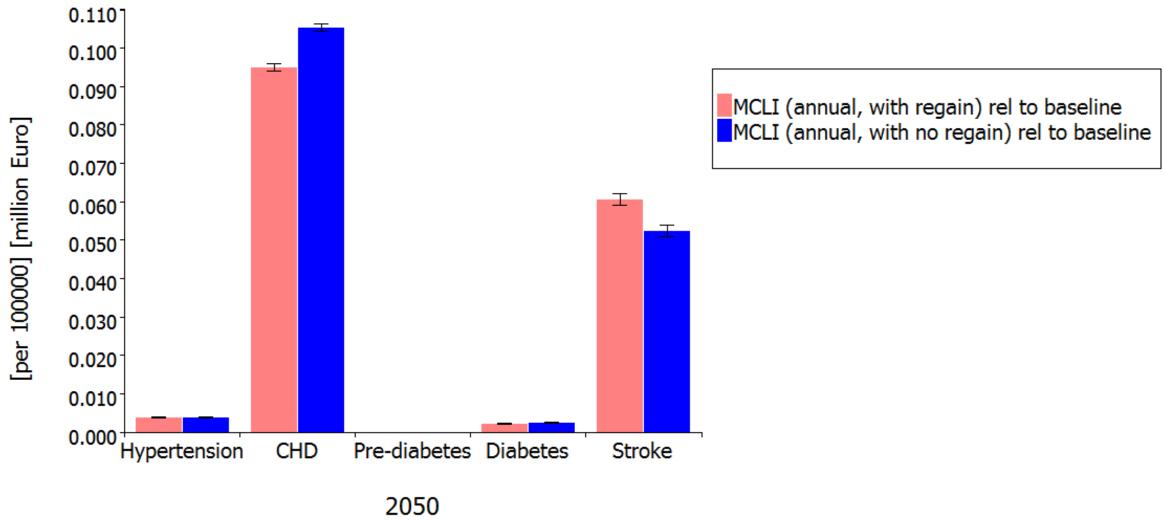


Figure 176. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

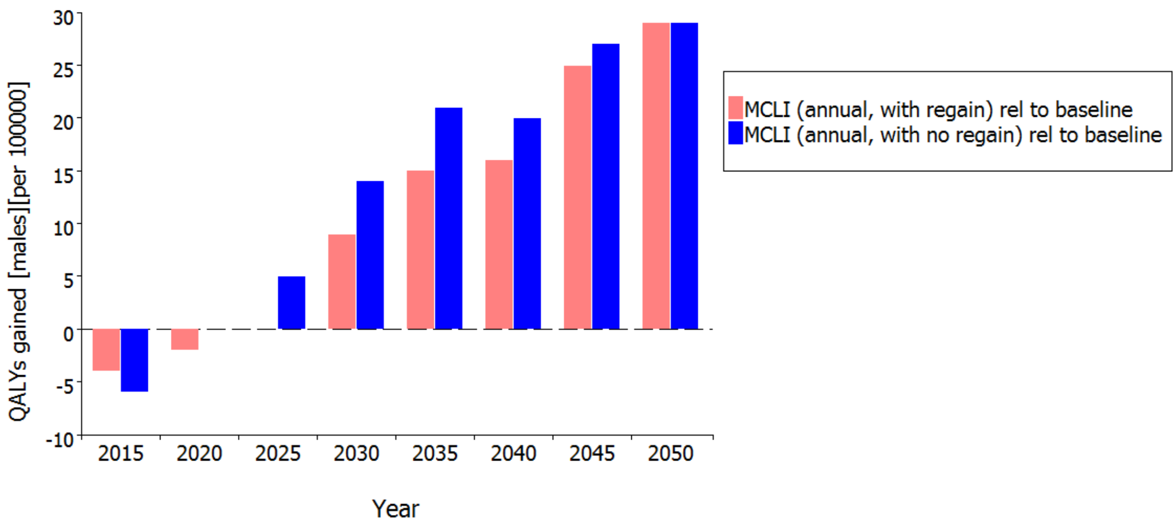


Figure 177. QALYS gained (per 100,000), relative to baseline (males)

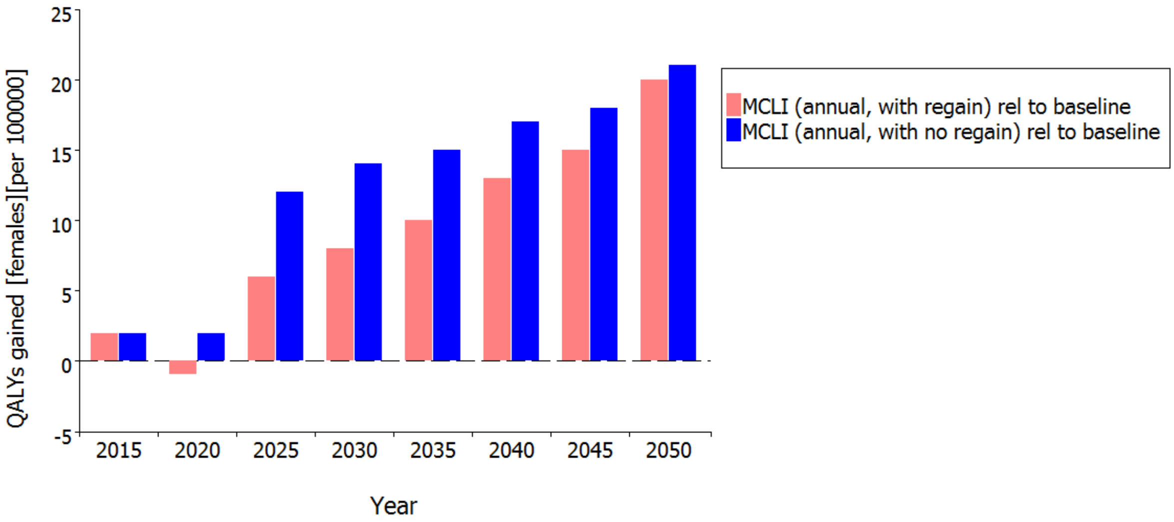


Figure 178 QALYs gained (per 100,000), relative to baseline (females)

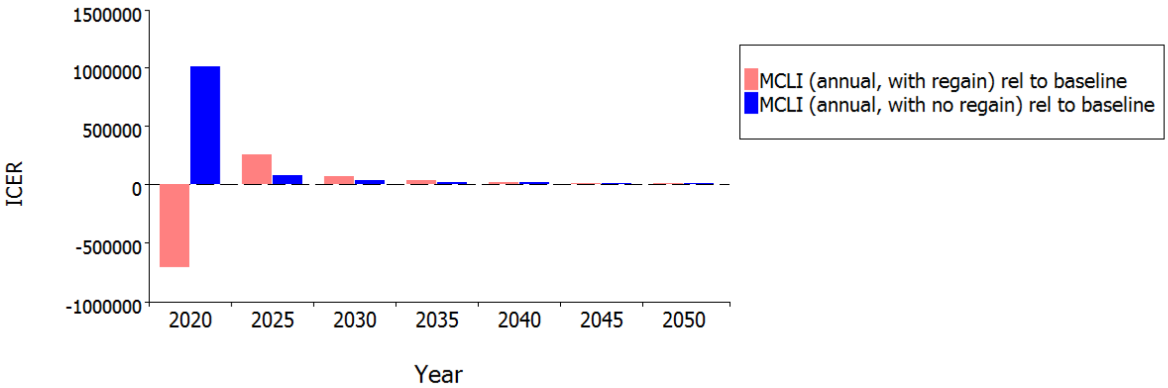


Figure 179. ICER

Sugar sweetened beverage (SSB) tax interventions

Due to the relatively low consumption of SSBs in Lithuania as indicated by the Eurostat consumption data we did not calculate a significant impact of a 20% SSB tax on BMI. Therefore, there are no results for SSB tax for Lithuania.

Smoking intervention results

Smoking cessation services

Table 115. SCS intervention input data

	Lithuania
Reach	
Willingness to quit smoking (%)	59%
Accessibility of the intervention (%)	50%
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 621

Impact on disease incidence and prevalence

Table 116 presents the incidence cases per 100,000 to 2050 for baseline and the smoking cessation scenario. Incidence cases increase over time for all diseases except hypertension. The smoking cessation intervention is effective in reducing the projected incidence cases over time. These results are discussed further in the discussion and appendix E8 and E9.

Cumulative incidence cases avoided per 100,000 for the intervention relative to baseline scenario can be seen in

Table 118 and Figure 180. The intervention would have its largest effect on stroke and COPD incidence with 1,649 per 100,000 and 1,165 per 100,000 incidence cases avoided respectively compared to baseline by 2050. The effect on other diseases is also significant and ranges from 267 per 100,000 incidence cases avoided by 2050 for CHD to 332 per 100,000 cases avoided for hypertension.

Table 119 and Figure 181 present the prevalence cases avoided for the intervention relative to baseline per 100,000 in five year increments. A smoking cessation intervention as modelled would have the desired effect on the prevalence of all diseases except for hypertension. The largest impact would be observed for COPD prevalence with 505 per 100,000 prevalence cases avoided in 2050 followed by 456 per 100,000 stroke prevalence cases avoided compared to baseline. Hypertension prevalence would be lower in the baseline scenario compared with the smoking cessation scenario in 2050 (-21 per 100,000).

Table 116 Incidence cases (per 100,000)

Scenario	Year	Hypertension	CHD	COPD	Lung cancer	Stroke
Baseline	2015	725 [+-2]	498 [+-1]	483 [+-1]	44 [+-0]	282 [+-1]
	2020	711 [+-2]	521 [+-1]	483 [+-1]	44 [+-0]	298 [+-1]
	2025	677 [+-2]	545 [+-1]	488 [+-1]	44 [+-0]	305 [+-1]
	2030	666 [+-2]	564 [+-2]	491 [+-1]	44 [+-0]	313 [+-1]
	2035	685 [+-2]	586 [+-2]	502 [+-1]	45 [+-0]	326 [+-1]
	2040	693 [+-2]	612 [+-2]	512 [+-1]	45 [+-0]	340 [+-1]
	2045	674 [+-2]	641 [+-2]	523 [+-2]	45 [+-0]	355 [+-1]
	2050	632 [+-2]	658 [+-2]	534 [+-2]	46 [+-0]	361 [+-1]
SCS	2015	726 [+-2]	496 [+-1]	484 [+-1]	44 [+-0]	281 [+-1]
	2020	712 [+-2]	520 [+-1]	478 [+-1]	43 [+-0]	286 [+-1]
	2025	675 [+-2]	540 [+-1]	473 [+-1]	40 [+-0]	278 [+-1]
	2030	660 [+-2]	559 [+-2]	468 [+-1]	37 [+-0]	272 [+-1]
	2035	678 [+-2]	579 [+-2]	469 [+-1]	35 [+-0]	276 [+-1]
	2040	685 [+-2]	607 [+-2]	471 [+-1]	34 [+-0]	282 [+-1]
	2045	665 [+-2]	635 [+-2]	475 [+-1]	33 [+-0]	291 [+-1]
	2050	621 [+-2]	656 [+-2]	478 [+-2]	33 [+-0]	297 [+-1]

Table 117 Cumulative incidence cases (per 100,000)

Scenario	Year	Hypertension	CHD	COPD	Lung cancer	Stroke
Baseline	2015	725 [+-2]	498 [+-1]	483 [+-1]	44 [+-0]	282 [+-1]
	2020	4335 [+-4]	3076 [+-3]	2914 [+-3]	268 [+-1]	1756 [+-3]
	2025	7900 [+-5]	5839 [+-5]	5421 [+-5]	498 [+-1]	3317 [+-4]
	2030	11516 [+-6]	8824 [+-6]	8062 [+-5]	738 [+-2]	4986 [+-4]
	2035	15379 [+-7]	12083 [+-7]	10888 [+-6]	990 [+-2]	6806 [+-5]
	2040	19524 [+-8]	15647 [+-8]	13919 [+-7]	1257 [+-2]	8793 [+-6]
	2045	23835 [+-9]	19528 [+-8]	17158 [+-8]	1540 [+-3]	10947 [+-7]
	2050	28210 [+-10]	23722 [+-9]	20630 [+-9]	1842 [+-3]	13263 [+-7]
SCS	2015	726 [+-2]	496 [+-1]	484 [+-1]	44 [+-0]	281 [+-1]
	2020	4337 [+-4]	3071 [+-3]	2900 [+-3]	265 [+-1]	1725 [+-3]
	2025	7892 [+-5]	5819 [+-5]	5353 [+-4]	479 [+-1]	3182 [+-3]
	2030	11482 [+-6]	8778 [+-6]	7888 [+-5]	688 [+-2]	4664 [+-4]
	2035	15299 [+-7]	11990 [+-7]	10549 [+-6]	897 [+-2]	6229 [+-5]
	2040	19376 [+-8]	15498 [+-8]	13365 [+-7]	1107 [+-2]	7900 [+-6]
	2045	23604 [+-9]	19319 [+-8]	16328 [+-8]	1322 [+-2]	9692 [+-6]
	2050	27878 [+-10]	23455 [+-9]	19465 [+-9]	1544 [+-3]	11614 [+-7]

Table 118 Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	Hypertension	CHD	COPD	Lung Cancer	Stroke
	2015	-1 [+-3]	2 [+-1]	-1 [+-1]	0 [+-0]	1 [+-1]
	2020	-2 [+-6]	5 [+-4]	14 [+-4]	3 [+-1]	31 [+-4]
	2025	8 [+-7]	20 [+-7]	68 [+-6]	19 [+-1]	135 [+-5]
	2030	34 [+-8]	46 [+-8]	174 [+-7]	50 [+-3]	322 [+-6]
	2035	80 [+-10]	93 [+-10]	339 [+-8]	93 [+-3]	577 [+-7]
	2040	148 [+-11]	149 [+-11]	554 [+-10]	150 [+-3]	893 [+-8]
SCS relative to baseline	2045	231 [+-13]	209 [+-11]	830 [+-11]	218 [+-4]	1255 [+-9]
	2050	332 [+-14]	267 [+-13]	1165 [+-13]	298 [+-4]	1649 [+-10]

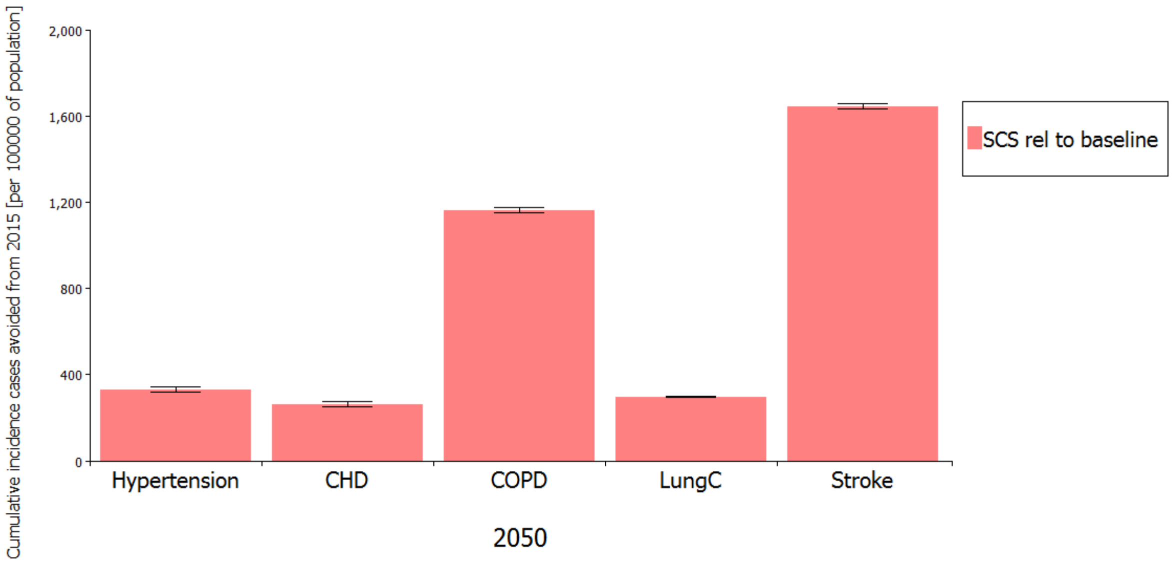


Figure 180. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 119 Prevalence cases avoided for each intervention relative to baseline, per 100,000

Scenario	Year	Hypertension	CHD	COPD	Lung cancer	Stroke
SCS relative to baseline	2015	-2 [+-11]	-2 [+-6]	-8 [+-8]	0 [+-1]	1 [+-4]
	2020	-6 [+-11]	1 [+-6]	3 [+-8]	2 [+-1]	27 [+-4]
	2025	-10 [+-13]	9 [+-7]	41 [+-8]	8 [+-1]	95 [+-4]
	2030	-7 [+-13]	22 [+-7]	104 [+-10]	14 [+-1]	190 [+-4]
	2035	-14 [+-13]	31 [+-7]	181 [+-10]	19 [+-1]	277 [+-4]
	2040	-18 [+-13]	38 [+-7]	274 [+-10]	24 [+-1]	358 [+-4]
	2045	-19 [+-13]	38 [+-7]	381 [+-10]	28 [+-1]	419 [+-4]
	2050	-21 [+-14]	32 [+-8]	505 [+-11]	31 [+-1]	456 [+-4]

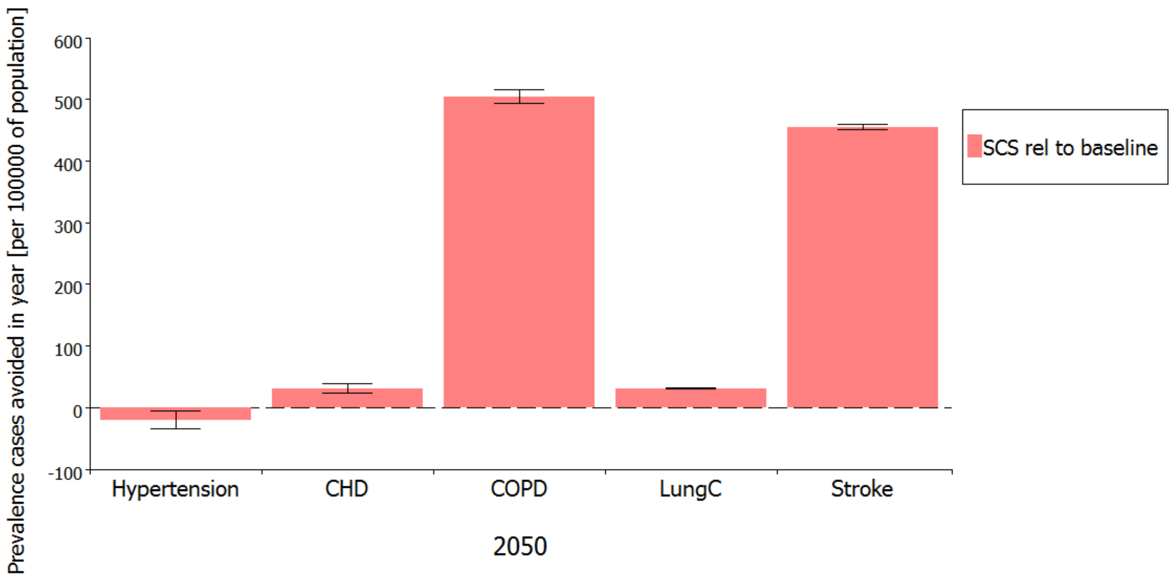


Figure 181. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYS and ICERs

Table 120 and Figure 182 present the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* are expected to occur in stroke (€1.8m per 100,000 population in 2050).

Table 121 and Figure 183 present the indirect costs that can be *avoided* (per 100,000) with the SCS intervention, relative to the baseline. The largest indirect costs *avoided* is expected to occur in stroke (€3.1 million per 100,000 population in 2050), followed by COPD (€0.5 million per 100,000 population in 2050).

Figure 184 and Figure 185 present the QALYs that can be *gained* (per 100,000 population) with the SCS intervention, relative to the baseline. For both males and females, the SCS intervention is expected to lead to increasing gains in QALYs over time.

In Figure 186, The negative ICER value for the SCS intervention (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SCS intervention is cost effective (the SCS intervention scenario *dominates* the baseline scenario). The positive ICER value in 2020 (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that the SCS may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Lithuania.

Table 120: Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	Hypertension	CHD	COPD	Lung Cancer	Stroke
SCS relative to baseline	2015	-0.00024 [+-0.000434]	-0.00853 [+-0.000887]	-0.008652 [+-0.001162]	-0.000021 [+-0]	0.025146 [+-0.001456]
	2020	-0.00077 [+-0.000358]	0.001481 [+-0.000769]	0.003004 [+-0.000962]	0.000269 [+-0]	0.460384 [+-0.001378]
	2025	-0.00096 [+-0.000293]	0.016799 [+-0.000648]	0.029058 [+-0.000786]	0.001078 [+-0]	1.321722 [+-0.00116]
	2030	-0.00053 [+-0.000239]	0.031404 [+-0.000548]	0.057508 [+-0.000643]	0.001568 [+-0]	2.05629 [+-0.000942]
	2035	-0.00083 [+-0.000197]	0.034735 [+-0.000467]	0.078298 [+-0.00053]	0.001644 [+-0]	2.350546 [+-0.000767]
	2040	-0.00086 [+-0.000163]	0.033186 [+-0.000401]	0.092784 [+-0.00044]	0.00161 [+-0]	2.381105 [+-0.000635]
	2045	-0.00069 [+-0.000133]	0.026606 [+-0.000346]	0.100987 [+-0.000364]	0.001471 [+-0]	2.186839 [+-0.000533]
	2050	-0.00061 [+-0.000107]	0.017365 [+-0.000294]	0.10488 [+-0.0003]	0.001272 [+-0]	1.863883 [+-0.000446]

Table 121: Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	Hypertension	CHD	COPD	Lung Cancer	Stroke
SCS relative to baseline	2015	-0.00038 [+-0.00069]	-0.022072 [+-0.002295]	-0.041954 [+-0.005635]	-0.000089 [+-0]	0.042236 [+-0.002447]
	2020	-0.00122 [+-0.00057]	0.003834 [+-0.001993]	0.014568 [+-0.004666]	0.001128 [+-0]	0.773335 [+-0.002315]
	2025	-0.00153 [+-0.000465]	0.043472 [+-0.001677]	0.140903 [+-0.003808]	0.004528 [+-0]	2.220154 [+-0.00195]
	2030	-0.00085 [+-0.00038]	0.081266 [+-0.001418]	0.278862 [+-0.003118]	0.006583 [+-0]	3.454041 [+-0.001583]
	2035	-0.00132 [+-0.000314]	0.089882 [+-0.00121]	0.379679 [+-0.002573]	0.006905 [+-0]	3.948317 [+-0.001289]
	2040	-0.00137 [+-0.000259]	0.085872 [+-0.001039]	0.449924 [+-0.002133]	0.006762 [+-0]	3.999649 [+-0.001066]
	2045	-0.0011 [+-0.000212]	0.06885 [+-0.000895]	0.489702 [+-0.001765]	0.006176 [+-0]	3.67333 [+-0.000895]
	2050	-0.00097 [+-0.000171]	0.044933 [+-0.000763]	0.508581 [+-0.001456]	0.005341 [+-0]	3.130848 [+-0.00075]

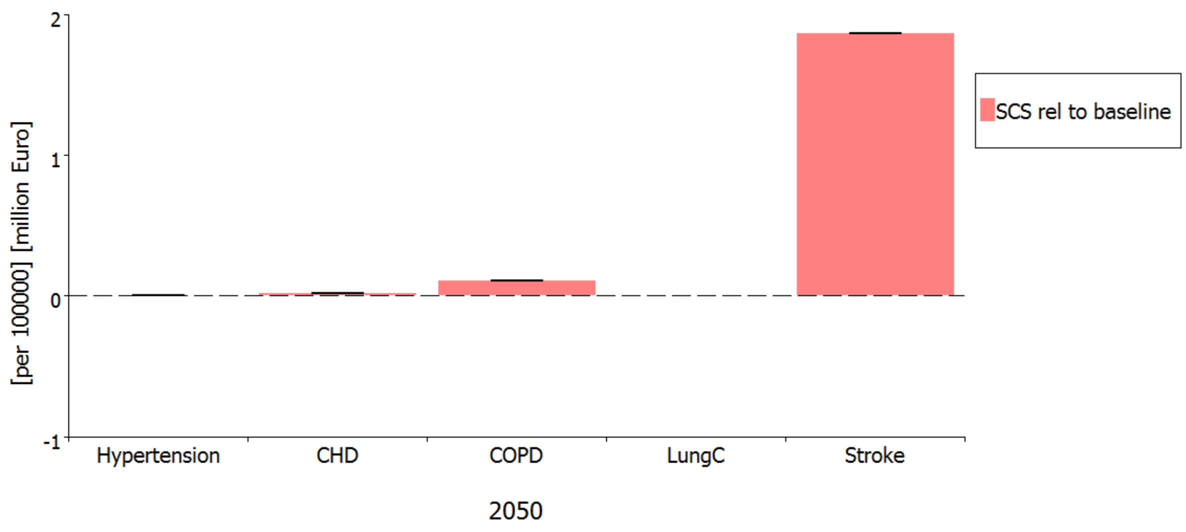


Figure 182. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

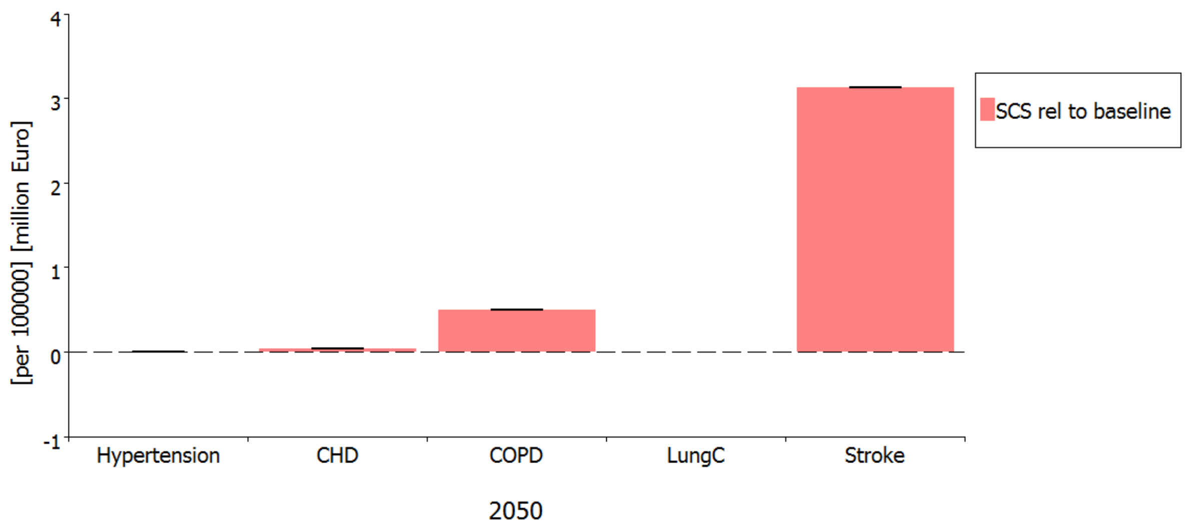


Figure 183. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

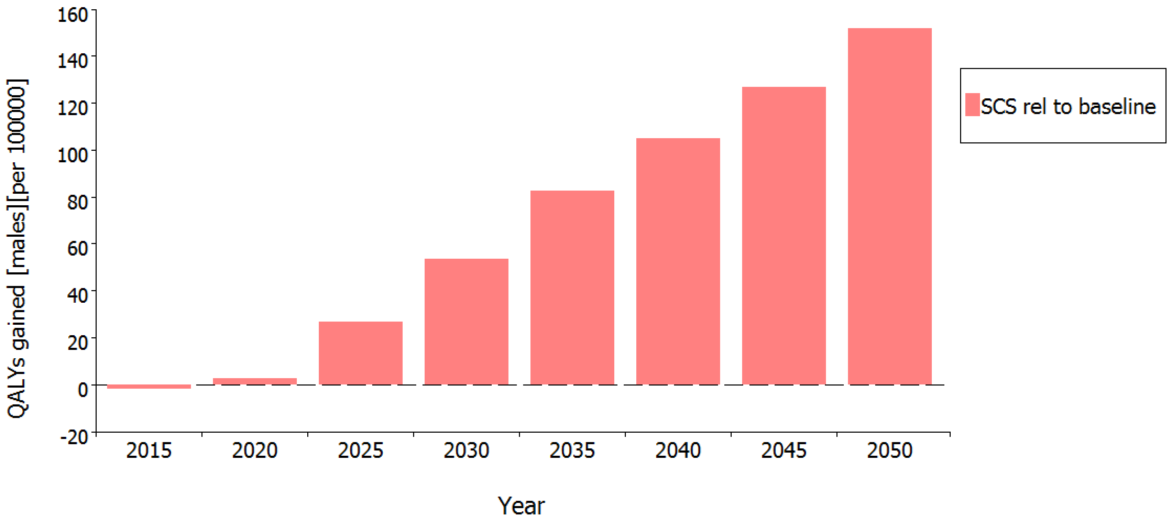


Figure 184. QALYS gained (per 100,000), relative to baseline (males)

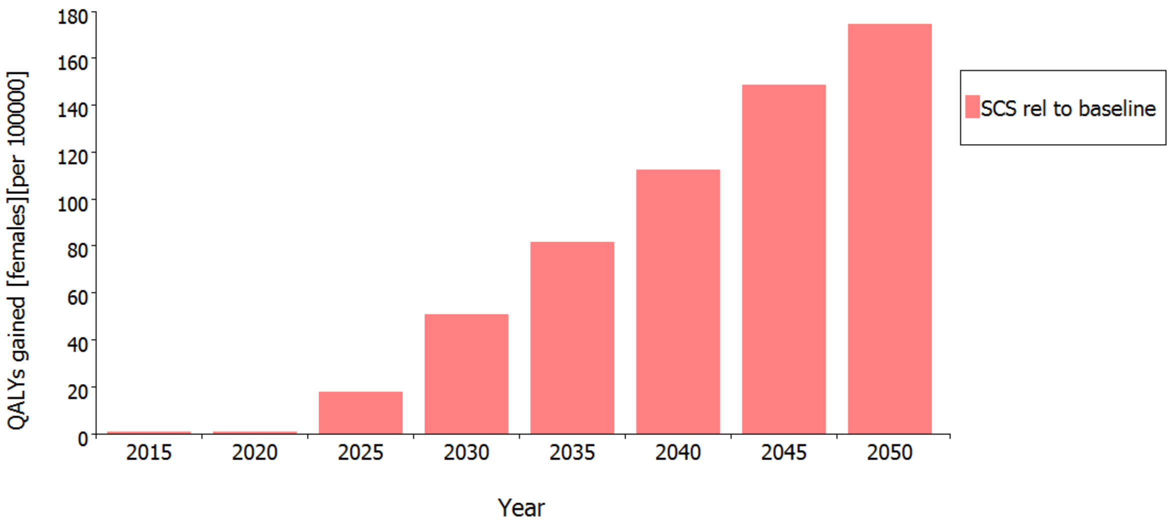


Figure 185 . QALYS gained (per 100,000), relative to baseline (females)

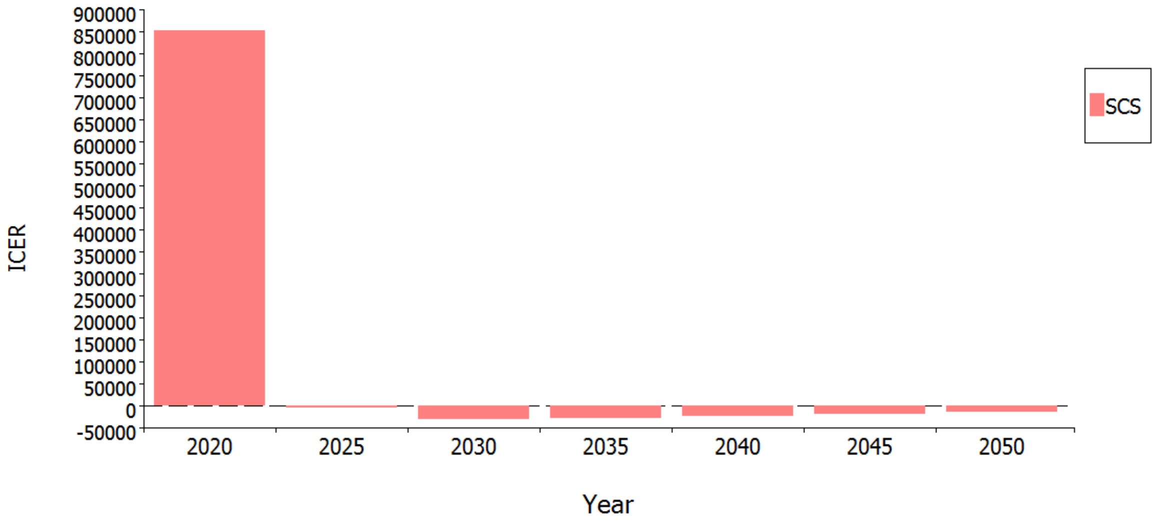


Figure 186. ICER

Netherlands

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m^2) in The Netherlands are presented in Table 122 and for smoking prevalence by age and sex are presented in Table 123. Data were also collected by personal communication where possible.

Data were disaggregated by education level where available to explore future prevalence of each risk factor by sub-groups.

Table 122. References used in the model for BMI prevalence

Reference	Year	Sample size		Age group	Measured/ Self-reported	National/ Subnational
		M	F			
Netherlands Central Bureau voor de Statistiek	2000	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2001	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2002	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2003	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2004	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2005	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2006	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2007	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2008	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2009	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2010	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2011	-	-	16-100	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2012	-	-	16 - ≥75	Self-reported	National
Netherlands Central Bureau voor de Statistiek	2013	-	-	17 - ≥75	Self-reported	National

Table 123. References used in the model for smoking prevalence

Year	Reference	Categories	National/regional
2000 - 2012	Dutch Continuous Survey of Smoking Habits; personal communication with Gera Nagelhout	Smoker/Non-smoker	National

Disease data

Disease data sources are detailed in appendix A5. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. The Netherlands provided a complete set of epidemiological data stratified by sex and age. Diabetes statistics for The Netherlands and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, Appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using incidence and mortality data (see technical appendix B4 for details). Cost data sources are detailed in appendix B5. UK data was used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Intervention data

Table 124 and Table 125 present the intervention input data for each of the interventions modelled:

Table 124. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (Euro)
Baseline	None	-	-
MCLI regain	1.1	100	110
MCLI no regain	1.1	0	110
SSB	0.02	0	0

Table 125. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	40%
Accessibility of the intervention (%)	50%
Overall reach (%)	20%
Impact of the intervention	
Type of pharmacological drug	Bupropion
12-month abstinence rate (%) *	17%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 282

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Section 2: Risk factor projections to 2050

BMI projections by age and sex

Table 126 presents prevalence of normal weight, over-weight and obese (according to BMI) in the adult population, by sex. Data from the Netherlands Central Bureau for Statistics (2000-2013) were used as a proxy for the Dutch population. Overall, in both Dutch men and females, obesity prevalence is projected to increase reaching 19% and 18% respectively by 2050. Overweight prevalence is projected to remain stable. The proportion of healthy weight men and females is projected to decline over the next 35 years. Figure 187 to Figure 192 present BMI-group projections to 2050 for males 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence described above is expected to be modest for among men in most age groups, with the exception of 60-69 year old males for whom a more marked increase is predicted, (Figure 192). Among men 60 to 69 years obesity prevalence could reach 40% by 2050, although error in the projections for later years in this age group means this finding should be interpreted with caution. The proportion of healthy weight men is predicted to decline in most age groups.

Figure 193 to Figure 198 present the BMI-group projections to 2050 for females 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence is expected for the 20-29, 40-49 and 70-79 age groups (Figure 193, Figure 195 & Figure 198). The largest increase is projected among 70 to 79 year olds in whom obesity prevalence is expected to exceed 25% in 2050, although this finding should be interpreted with caution due to wide error in later projections (Figure 198). Overweight prevalence projections vary by age group, although most groups are predicted to remain stable or show a decline in overweight.

The proportion of healthy weight females is predicted to decrease in females 20-29, 40-49 and 70-79 years,, remain steady in 30-39 and 60-69 year olds, and increase in 50-59 year olds.

Table 126. Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both sexes					
Year	BMI<25	95% CI	BMI 25-29.9	95% CI	BMI≥30	95% CI	BMI<25	95% CI	BMI 25-29.9	95% CI	BMI≥30	95% CI	BMI<25	95% CI	BMI 25-29.9	95% CI	BMI≥30	95% CI
2015	45.0	2.7	44.0	2.7	11.0	1.9	56.0	2.7	31.0	2.6	13.0	2.0	51.0	2.7	37.0	2.7	12.0	1.9
2020	44.0	4.3	44.0	4.3	12.0	2.9	55.0	4.2	31.0	4.0	14.0	3.1	50.0	4.2	37.0	4.1	13.0	3.0
2025	42.0	5.8	45.0	5.9	13.0	3.9	54.0	5.8	31.0	5.5	15.0	4.1	48.0	5.8	38.0	5.7	14.0	4.0
2030	41.0	7.4	45.0	7.5	14.0	4.9	53.0	7.4	31.0	7.0	15.0	5.3	47.0	7.4	38.0	7.2	15.0	5.1
2035	40.0	9.0	45.0	9.1	15.0	5.9	53.0	8.9	32.0	8.5	16.0	6.4	46.0	9.0	38.0	8.8	15.0	6.1
2040	38.0	10.7	46.0	10.7	16.0	6.9	52.0	10.5	32.0	10.0	17.0	7.5	45.0	10.6	39.0	10.4	16.0	7.2
2045	37.0	12.3	46.0	12.4	17.0	8.0	51.0	12.1	32.0	11.5	17.0	8.6	44.0	12.2	39.0	12.0	17.0	8.3
2050	36.0	13.9	46.0	14.0	19.0	9.0	50.0	13.7	32.0	13.0	18.0	9.7	43.0	13.8	39.0	13.5	18.0	9.4

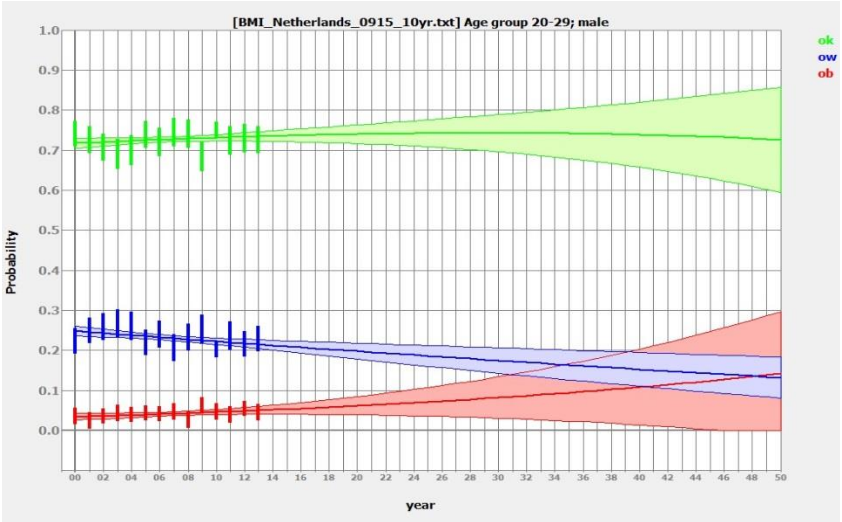


Figure 187. Predicted BMI-group in 20-29 year old males

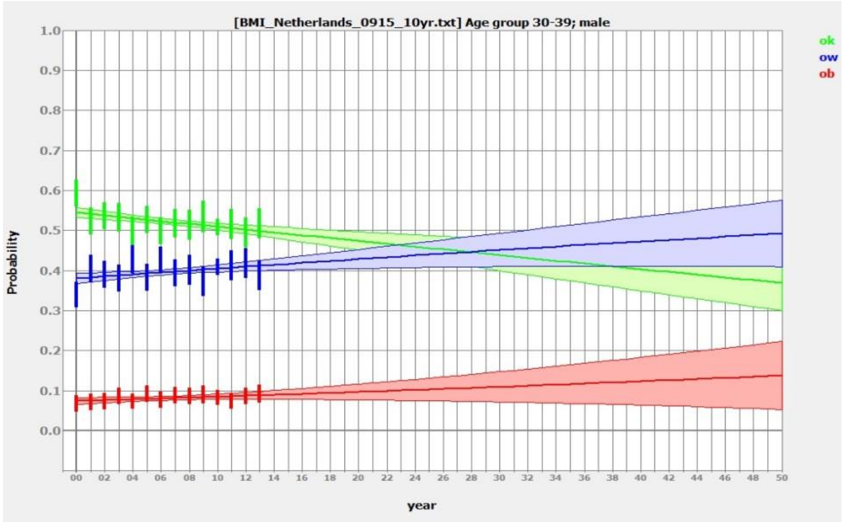


Figure 188. Predicted BMI-group in 30-39 year old males

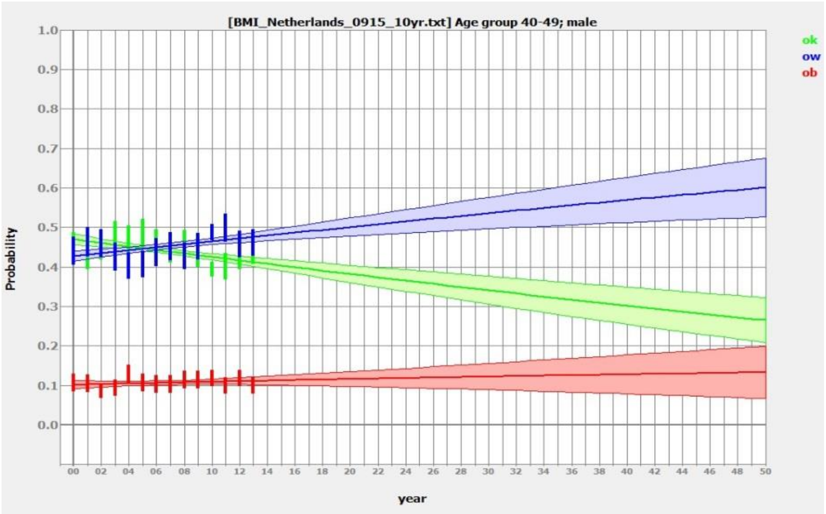


Figure 189. Predicted BMI-group in 40-49 year old males

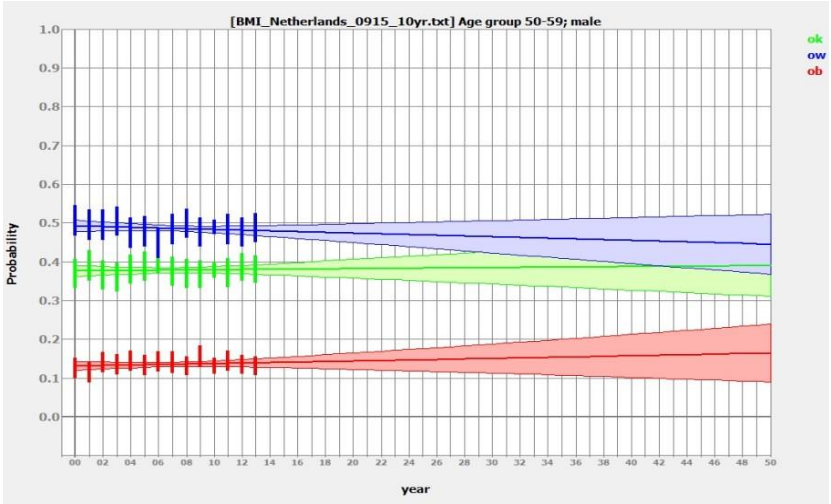


Figure 190. Predicted BMI-group in 50-59 year old males

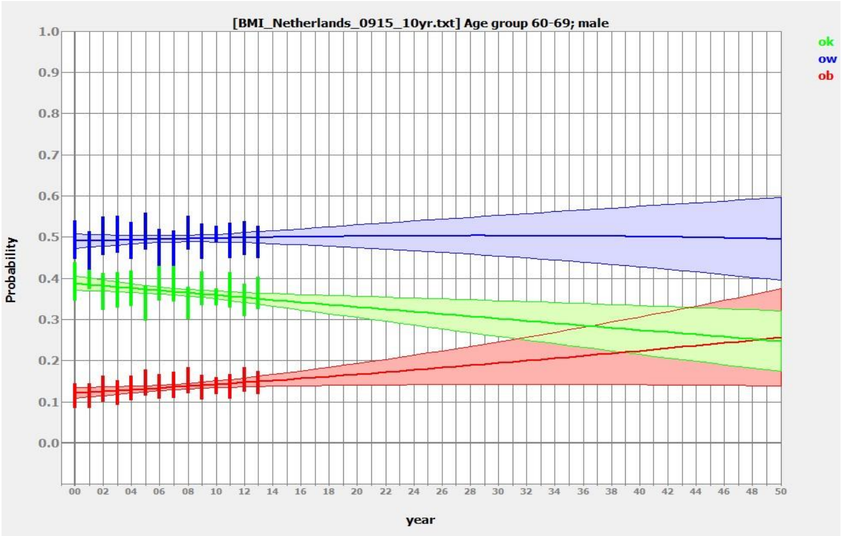


Figure 191. Predicted BMI-group in 60-69 year old males

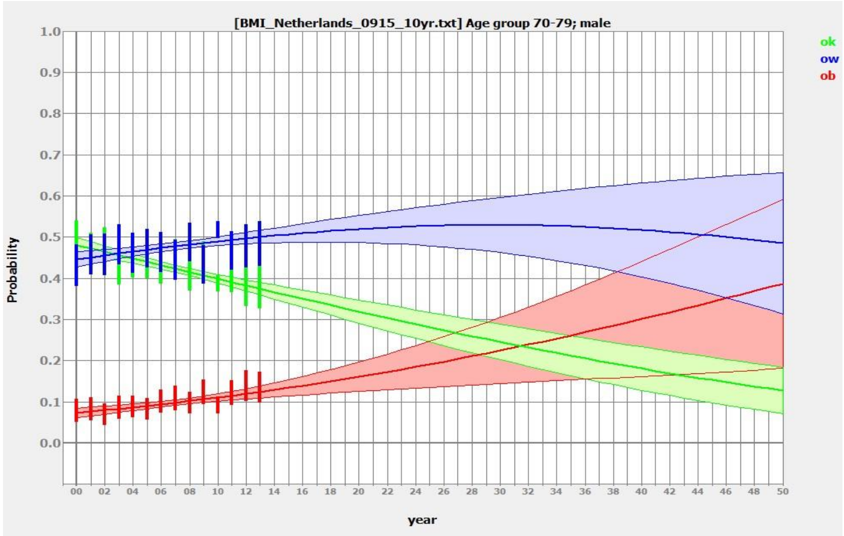


Figure 192. Predicted BMI-group in 70-79 year old males

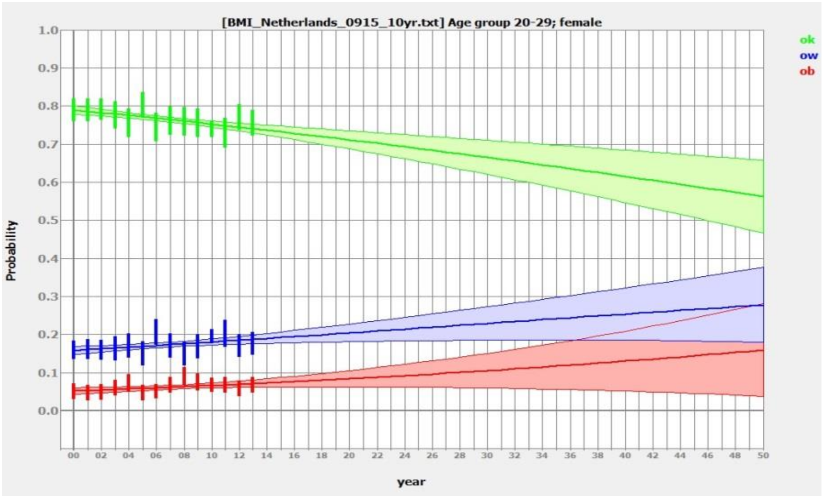


Figure 193. Predicted BMI-group in 20-29 year old females

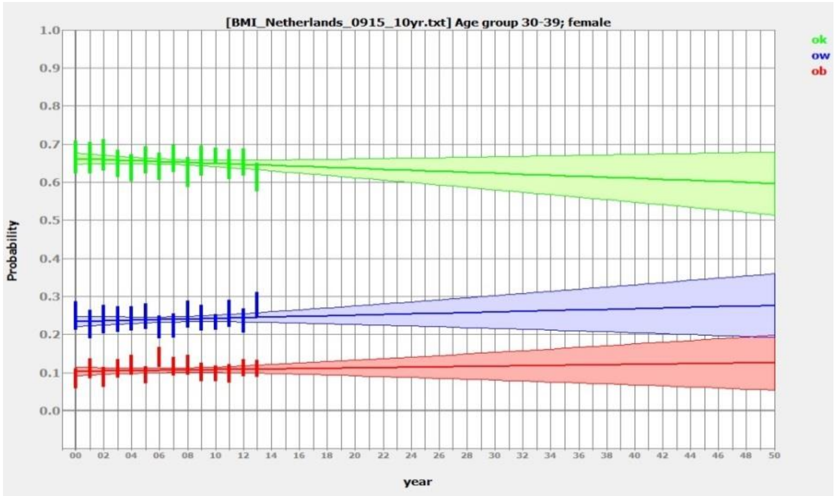


Figure 194. Predicted BMI-group in 30-39 year old females

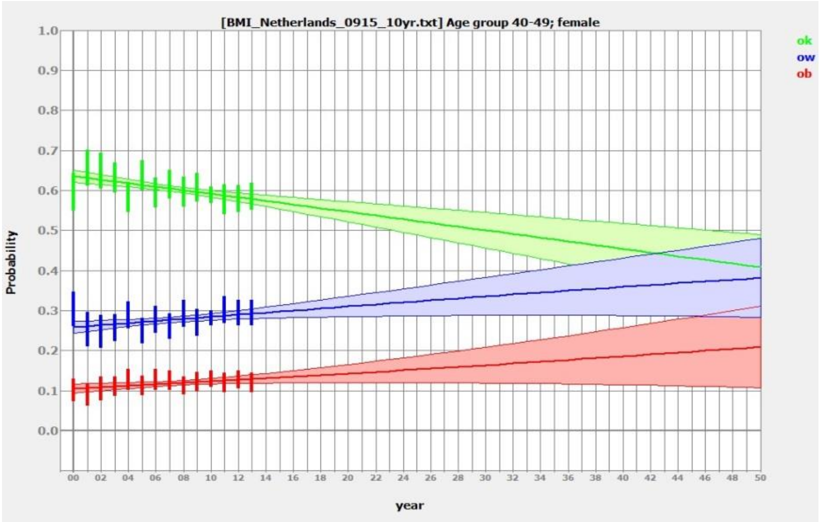


Figure 195. Predicted BMI-group in 40-49 year old females

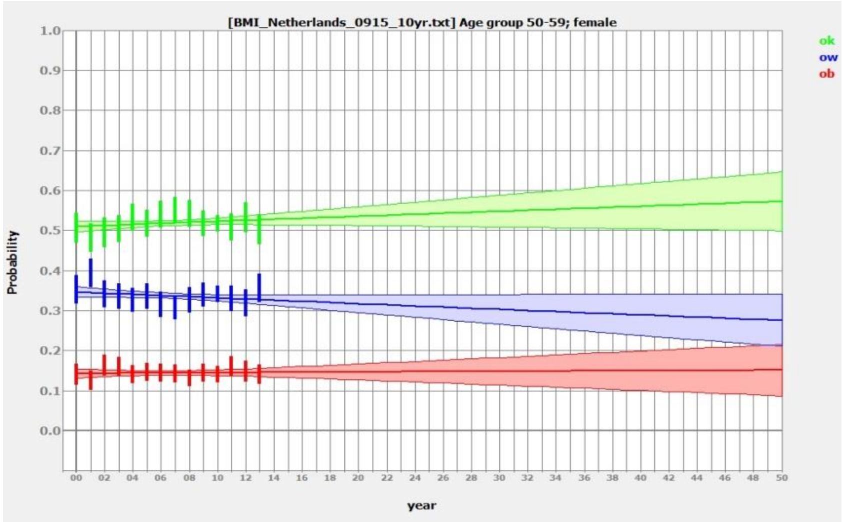


Figure 196. Predicted BMI-group in 50-59 year old females

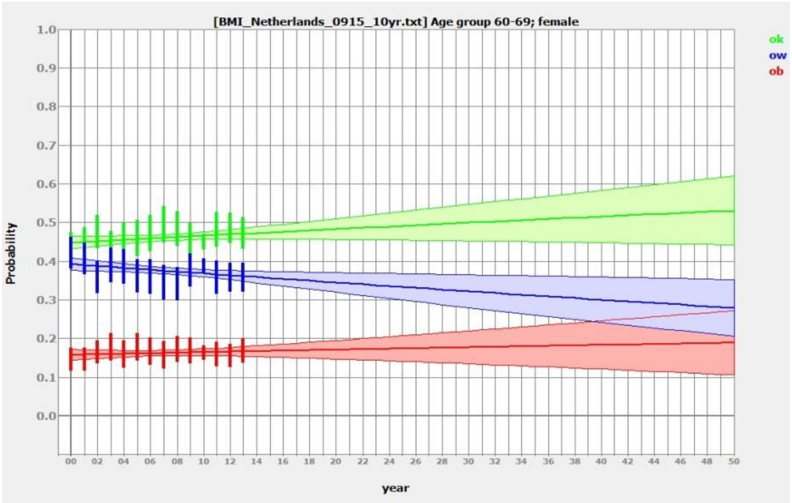


Figure 197. Predicted BMI-group in 60-69 year old females

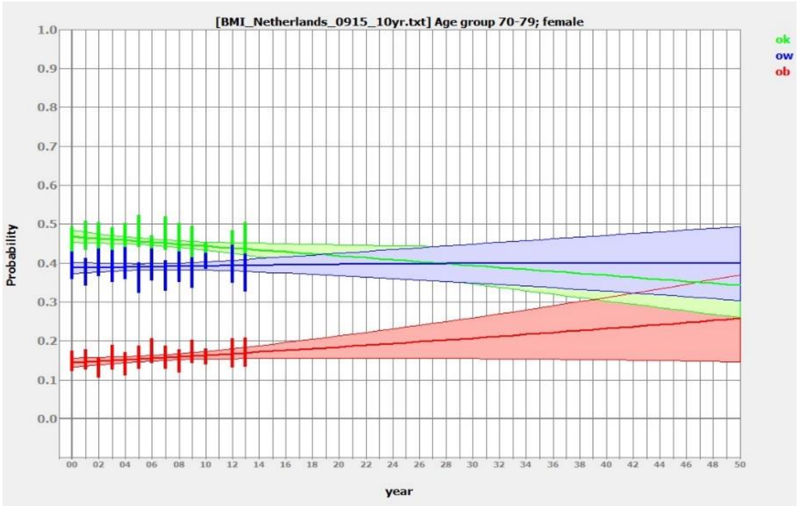


Figure 198. Predicted BMI-group in 70-79 year old females

BMI projections by education level

Education was divided into two groups: 1) below tertiary education 2) tertiary education and above. Tertiary education was defined as 'post-secondary education'.

Males

In the past (up to 2010), overweight prevalence had been similar between men with tertiary education and men with less than tertiary education (**Error! Reference source not found.**) Overweight prevalence is projected to decline slowly in the less than tertiary education group, and decline rapidly in the tertiary education group to 2050. However, error bars are wide and overlap for all years so these findings should be viewed with caution.

Obesity prevalence is predicted to rise amongst tertiary educated men, and decline amongst less than tertiary educated men (Figure 200). It is projected that by 2030, obesity prevalence among males with tertiary education will be 16% compared to 7% among males with less than tertiary education (Appendix E2). Again, error bars are wide and overlapping, particularly from 2015 onwards so these findings should be interpreted with caution.

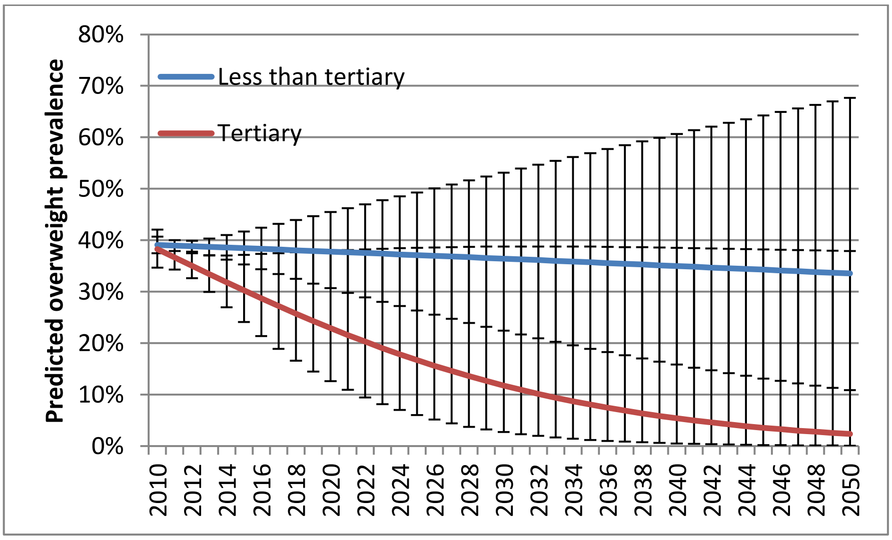


Figure 199 Overweight prevalence by education level among males

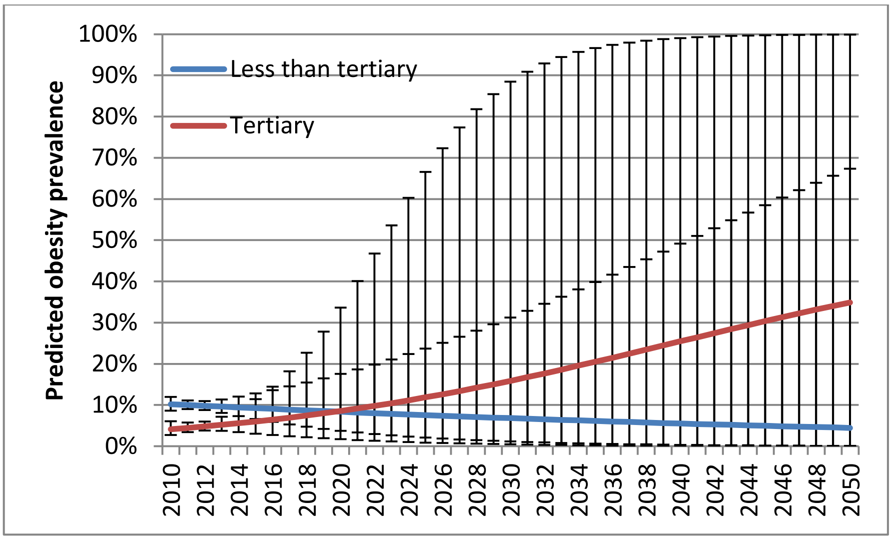


Figure 200 Obesity prevalence by education level among males

Females

Overweight prevalence is projected to remain fairly constant for both education groups (Figure 201). Wide and overlapping error bars do not permit conclusions about the significance of the slightly higher predicted overweight prevalence for less educated females compared to their more educated counterparts. Obesity prevalence is projected to increase only among females with tertiary education (Figure 202), where and is projected to be higher than females with less than tertiary education by 2030. Again, wide and overlapping error bars from 2016 onwards mean that these trends are only indicative; more data would be needed to determine their significance.

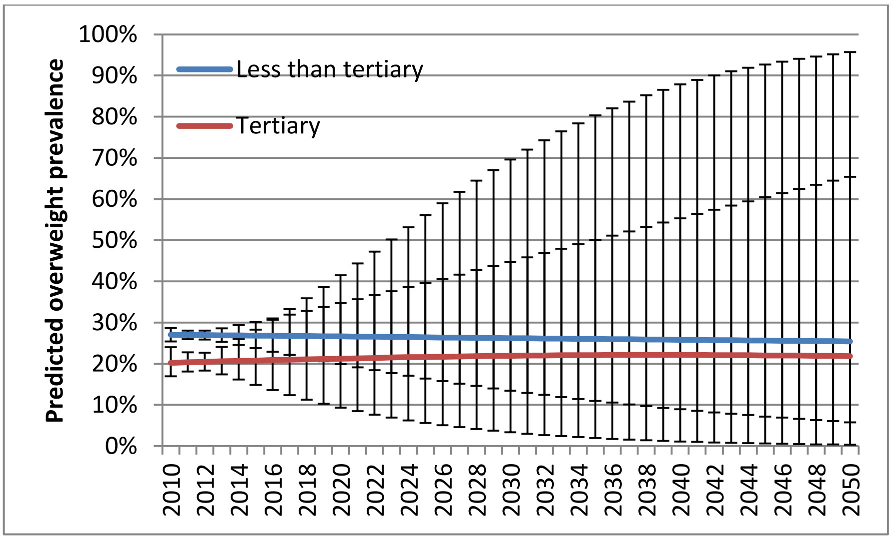


Figure 201. Overweight prevalence by education level among females

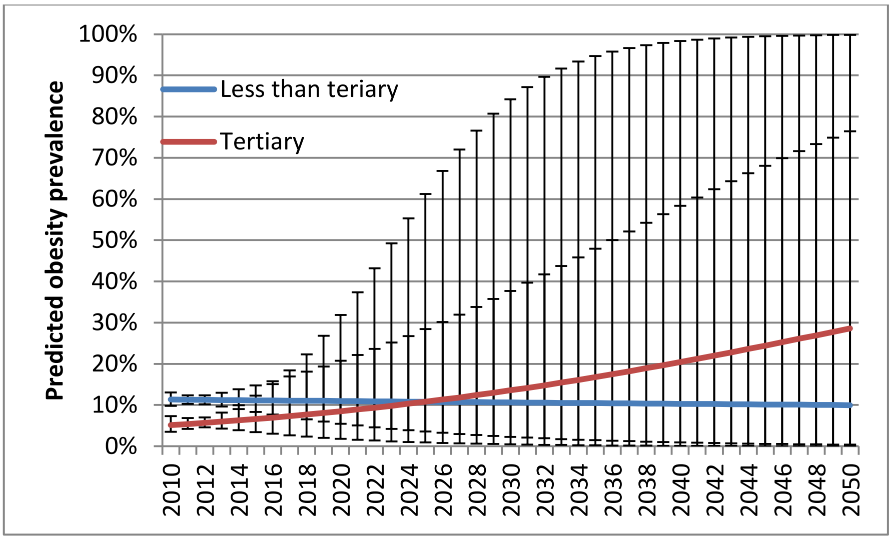


Figure 202. Obesity prevalence by education level among females

Smoking projections by sex and age group

Table 127 presents smoking prevalence projections to 2050 for males and females aged 20 to 100.. Smoking prevalence is projected to decline in both males and females. Based on these projections smoking prevalence could decline to 17% by 2050.

The decline in smoking prevalence is expected across all age groups among both males and females Smoking prevalence in males is projected to decrease amongst all age groups. The biggest decrease in obesity prevalence is observed in 40-49 year olds, decreasing from 30% in 2012 to 11% by 2050. Smoking prevalence in females is also expected to decrease in all age groups, except for the 60-69 year, where smoking is expected to increase. In this age group, uncertainty around the estimate is relatively great, whereas the uncertainty around the estimates for other age groups is small, even in the year 2050.

Table 127. Smoker prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	Non-smokers	95% CI	Smokers	95% CI	Non-smokers	95% CI	Smokers	95% CI	Non-smokers	95% CI	Smokers	95% CI
2015	73.0	2.0	27.0	1.9	79.0	1.8	21.0	1.8	76.0	1.9	24.0	1.9
2020	75.0	1.0	25.0	1.0	80.0	1.0	20.0	1.0	77.0	1.0	23.0	1.0
2025	76.0	1.6	24.0	1.6	81.0	1.4	19.0	1.4	79.0	1.5	21.0	1.5
2030	77.0	2.8	23.0	2.8	82.0	2.6	18.0	2.6	80.0	2.7	20.0	2.7
2035	78.0	4.2	22.0	4.2	83.0	3.9	17.0	3.9	81.0	4.0	19.0	4.0
2040	79.0	5.6	21.0	5.6	84.0	5.2	16.0	5.2	82.0	5.4	18.0	5.4
2045	80.0	7.0	20.0	7.0	84.0	6.5	16.0	6.5	82.0	6.8	18.0	6.8
2050	81.0	8.4	19.0	8.4	84.0	7.9	16.0	7.9	83.0	8.1	17.0	8.1

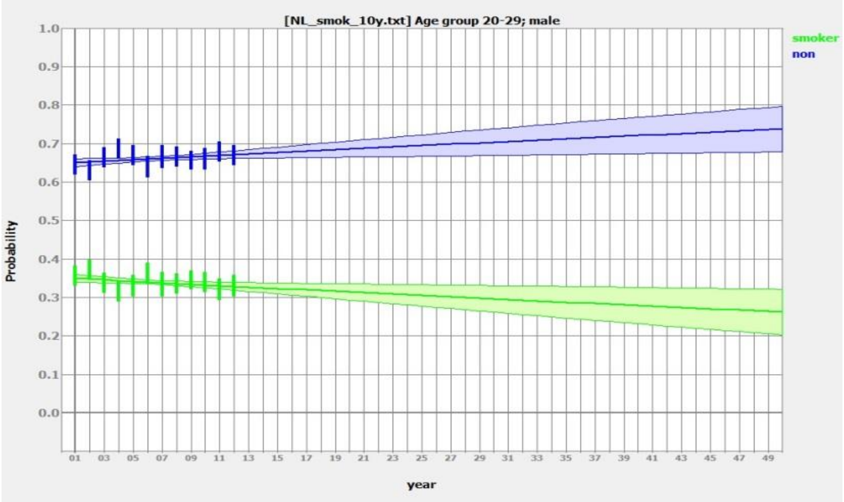


Figure 203. Projected smoking prevalence in 20-29 year old males

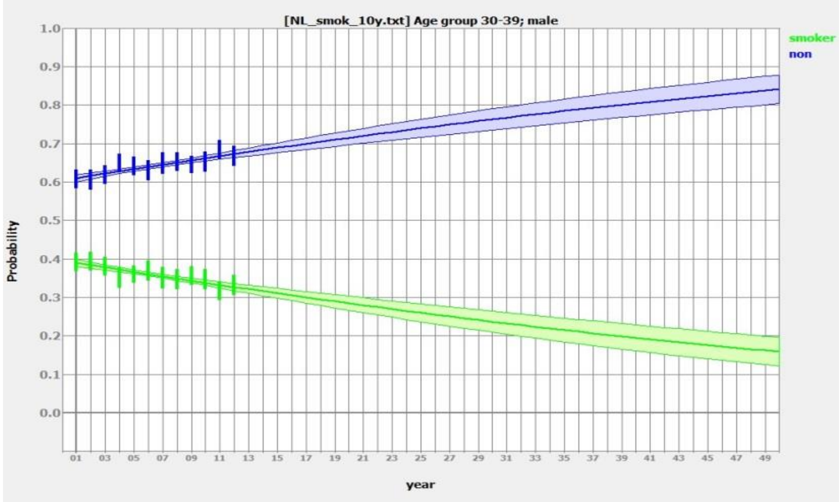


Figure 204. Projected smoking prevalence in 30-39 year old males

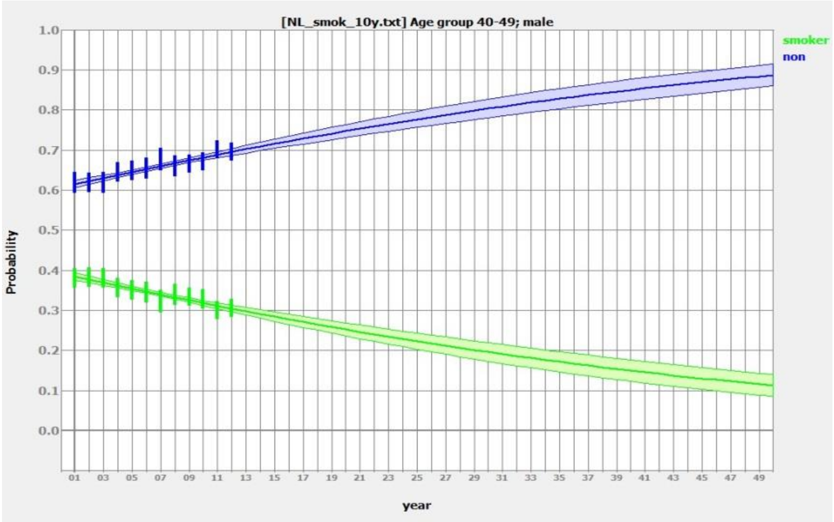


Figure 205.Projected smoking prevalence in 40-49 year old males

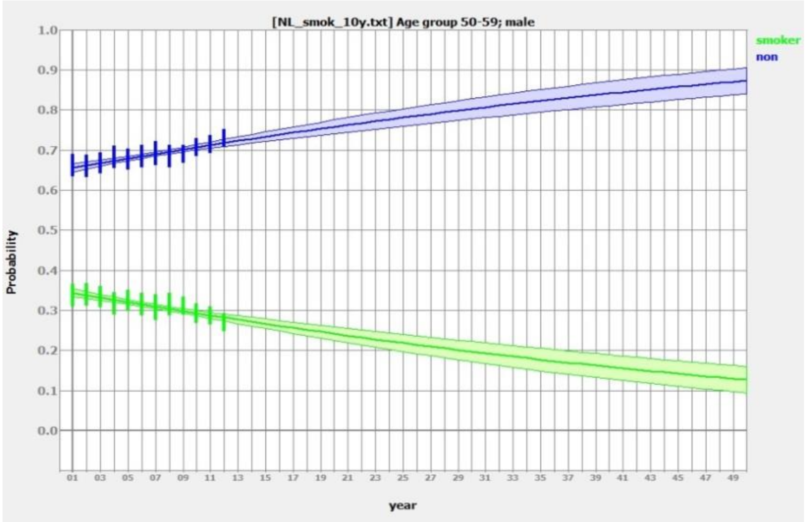


Figure 206. Projected smoking prevalence in 50-59 year old males

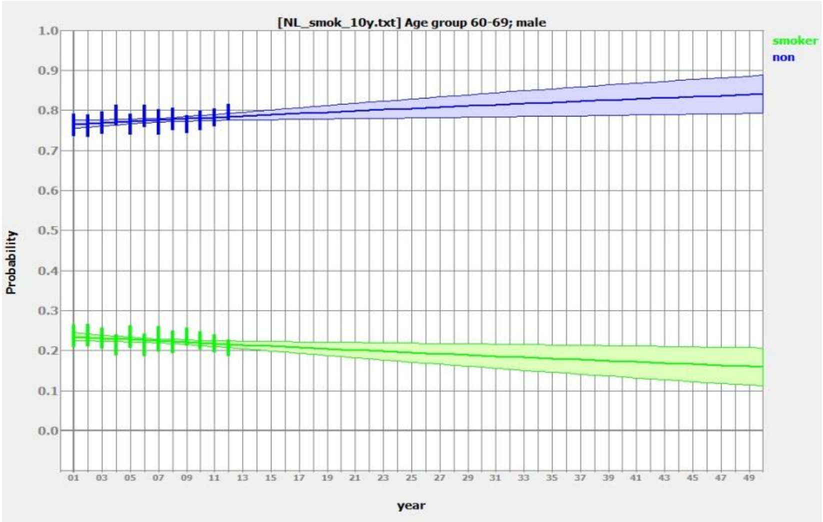


Figure 207. Projected smoking prevalence in 60-69 year old males

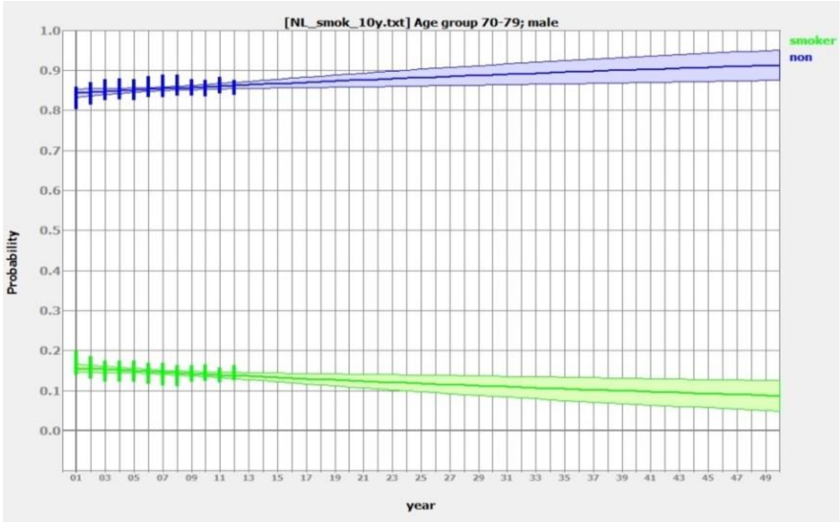


Figure 208. Projected smoking prevalence in 70-79 year old males

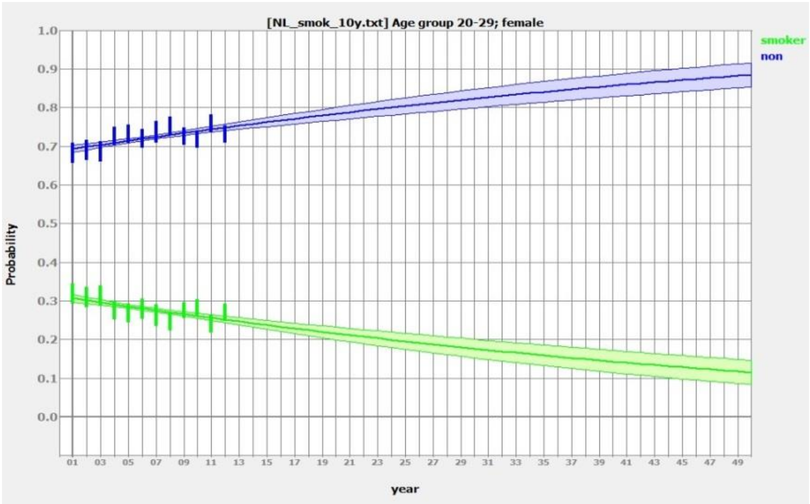


Figure 209. Projected smoking prevalence in 20-29 year old females

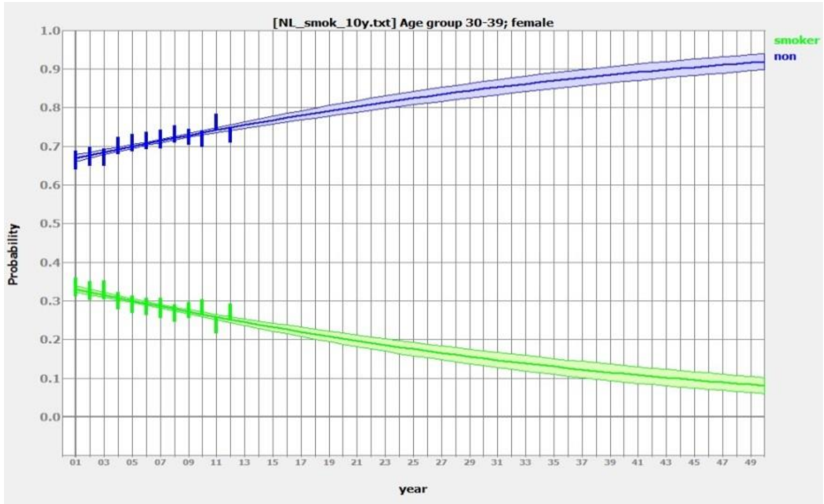


Figure 210. Projected smoking prevalence in 30-39 year old females

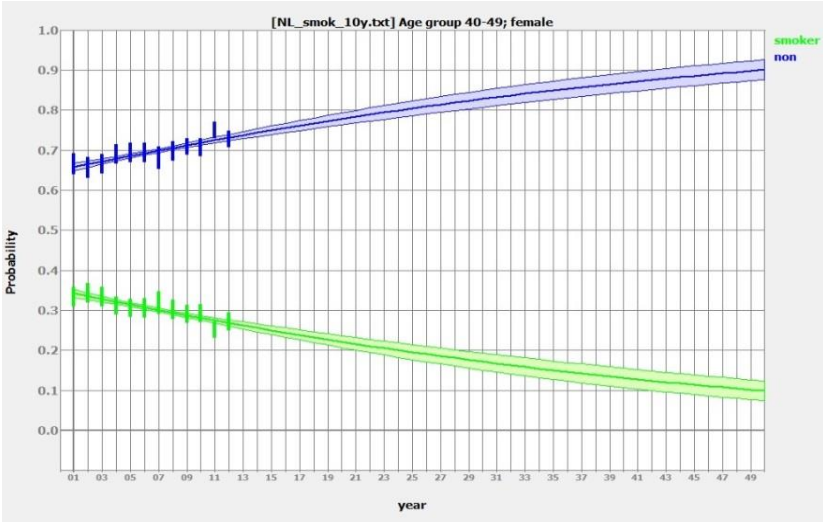


Figure 211. Projected smoking prevalence in 40-49 year old females

Figure 212. Projected smoking prevalence in 50-59 year old females

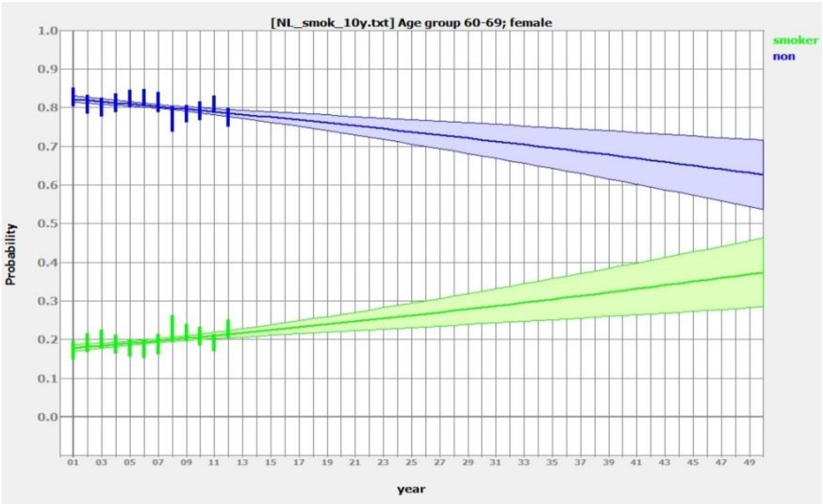


Figure 213. Projected smoking prevalence in 60-69 year old females

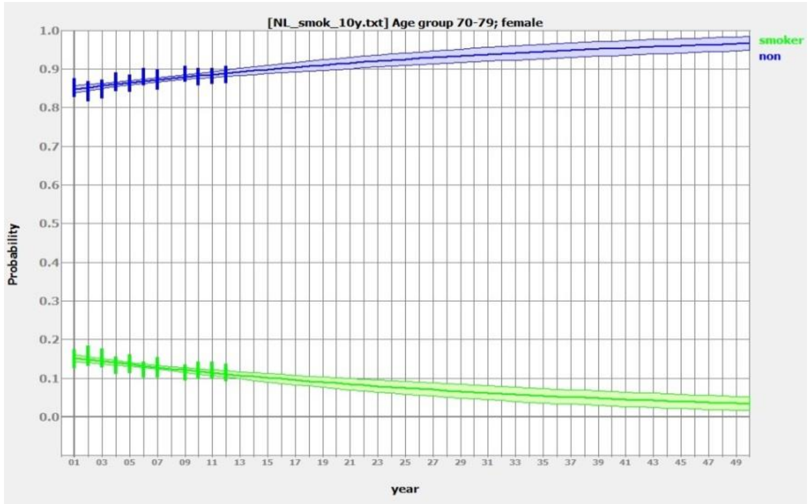


Figure 214. Projected smoking prevalence in 70-79 year old females

Smoking projections by education level

Males

Males with less than tertiary education, defined as lower than degree level, smoke significantly more than males educated to degree level or above (Figure 215). In 2015, smoking prevalence was 10 percentage points higher among males with less than tertiary education compared to males with tertiary education (Figure 215 and appendix E2). Smoking prevalence is projected to decline in both education groups but absolute inequalities in smoking will persist according to the projected trends. Relative inequalities are projected to increase so that by 2035, smoking prevalence among males with less than tertiary education will be two times higher than that of males with tertiary education (appendix E2).

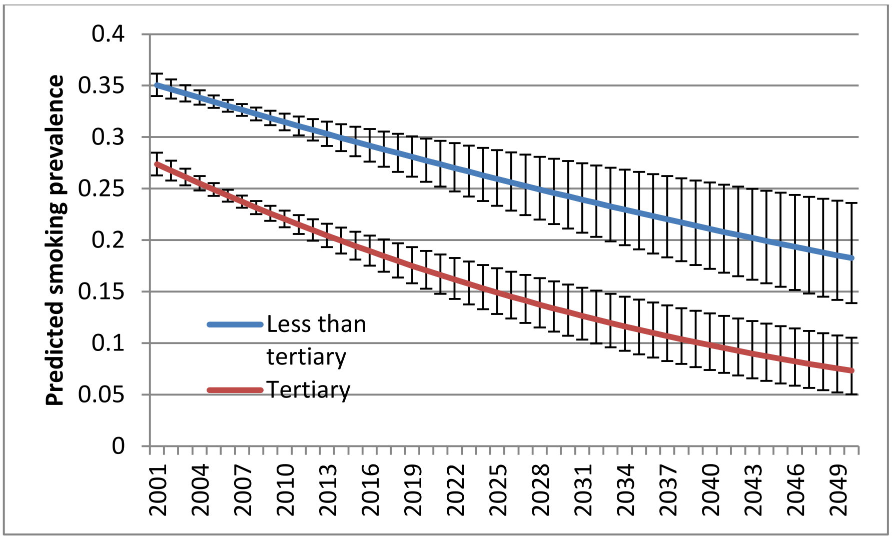


Figure 215. Smoking prevalence projections by education level among males

Females

Smoking prevalence is predicted to decline in both education groups, but at a much faster rate among Dutch females educated to tertiary level compared with females with less than tertiary education (Figure 216). Both absolute and relative inequalities are projected to increase. Based on these projections, by 2035, smoking prevalence will be three times higher in females with less than tertiary education compared to females with tertiary education (appendix E2).

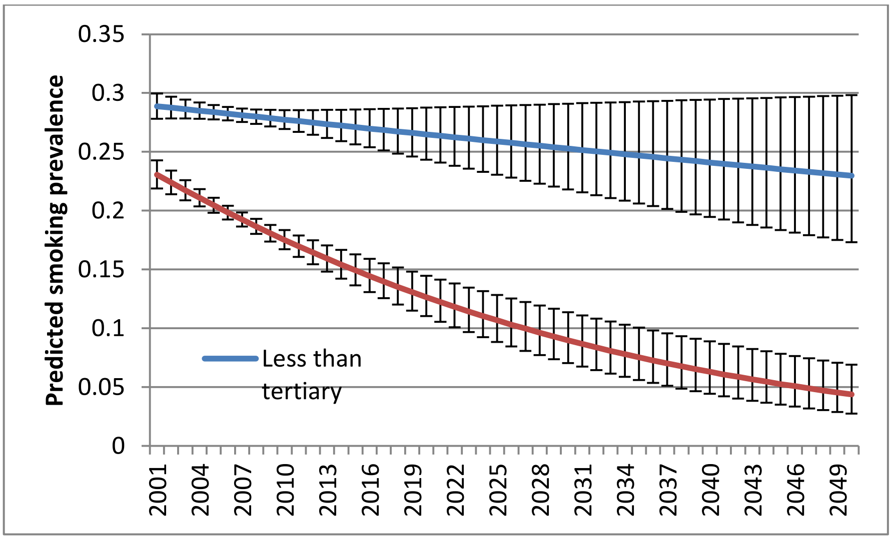


Figure 216. Smoking prevalence projections by education level among females

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 128.
Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

The BMI interventions tested and related input data are presented in Table 128.

Table 128. BMI interventions input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (zł)
Baseline	None	-	-
MCLI regain	1.1	100	110*
MCLI no regain	1.1	0	110*
SSB	0.02	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. *Portugal proxy

Multi-component lifestyle interventions (MCLI)

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain –** these results are presented in appendix E1.

Impact on disease incidence and prevalence

Table 129 presents the incidence cases per 100,000 to 2050 for baseline and each scenario. Incidence cases increase over time. The interventions are effective in reducing the projected incidence cases over time. Table 130 presents the cumulative incidence cases per 100,000 to 2050 for baseline and each scenario.

Table 131 and Figure 217 both present the cumulative incidence cases avoided per 100,000 per year for each intervention relative to baseline (the table presents data for all years whilst the figure presents 2050 projections). With the exception of pre-diabetes, each table/figure indicates that both MCLI interventions would result in a lower cumulative incidence of all diseases by 2050 compared to baseline. For example, MCLI (no regain) would result in the avoidance of 200 cumulative incidence cases of CHD per 100,000 relative to baseline by 2050. Even when MCLI is modelled with weight regain there is a positive effect, with the avoidance of 145, 143 and 105 cumulative incidence cases of CHD, hypertension and type 2 diabetes per 100,000 respectively.

Table 132 and Figure 218 presents the prevalence cases avoided for each intervention relative to baseline, per 100,000. The table indicates that each MCLI intervention would result in a reduced number of prevalence cases per 100,000 compared to baseline for all diseases by 2050, and for each five year increment from 2030 to 2050. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for hypertension (116/100,000 and 124/100,000 for MCLI regain and no-regain scenarios respectively).

Table 129. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
Baseline	2015	413 [+-2]	887 [+-3]	190 [+-1]	881 [+-3]	235 [+-1]
	2020	450 [+-2]	897 [+-3]	209 [+-1]	924 [+-3]	252 [+-1]
	2025	489 [+-2]	877 [+-3]	230 [+-1]	951 [+-3]	269 [+-1]
	2030	520 [+-2]	854 [+-3]	252 [+-1]	978 [+-3]	281 [+-1]
	2035	545 [+-2]	834 [+-3]	274 [+-1]	1002 [+-3]	292 [+-1]
	2040	562 [+-2]	834 [+-3]	294 [+-2]	1013 [+-3]	299 [+-2]
	2045	571 [+-2]	842 [+-3]	308 [+-2]	1014 [+-3]	304 [+-2]
	2050	572 [+-2]	857 [+-3]	316 [+-2]	1018 [+-3]	308 [+-2]
MCLI (annual, with regain)	2015	414 [+-2]	888 [+-3]	190 [+-1]	882 [+-3]	235 [+-1]
	2020	450 [+-2]	894 [+-3]	210 [+-1]	920 [+-3]	252 [+-1]
	2025	484 [+-2]	876 [+-3]	229 [+-1]	947 [+-3]	267 [+-1]
	2030	516 [+-2]	849 [+-3]	251 [+-1]	969 [+-3]	279 [+-1]
	2035	541 [+-2]	829 [+-3]	274 [+-1]	991 [+-3]	287 [+-1]
	2040	556 [+-2]	827 [+-3]	294 [+-2]	1005 [+-3]	295 [+-2]
	2045	565 [+-2]	838 [+-3]	308 [+-2]	1010 [+-3]	302 [+-2]
	2050	567 [+-2]	852 [+-3]	315 [+-2]	1010 [+-3]	304 [+-2]
MCLI (annual, with no regain)	2015	413 [+-2]	888 [+-3]	190 [+-1]	882 [+-3]	234 [+-1]
	2020	447 [+-2]	890 [+-3]	209 [+-1]	919 [+-3]	251 [+-1]
	2025	481 [+-2]	873 [+-3]	229 [+-1]	945 [+-3]	265 [+-1]
	2030	514 [+-2]	848 [+-3]	250 [+-1]	969 [+-3]	278 [+-1]
	2035	540 [+-2]	829 [+-3]	273 [+-1]	991 [+-3]	286 [+-1]
	2040	555 [+-2]	826 [+-3]	293 [+-2]	1006 [+-3]	296 [+-2]
	2045	564 [+-2]	839 [+-3]	308 [+-2]	1009 [+-3]	301 [+-2]
	2050	566 [+-2]	852 [+-3]	315 [+-2]	1011 [+-3]	304 [+-2]

Table 130. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
Baseline	2015	413 [+-2]	887 [+-3]	190 [+-1]	881 [+-3]	235 [+-1]
	2020	2583 [+-4]	5330 [+-6]	1200 [+-3]	5389 [+-6]	1458 [+-3]
	2025	4941 [+-6]	9726 [+-8]	2309 [+-4]	10069 [+-8]	2763 [+-5]
	2030	7495 [+-7]	14072 [+-10]	3536 [+-5]	14943 [+-10]	4151 [+-6]
	2035	10249 [+-8]	18418 [+-11]	4903 [+-6]	20053 [+-11]	5628 [+-6]
	2040	13202 [+-9]	22887 [+-12]	6423 [+-7]	25426 [+-12]	7205 [+-7]
	2045	16338 [+-10]	27591 [+-13]	8087 [+-8]	31078 [+-13]	8883 [+-8]
	2050	19640 [+-11]	32576 [+-13]	9868 [+-9]	36990 [+-14]	10656 [+-9]
MCLI (annual, with regain)	2015	414 [+-2]	888 [+-3]	190 [+-1]	882 [+-3]	235 [+-1]
	2020	2583 [+-4]	5320 [+-6]	1199 [+-3]	5383 [+-6]	1457 [+-3]
	2025	4928 [+-6]	9708 [+-8]	2304 [+-4]	10043 [+-8]	2755 [+-5]
	2030	7460 [+-7]	14032 [+-10]	3528 [+-5]	14871 [+-10]	4132 [+-5]
	2035	10192 [+-8]	18352 [+-11]	4893 [+-6]	19939 [+-11]	5590 [+-6]
	2040	13120 [+-9]	22795 [+-12]	6411 [+-7]	25269 [+-12]	7146 [+-7]
	2045	16229 [+-10]	27473 [+-13]	8063 [+-8]	30875 [+-13]	8803 [+-8]
	2050	19495 [+-11]	32433 [+-13]	9838 [+-9]	36744 [+-14]	10551 [+-9]
MCLI (annual, with no regain)	2015	413 [+-2]	888 [+-3]	190 [+-1]	882 [+-3]	234 [+-1]
	2020	2575 [+-4]	5313 [+-6]	1197 [+-3]	5381 [+-6]	1455 [+-3]
	2025	4906 [+-6]	9690 [+-8]	2300 [+-4]	10036 [+-8]	2749 [+-5]
	2030	7426 [+-7]	14009 [+-10]	3522 [+-5]	14863 [+-10]	4121 [+-5]
	2035	10151 [+-8]	18328 [+-11]	4884 [+-6]	19931 [+-11]	5576 [+-6]
	2040	13072 [+-9]	22770 [+-12]	6399 [+-7]	25262 [+-12]	7131 [+-7]
	2045	16178 [+-10]	27446 [+-13]	8051 [+-8]	30866 [+-13]	8785 [+-8]
	2050	19440 [+-11]	32404 [+-13]	9823 [+-8]	36734 [+-14]	10531 [+-9]

Table 131. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
MCLI (annual, with regain) relative to baseline	2015	-1 [+-3]	-1 [+-4]	0 [+-1]	-1 [+-4]	0 [+-1]
	2020	0 [+-6]	10 [+-8]	1 [+-4]	6 [+-8]	1 [+-4]
	2025	13 [+-8]	18 [+-11]	5 [+-6]	26 [+-11]	8 [+-7]
	2030	35 [+-10]	40 [+-14]	8 [+-7]	72 [+-14]	19 [+-8]
	2035	57 [+-11]	66 [+-16]	10 [+-8]	114 [+-16]	38 [+-8]
	2040	82 [+-13]	92 [+-17]	12 [+-10]	157 [+-17]	59 [+-10]
	2045	109 [+-14]	118 [+-18]	24 [+-11]	203 [+-18]	80 [+-11]
	2050	145 [+-16]	143 [+-18]	30 [+-13]	246 [+-20]	105 [+-13]
MCLI (annual, with no regain) relative to baseline	2015	0 [+-3]	-1 [+-4]	0 [+-1]	-1 [+-4]	1 [+-1]
	2020	8 [+-6]	17 [+-8]	3 [+-4]	8 [+-8]	3 [+-4]
	2025	35 [+-8]	36 [+-11]	9 [+-6]	33 [+-11]	14 [+-7]
	2030	69 [+-10]	63 [+-14]	14 [+-7]	80 [+-14]	30 [+-8]
	2035	98 [+-11]	90 [+-16]	19 [+-8]	122 [+-16]	52 [+-8]
	2040	130 [+-13]	117 [+-17]	24 [+-10]	164 [+-17]	74 [+-10]
	2045	160 [+-14]	145 [+-18]	36 [+-11]	212 [+-18]	98 [+-11]
	2050	200 [+-16]	172 [+-18]	45 [+-12]	256 [+-20]	125 [+-13]

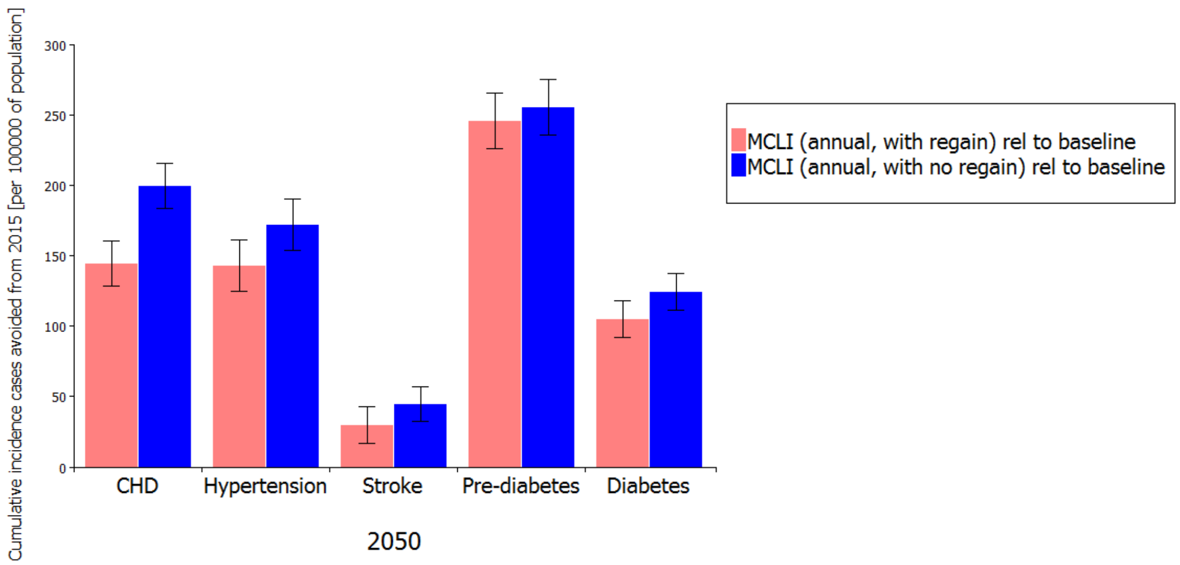


Figure 217. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 132. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
MCLI (annual, with regain) relative to baseline	2015	11 [+-8]	16 [+-17]	4 [+-6]	10 [+-11]	2 [+-8]
	2020	13 [+-10]	27 [+-17]	5 [+-6]	8 [+-11]	3 [+-8]
	2025	21 [+-10]	34 [+-18]	10 [+-6]	13 [+-11]	10 [+-8]
	2030	36 [+-10]	50 [+-18]	9 [+-6]	35 [+-11]	17 [+-8]
	2035	50 [+-11]	67 [+-18]	5 [+-6]	44 [+-11]	30 [+-8]
	2040	69 [+-11]	91 [+-18]	9 [+-7]	57 [+-11]	47 [+-10]
	2045	74 [+-11]	102 [+-18]	11 [+-7]	57 [+-11]	55 [+-10]
	2050	88 [+-11]	116 [+-18]	15 [+-7]	54 [+-11]	63 [+-10]
MCLI (annual, with no regain) relative to baseline	2015	12 [+-8]	15 [+-17]	5 [+-6]	10 [+-11]	2 [+-8]
	2020	18 [+-10]	32 [+-17]	7 [+-6]	11 [+-11]	5 [+-8]
	2025	38 [+-10]	48 [+-18]	14 [+-6]	17 [+-11]	15 [+-8]
	2030	61 [+-10]	67 [+-18]	13 [+-6]	39 [+-11]	24 [+-8]
	2035	81 [+-11]	83 [+-18]	9 [+-6]	46 [+-11]	41 [+-8]
	2040	98 [+-11]	106 [+-18]	14 [+-6]	56 [+-11]	59 [+-10]
	2045	100 [+-11]	113 [+-18]	14 [+-7]	56 [+-11]	66 [+-10]
	2050	104 [+-11]	124 [+-18]	18 [+-7]	53 [+-11]	73 [+-10]

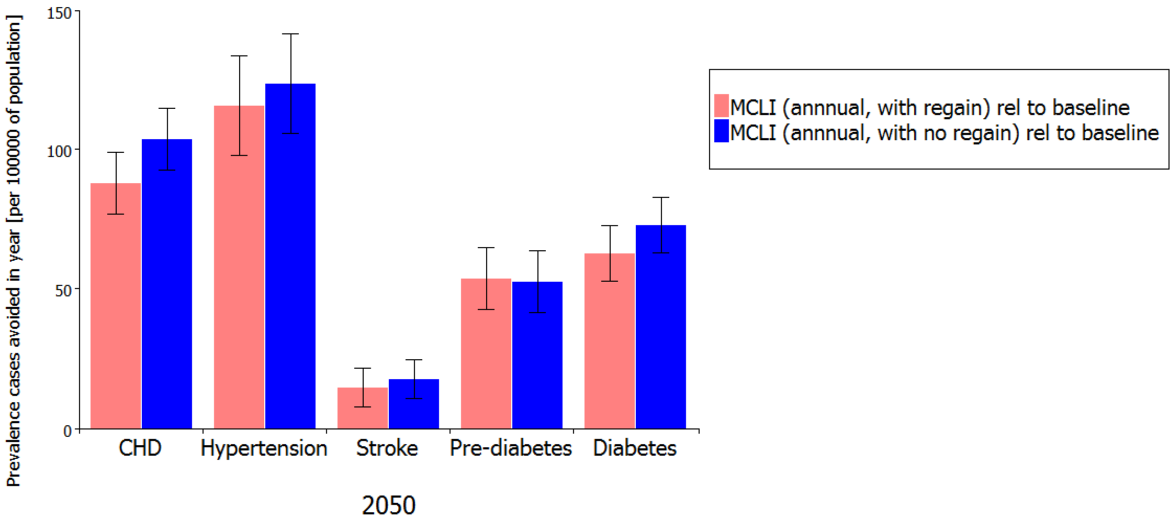


Figure 218. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 133 and Figure 219 presents the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in stroke for both MCLI interventions (€0.08 million and €0.10 million per 100,000 population for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Table 134 and Figure 220 presents the indirect costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to occur in CHD for both MCLI interventions (€0.10 million and €0.12 million per 100,000 population for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Figure 221 and Figure 222 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the baseline. For both males and females, both variations of the MCLI interventions are expected to lead to increasing gains in QALYs over time.

In Figure 223, the positive ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both versions of the MCLI scenarios may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in the Netherlands. This is because a cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. Over time, however, the ICER is expected to approach near zero, indicating that the interventions are likely to become cost effective.

Table 133. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
MCLI (annual, with regain) relative to baseline	2015	0.042517 [+-0.001926]	0.002968 [+-0.000924]	0.103512 [+-0.002478]	0.000804 [+-0.000074]	0.011047 [+-0.00174]
	2020	0.038746 [+-0.00181]	0.004334 [+-0.000805]	0.119698 [+-0.002329]	0.000594 [+-0.000064]	0.01597 [+-0.001603]
	2025	0.0509 [+-0.001699]	0.004386 [+-0.000697]	0.185791 [+-0.002191]	0.000733 [+-0.000055]	0.036577 [+-0.001476]
	2030	0.072753 [+-0.001576]	0.005374 [+-0.000595]	0.123508 [+-0.002057]	0.001616 [+-0.000047]	0.048772 [+-0.001344]
	2035	0.08336 [+-0.00143]	0.005954 [+-0.000503]	0.070269 [+-0.001916]	0.001706 [+-0.000041]	0.07188 [+-0.001202]
	2040	0.093706 [+-0.001266]	0.006604 [+-0.000422]	0.092033 [+-0.001751]	0.001772 [+-0.000035]	0.092417 [+-0.001055]
	2045	0.083247 [+-0.001093]	0.00607 [+-0.000353]	0.093878 [+-0.001556]	0.001482 [+-0.00003]	0.089429 [+-0.000909]
	2050	0.08076 [+-0.000923]	0.005652 [+-0.000295]	0.099455 [+-0.00135]	0.001138 [+-0.000024]	0.082934 [+-0.000769]
MCLI (annual, with no regain) relative to baseline	2015	0.04694 [+-0.001926]	0.002809 [+-0.000924]	0.151604 [+-0.002476]	0.000815 [+-0.000074]	0.014645 [+-0.00174]
	2020	0.054104 [+-0.001809]	0.005074 [+-0.000805]	0.17672 [+-0.002326]	0.000743 [+-0.000064]	0.023243 [+-0.001602]
	2025	0.092398 [+-0.001696]	0.00616 [+-0.000697]	0.247723 [+-0.002189]	0.000945 [+-0.000055]	0.052486 [+-0.001474]
	2030	0.124299 [+-0.001572]	0.007178 [+-0.000595]	0.185314 [+-0.002054]	0.00179 [+-0.000047]	0.068929 [+-0.001342]
	2035	0.134315 [+-0.001426]	0.007306 [+-0.000503]	0.120138 [+-0.001913]	0.001773 [+-0.000041]	0.096861 [+-0.0012]
	2040	0.133119 [+-0.001263]	0.007677 [+-0.000422]	0.144489 [+-0.001748]	0.001746 [+-0.000035]	0.114684 [+-0.001053]
	2045	0.111556 [+-0.096216]	0.006742 [+-0.000353]	0.120056 [+-0.001554]	0.001455 [+-0.00003]	0.106152 [+-0.000907]
	2050	0.096216 [+-0.000921]	0.006057 [+-0.000295]	0.121496 [+-0.001348]	0.001108 [+-0.000024]	0.0957 [+-0.000769]

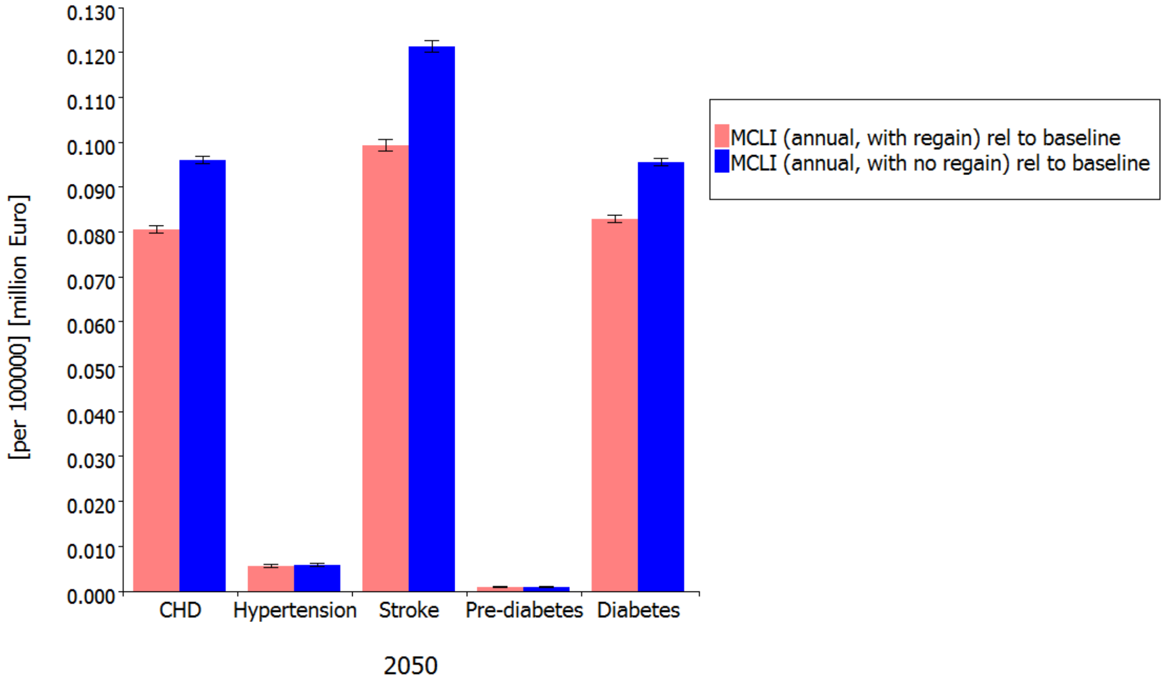


Figure 219. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 134. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
MCLI (annual, with regain) relative to baseline	2015	0.052624 [+-0.002385]	0.002649 [+-0.000825]	0.074478 [+-0.001783]	0 [+-0]	0.005599 [+-0.000882]
	2020	0.047956 [+-0.002241]	0.003867 [+-0.000719]	0.086124 [+-0.001675]	0 [+-0]	0.008097 [+-0.000812]
	2025	0.063 [+-0.002103]	0.003915 [+-0.000622]	0.133682 [+-0.001577]	0 [+-0]	0.018541 [+-0.000748]
	2030	0.090046 [+-0.001951]	0.004796 [+-0.000531]	0.088869 [+-0.00148]	0 [+-0]	0.024723 [+-0.000682]
	2035	0.103176 [+-0.00177]	0.005314 [+-0.000449]	0.05056 [+-0.001379]	0 [+-0]	0.036436 [+-0.00061]
	2040	0.115981 [+-0.001568]	0.005893 [+-0.000377]	0.066221 [+-0.00126]	0 [+-0]	0.046846 [+-0.000535]
	2045	0.103037 [+-0.001353]	0.005418 [+-0.000315]	0.067547 [+-0.001119]	0 [+-0]	0.045332 [+-0.00046]
	2050	0.099957 [+-0.001143]	0.005044 [+-0.000264]	0.07156 [+-0.000971]	0 [+-0]	0.04204 [+-0.00039]
MCLI (annual, with no regain) relative to baseline	2015	0.058098 [+-0.002384]	0.002507 [+-0.000825]	0.109081 [+-0.001782]	0 [+-0]	0.007422 [+-0.000882]
	2020	0.066963 [+-0.002239]	0.004528 [+-0.000719]	0.127153 [+-0.001674]	0 [+-0]	0.011783 [+-0.000812]
	2025	0.114363 [+-0.002099]	0.005498 [+-0.000622]	0.178242 [+-0.001575]	0 [+-0]	0.026605 [+-0.000747]
	2030	0.153847 [+-0.001946]	0.006407 [+-0.000531]	0.133339 [+-0.001478]	0 [+-0]	0.03494 [+-0.000681]
	2035	0.166245 [+-0.001765]	0.006521 [+-0.000449]	0.086443 [+-0.001377]	0 [+-0]	0.049099 [+-0.000609]
	2040	0.164764 [+-0.001563]	0.006852 [+-0.000377]	0.103966 [+-0.001258]	0 [+-0]	0.058133 [+-0.000534]
	2045	0.138074 [+-0.119088]	0.006018 [+-0.000315]	0.086382 [+-0.001119]	0 [+-0]	0.053809 [+-0.00046]
	2050	0.119088 [+-0.001141]	0.005405 [+-0.000264]	0.087419 [+-0.00097]	0 [+-0]	0.048511 [+-0.00039]

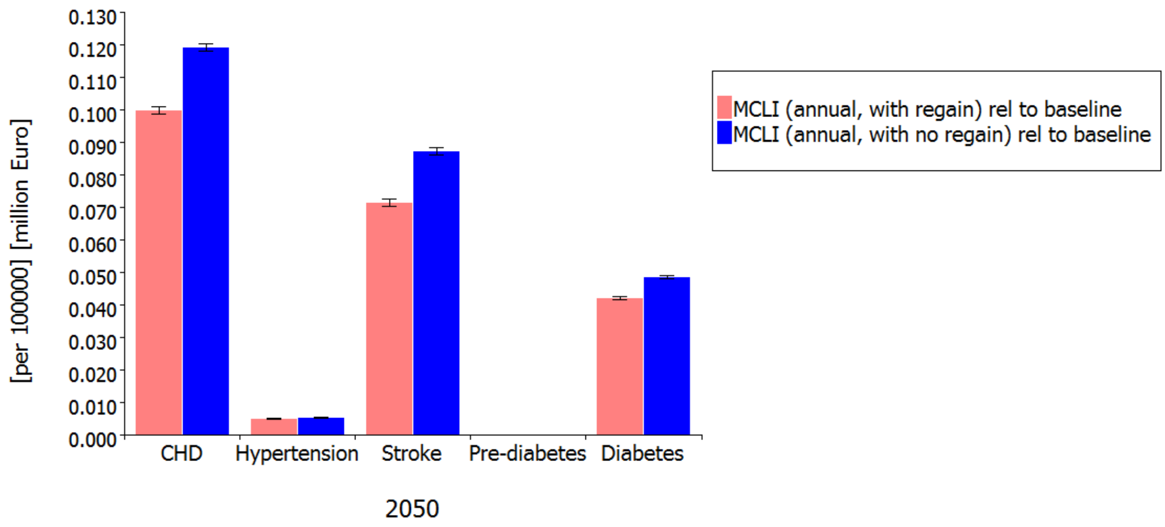


Figure 220. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

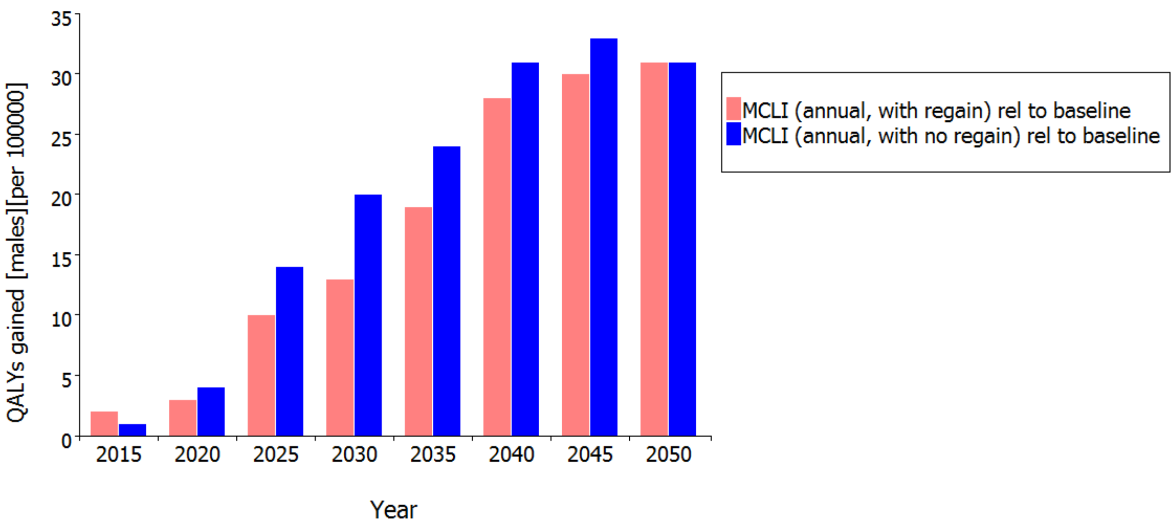


Figure 221. QALYS gained (per 100,000), relative to baseline (males)

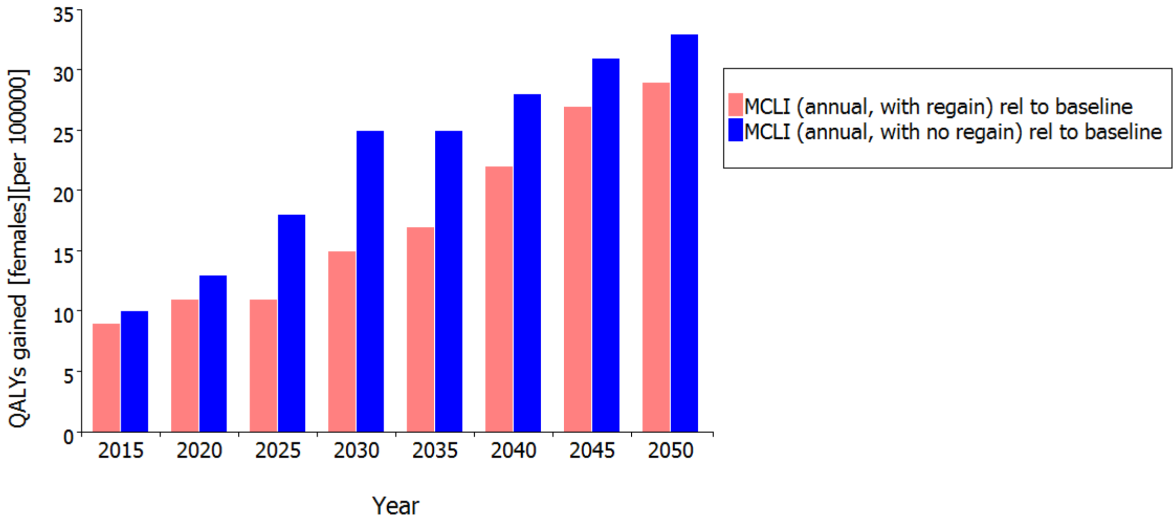


Figure 222. QALYS gained (per 100,000), relative to baseline (females)

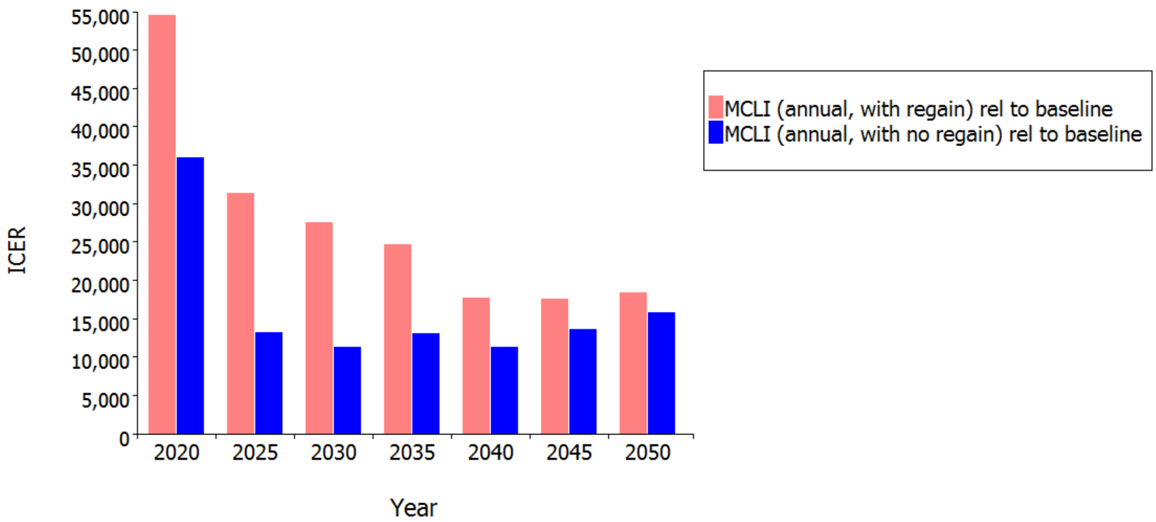


Figure 223. ICER

Sugar-sweetened beverage tax (SSBs) interventions

Impact on disease incidence and prevalence

Table 135 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios, except for hypertension which is expected to go down.

Table 136 presents the cumulative incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Cumulative incidence is marginally lower for all diseases in the SSB scenario compared to baseline by 2050.

Table 137 and Figure 224 present the cumulative incidence cases avoided (per 100,000) from 2015 to 2050 for each intervention relative to baseline. The SSB scenario is predicted to reduce the cumulative incidence of all diseases, where the largest effect is observed for pre-diabetes (44 cases avoided per 100,000 compared to baseline by 2050) followed by hypertension (26 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on incidence of each disease as a result of an SSB tax relative to baseline by 2050.

Figure 225 and Table 138 presents the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. The SSB scenario is predicted to reduce prevalence cases per 100,000 compared to baseline for all diseases by 2050, with the greatest effect observed for hypertension (17 prevalence cases avoided per 100,000 compared to baseline) followed by diabetes (12 prevalence cases avoided per 100,000 compared to baseline). The graph illustrates the predicted impact on prevalence of each disease as a result of an SSB tax relative to baseline by 2050.

Table 135. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
Baseline	2015	413 [+-1]	889 [+-2]	191 [+-1]	883 [+-2]	235 [+-1]
	2020	454 [+-1]	896 [+-2]	212 [+-1]	927 [+-2]	255 [+-1]
	2025	496 [+-1]	874 [+-2]	236 [+-1]	957 [+-2]	271 [+-1]
	2030	532 [+-1]	849 [+-2]	262 [+-1]	988 [+-2]	285 [+-1]
	2035	560 [+-1]	828 [+-2]	288 [+-1]	1009 [+-2]	296 [+-1]
	2040	579 [+-1]	823 [+-2]	309 [+-1]	1023 [+-2]	306 [+-1]
	2045	589 [+-2]	832 [+-2]	325 [+-1]	1028 [+-2]	313 [+-1]
	2050	591 [+-2]	847 [+-2]	334 [+-1]	1030 [+-2]	317 [+-1]
SSB	2015	413 [+-1]	888 [+-2]	190 [+-1]	882 [+-2]	234 [+-1]
	2020	454 [+-1]	894 [+-2]	212 [+-1]	925 [+-2]	254 [+-1]
	2025	496 [+-1]	872 [+-2]	235 [+-1]	956 [+-2]	270 [+-1]
	2030	531 [+-1]	849 [+-2]	261 [+-1]	987 [+-2]	285 [+-1]
	2035	560 [+-1]	827 [+-2]	288 [+-1]	1008 [+-2]	295 [+-1]
	2040	578 [+-1]	823 [+-2]	309 [+-1]	1023 [+-2]	305 [+-1]
	2045	589 [+-2]	832 [+-2]	325 [+-1]	1027 [+-2]	312 [+-1]
	2050	591 [+-2]	847 [+-2]	334 [+-1]	1029 [+-2]	316 [+-1]

Table 136. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
Baseline	2015	413 [+-1]	889 [+-2]	191 [+-1]	883 [+-2]	235 [+-1]
	2020	2594 [+-3]	5316 [+-4]	1207 [+-2]	5395 [+-4]	1459 [+-2]
	2025	4970 [+-4]	9667 [+-6]	2332 [+-3]	10073 [+-6]	2770 [+-3]
	2030	7554 [+-5]	13943 [+-7]	3591 [+-4]	14935 [+-7]	4165 [+-4]
	2035	10352 [+-6]	18202 [+-7]	5005 [+-4]	20033 [+-8]	5653 [+-4]
	2040	13360 [+-7]	22576 [+-8]	6586 [+-5]	25402 [+-9]	7244 [+-5]
	2045	16571 [+-7]	27187 [+-9]	8325 [+-5]	31060 [+-9]	8945 [+-6]
	2050	19956 [+-8]	32090 [+-9]	10197 [+-6]	37003 [+-10]	10746 [+-6]
SSB	2015	413 [+-1]	888 [+-2]	190 [+-1]	882 [+-2]	234 [+-1]
	2020	2592 [+-3]	5308 [+-4]	1207 [+-2]	5385 [+-4]	1457 [+-2]
	2025	4966 [+-4]	9653 [+-6]	2331 [+-3]	10055 [+-6]	2765 [+-3]
	2030	7546 [+-5]	13925 [+-7]	3589 [+-4]	14911 [+-7]	4157 [+-4]
	2035	10340 [+-6]	18181 [+-7]	5001 [+-4]	20002 [+-8]	5641 [+-4]
	2040	13345 [+-7]	22553 [+-8]	6582 [+-5]	25366 [+-9]	7229 [+-5]
	2045	16553 [+-7]	27163 [+-9]	8320 [+-5]	31020 [+-9]	8926 [+-6]
	2050	19935 [+-8]	32064 [+-9]	10192 [+-6]	36959 [+-10]	10723 [+-6]

Table 137. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	0 [+-1]	1 [+-3]	1 [+-1]	1 [+-3]	1 [+-1]
	2020	2 [+-4]	8 [+-6]	0 [+-3]	10 [+-6]	2 [+-3]
	2025	4 [+-6]	14 [+-8]	1 [+-4]	18 [+-8]	5 [+-4]
	2030	8 [+-7]	18 [+-10]	2 [+-6]	24 [+-10]	8 [+-6]
	2035	12 [+-8]	21 [+-10]	4 [+-6]	31 [+-11]	12 [+-6]
	2040	15 [+-10]	23 [+-11]	4 [+-7]	36 [+-13]	15 [+-7]
	2045	18 [+-10]	24 [+-13]	5 [+-7]	40 [+-13]	19 [+-8]
	2050	21 [+-11]	26 [+-13]	5 [+-8]	44 [+-14]	23 [+-8]

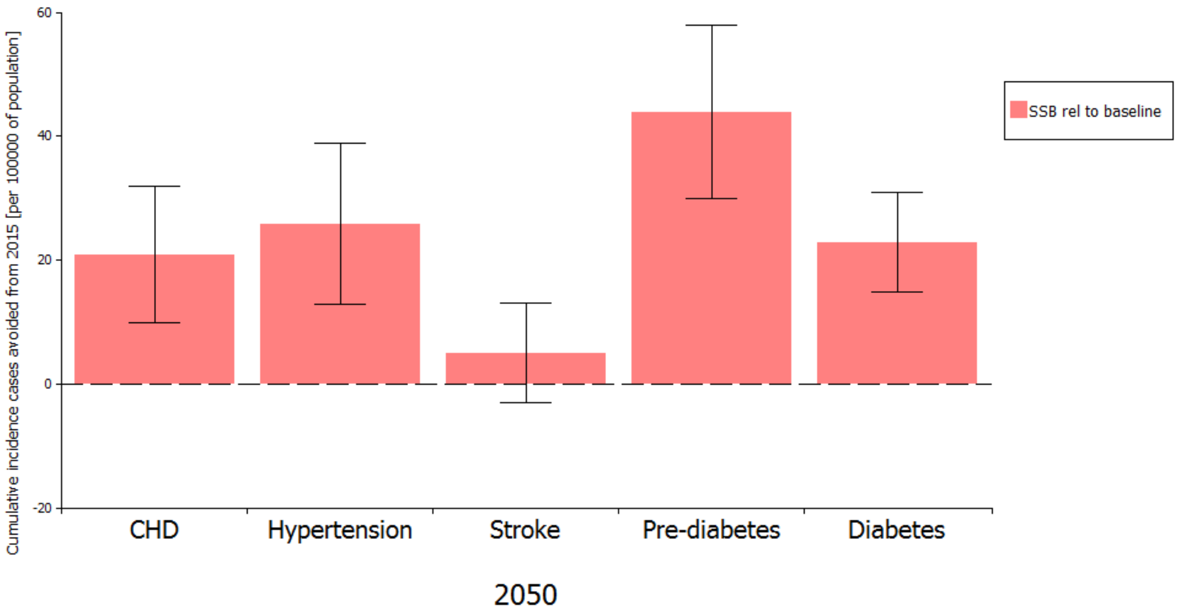


Figure 224. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 138. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	0 [+-7]	1 [+-13]	0 [+-4]	0 [+-7]	0 [+-6]
	2020	2 [+-7]	8 [+-13]	0 [+-4]	8 [+-7]	2 [+-6]
	2025	4 [+-7]	14 [+-13]	0 [+-4]	11 [+-8]	5 [+-6]
	2030	6 [+-7]	18 [+-13]	2 [+-4]	12 [+-8]	8 [+-6]
	2035	8 [+-7]	20 [+-13]	2 [+-4]	11 [+-8]	9 [+-7]
	2040	9 [+-8]	20 [+-13]	2 [+-4]	10 [+-8]	12 [+-7]
	2045	11 [+-8]	19 [+-13]	1 [+-4]	8 [+-8]	13 [+-7]
	2050	10 [+-8]	17 [+-13]	2 [+-4]	7 [+-8]	12 [+-7]

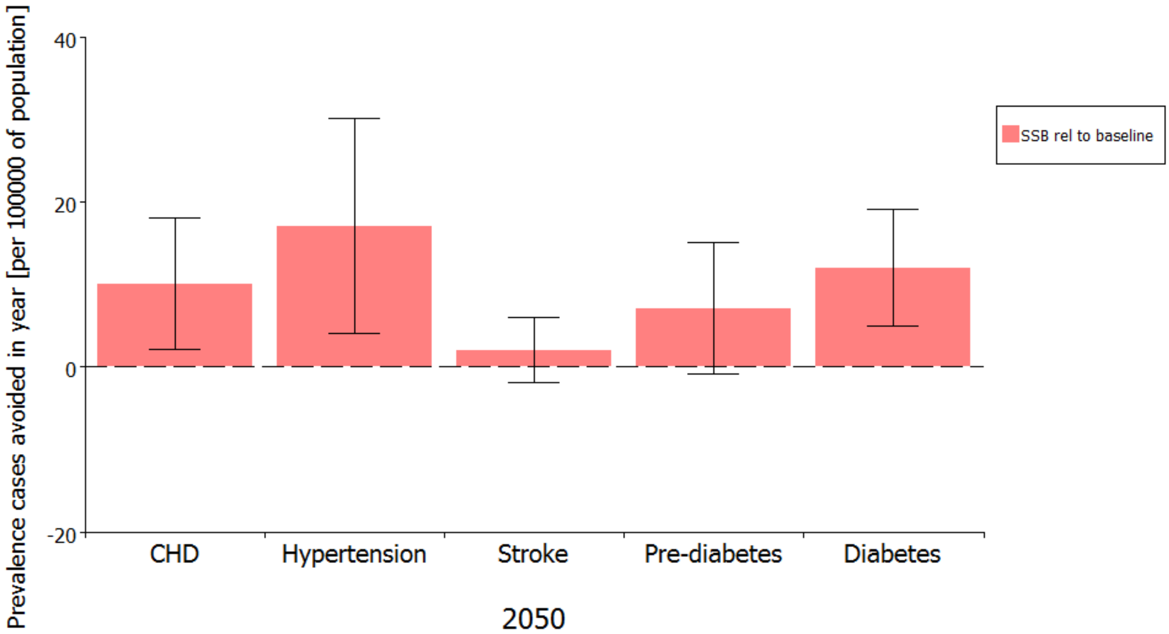


Figure 225. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 139 and Figure 226 presents the direct healthcare costs that can be avoided (per 100,000 population) with the SSB intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in diabetes (€0.016m per 100,000 population in 2050), followed by stroke (€0.012m per 100,000 population in 2050).

Table 140 and Figure 227 presents the indirect costs that can be *avoided* (per 100,000 population) with the SSB intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to occur in CHD (€0.011m per 100,000 population in 2050), followed by diabetes (€0.008m per 100,000 population in 2050).

Figure 228 and Figure 229 present the QALYs that can be *gained* (per 100,000 population) with the SSB intervention, relative to the baseline. For both males and females, the SSB tax intervention is expected to lead to increasing gains in QALYs between 2015 and 2035, and then start decreasing thereafter.

In Figure 230, the negative ICER values (which in this case is comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SSB tax intervention is cost effective (the SSB tax intervention scenario *dominate* the baseline scenario).

Table 139. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	-0.00172 [+-0.00137]	0.000213 [+-0.000656]	0.006531 [+-0.001761]	0.000055 [+-0.000052]	0.001291 [+-0.001236]
	2020	0.006029 [+-0.00131]	0.001366 [+-0.000574]	0.008595 [+-0.00169]	0.000549 [+-0.000045]	0.008717 [+-0.001154]
	2025	0.009546 [+-0.001248]	0.001858 [+-0.000498]	0.012192 [+-0.001617]	0.000622 [+-0.00004]	0.016817 [+-0.001076]
	2030	0.012602 [+-0.001172]	0.001907 [+-0.000427]	0.021965 [+-0.001544]	0.00055 [+-0.000034]	0.020662 [+-0.000989]
	2035	0.01395 [+-0.001073]	0.001772 [+-0.000361]	0.022709 [+-0.001456]	0.000414 [+-0.00003]	0.023265 [+-0.000892]
	2040	0.013263 [+-0.000955]	0.001463 [+-0.000304]	0.019804 [+-0.001343]	0.000287 [+-0.000025]	0.022388 [+-0.000787]
	2045	0.011688 [+-0.000829]	0.001132 [+-0.000255]	0.015036 [+-0.001201]	0.000197 [+-0.000021]	0.020432 [+-0.000682]
	2050	0.009212 [+-0.000703]	0.000818 [+-0.000212]	0.012136 [+-0.001047]	0.000145 [+-0.000018]	0.016373 [+-0.000579]

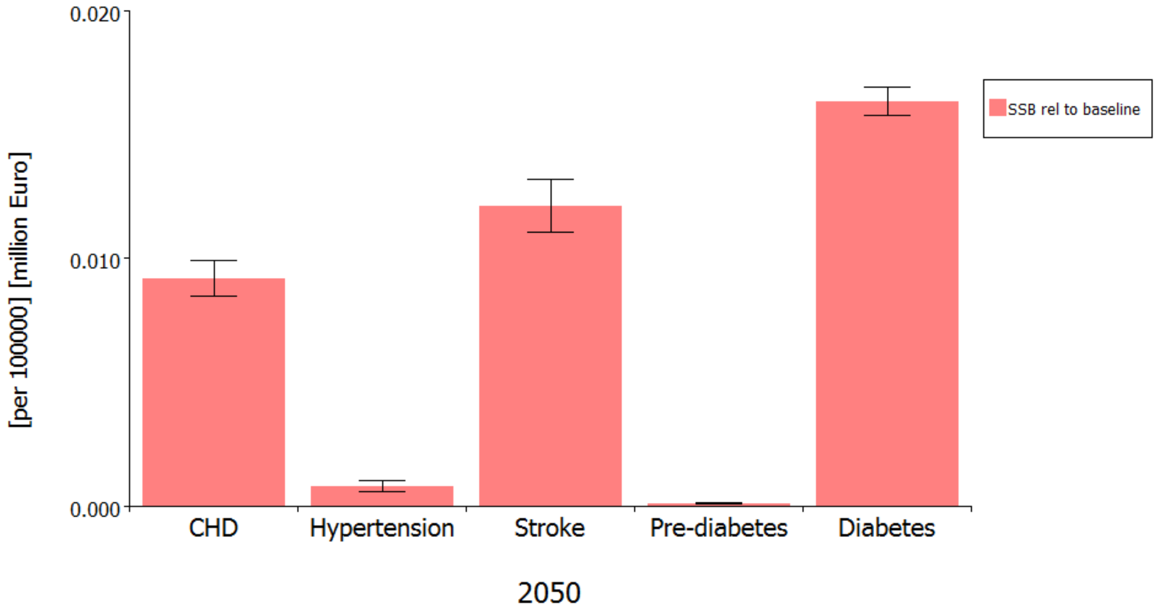


Figure 226. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 140. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	-0.002131 [+-0.001696]	0.00019 [+-0.000585]	0.0047 [+-0.001267]	0 [+-0]	0.000655 [+-0.000626]
	2020	0.007463 [+-0.001621]	0.001219 [+-0.000512]	0.006184 [+-0.001216]	0 [+-0]	0.004418 [+-0.000585]
	2025	0.011814 [+-0.001544]	0.001658 [+-0.000444]	0.008774 [+-0.001164]	0 [+-0]	0.008525 [+-0.000545]
	2030	0.015598 [+-0.00145]	0.001703 [+-0.00038]	0.015806 [+-0.001111]	0 [+-0]	0.010474 [+-0.000501]
	2035	0.017267 [+-0.001327]	0.001581 [+-0.000322]	0.01634 [+-0.001048]	0 [+-0]	0.011792 [+-0.000452]
	2040	0.016417 [+-0.001183]	0.001305 [+-0.000271]	0.01425 [+-0.000966]	0 [+-0]	0.011349 [+-0.0004]
	2045	0.014467 [+-0.001027]	0.00101 [+-0.000226]	0.010818 [+-0.000864]	0 [+-0]	0.010357 [+-0.000346]
	2050	0.011402 [+-0.00087]	0.000731 [+-0.00019]	0.008734 [+-0.000753]	0 [+-0]	0.0083 [+-0.000293]

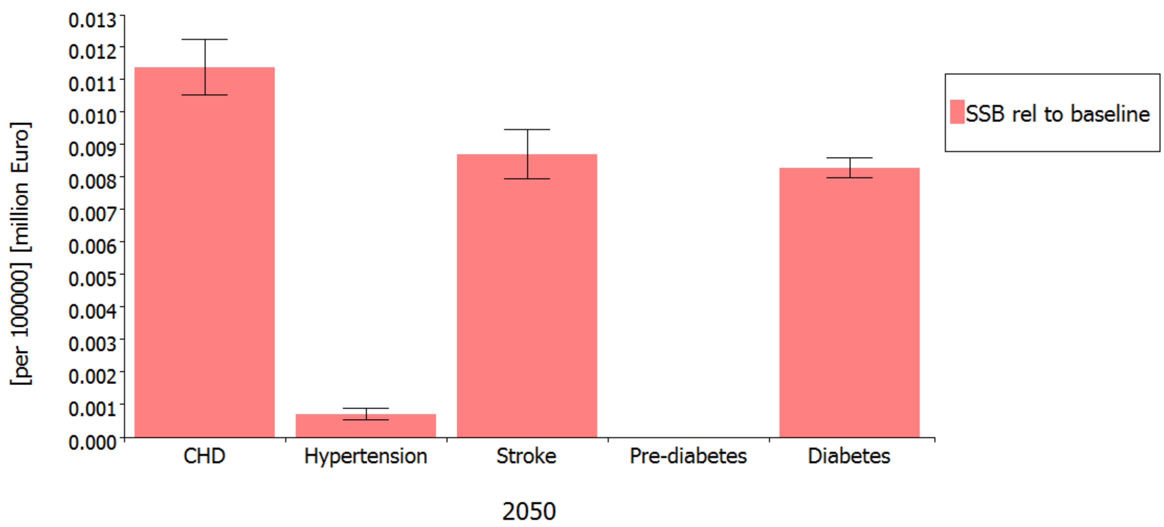


Figure 227. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

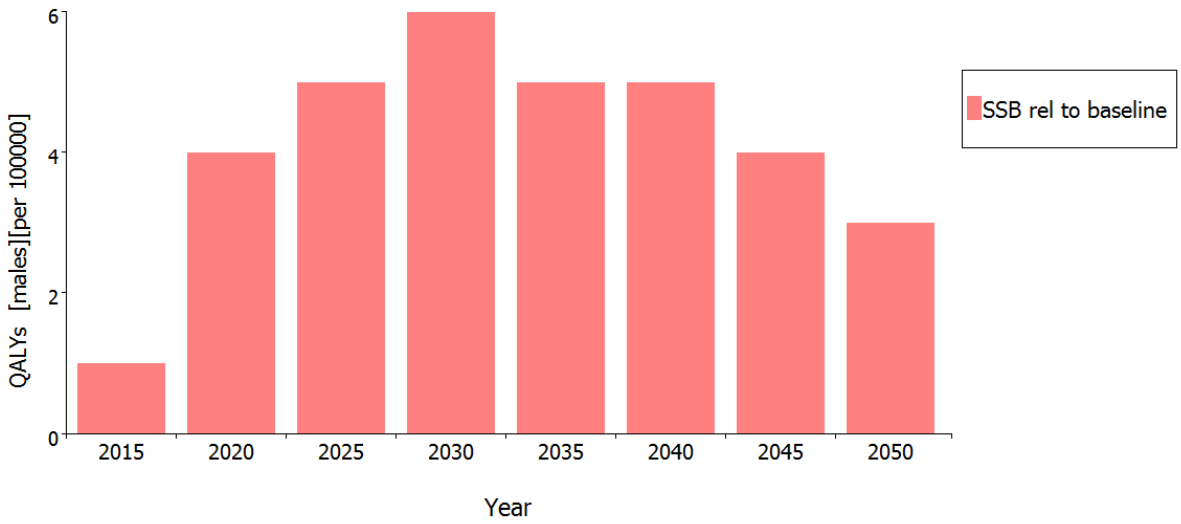


Figure 228. QALYS gained (per 100,000), relative to baseline (males)

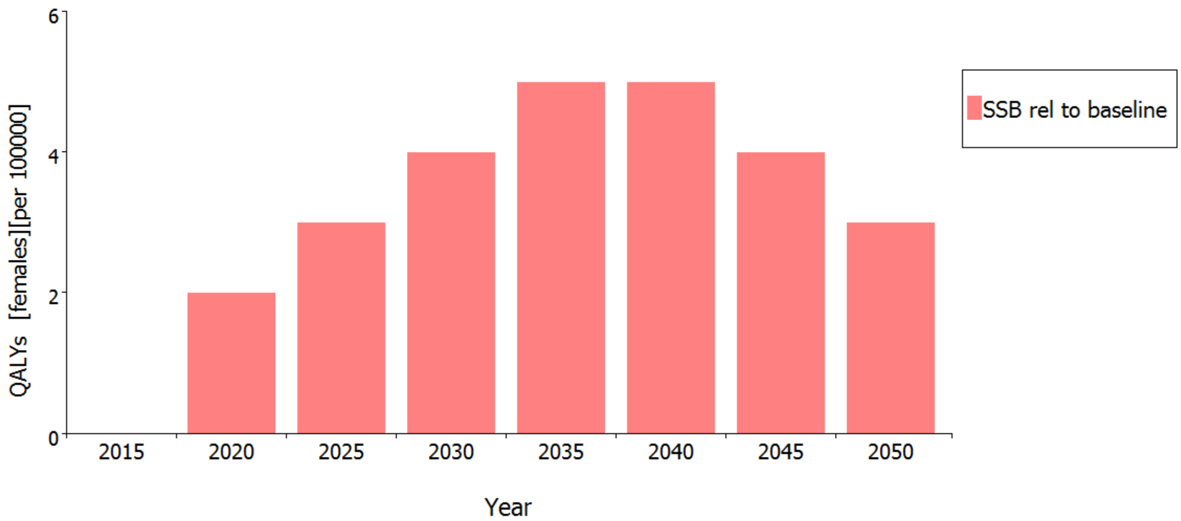


Figure 229. QALYS gained (per 100,000), relative to baseline (females)

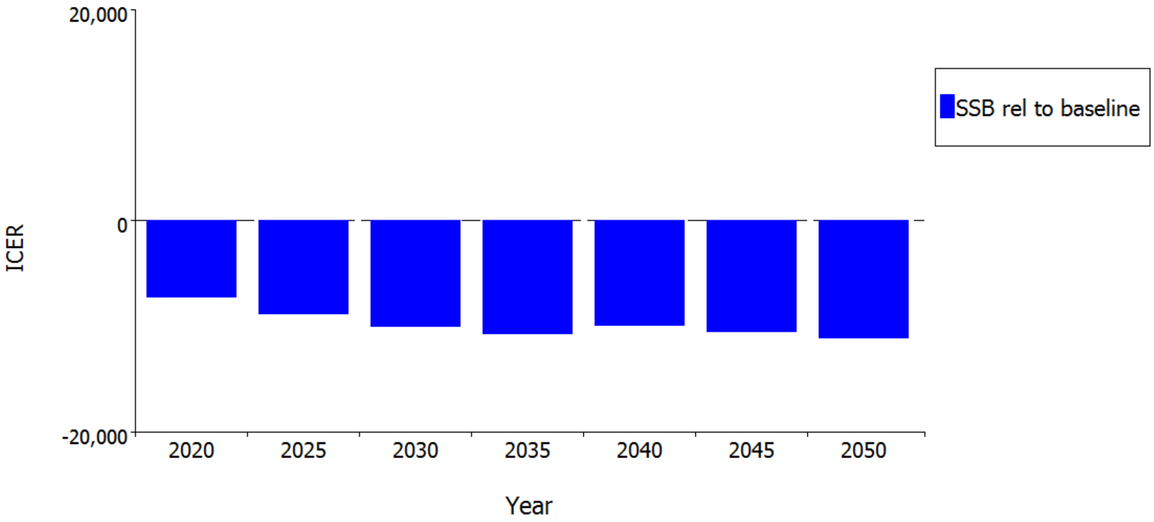


Figure 230. ICER

Smoking intervention results

Smoking cessation services

Table 141 shows the assumptions made for the Smoking Cessation Services (SCS) intervention

Table 141. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	40%
Accessibility of the intervention (%)	50%
Overall reach (%)	20%
Impact of the intervention	
Type of pharmacological drug	Bupropion
12-month abstinence rate (%) *	17%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 282

Impact on disease incidence and prevalence

Table 142 presents the incidence cases per 100,000 to 2050 for baseline and the SCS scenario. Incidence cases decrease over time for CHD, and increase for COPD (Chronic Obstructive Pulmonary Disease), hypertension and stroke. Incidence stays relatively constant for lung cancer. The interventions are effective in reducing the projected incidence cases over time, especially hypertension, lung cancer and stroke.

Table 143 presents the cumulative incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and the SCS scenario. Cumulative incidence is lower for all diseases in the SSB scenario compared to baseline by 2050.

Table 144 and Figure 231 present the cumulative incidence cases avoided (per 100,000) from 2015 to 2050 for each intervention relative to baseline. The SCS scenario is predicted to reduce the cumulative incidence of all diseases, where the largest effect is observed for stroke (381 cases avoided per 100,000 compared to baseline by 2050) followed by COPD (233 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on incidence of each disease as a result of SCS relative to baseline by 2050.

Table 145 and Figure 232 present the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. The SSB scenario is predicted to reduce prevalence cases per 100,000 compared to baseline for all diseases by 2050, with the greatest effect observed for stroke (178 prevalence cases avoided per 100,000 compared to baseline) followed by COPD (118 prevalence cases avoided per 100,000 compared to baseline). The graph illustrates the predicted impact on prevalence of each disease as a result of SCS relative to baseline by 2050.

Table 142. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	416 [+-1]	143 [+-1]	971 [+-2]	68 [+-1]	189 [+-1]
	2020	449 [+-1]	156 [+-1]	971 [+-2]	75 [+-1]	207 [+-1]
	2025	483 [+-1]	169 [+-1]	937 [+-2]	81 [+-1]	227 [+-1]
	2030	510 [+-1]	178 [+-1]	895 [+-2]	86 [+-1]	247 [+-1]
	2035	530 [+-1]	183 [+-1]	862 [+-2]	89 [+-1]	267 [+-1]
	2040	544 [+-1]	185 [+-1]	861 [+-2]	89 [+-1]	285 [+-1]
	2045	555 [+-1]	186 [+-1]	858 [+-2]	91 [+-1]	296 [+-1]
	2050	555 [+-1]	194 [+-1]	864 [+-2]	92 [+-1]	302 [+-1]
SCS	2015	416 [+-1]	143 [+-1]	972 [+-2]	67 [+-1]	188 [+-1]
	2020	449 [+-1]	157 [+-1]	970 [+-2]	74 [+-1]	206 [+-1]
	2025	480 [+-1]	166 [+-1]	936 [+-2]	79 [+-1]	224 [+-1]
	2030	507 [+-1]	174 [+-1]	894 [+-2]	82 [+-1]	239 [+-1]
	2035	528 [+-1]	176 [+-1]	862 [+-2]	82 [+-1]	256 [+-1]
	2040	541 [+-1]	177 [+-1]	855 [+-2]	81 [+-1]	268 [+-1]
	2045	555 [+-1]	176 [+-1]	852 [+-2]	80 [+-1]	278 [+-1]
	2050	555 [+-1]	180 [+-1]	861 [+-2]	78 [+-1]	282 [+-1]

Table 143. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	416 [+-1]	143 [+-1]	971 [+-2]	68 [+-1]	189 [+-1]
	2020	2587 [+-3]	898 [+-2]	5801 [+-5]	426 [+-1]	1190 [+-2]
	2025	4927 [+-4]	1715 [+-3]	10517 [+-6]	819 [+-2]	2288 [+-3]
	2030	7432 [+-5]	2591 [+-3]	15102 [+-7]	1243 [+-2]	3495 [+-4]
	2035	10112 [+-6]	3522 [+-4]	19615 [+-8]	1695 [+-3]	4833 [+-4]
	2040	12972 [+-7]	4503 [+-4]	24237 [+-8]	2169 [+-3]	6307 [+-5]
	2045	16017 [+-7]	5534 [+-5]	29059 [+-9]	2670 [+-3]	7906 [+-5]
	2050	19220 [+-8]	6637 [+-5]	34127 [+-10]	3197 [+-4]	9618 [+-6]
SCS	2015	416 [+-1]	143 [+-1]	972 [+-2]	67 [+-1]	188 [+-1]
	2020	2588 [+-3]	896 [+-2]	5800 [+-5]	424 [+-1]	1187 [+-2]
	2025	4920 [+-4]	1705 [+-3]	10518 [+-6]	810 [+-2]	2268 [+-3]
	2030	7420 [+-5]	2563 [+-3]	15095 [+-7]	1218 [+-2]	3443 [+-4]
	2035	10089 [+-6]	3462 [+-4]	19595 [+-8]	1639 [+-2]	4727 [+-4]
	2040	12932 [+-7]	4400 [+-4]	24184 [+-8]	2072 [+-3]	6126 [+-5]
	2045	15961 [+-7]	5376 [+-4]	28968 [+-9]	2518 [+-3]	7635 [+-5]
	2050	19148 [+-8]	6404 [+-5]	33996 [+-10]	2974 [+-3]	9237 [+-6]

Table 144. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	0 [+-1]	0 [+-1]	-1 [+-3]	1 [+-1]	1 [+-1]
	2020	-1 [+-4]	2 [+-3]	1 [+-7]	2 [+-1]	3 [+-3]
	2025	7 [+-6]	10 [+-4]	-1 [+-8]	9 [+-3]	20 [+-4]
	2030	12 [+-7]	28 [+-4]	7 [+-10]	25 [+-3]	52 [+-6]
	2035	23 [+-8]	60 [+-6]	20 [+-11]	56 [+-4]	106 [+-6]
	2040	40 [+-10]	103 [+-6]	53 [+-11]	97 [+-4]	181 [+-7]
	2045	56 [+-10]	158 [+-6]	91 [+-13]	152 [+-4]	271 [+-7]
	2050	72 [+-11]	233 [+-7]	131 [+-14]	223 [+-5]	381 [+-8]

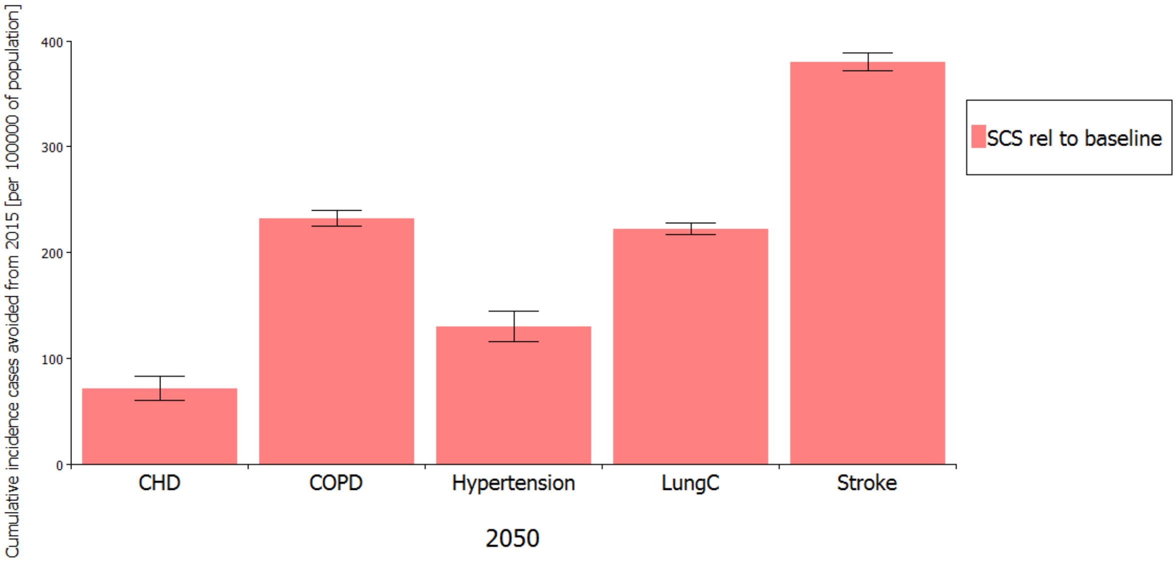


Figure 231. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 145. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	0 [+-7]	-2 [+-3]	6 [+-13]	2 [+-1]	1 [+-4]
	2020	0 [+-7]	1 [+-4]	8 [+-13]	1 [+-1]	2 [+-4]
	2025	5 [+-7]	7 [+-4]	0 [+-13]	4 [+-1]	15 [+-4]
	2030	6 [+-7]	20 [+-4]	-4 [+-13]	11 [+-1]	35 [+-4]
	2035	8 [+-7]	39 [+-4]	-15 [+-13]	16 [+-1]	69 [+-4]
	2040	11 [+-7]	61 [+-4]	-10 [+-13]	22 [+-1]	109 [+-4]
	2045	10 [+-8]	86 [+-4]	-9 [+-13]	29 [+-1]	139 [+-4]
	2050	5 [+-8]	118 [+-4]	-14 [+-14]	34 [+-1]	178 [+-4]

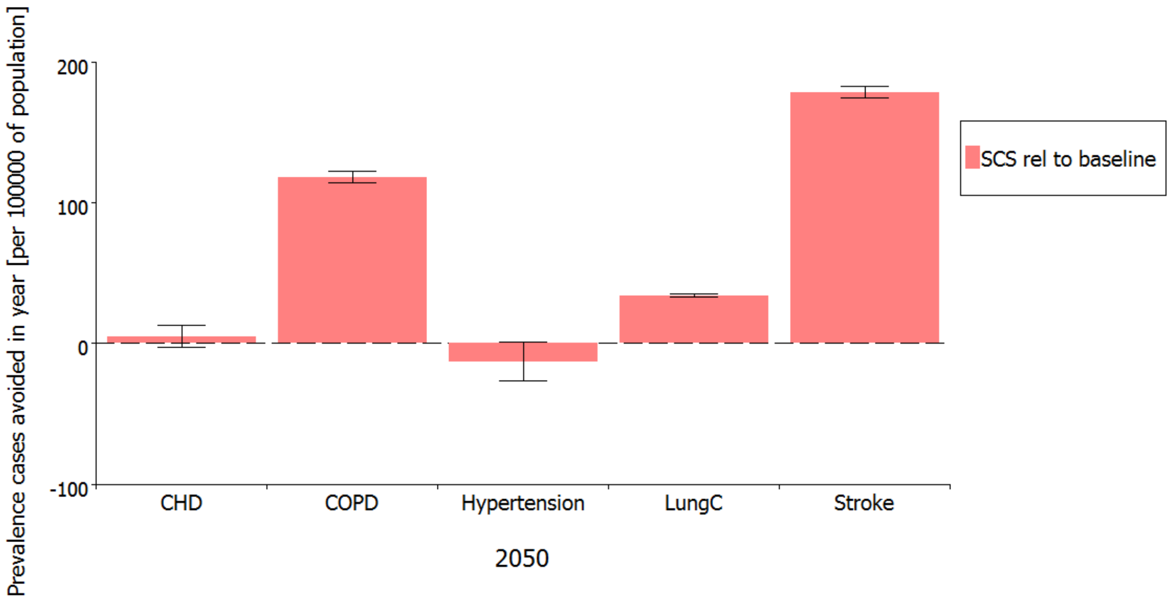


Figure 232. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 146 and Figure 233 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in stroke and COPD (€1.18m and €0.03m per 100,000 population in 2050, respectively).

Table 147 and Figure 234 presents the indirect costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to occur in stroke (€0.89m per 100,000 population in 2050) and COPD (€0.2m per 100,000 population in 2050).

Figure 235 and Figure 236 present the QALYs that can be *gained* (per 100,000) with the SSB intervention, relative to the baseline. For both males and females, the SSB tax intervention is expected to lead to increasing gains in QALYs over time.

In Figure 237, the negative ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SCS intervention is cost effective (the SCS intervention scenario *dominates* the baseline scenario). The positive ICER value in 2020 (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that the SCS may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Netherlands.

Table 146. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	0.000391 [+-0.001369]	-0.002164 [+-0.000069]	0.001198 [+-0.000718]	0.001851 [+-0.000001]	0.032516 [+-0.001611]
	2020	0.001581 [+-0.001291]	0.001303 [+-0.000069]	0.00125 [+-0.000627]	0.00115 [+-0.000001]	0.044655 [+-0.001565]
	2025	0.011591 [+-0.001207]	0.006705 [+-0.000068]	-0.000089 [+-0.000542]	0.00258 [+-0.000001]	0.270824 [+-0.001491]
	2030	0.013016 [+-0.001109]	0.014883 [+-0.000064]	-0.000435 [+-0.000461]	0.006157 [+-0.000001]	0.541824 [+-0.001398]
	2035	0.013623 [+-0.000995]	0.023334 [+-0.000057]	-0.001275 [+-0.000387]	0.007963 [+-0.000001]	0.869438 [+-0.001287]
	2040	0.015265 [+-0.000871]	0.030219 [+-0.00005]	-0.000738 [+-0.000322]	0.009079 [+-0.000001]	1.115831 [+-0.001155]
	2045	0.011027 [+-0.000749]	0.034778 [+-0.000042]	-0.000587 [+-0.000267]	0.009441 [+-0.000001]	1.176102 [+-0.001009]
	2050	0.004347 [+-0.000634]	0.039366 [+-0.000035]	-0.000699 [+-0.000221]	0.009497 [+-0.000001]	1.230795 [+-0.000864]

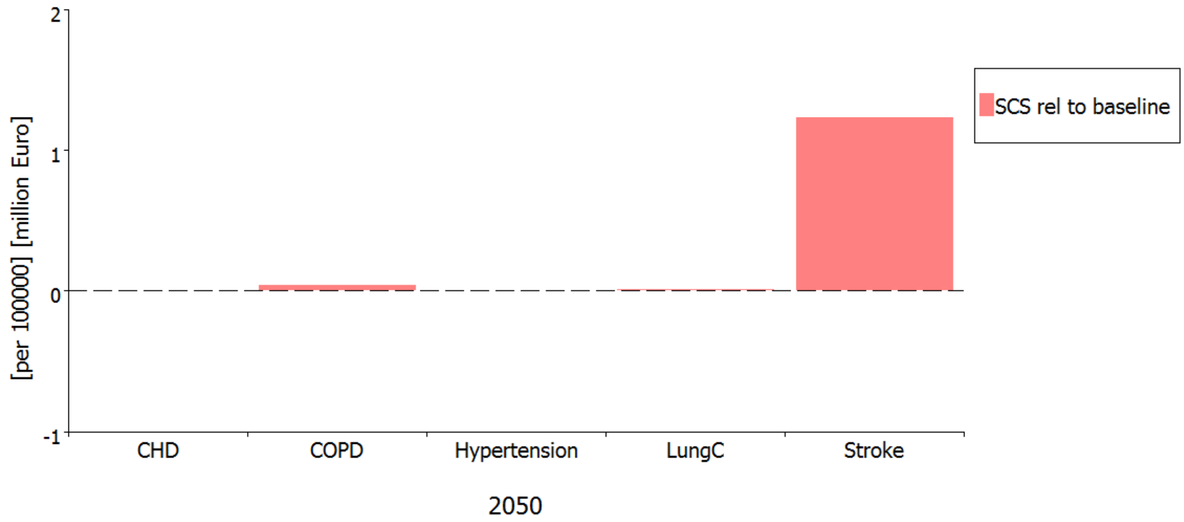


Figure 233. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 147. Indirect costs (€ millions) avoided (per 100,000) relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	0.000484 [+-0.001694]	-0.01049 [+-0.000337]	0.001069 [+-0.000641]	0.006166 [+-0.000006]	0.023396 [+-0.00116]
	2020	0.001955 [+-0.001598]	0.006318 [+-0.000337]	0.001116 [+-0.00056]	0.003833 [+-0.000007]	0.032127 [+-0.001126]
	2025	0.014347 [+-0.001494]	0.032516 [+-0.000328]	-0.000079 [+-0.000484]	0.008598 [+-0.000007]	0.194864 [+-0.001073]
	2030	0.016109 [+-0.001372]	0.072171 [+-0.000308]	-0.000388 [+-0.000412]	0.020512 [+-0.000006]	0.389858 [+-0.001006]
	2035	0.016861 [+-0.001231]	0.113151 [+-0.000277]	-0.001138 [+-0.000345]	0.026532 [+-0.000005]	0.625586 [+-0.000927]
	2040	0.018894 [+-0.001078]	0.146539 [+-0.00024]	-0.000658 [+-0.000287]	0.030248 [+-0.000004]	0.802872 [+-0.000831]
	2045	0.013648 [+-0.000928]	0.168647 [+-0.000202]	-0.000525 [+-0.000239]	0.031455 [+-0.000004]	0.846237 [+-0.000726]
	2050	0.00538 [+-0.000786]	0.190891 [+-0.000169]	-0.000623 [+-0.000198]	0.031641 [+-0.000003]	0.885592 [+-0.000622]

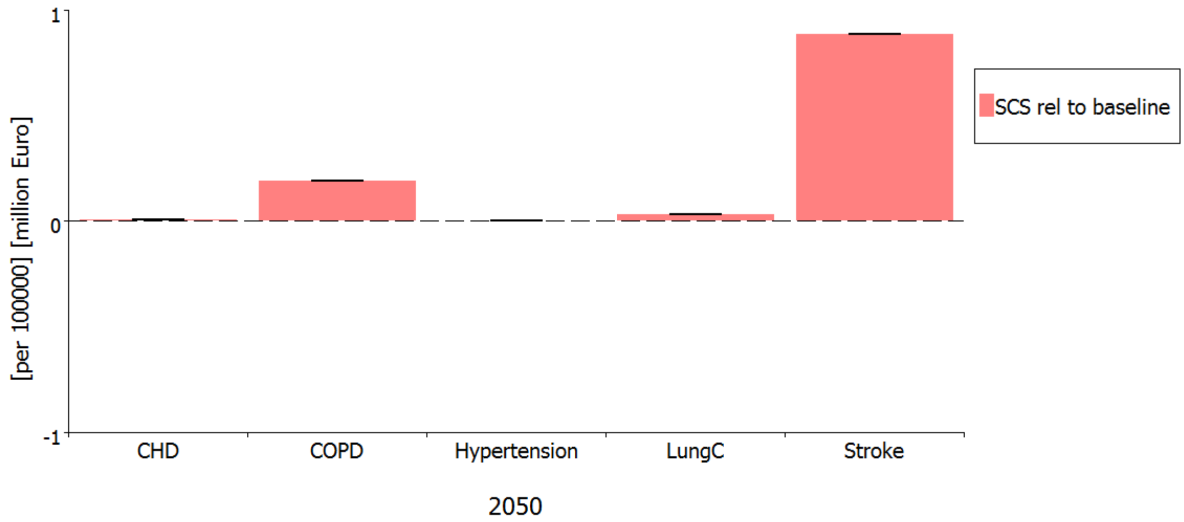


Figure 234. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

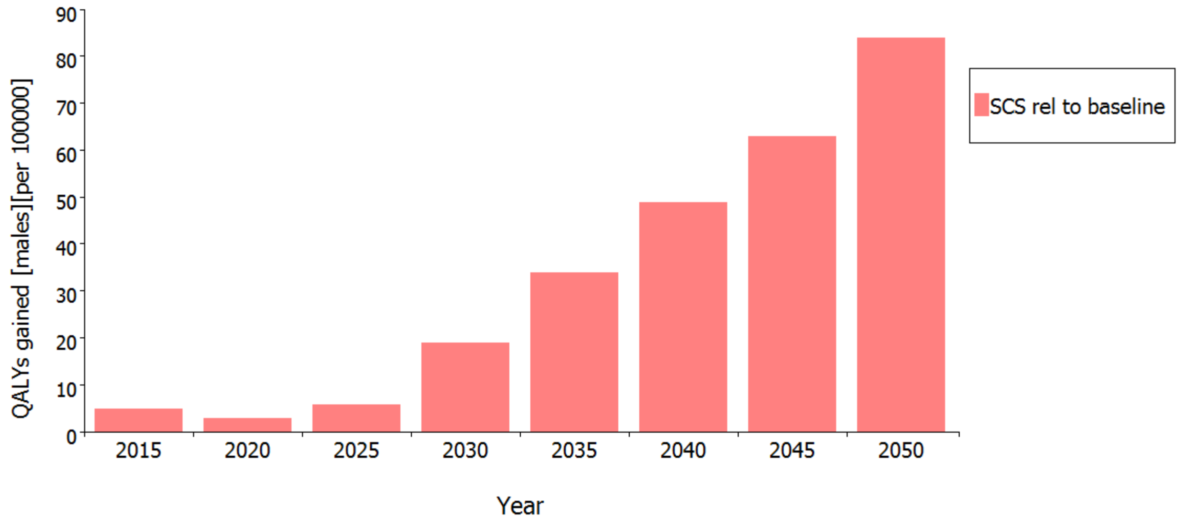


Figure 235. QALYS gained (per 100,000), relative to baseline (male)

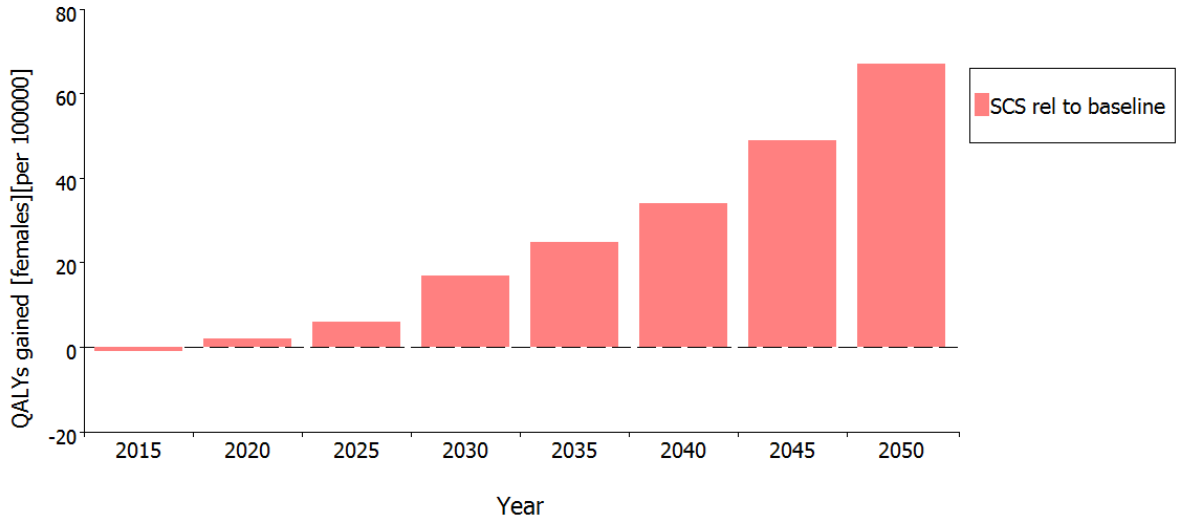


Figure 236. QALYS gained (per 100,000), relative to baseline (female)

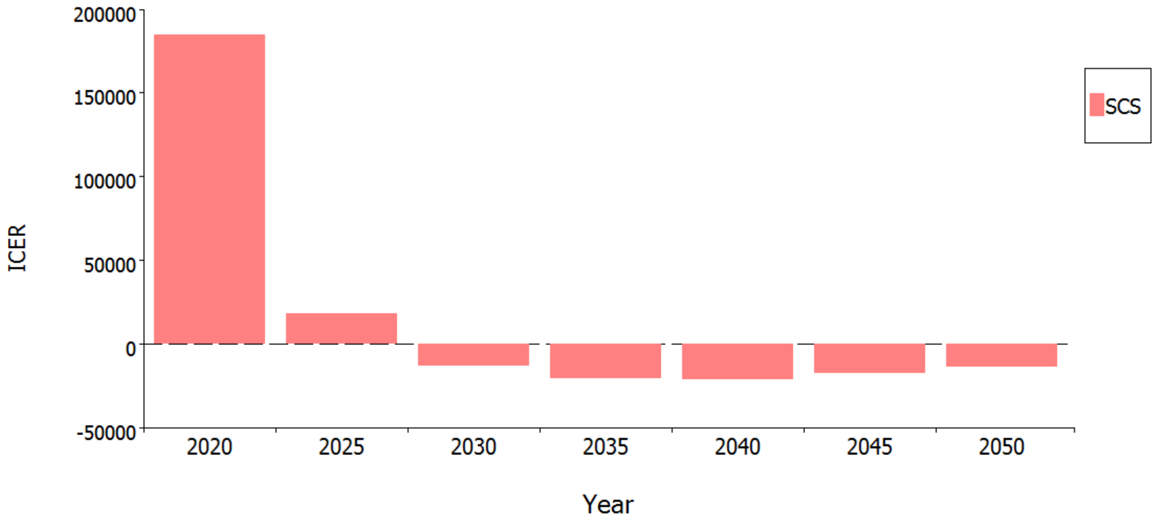
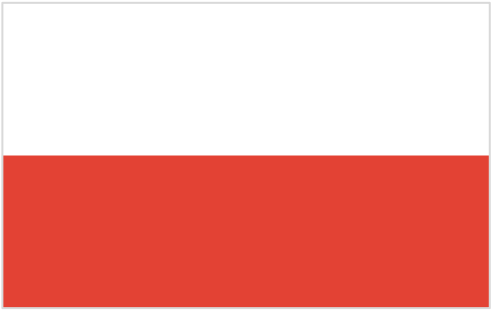


Figure 237. ICER

Poland



Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m^2) in Poland are presented in Table 148 , and for smoking prevalence by age and sex are presented in Table 149. Data were also collected by personal communication where possible.

Data were disaggregated by education level where available to explore future prevalence of each risk factor by sub-groups.

Table 148. References used in the model for BMI prevalence

Reference	Year	Sample size		Age group	Measured/ Self-reported	National/ Regional
		M	F			
WHO; CINDI 2003	1992	792	904	25-64	Measured	Subnational
Eurostat database: National Health Interview Survey for Poland[1]	1996	3137	9411	15-100	Self-reported	National
Szponar et al. Household food consumption and anthropometric survey, 2003	2001	1949	-	19-100	Both	National
National Health Interview Survey for Poland, Statistical Office Poland, personal communication[1]	2004	19335	19446	15-70	Self-reported	National
European Health Interview Survey[1]	2009	12956	16827	15-70	Self-reported	National

1 Surveys used for BMI projections by education level

Table 149 References used in the model for smoking prevalence

Reference	Year	Sample size	Age group	National/regional
Health interview survey	2004	30414	20-100	National
European Health Interview Survey (Personal communication with Zajenkowska-Kozlowska, A)	2008	25082	20-100	National
Global Adult Tobacco Survey. Poland 2009-2010	2010	8889	20-100	National

Disease data

Disease data sources are detailed in appendix A6. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. For Poland, Lithuanian proxy data were used for CHD and COPD incidence (Personal communication with V Kraucioniene). Diabetes statistics for Poland and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, Appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using prevalence and mortality data (see technical appendix B4 for details). Hypertension incidence was calculated within the programme using prevalence data. Dutch data were used as proxy for direct costs of COPD, hypertension and pre-diabetes; for indirect costs for diabetes and hypertension and for utility weights for CHD and COPD accounting for exchange rates and purchasing price parities (appendix B5). UK data was used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Intervention data

Table 150 and Table 151 present the intervention input data for each of the interventions modelled:

Table 150. BMI interventions input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (Zloty)
Baseline	None	-	-
MCLI regain	0.6	100	495
MCLI no regain	0.6	0	495
SSB	0.01	0	0

Table 151. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59% (Finland proxy)
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	621 zł (NL proxy)

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Section 2: Results of risk factor projections to 2050

BMI projections by age and sex

Table 152 presents the total BMI prevalence in the adult population by sex. Obesity prevalence is expected to increase among Polish males reaching 42% in 2050. Overweight prevalence is expected to remain stable among males. Among females, a small increase in obesity prevalence is projected reaching 22% in 2050, while overweight prevalence remains stable.

Figure 238 to Figure 243 present the projected prevalence of overweight (25-29.9 kg/m^2, in blue) and obesity (≥30 kg/m^2, in red) by 10-year age groups for 20-79 year old males. The increase in obesity prevalence among males described above is expected across all age groups. Obesity prevalence is projected to reach 40% among 50 to 59 year olds males in 2050. Overweight prevalence is projected to increase in some age groups. The largest change is expected among 20 to 29 year olds in whom overweight prevalence will increase from 31% in 2014 to 57% in 2050. In general BMI trends for Polish males are worrying since according to these projections most of them will be in a high risk BMI category by 2050.

Figure 244 to Figure 249 present the BMI projections by 10-year age groups for 20-79 year old females. The projections for Polish females are more encouraging than those for males. With the exception of 20-29 and 70-79 year olds, the trend in the prevalence of overweight and obesity is projected to remain stable over the projected time-period. Among 30 to 39 year olds, obesity prevalence was very low and is projected to decrease slightly to 7% in 2050 while among the 60 to 69 year olds the increase is more marked. Obesity prevalence is projected to reach 33% in 2050 in this age group.

Table 152. Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	**BMI<25**	95% CI	**BMI 25-29.9**	95% CI	**BMI≥30**	95% CI	**BMI<25**	95% CI	**BMI 25-29.9**	95% CI	**BMI≥30**	95% CI	**BMI<25**	95% CI	**BMI 25-29.9**	95% CI	**BMI≥30**	95% CI
2015	33.0	3.6	47.0	3.8	20.0	3.1	53.0	3.2	31.0	3.2	16.0	2.9	43.0	3.4	39.0	3.5	18.0	3.0
2020	29.0	4.9	48.0	5.2	23.0	4.2	52.0	4.3	31.0	4.3	17.0	3.9	41.0	4.7	39.0	4.8	20.0	4.0
2025	25.0	6.3	49.0	6.6	25.0	5.3	51.0	5.5	31.0	5.4	18.0	4.9	39.0	5.9	40.0	6.0	21.0	5.1
2030	22.0	7.7	50.0	8.0	28.0	6.4	50.0	6.6	32.0	6.6	18.0	6.0	37.0	7.2	40.0	7.3	23.0	6.2
2035	19.0	9.0	50.0	9.4	32.0	7.6	49.0	7.8	32.0	7.7	19.0	7.0	35.0	8.4	40.0	8.6	25.0	7.3
2040	16.0	10.4	49.0	10.9	35.0	8.7	48.0	8.9	32.0	8.8	20.0	8.1	33.0	9.7	40.0	9.9	27.0	8.4
2045	13.0	11.8	49.0	12.3	38.0	9.9	47.0	10.1	32.0	10.0	21.0	9.1	31.0	11.0	40.0	11.2	29.0	9.5
2050	11.0	13.2	48.0	13.8	42.0	11.0	46.0	11.2	32.0	11.2	22.0	10.2	29.0	12.3	39.0	12.5	31.0	10.6

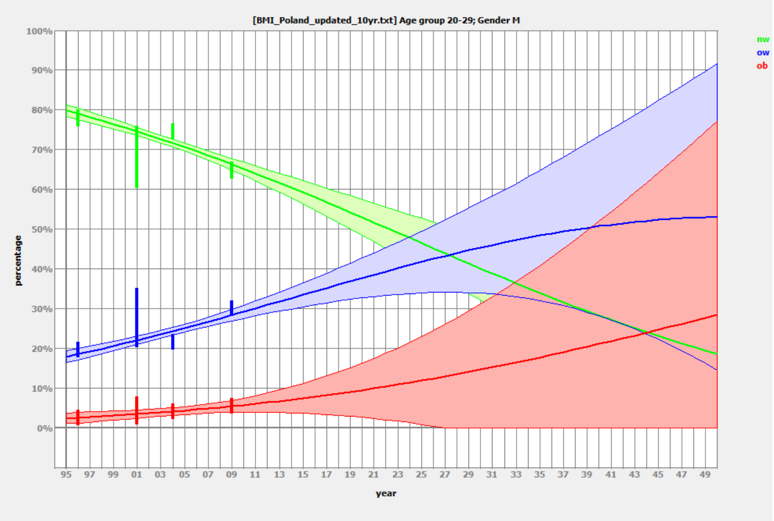


Figure 238. Projected BMI-group 20-29 year old males

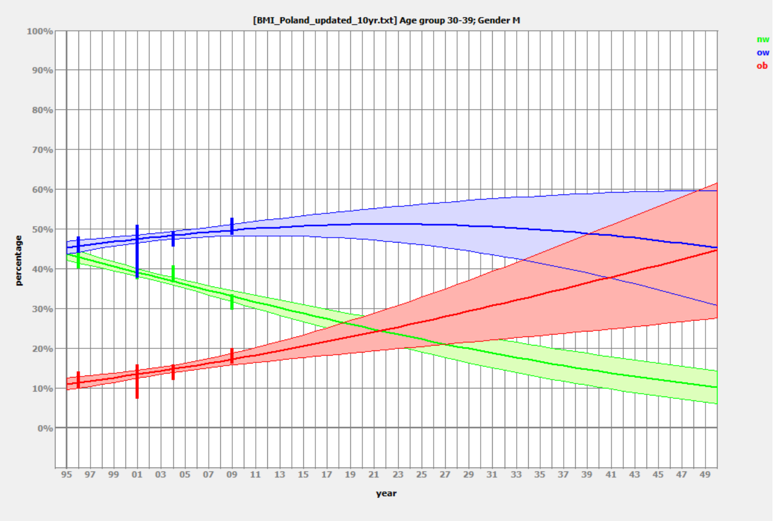


Figure 239. Projected BMI-group 30-39 year old males

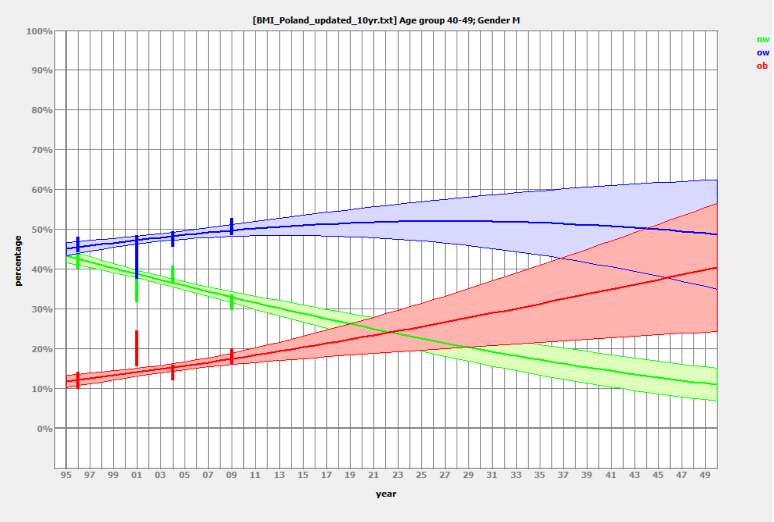


Figure 240. Projected BMI-group 40-49 year old males

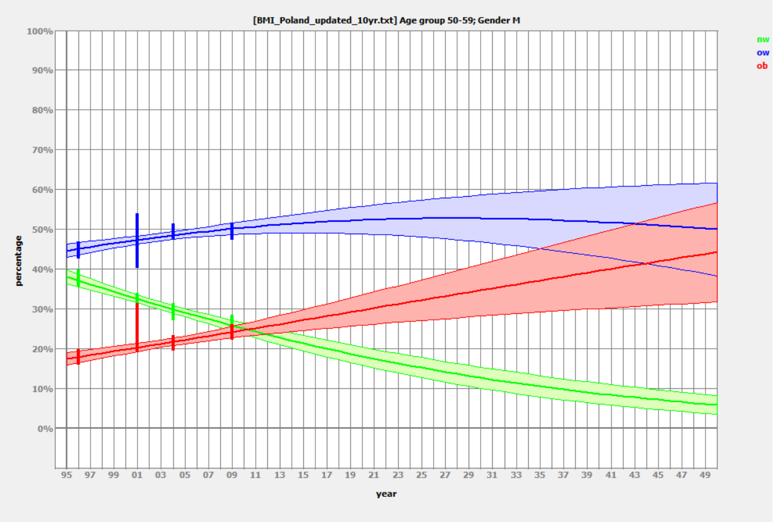


Figure 241. Projected BMI-group 50-59 year old males

Figure 242. Projected BMI-group 60-69 year old males

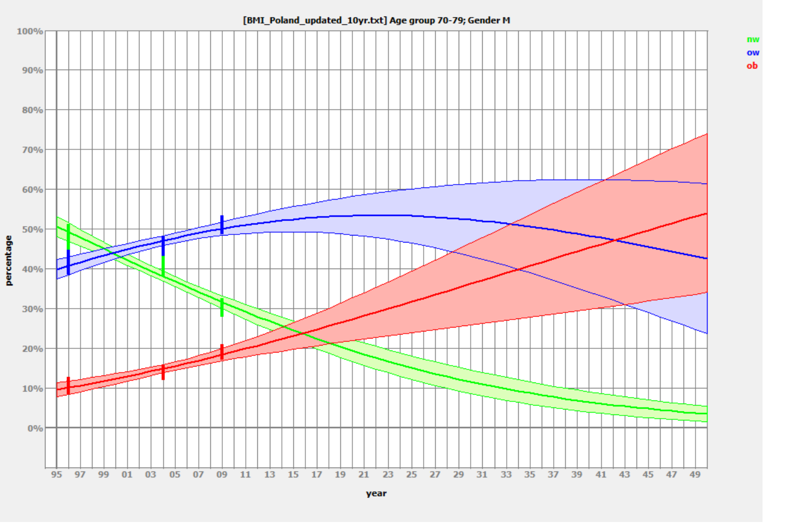


Figure 243. Projected BMI-group 70-79 year old males

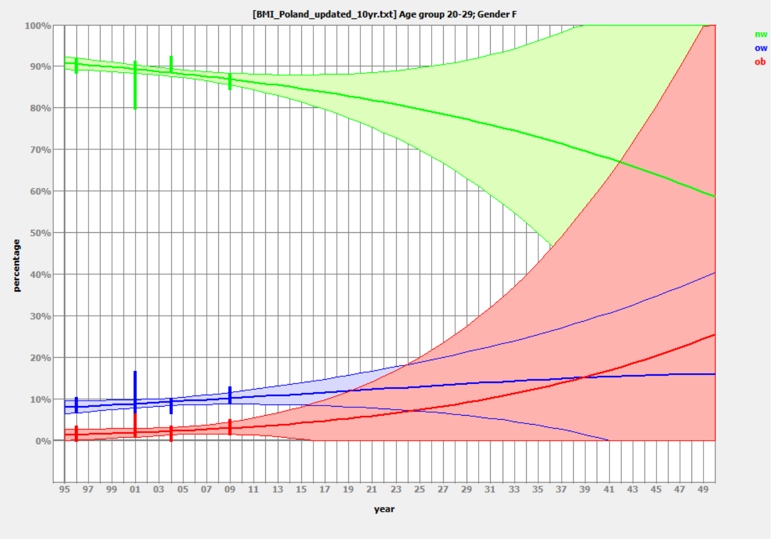


Figure 244. Projected BMI-group 20-29 year old females

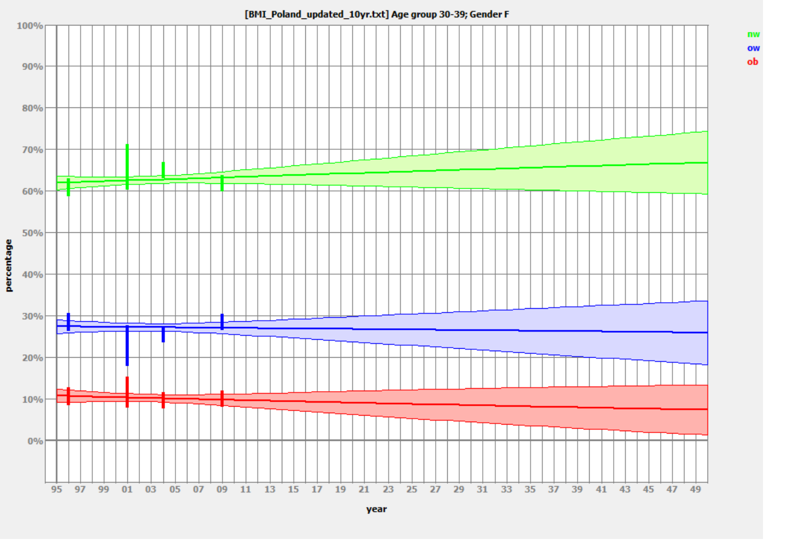


Figure 245. Projected BMI-group 30-39 year old females

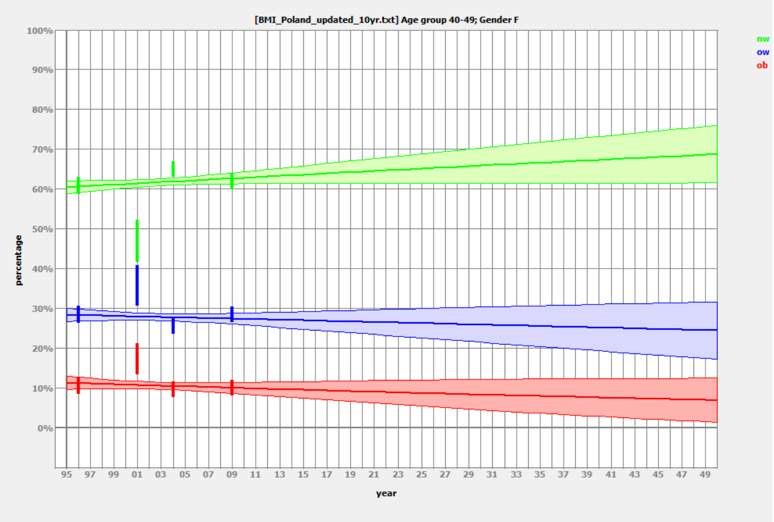


Figure 246. Projected BMI-group 40-49 year old females

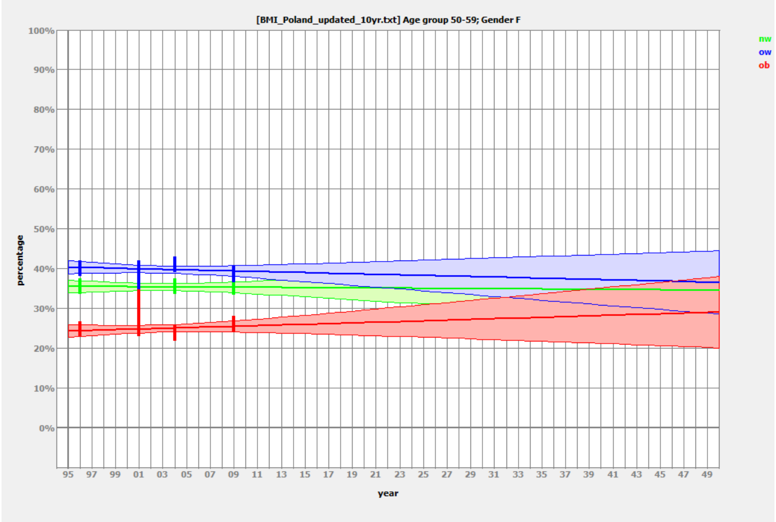


Figure 247. Projected BMI-group 50-59 year old females

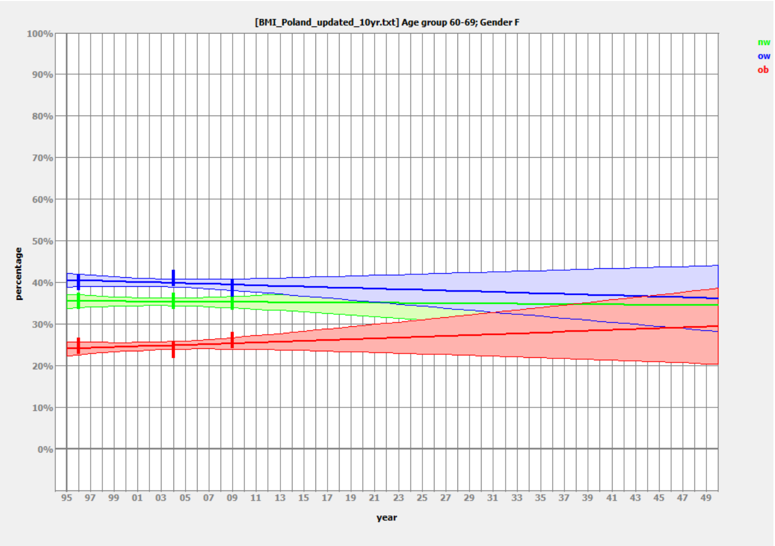


Figure 248. Projected BMI-group 60-69 year old females

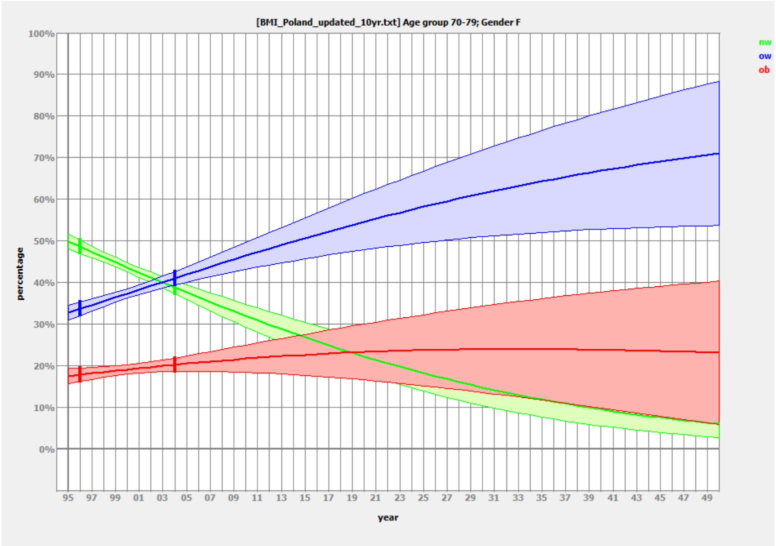


Figure 249. Projected BMI-group 70-79 year old females

BMI projections by education level

Males

Overweight prevalence was higher among Polish males with tertiary education compared to Polish males with less than tertiary education. However, overweight prevalence has increased faster among less educated Polish males compared to more educated males so that inequalities in overweight prevalence are projected to emerge in the near future and remain constant over the next 35 years (Figure 250).
Obesity prevalence is projected to increase both in males with tertiary education and less than tertiary education. The projected increase is similar in both groups (Figure 251).

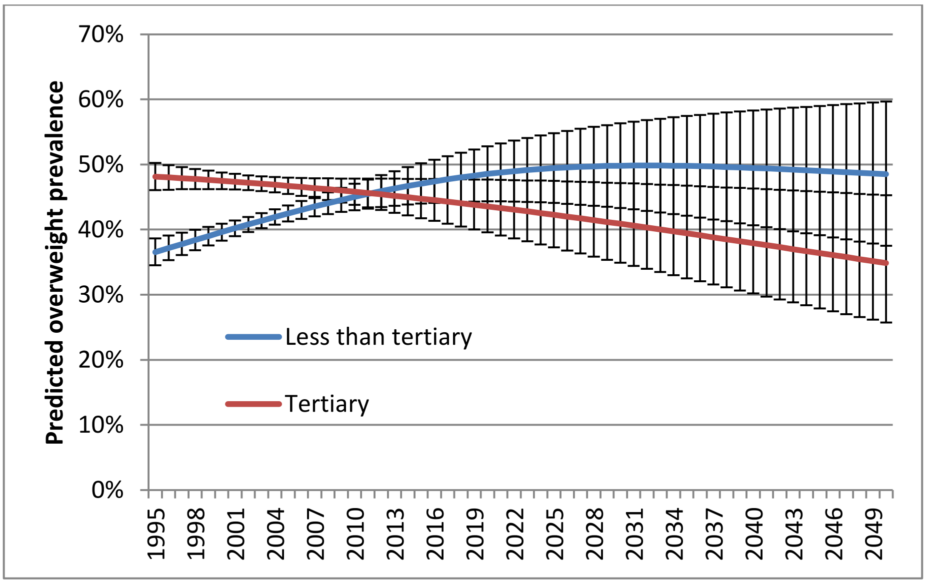


Figure 250. Predicted overweight prevalence among males, by education group

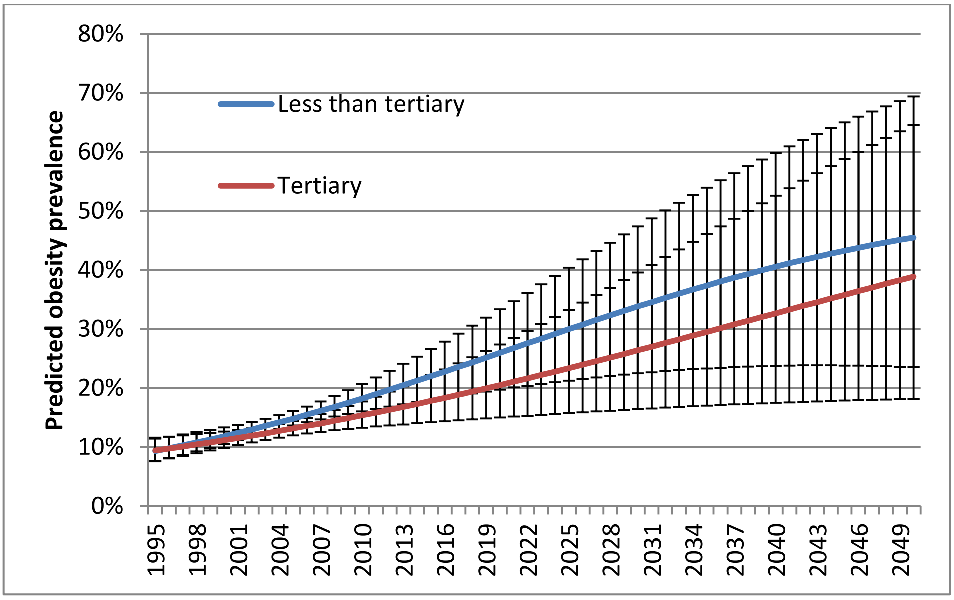


Figure 251. Predicted obesity prevalence among males, by education group

Females

Among Polish females, overweight prevalence will increase more rapidly among those with less than tertiary education compared to those with at least tertiary education. Inequalities are projected to increase so that by 2030 overweight prevalence will be approximately 55% higher among females with less than tertiary education compared to females with tertiary education (Figure 252). Obesity prevalence was twice as high among Polish females with less than tertiary education compared to Polish females with tertiary education (Appendix E5). The gap is not projected to close over the next 35 years (Figure 253).

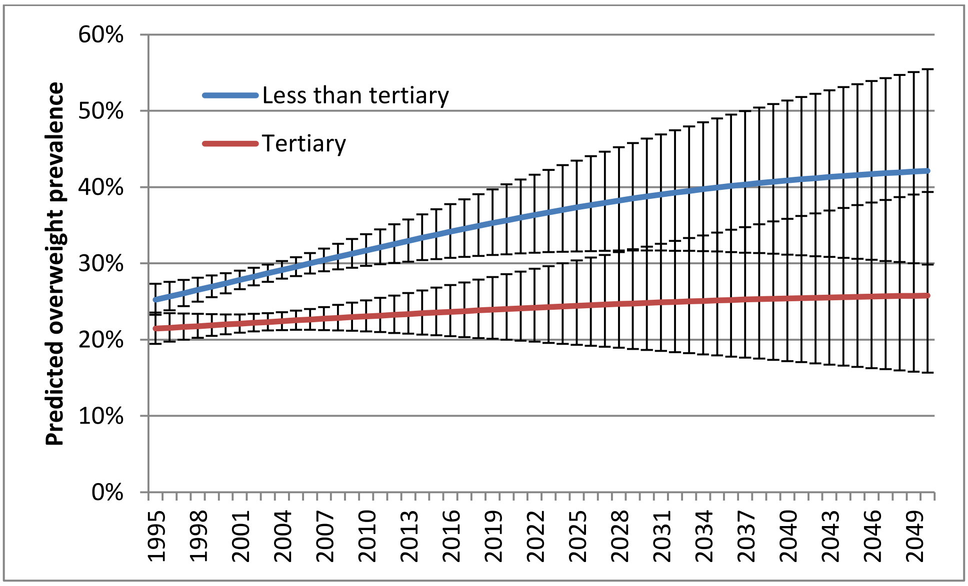


Figure 252. Predicted overweight prevalence among females, by education group

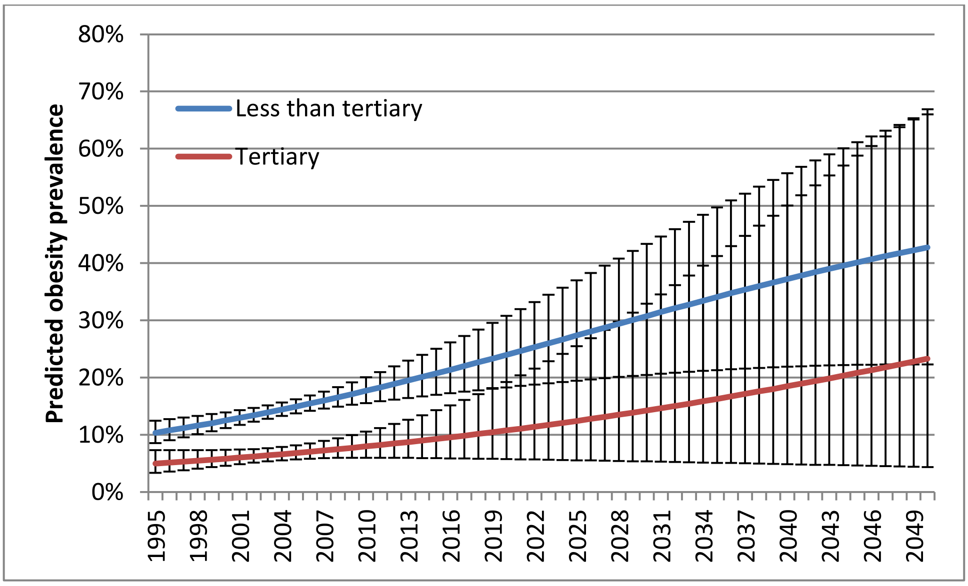


Figure 253. Predicted obesity prevalence among females, by education group

Smoking projections by sex and age group

Table 153 presents the total smoking prevalence in the adult population by sex. Among Polish males smoking prevalence is projected to decline to 12% by 2050; the decline in prevalence is projected for all age groups (Figure 254 to Figure 259).

A contrasting trend is projected among Polish females for whom smoking prevalence is projected to increase, potentially to 48% by 2050 if trends are unaltered. However, this prediction is not true for all age groups: Among 20 to 49 year olds smoking prevalence is actually projected to decline; it is also expected that smoking prevalence in the oldest age group (70-74 year olds) will decline. Conversely, a large increase in smoking prevalence is projected among 50 to 69 year olds (Figure 260 to Figure 265).

Table 153. Smoking prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-
2015	74.0	7.1	26.0	7.1	72.0	6.0	28.0	6.0	73.0	6.6	27.0	6.6
2020	80.0	11.1	20.0	11.1	66.0	9.2	34.0	9.2	73.0	10.2	27.0	10.2
2025	84.0	15.1	16.0	15.1	60.0	12.5	40.0	12.5	71.0	13.9	29.0	13.9
2030	86.0	19.2	14.0	19.2	57.0	15.8	43.0	15.8	71.0	17.6	29.0	17.6
2035	87.0	23.2	13.0	23.2	55.0	19.1	45.0	19.1	70.0	21.3	30.0	21.3
2040	88.0	27.3	12.0	27.3	53.0	22.4	47.0	22.4	70.0	25.0	30.0	25.0
2045	88.0	31.3	12.0	31.3	52.0	25.7	48.0	25.7	70.0	28.7	30.0	28.7
2050	88.0	35.4	12.0	35.4	52.0	29.0	48.0	29.0	69.0	32.4	31.0	32.4

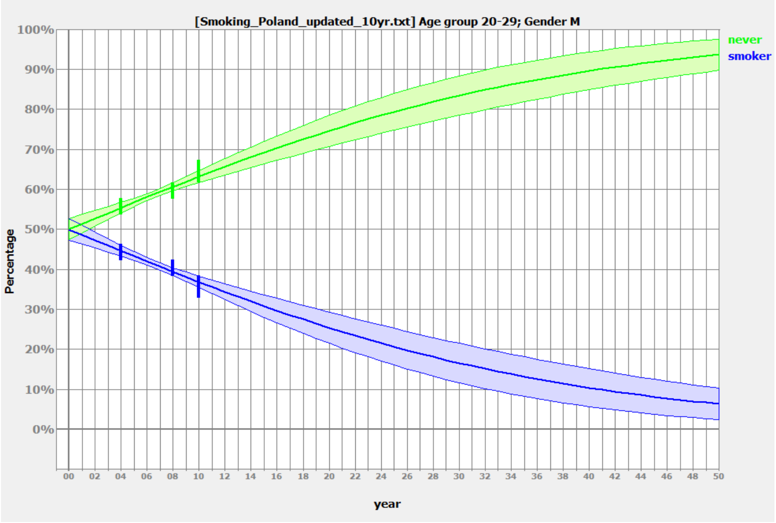


Figure 254. Projected smoking prevalence in 20-29 year old males

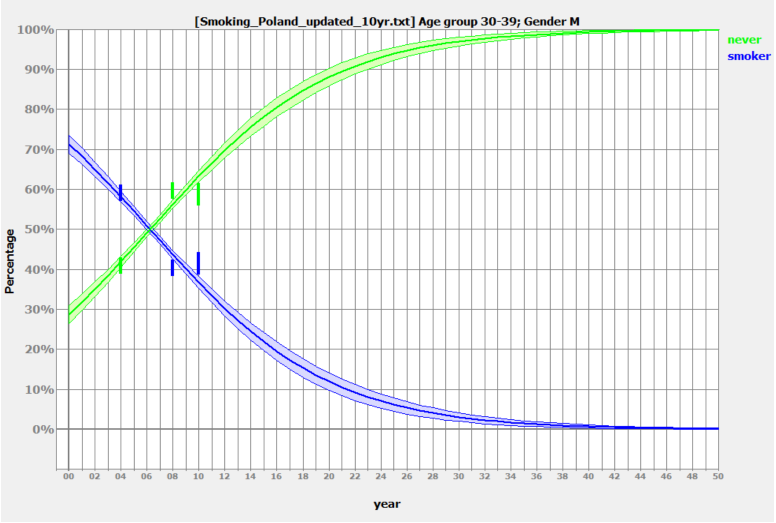


Figure 255. Projected smoking prevalence in 30-39 year old males

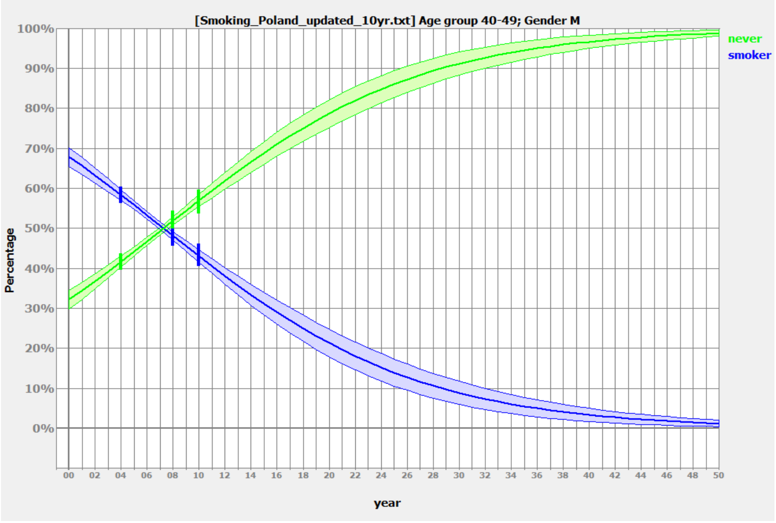


Figure 256. Projected smoking prevalence in 40-49 year old males

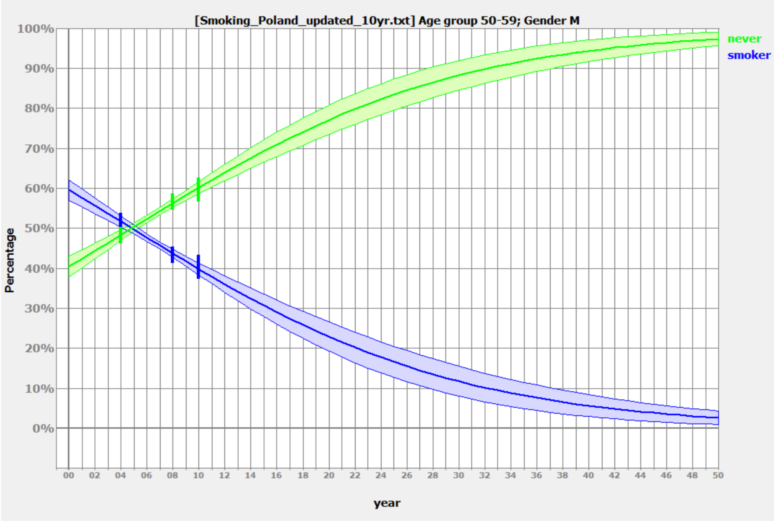


Figure 257. Projected smoking prevalence in 50-59 year old males

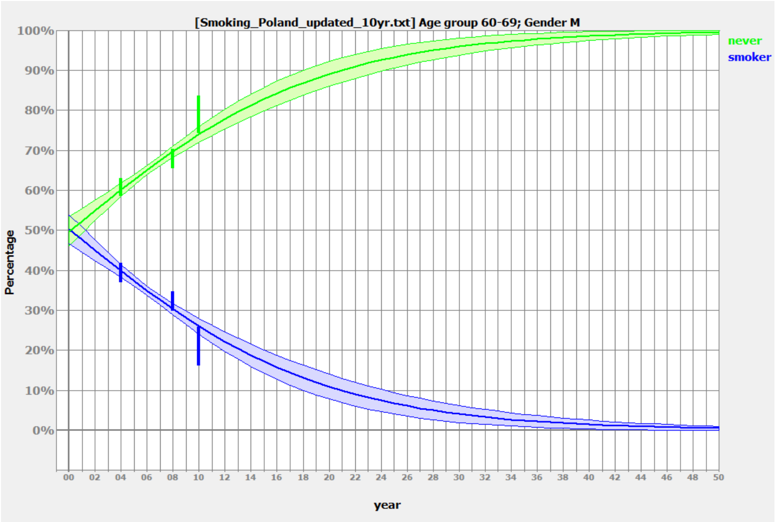


Figure 258. Projected smoking prevalence in 60-69 year old males

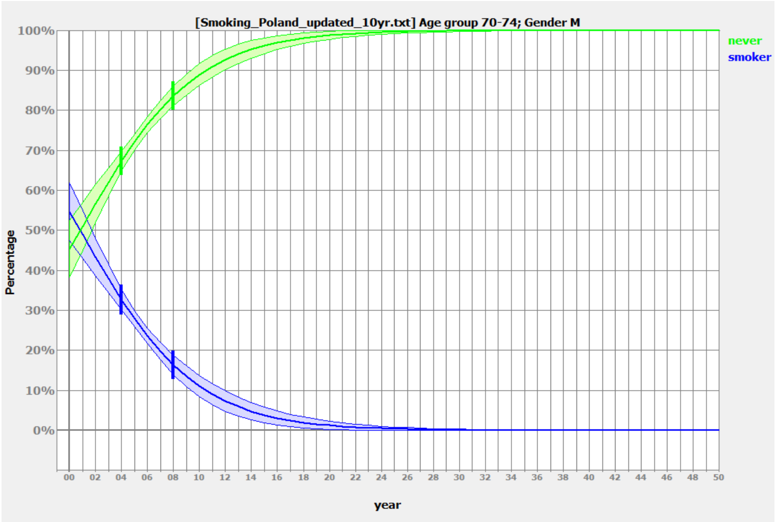


Figure 259. Projected smoking prevalence in 70-74 year old males

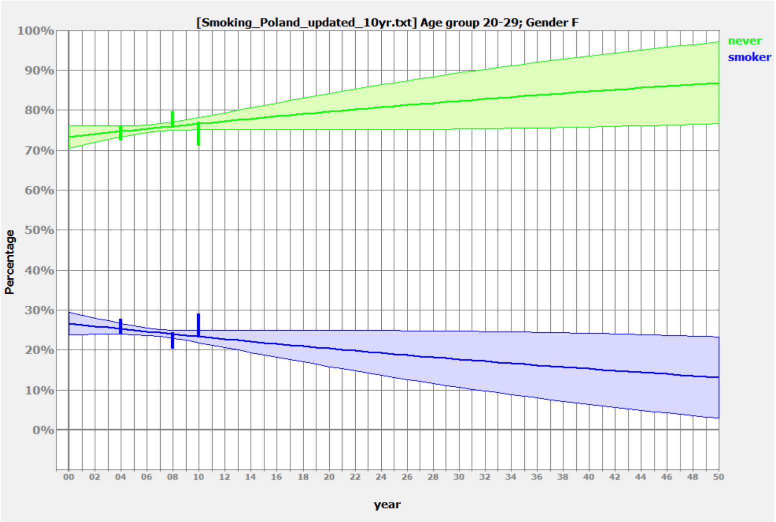


Figure 260. Projected smoking prevalence in 20-29 year old females

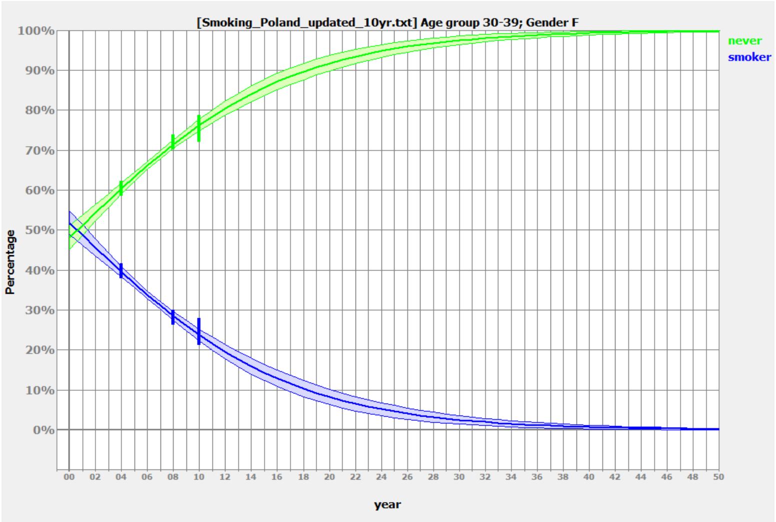


Figure 261. Projected smoking prevalence in 30-39 year old females

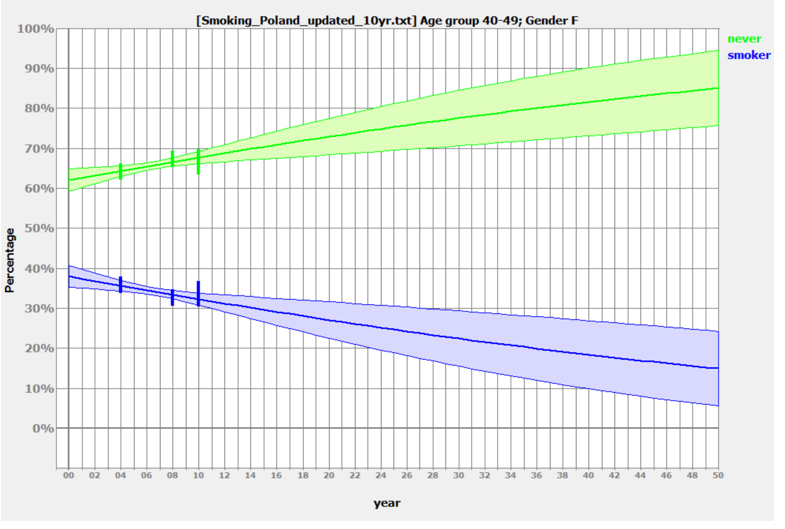


Figure 262. Projected smoking prevalence in 40-49 year old females

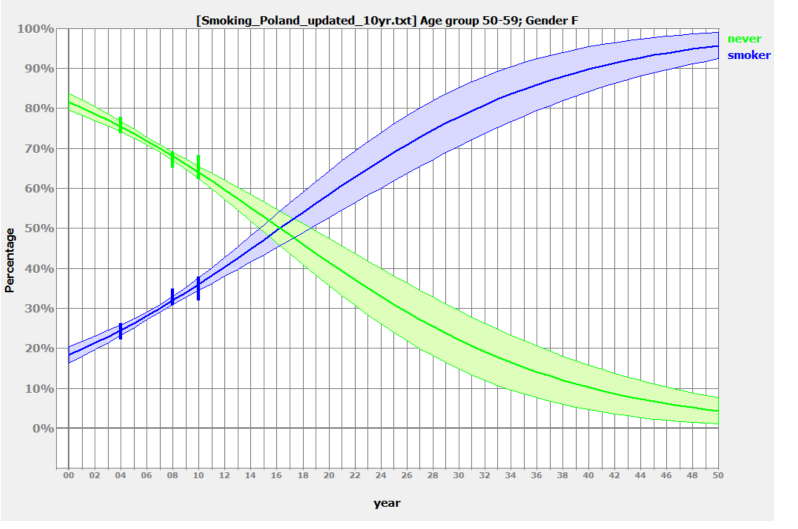


Figure 263. Projected smoking prevalence in 50-59 year old females

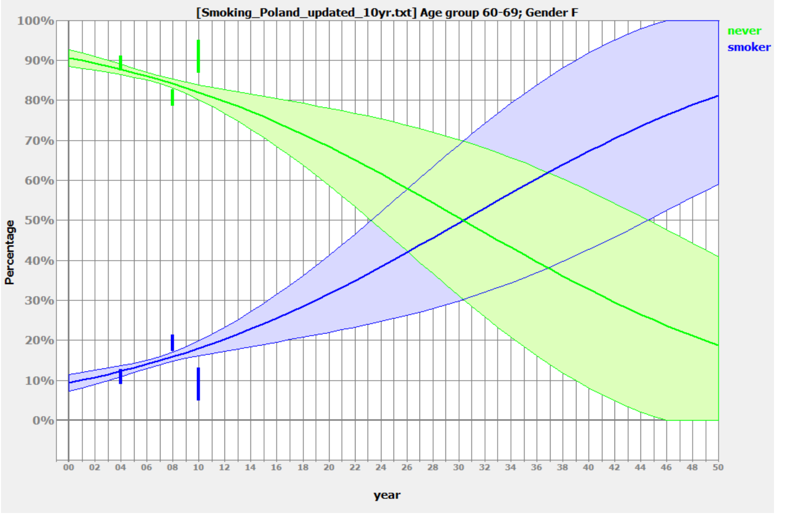


Figure 264. Projected smoking prevalence in 60-69 year old females

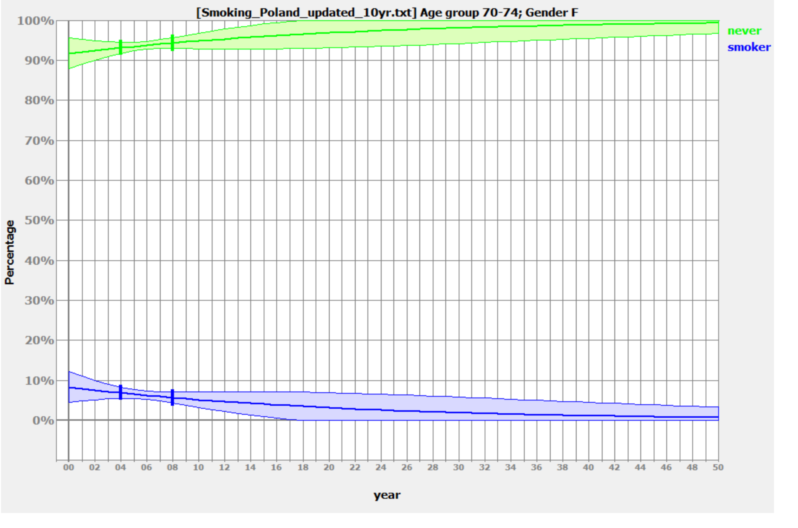


Figure 265. Projected smoking prevalence in 70-74 year old females

Smoking projections by education level

There were no data by education level and smoking prevalence.

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 154. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

The BMI interventions tested and related input data are presented in Table 154.

Table 154. BMI interventions input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (zł)
Baseline	None	-	-
MCLI regain	0.6	100	495*
MCLI no regain	0.6	0	495*
SSB	0.01	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax. *Greece proxy

Multi-component lifestyle interventions (MCLI)

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain –** these results are presented in appendix E1.

Impact on disease incidence and prevalence

Table 155 presents the incidence cases per 100,000 to 2050 for baseline (no intervention) and each MCLI intervention scenario. For each disease, incidence cases increase over time, but the interventions are effective in reducing incidence over time.
Table 156 presents the cumulative incidence cases per 100,000 to 2050 for baseline and each intervention.

Table 157 and Figure 266 both present the cumulative incidence cases avoided per 100,000 for baseline and each intervention (the table presents data for all years whilst the figure presents 2050 projections). Each table/figure indicates that both MCLI interventions would result in a lower cumulative incidence of all diseases by 2050 compared to baseline. For example, MCLI (no regain) would result in the avoidance of 223 cumulative incidence cases of CHD per 100,000 relative to baseline by 2050. Even when MCLI is modelled with weight regain there is a positive effect, with the avoidance of 179, 153 and 129 cumulative incidence cases of CHD, hypertension and type 2 diabetes per 100,000 respectively.

Table 158 and Figure 267 present the prevalence cases avoided for each intervention relative to baseline, per 100,000 (the table presents data for all years; the figure presents 2050 projections). The table indicates that each MCLI intervention would result in a reduced number of prevalence cases per 100,000 compared to baseline for all diseases by 2050, and for each five year increment from 2030 to 2050. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for hypertension (92/100,000 and 95/100,000 for MCLI regain and no-regain scenarios respectively), followed by CHD (83/100,000 and 89/100,000 respectively).

Table 155. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	460 [+-2]	656 [+-2]	1378 [+-3]	639 [+-2]	243 [+-1]
	2020	493 [+-2]	641 [+-2]	1436 [+-3]	691 [+-2]	267 [+-1]
	2025	526 [+-2]	640 [+-2]	1491 [+-3]	743 [+-2]	292 [+-2]
	2030	563 [+-2]	675 [+-2]	1533 [+-3]	788 [+-2]	320 [+-2]
	2035	611 [+-2]	719 [+-2]	1574 [+-4]	832 [+-3]	346 [+-2]
	2040	650 [+-2]	747 [+-3]	1610 [+-4]	855 [+-3]	367 [+-2]
	2045	681 [+-2]	741 [+-3]	1635 [+-4]	874 [+-3]	383 [+-2]
	2050	699 [+-3]	714 [+-3]	1651 [+-4]	899 [+-3]	401 [+-2]
MCLI (annual, with regain)	2015	463 [+-2]	653 [+-2]	1377 [+-3]	638 [+-2]	243 [+-1]
	2020	494 [+-2]	643 [+-2]	1435 [+-3]	690 [+-2]	267 [+-1]
	2025	522 [+-2]	636 [+-2]	1484 [+-3]	741 [+-2]	290 [+-1]
	2030	560 [+-2]	669 [+-2]	1529 [+-3]	787 [+-2]	318 [+-2]
	2035	603 [+-2]	720 [+-2]	1571 [+-4]	831 [+-3]	343 [+-2]
	2040	647 [+-2]	742 [+-2]	1602 [+-4]	854 [+-3]	364 [+-2]
	2045	674 [+-2]	735 [+-3]	1632 [+-4]	871 [+-3]	385 [+-2]
	2050	693 [+-3]	710 [+-3]	1648 [+-4]	896 [+-3]	402 [+-2]
MCLI (annual, with no regain)	2015	464 [+-2]	654 [+-2]	1378 [+-3]	638 [+-2]	243 [+-1]
	2020	490 [+-2]	641 [+-2]	1432 [+-3]	690 [+-2]	266 [+-1]
	2025	519 [+-2]	634 [+-2]	1484 [+-3]	739 [+-2]	289 [+-1]
	2030	558 [+-2]	668 [+-2]	1529 [+-3]	787 [+-2]	318 [+-2]
	2035	602 [+-2]	719 [+-2]	1571 [+-4]	831 [+-3]	343 [+-2]
	2040	647 [+-2]	742 [+-2]	1602 [+-4]	855 [+-3]	365 [+-2]
	2045	675 [+-2]	736 [+-3]	1631 [+-4]	870 [+-3]	384 [+-2]
	2050	693 [+-3]	710 [+-3]	1651 [+-4]	896 [+-3]	401 [+-2]

Table 156. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	460 [+-2]	656 [+-2]	1378 [+-3]	639 [+-2]	243 [+-1]
	2020	2881 [+-5]	3891 [+-5]	8480 [+-8]	3999 [+-5]	1536 [+-3]
	2025	5488 [+-6]	7138 [+-7]	15941 [+-10]	7664 [+-7]	2968 [+-5]
	2030	8354 [+-8]	10589 [+-9]	23857 [+-12]	11686 [+-9]	4579 [+-6]
	2035	11585 [+-9]	14435 [+-10]	32411 [+-13]	16147 [+-10]	6406 [+-7]
	2040	15251 [+-10]	18716 [+-11]	41753 [+-14]	21063 [+-12]	8473 [+-8]
	2045	19362 [+-12]	23368 [+-13]	51965 [+-15]	26463 [+-13]	10789 [+-9]
	2050	23882 [+-13]	28267 [+-14]	63037 [+-15]	32365 [+-14]	13357 [+-10]
MCLI (annual, with regain)	2015	463 [+-2]	653 [+-2]	1377 [+-3]	638 [+-2]	243 [+-1]
	2020	2877 [+-5]	3883 [+-5]	8461 [+-8]	3989 [+-5]	1536 [+-3]
	2025	5470 [+-6]	7112 [+-7]	15902 [+-10]	7637 [+-7]	2965 [+-5]
	2030	8316 [+-8]	10538 [+-9]	23797 [+-12]	11649 [+-9]	4572 [+-6]
	2035	11517 [+-9]	14369 [+-10]	32333 [+-13]	16094 [+-10]	6393 [+-7]
	2040	15154 [+-10]	18630 [+-11]	41642 [+-14]	20994 [+-12]	8455 [+-8]
	2045	19224 [+-12]	23247 [+-13]	51826 [+-15]	26365 [+-13]	10766 [+-9]
	2050	23703 [+-13]	28114 [+-14]	62875 [+-15]	32236 [+-14]	13329 [+-10]
MCLI (annual, with no regain)	2015	464 [+-2]	654 [+-2]	1378 [+-3]	638 [+-2]	243 [+-1]
	2020	2868 [+-5]	3880 [+-5]	8457 [+-8]	3989 [+-5]	1535 [+-3]
	2025	5449 [+-6]	7101 [+-7]	15897 [+-10]	7633 [+-7]	2960 [+-5]
	2030	8285 [+-8]	10522 [+-9]	23793 [+-12]	11642 [+-9]	4564 [+-6]
	2035	11481 [+-9]	14350 [+-10]	32333 [+-13]	16085 [+-10]	6381 [+-7]
	2040	15113 [+-10]	18611 [+-11]	41644 [+-14]	20988 [+-12]	8442 [+-8]
	2045	19182 [+-12]	23228 [+-13]	51834 [+-15]	26361 [+-13]	10752 [+-9]
	2050	23659 [+-13]	28095 [+-14]	62886 [+-15]	32235 [+-14]	13313 [+-10]

Table 157. Cumulative incidence cases avoided (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain)	2015	-3 [+-3]	3 [+-3]	1 [+-4]	1 [+-3]	0 [+-1]
	2020	4 [+-7]	8 [+-7]	19 [+-11]	10 [+-7]	0 [+-4]
	2025	18 [+-8]	26 [+-10]	39 [+-14]	27 [+-10]	3 [+-7]
	2030	38 [+-11]	51 [+-13]	60 [+-17]	37 [+-13]	7 [+-8]
	2035	68 [+-13]	66 [+-14]	78 [+-18]	53 [+-14]	13 [+-10]
	2040	97 [+-14]	86 [+-16]	111 [+-20]	69 [+-17]	18 [+-11]
	2045	138 [+-17]	121 [+-18]	139 [+-21]	98 [+-18]	23 [+-13]
	2050	179 [+-18]	153 [+-20]	162 [+-21]	129 [+-20]	28 [+-14]
MCLI (annual, with no regain)	2015	-4 [+-3]	2 [+-3]	0 [+-4]	1 [+-3]	0 [+-1]
	2020	13 [+-7]	11 [+-7]	23 [+-11]	10 [+-7]	1 [+-4]
	2025	39 [+-8]	37 [+-10]	44 [+-14]	31 [+-10]	8 [+-7]
	2030	69 [+-11]	67 [+-13]	64 [+-17]	44 [+-13]	15 [+-8]
	2035	104 [+-13]	85 [+-14]	78 [+-18]	62 [+-14]	25 [+-10]
	2040	138 [+-14]	105 [+-16]	109 [+-20]	75 [+-17]	31 [+-11]
	2045	180 [+-17]	140 [+-18]	131 [+-21]	102 [+-18]	37 [+-13]
	2050	223 [+-18]	172 [+-20]	151 [+-21]	130 [+-20]	44 [+-14]

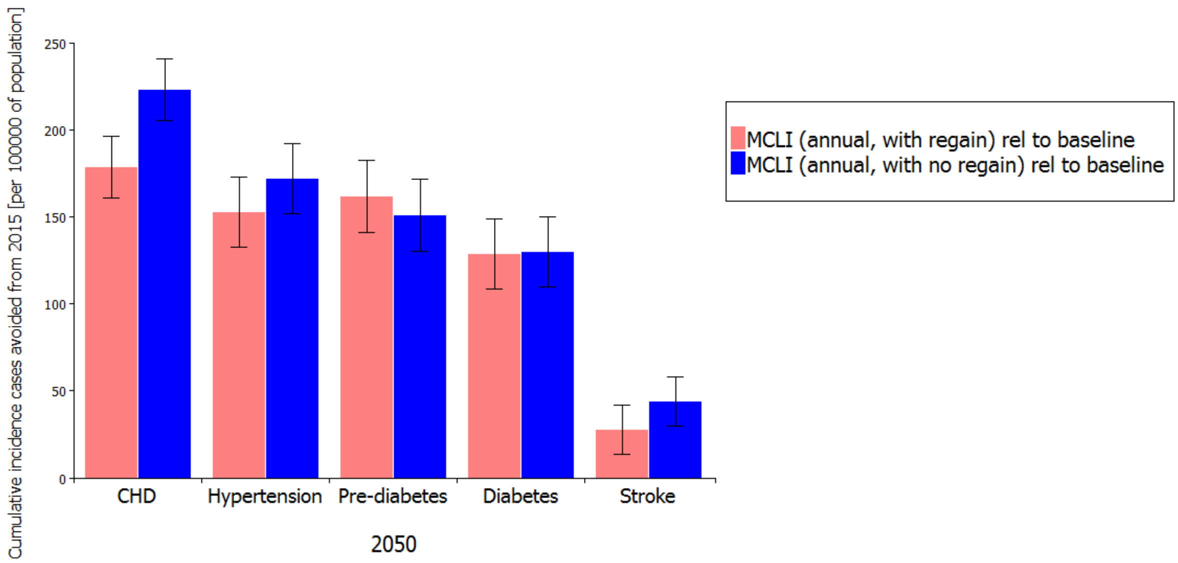


Figure 266 Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 158. Prevalence cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain)	2015	-2 [+-8]	-1 [+-14]	-1 [+-13]	-4 [+-14]	-2 [+-6]
	2020	-3 [+-10]	-2 [+-16]	7 [+-13]	2 [+-14]	1 [+-6]
	2025	9 [+-10]	13 [+-16]	16 [+-13]	12 [+-14]	3 [+-6]
	2030	21 [+-10]	32 [+-16]	21 [+-13]	16 [+-16]	8 [+-7]
	2035	40 [+-11]	39 [+-17]	17 [+-14]	26 [+-16]	10 [+-7]
	2040	54 [+-11]	52 [+-17]	22 [+-14]	27 [+-17]	14 [+-7]
	2045	70 [+-11]	76 [+-17]	20 [+-14]	45 [+-17]	8 [+-7]
	2050	83 [+-13]	92 [+-18]	8 [+-14]	64 [+-18]	5 [+-8]
MCLI (annual, with no regain)	2015	-4 [+-8]	-2 [+-14]	-1 [+-13]	-1 [+-14]	-1 [+-6]
	2020	4 [+-10]	-1 [+-16]	11 [+-13]	4 [+-14]	2 [+-6]
	2025	24 [+-10]	21 [+-16]	17 [+-13]	17 [+-14]	7 [+-6]
	2030	41 [+-10]	42 [+-16]	18 [+-13]	21 [+-16]	10 [+-7]
	2035	58 [+-11]	48 [+-17]	10 [+-14]	32 [+-16]	13 [+-7]
	2040	71 [+-11]	59 [+-17]	20 [+-14]	31 [+-17]	16 [+-7]
	2045	83 [+-11]	84 [+-17]	16 [+-14]	50 [+-17]	10 [+-7]
	2050	89 [+-13]	95 [+-18]	5 [+-14]	62 [+-18]	5 [+-8]

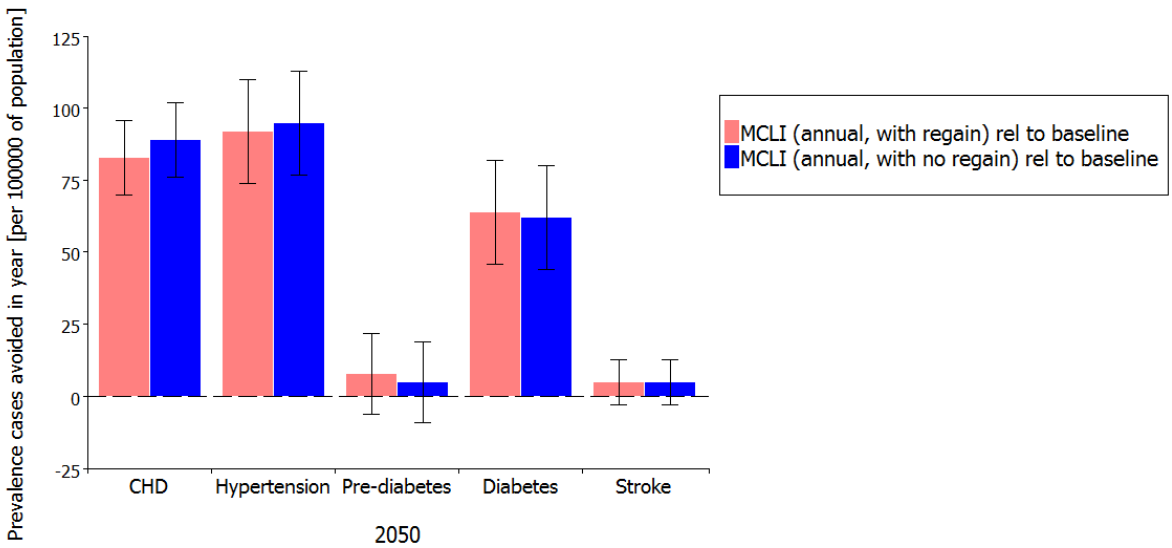


Figure 267 Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYS and ICERs

Table 159 and Figure 268 present the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in CHD for both MCLI interventions (0.12m zloty and 0.13m zloty per 100,000 population in 2050 for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Table 160 and Figure 269 presents the indirect costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to occur in CHD for both MCLI interventions (0.26m zloty per 100,000 population and 0.25 million zloty per 100,000 population for *MCLI (no weight regain)* and *MCLI (weight regain)*, respectively).

Figure 270 and Figure 271 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the baseline. For both males and females, both variations of the MCLI interventions are expected to lead to increasing gains in QALYs over time.

In Figure 272, the positive ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both versions of the MCLI interventions may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Poland. A cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. However, since no cost effectiveness thresholds have been assigned in this project, we cannot categorically determine whether or not this set of interventions is cost effective. Over time, however, the ICER is expected to approach near zero, indicating that the interventions are likely to become cost effective.

Table 159. Direct healthcare costs (zloty millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	-0.01526 [+-0.003862]	-0.000479 [+-0.001017]	-0.000243 [+-0.000274]	-0.01229 [+-0.00662]	-0.0865 [+-0.006649]
	2020	-0.01925 [+-0.003485]	-0.000401 [+-0.000865]	0.001062 [+-0.000226]	0.006435 [+-0.005667]	0.025421 [+-0.006206]
	2025	0.042797 [+-0.003072]	0.003209 [+-0.000728]	0.001746 [+-0.000185]	0.025551 [+-0.004883]	0.113167 [+-0.005632]
	2030	0.078302 [+-0.002715]	0.00636 [+-0.000614]	0.001787 [+-0.00015]	0.024336 [+-0.004243]	0.217751 [+-0.005127]
	2035	0.119692 [+-0.00243]	0.0061 [+-0.000525]	0.001239 [+-0.000122]	0.033703 [+-0.003702]	0.237862 [+-0.00469]
	2040	0.126335 [+-0.00217]	0.006419 [+-0.000452]	0.00121 [+-0.0001]	0.027042 [+-0.003202]	0.234299 [+-0.004233]
	2045	0.126912 [+-0.001901]	0.007354 [+-0.000384]	0.000863 [+-0.000082]	0.035641 [+-0.002735]	0.112038 [+-0.003715]
	2050	0.117931 [+-0.001631]	0.006994 [+-0.000323]	0.000274 [+-0.000068]	0.038676 [+-0.002318]	0.05574 [+-0.003185]
MCLI (annual, with no regain), relative to baseline	2015	-0.03277 [+-0.003863]	-0.001069 [+-0.001017]	-0.000257 [+-0.000274]	-0.00259 [+-0.006619]	-0.05521 [+-0.006648]
	2020	0.026207 [+-0.003481]	-0.000168 [+-0.000864]	0.001624 [+-0.000226]	0.011475 [+-0.005667]	0.073814 [+-0.006203]
	2025	0.115187 [+-0.003067]	0.005343 [+-0.000728]	0.001908 [+-0.000185]	0.034351 [+-0.004882]	0.26577 [+-0.005625]
	2030	0.154011 [+-0.00271]	0.008374 [+-0.000614]	0.001524 [+-0.00015]	0.032785 [+-0.004242]	0.274124 [+-0.005124]
	2035	0.172928 [+-0.002425]	0.007489 [+-0.000525]	0.000702 [+-0.000122]	0.041464 [+-0.0037]	0.298393 [+-0.004687]
	2040	0.165712 [+-0.002167]	0.007359 [+-0.000451]	0.001066 [+-0.0001]	0.030588 [+-0.003202]	0.271648 [+-0.004231]
	2045	0.150737 [+-0.126514]	0.008101 [+-0.000384]	0.000669 [+-0.000082]	0.039185 [+-0.002734]	0.140961 [+-0.003714]
	2050	0.126514 [+-0.001631]	0.007183 [+-0.000323]	0.00016 [+-0.000068]	0.037566 [+-0.002319]	0.055328 [+-0.003185]

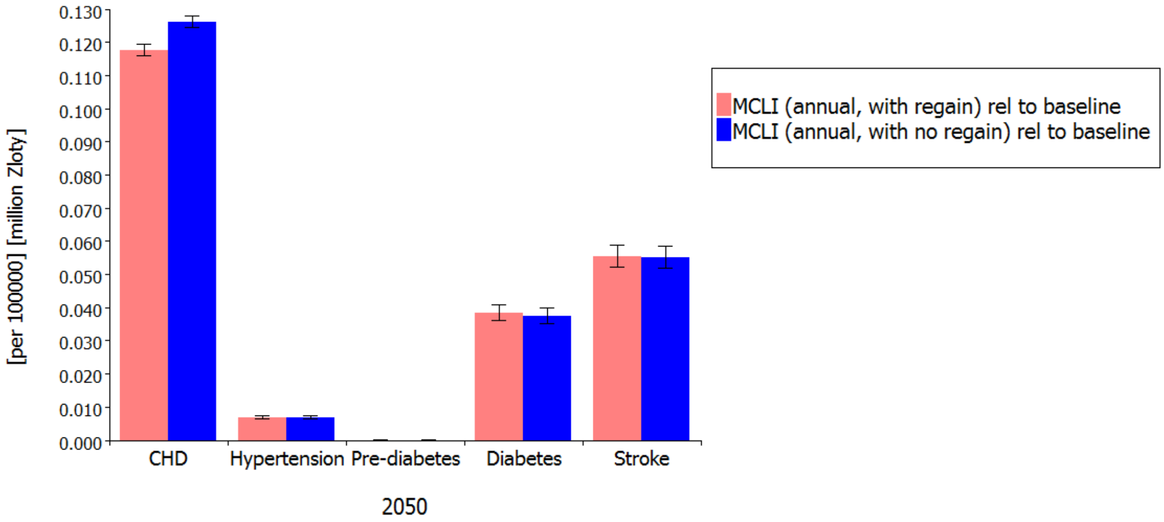


Figure 268 Direct healthcare costs (zloty millions) avoided (per 100,000), relative to baseline

Table 160. Indirect costs (zloty millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	-0.03183 [+-0.008055]	-0.000587 [+-0.001247]	0 [+-0]	-0.06012 [+-0.032388]	-0.15778 [+-0.012128]
	2020	-0.04016 [+-0.007268]	-0.000492 [+-0.001061]	0 [+-0]	0.031479 [+-0.027724]	0.046371 [+-0.011319]
	2025	0.089279 [+-0.006409]	0.003938 [+-0.000892]	0 [+-0]	0.125015 [+-0.023888]	0.206406 [+-0.010273]
	2030	0.163342 [+-0.005664]	0.007802 [+-0.000754]	0 [+-0]	0.119064 [+-0.020757]	0.397171 [+-0.009351]
	2035	0.249676 [+-0.005069]	0.007483 [+-0.000646]	0 [+-0]	0.164886 [+-0.018111]	0.433853 [+-0.008554]
	2040	0.263535 [+-0.004528]	0.007875 [+-0.000554]	0 [+-0]	0.132309 [+-0.015669]	0.427368 [+-0.007722]
	2045	0.264736 [+-0.003966]	0.009022 [+-0.000472]	0 [+-0]	0.17437 [+-0.013381]	0.204361 [+-0.006777]
	2050	0.246004 [+-0.003403]	0.008581 [+-0.000397]	0 [+-0]	0.18922 [+-0.01134]	0.101662 [+-0.005809]
MCLI (annual, with no regain), relative to baseline	2015	-0.06836 [+-0.008057]	-0.00131 [+-0.001247]	0 [+-0]	-0.01265 [+-0.032384]	-0.10072 [+-0.012125]
	2020	0.054665 [+-0.007262]	-0.000206 [+-0.001061]	0 [+-0]	0.056137 [+-0.027721]	0.134644 [+-0.011314]
	2025	0.24028 [+-0.006397]	0.006556 [+-0.000892]	0 [+-0]	0.168076 [+-0.023884]	0.484772 [+-0.01026]
	2030	0.321262 [+-0.005653]	0.010274 [+-0.000754]	0 [+-0]	0.1604 [+-0.020752]	0.5 [+-0.009346]
	2035	0.360725 [+-0.00506]	0.009188 [+-0.000645]	0 [+-0]	0.20285 [+-0.018106]	0.544281 [+-0.008548]
	2040	0.345673 [+-0.004521]	0.009029 [+-0.000554]	0 [+-0]	0.149651 [+-0.015667]	0.495499 [+-0.007718]
	2045	0.314434 [+-0.263906]	0.009938 [+-0.000472]	0 [+-0]	0.191711 [+-0.013378]	0.257118 [+-0.006774]
	2050	0.263906 [+-0.003401]	0.008813 [+-0.000397]	0 [+-0]	0.183788 [+-0.011341]	0.100914 [+-0.005809]

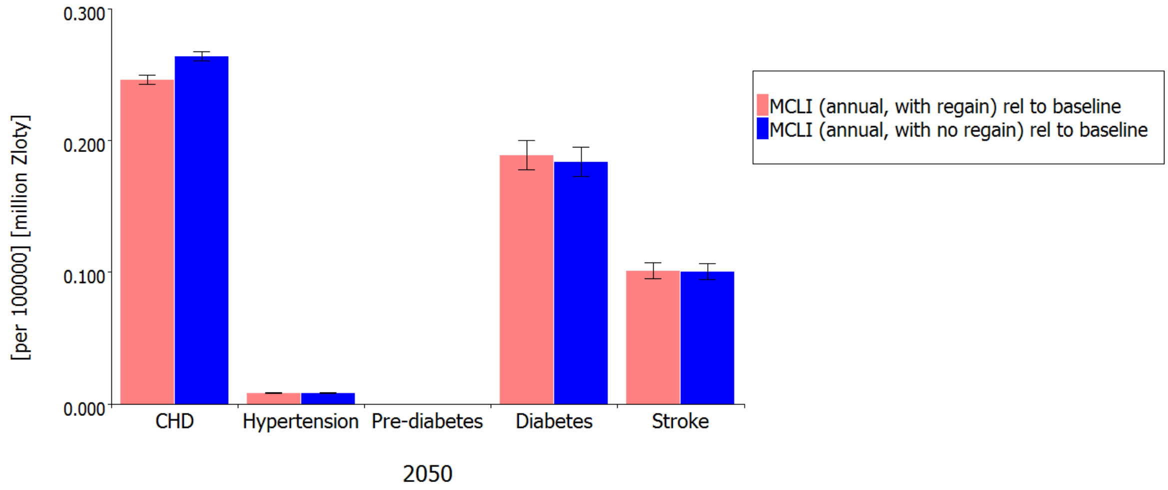


Figure 269 Indirect costs (zloty millions) avoided (per 100,000), relative to baseline

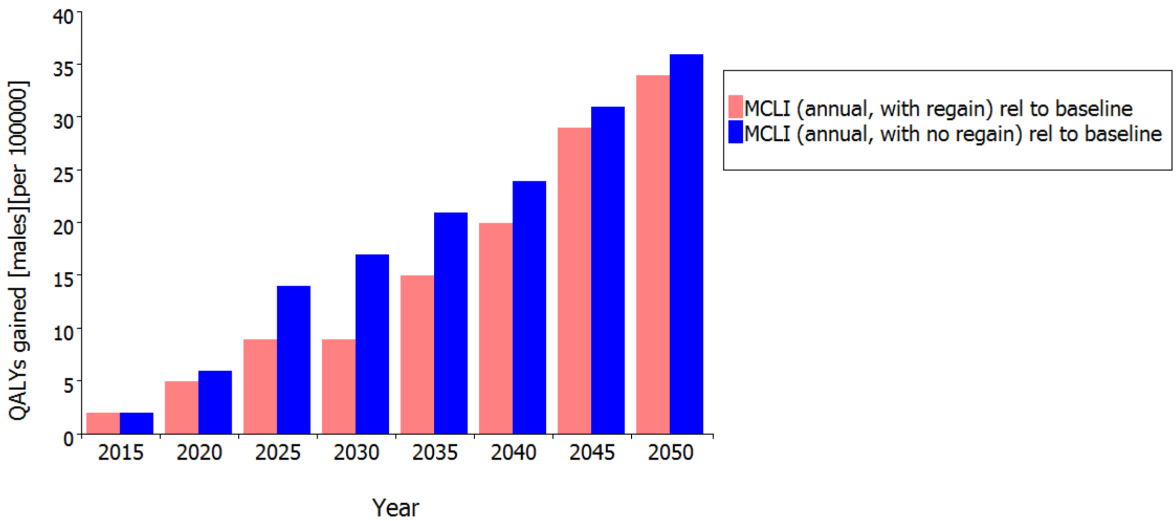


Figure 270 QALYS gained (per 100,000), relative to baseline (males)

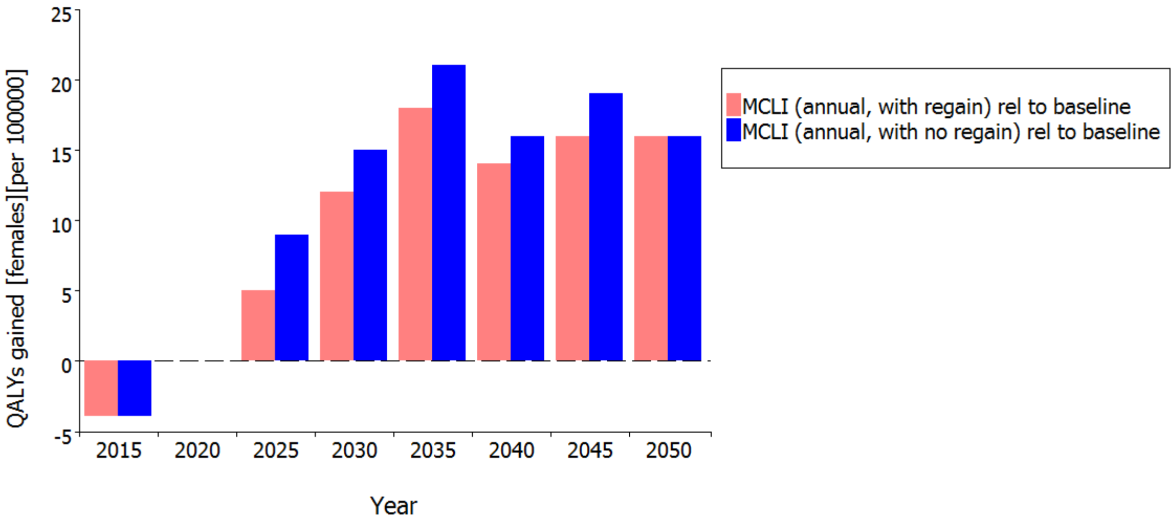


Figure 271 QALYS gained (per 100,000), relative to baseline (females)

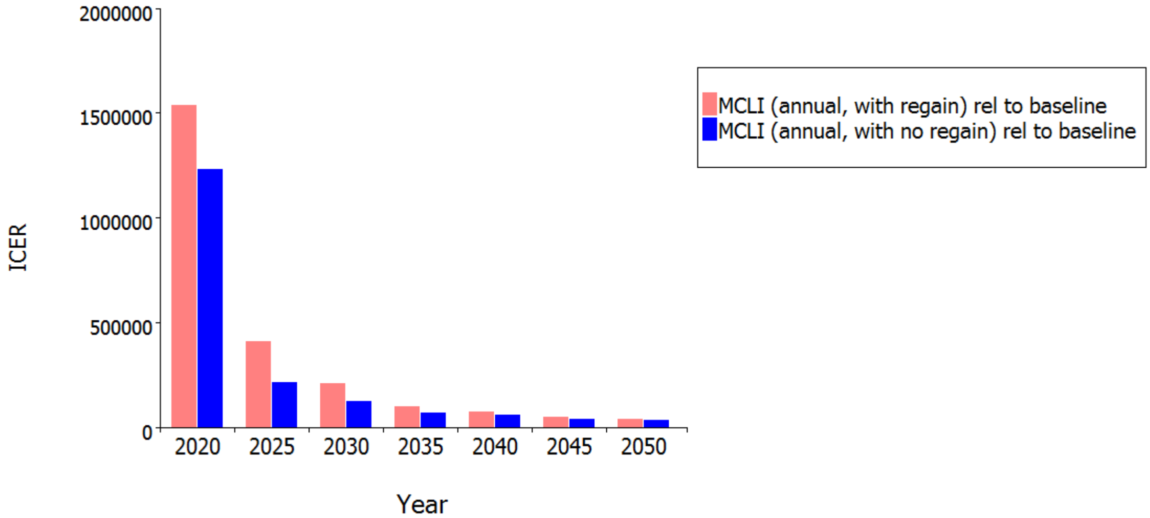


Figure 272. ICER

Sugar sweetened beverage (SSB) tax intervention

Impact on disease incidence and prevalence

Due to the small BMI drop, 100 million simulations were run to provide more accurate results

Table 161 presents the incidence cases per 100,000 to 2050 for baseline (no intervention) and SSB. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios.

Table 162 presents the cumulative incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Cumulative incidence is lower for all diseases in the SSB scenario compared to baseline by 2050.

Table 163 and Figure 273 present the cumulative incidence cases avoided (per 100,000) for SSB relative to baseline. The SSB scenario is predicted to reduce the cumulative incidence of all diseases, where the largest effect is observed for pre-diabetes (25 cases avoided per 100,000 compared to baseline by 2050) followed by diabetes (24 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on cumulative incidence of each disease as a result of an SSB tax relative to baseline by 2050.

Table 164 and Figure 274 present the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. With the exception of diabetes, the SSB scenario is predicted to have little impact by 2050 on the prevalence cases of each disease.

Table 161. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	461 [+-1]	656 [+-2]	1378 [+-2]	639 [+-2]	242 [+-1]
	2020	494 [+-1]	641 [+-2]	1436 [+-2]	692 [+-2]	267 [+-1]
	2025	526 [+-1]	639 [+-2]	1492 [+-2]	743 [+-2]	292 [+-1]
	2030	564 [+-1]	674 [+-2]	1533 [+-2]	789 [+-2]	320 [+-1]
	2035	610 [+-2]	720 [+-2]	1573 [+-3]	832 [+-2]	345 [+-1]
	2040	649 [+-2]	746 [+-2]	1609 [+-3]	855 [+-2]	367 [+-1]
	2045	680 [+-2]	740 [+-2]	1632 [+-3]	873 [+-2]	384 [+-1]
	2050	699 [+-2]	715 [+-2]	1652 [+-3]	899 [+-2]	402 [+-1]
SSB	2015	462 [+-1]	656 [+-2]	1377 [+-2]	638 [+-2]	242 [+-1]
	2020	494 [+-1]	641 [+-2]	1435 [+-2]	691 [+-2]	267 [+-1]
	2025	526 [+-1]	638 [+-2]	1491 [+-2]	742 [+-2]	292 [+-1]
	2030	563 [+-1]	674 [+-2]	1533 [+-2]	789 [+-2]	320 [+-1]
	2035	610 [+-2]	719 [+-2]	1573 [+-3]	831 [+-2]	345 [+-1]
	2040	649 [+-2]	746 [+-2]	1608 [+-3]	855 [+-2]	367 [+-1]
	2045	679 [+-2]	740 [+-2]	1632 [+-3]	873 [+-2]	384 [+-1]
	2050	698 [+-2]	714 [+-2]	1652 [+-3]	898 [+-2]	402 [+-1]

Table 162. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	461 [+-1]	656 [+-2]	1378 [+-2]	639 [+-2]	242 [+-1]
	2020	2883 [+-3]	3891 [+-4]	8479 [+-5]	3996 [+-4]	1538 [+-2]
	2025	5487 [+-4]	7136 [+-5]	15945 [+-7]	7659 [+-5]	2971 [+-3]
	2030	8352 [+-6]	10585 [+-6]	23860 [+-8]	11684 [+-6]	4583 [+-4]
	2035	11584 [+-6]	14435 [+-7]	32415 [+-9]	16142 [+-7]	6410 [+-5]
	2040	15251 [+-7]	18717 [+-8]	41756 [+-10]	21059 [+-8]	8477 [+-6]
	2045	19358 [+-8]	23368 [+-9]	51966 [+-11]	26456 [+-9]	10795 [+-7]
	2050	23879 [+-9]	28269 [+-10]	63043 [+-10]	32356 [+-10]	13368 [+-7]
SSB	2015	462 [+-1]	656 [+-2]	1377 [+-2]	638 [+-2]	242 [+-1]
	2020	2881 [+-3]	3888 [+-4]	8473 [+-5]	3994 [+-4]	1537 [+-2]
	2025	5484 [+-4]	7130 [+-5]	15934 [+-7]	7653 [+-5]	2970 [+-3]
	2030	8347 [+-6]	10576 [+-6]	23846 [+-8]	11674 [+-6]	4582 [+-4]
	2035	11577 [+-6]	14423 [+-7]	32398 [+-9]	16128 [+-7]	6408 [+-5]
	2040	15241 [+-7]	18703 [+-8]	41735 [+-10]	21041 [+-8]	8475 [+-6]
	2045	19346 [+-8]	23351 [+-9]	51943 [+-11]	26435 [+-9]	10793 [+-7]
	2050	23864 [+-9]	28249 [+-10]	63018 [+-10]	32332 [+-10]	13364 [+-7]

Table 163. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	-1 [+-1]	0 [+-3]	1 [+-3]	1 [+-3]	0 [+-1]
	2020	2 [+-4]	3 [+-6]	6 [+-7]	2 [+-6]	1 [+-3]
	2025	3 [+-6]	6 [+-7]	11 [+-10]	6 [+-7]	1 [+-4]
	2030	5 [+-8]	9 [+-8]	14 [+-11]	10 [+-8]	1 [+-6]
	2035	7 [+-8]	12 [+-10]	17 [+-13]	14 [+-10]	2 [+-7]
	2040	10 [+-10]	14 [+-11]	21 [+-14]	18 [+-11]	2 [+-8]
	2045	12 [+-11]	17 [+-13]	23 [+-16]	21 [+-13]	2 [+-10]
	2050	15 [+-13]	20 [+-14]	25 [+-14]	24 [+-14]	4 [+-10]

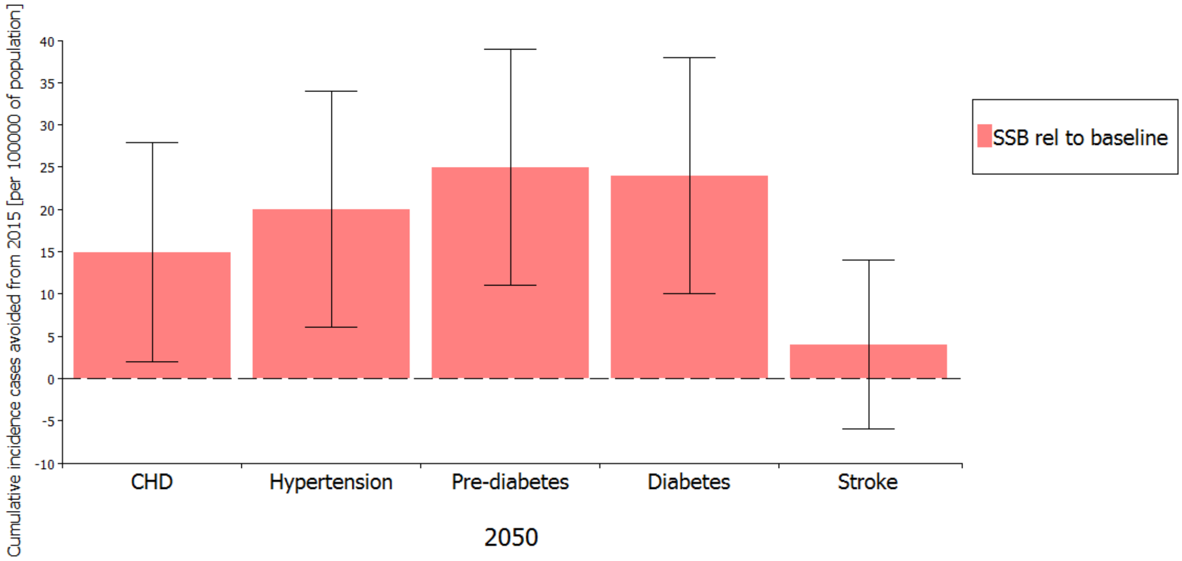


Figure 273 Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 164. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	0 [+-6]	1 [+-10]	1 [+-8]	0 [+-10]	0 [+-4]
	2020	1 [+-7]	4 [+-10]	5 [+-8]	3 [+-10]	0 [+-4]
	2025	3 [+-7]	7 [+-11]	5 [+-10]	6 [+-10]	0 [+-4]
	2030	4 [+-7]	8 [+-11]	4 [+-10]	8 [+-11]	1 [+-4]
	2035	5 [+-7]	10 [+-11]	2 [+-10]	11 [+-11]	1 [+-4]
	2040	6 [+-8]	11 [+-11]	2 [+-10]	12 [+-11]	1 [+-6]
	2045	6 [+-8]	13 [+-13]	0 [+-10]	14 [+-13]	1 [+-6]
	2050	6 [+-8]	12 [+-13]	0 [+-10]	14 [+-13]	1 [+-6]

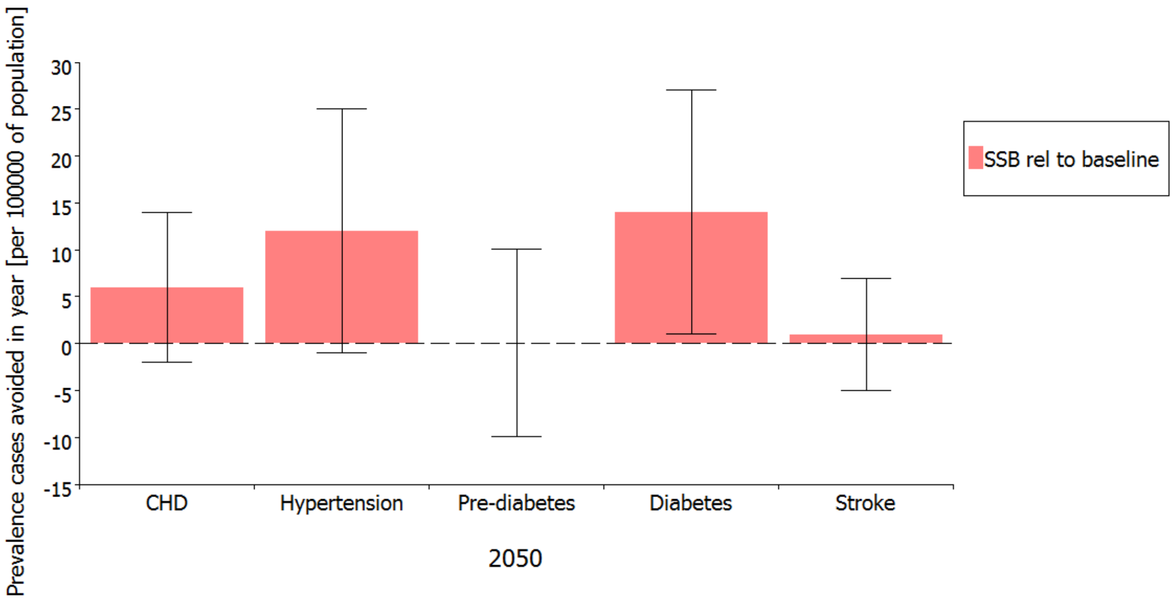


Figure 274 Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 165 and Figure 275 present the direct healthcare costs that can be *avoided* (per 100,000 population) with the SSB intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to be observed in stroke (0.12m zloty per 100,000 population in 2050).

Table 166 and Figure 276 present the indirect costs that can be avoided (per 100,000) with the SSB intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to be observed for diabetes (0.04m zloty per 100,000 population in 2050), followed by stroke (0.02m zloty per 100,000 population in 2050) and CHD (0.018m zloty per 100,000 population in 2050).

Figure 277 and Figure 278 present the QALYs that can *gained* for the SSB intervention, relative to the baseline. For both males and females, the SSB tax intervention is expected to remain steady over time.

In Figure 279, the negative ICER values (which in this case is comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SSB tax intervention is cost effective (the SSB tax intervention scenario *dominates* the baseline scenario).

Table 165 Direct healthcare costs (zloty millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	0.003639 [+-0.002732]	0.000595 [+-0.000718]	0.000176 [+-0.000194]	0.002285 [+-0.004681]	-0.00035 [+-0.004698]
	2020	0.009708 [+-0.002466]	0.001204 [+-0.000612]	0.000647 [+-0.00016]	0.007362 [+-0.004008]	0.01368 [+-0.004392]
	2025	0.011948 [+-0.002175]	0.001599 [+-0.000515]	0.000539 [+-0.00013]	0.012314 [+-0.003454]	0.015221 [+-0.00399]
	2030	0.014021 [+-0.001924]	0.001676 [+-0.000436]	0.000367 [+-0.000106]	0.013577 [+-0.003002]	0.016731 [+-0.003634]
	2035	0.014975 [+-0.001725]	0.001565 [+-0.000372]	0.00014 [+-0.000086]	0.014242 [+-0.002619]	0.017082 [+-0.003326]
	2040	0.014111 [+-0.001542]	0.00143 [+-0.00032]	0.000118 [+-0.000071]	0.012556 [+-0.002266]	0.020073 [+-0.003003]
	2045	0.011408 [+-0.001351]	0.001209 [+-0.000273]	0.000035 [+-0.000058]	0.010624 [+-0.001936]	0.015862 [+-0.002634]
	2050	0.008966 [+-0.00116]	0.000905 [+-0.000229]	0.000013 [+-0.000048]	0.008074 [+-0.001641]	0.012012 [+-0.002258]

Table 166. Indirect costs (zloty millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	0.007584 [+-0.005698]	0.00073 [+-0.000882]	0 [+-0]	0.011185 [+-0.0229]	-0.00066 [+-0.00857]
	2020	0.020248 [+-0.005143]	0.001478 [+-0.000751]	0 [+-0]	0.036026 [+-0.019607]	0.024963 [+-0.008011]
	2025	0.024918 [+-0.004537]	0.001962 [+-0.000631]	0 [+-0]	0.060257 [+-0.016897]	0.027771 [+-0.007278]
	2030	0.029251 [+-0.004012]	0.002056 [+-0.000535]	0 [+-0]	0.066422 [+-0.014686]	0.030518 [+-0.006628]
	2035	0.031235 [+-0.003597]	0.00192 [+-0.000457]	0 [+-0]	0.069672 [+-0.012814]	0.031158 [+-0.006066]
	2040	0.029434 [+-0.003216]	0.001755 [+-0.000392]	0 [+-0]	0.061432 [+-0.011087]	0.036621 [+-0.005477]
	2045	0.0238 [+-0.002819]	0.001483 [+-0.000334]	0 [+-0]	0.051971 [+-0.009471]	0.028931 [+-0.004804]
	2050	0.018703 [+-0.00242]	0.00111 [+-0.000281]	0 [+-0]	0.039505 [+-0.00803]	0.021912 [+-0.00412]

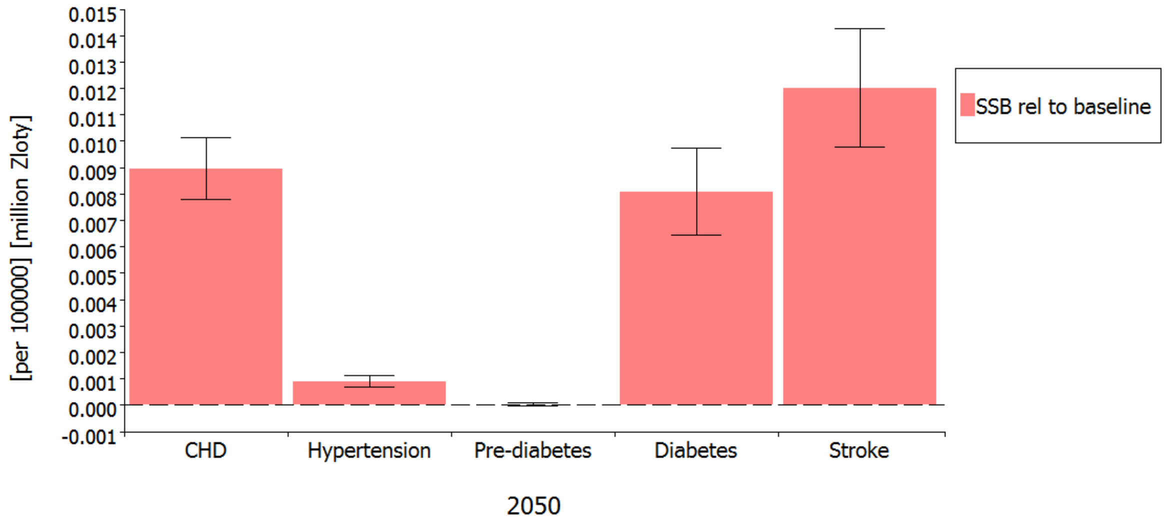


Figure 275 Direct healthcare costs (zloty millions) avoided (per 100,000), relative to baseline

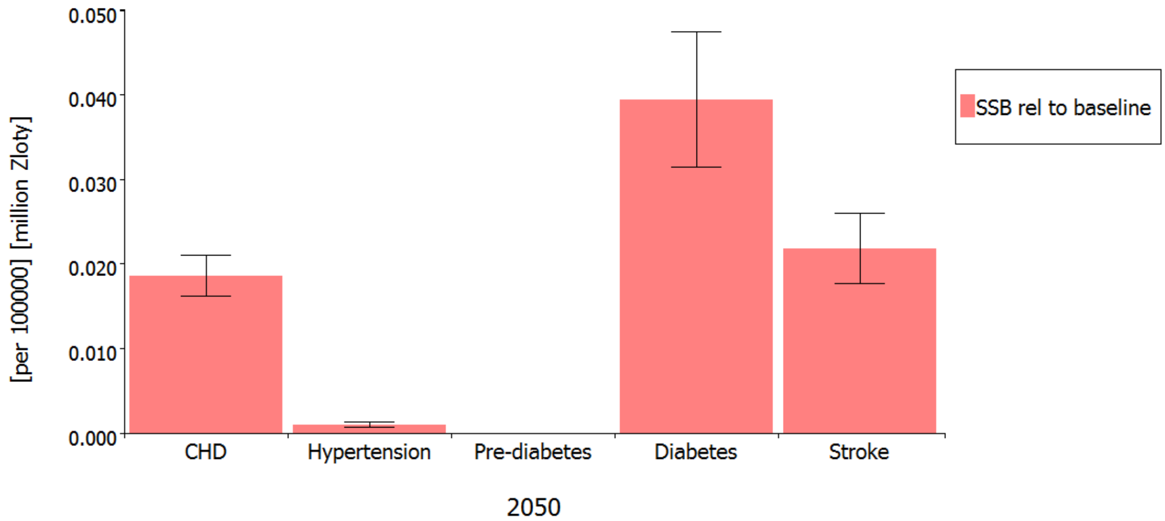


Figure 276 Indirect costs (zloty millions) avoided (per 100,000), relative to baseline

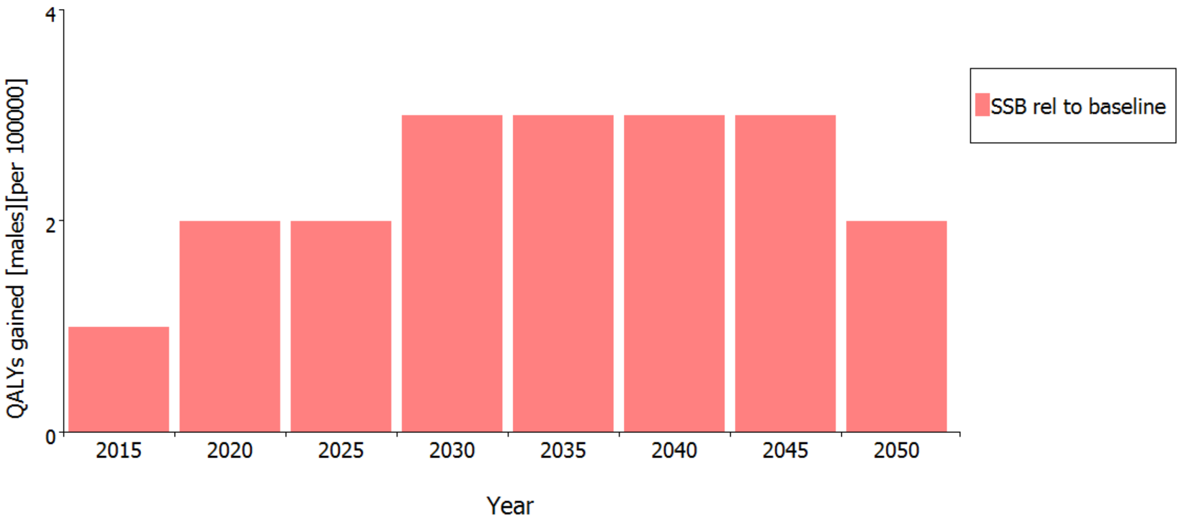


Figure 277. QALYS gained (per 100,000) relative to baseline (males)

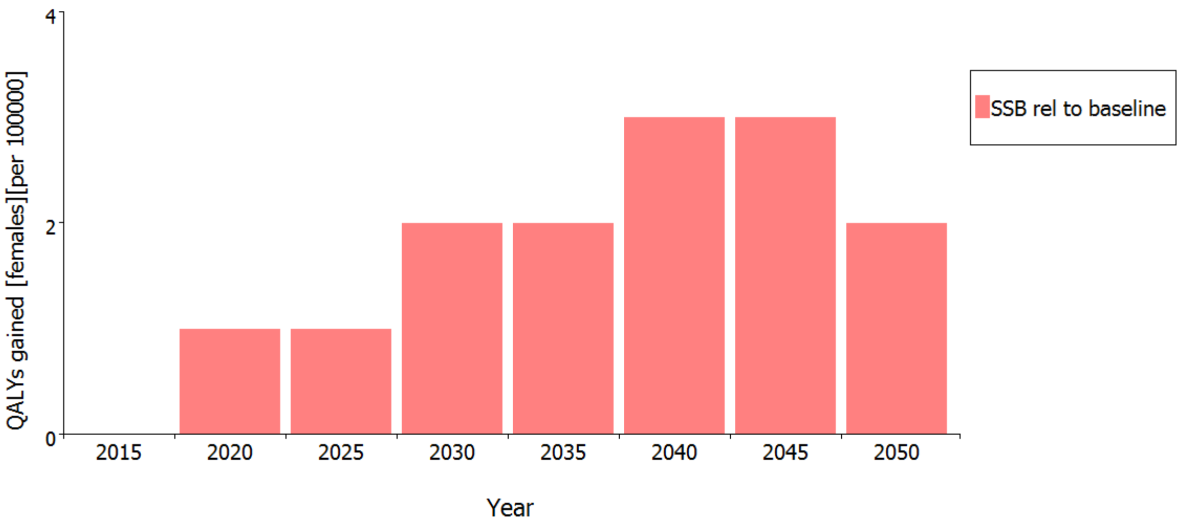


Figure 278. QALYS gained (per 100,000), relative to baseline (females)

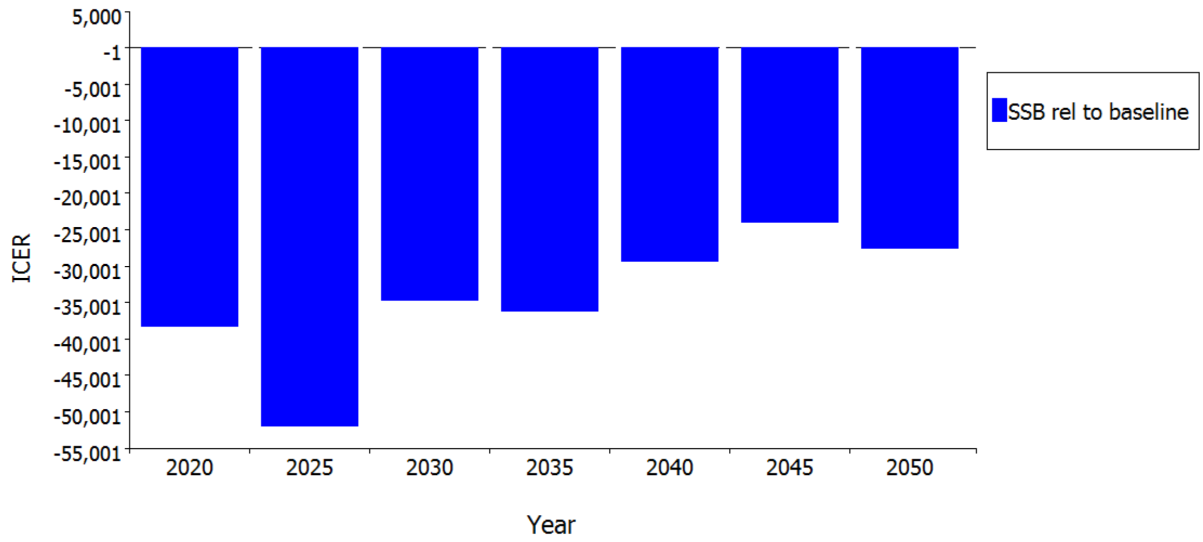


Figure 279. ICER

Smoking intervention results

Smoking cessation services (SCS)

Table 167. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59% (Finland proxy)
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	621 zł (NL proxy)

Impact on disease incidence and prevalence

Table 168 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SCS scenarios. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios. The SCS scenario results in fewer cases each disease per 100,000 in 2050 compared to baseline. These results are discussed further in the discussion and appendix E8 and E9.

Table 169 presents the cumulative incidence cases per 100,000 to 2050 for baseline (no intervention) and SCS scenario. Cumulative incidence is lower for all diseases in the SCS scenario compared to baseline by 2050.

Table 170 and Figure 280 present the cumulative incidence cases avoided (per 100,000) from 2015 to 2050 for each intervention relative to baseline. The SCS scenario is predicted to reduce the cumulative incidence of all diseases, where the largest effect is observed for stroke (2108 cases avoided per 100,000 compared to baseline by 2050) followed by lung cancer (508 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on incidence of each disease as a result of a SCS relative to baseline by 2050.

Table 171 and Figure 281presents the prevalence cases avoided for each intervention relative to baseline, per 100,000. The SCS scenario is predicted to reduce the prevalence of all diseases except hypertension and CHD (discussed in the discussion and in appendix E8 and E9), where the largest effect is observed for stroke (718 cases avoided per 100,000 compared to baseline by 2050).

Table 168. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	476 [+-1]	20 [+-0]	703 [+-2]	65 [+-1]	251 [+-1]
	2020	546 [+-1]	29 [+-0]	687 [+-2]	88 [+-1]	312 [+-1]
	2025	594 [+-2]	36 [+-0]	675 [+-2]	107 [+-1]	360 [+-1]
	2030	635 [+-2]	40 [+-0]	706 [+-2]	120 [+-1]	399 [+-1]
	2035	677 [+-2]	41 [+-0]	747 [+-2]	127 [+-1]	424 [+-1]
	2040	715 [+-2]	42 [+-0]	770 [+-2]	130 [+-1]	441 [+-1]
	2045	749 [+-2]	44 [+-0]	758 [+-2]	135 [+-1]	451 [+-1]
	2050	771 [+-2]	48 [+-0]	722 [+-2]	142 [+-1]	466 [+-1]
SCS	2015	477 [+-1]	20 [+-0]	705 [+-2]	65 [+-0]	251 [+-1]
	2020	544 [+-1]	28 [+-0]	687 [+-2]	86 [+-1]	302 [+-1]
	2025	590 [+-2]	35 [+-0]	671 [+-2]	101 [+-1]	336 [+-1]
	2030	633 [+-2]	37 [+-0]	702 [+-2]	111 [+-1]	358 [+-1]
	2035	670 [+-2]	38 [+-0]	740 [+-2]	112 [+-1]	361 [+-1]
	2040	708 [+-2]	38 [+-0]	761 [+-2]	112 [+-1]	360 [+-1]
	2045	744 [+-2]	40 [+-0]	746 [+-2]	114 [+-1]	359 [+-1]
	2050	767 [+-2]	42 [+-0]	707 [+-2]	115 [+-1]	363 [+-1]

Table 169 Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
Baseline	2015	476 [+-1]	20 [+-0]	703 [+-2]	65 [+-1]	251 [+-1]
	2020	3079 [+-3]	148 [+-1]	4178 [+-4]	463 [+-1]	1699 [+-3]
	2025	6005 [+-5]	315 [+-1]	7634 [+-5]	969 [+-2]	3445 [+-4]
	2030	9259 [+-6]	514 [+-1]	11288 [+-6]	1571 [+-2]	5460 [+-5]
	2035	12900 [+-7]	734 [+-2]	15344 [+-7]	2251 [+-3]	7736 [+-5]
	2040	16981 [+-8]	976 [+-2]	19831 [+-8]	3000 [+-4]	10262 [+-6]
	2045	21541 [+-9]	1245 [+-2]	24663 [+-9]	3825 [+-4]	13032 [+-7]
	2050	26552 [+-10]	1546 [+-3]	29703 [+-10]	4737 [+-5]	16054 [+-8]
SCS	2015	477 [+-1]	20 [+-0]	705 [+-2]	65 [+-0]	251 [+-1]
	2020	3073 [+-3]	146 [+-1]	4177 [+-4]	458 [+-1]	1671 [+-3]
	2025	5986 [+-5]	310 [+-1]	7623 [+-5]	942 [+-2]	3326 [+-4]
	2030	9218 [+-6]	500 [+-1]	11253 [+-6]	1500 [+-2]	5159 [+-4]
	2035	12819 [+-7]	706 [+-2]	15267 [+-7]	2112 [+-3]	7147 [+-5]
	2040	16849 [+-8]	928 [+-2]	19688 [+-8]	2766 [+-3]	9265 [+-6]
	2045	21345 [+-9]	1170 [+-2]	24427 [+-9]	3470 [+-4]	11522 [+-7]
	2050	26288 [+-10]	1439 [+-3]	29348 [+-10]	4229 [+-4]	13946 [+-7]

Table 170. Cumulative incidence cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
SCS relative to baseline	2015	-1 [+-1]	0 [+-0]	-2 [+-3]	0 [+-1]	0 [+-1]
	2020	6 [+-4]	2 [+-1]	1 [+-6]	5 [+-1]	28 [+-4]
	2025	19 [+-7]	5 [+-1]	11 [+-7]	27 [+-3]	119 [+-6]
	2030	41 [+-8]	14 [+-1]	35 [+-8]	71 [+-3]	301 [+-6]
	2035	81 [+-10]	28 [+-3]	77 [+-10]	139 [+-4]	589 [+-7]
	2040	132 [+-11]	48 [+-3]	143 [+-11]	234 [+-5]	997 [+-8]
	2045	196 [+-13]	75 [+-3]	236 [+-13]	355 [+-6]	1510 [+-10]
	2050	264 [+-14]	107 [+-4]	355 [+-14]	508 [+-6]	2108 [+-11]

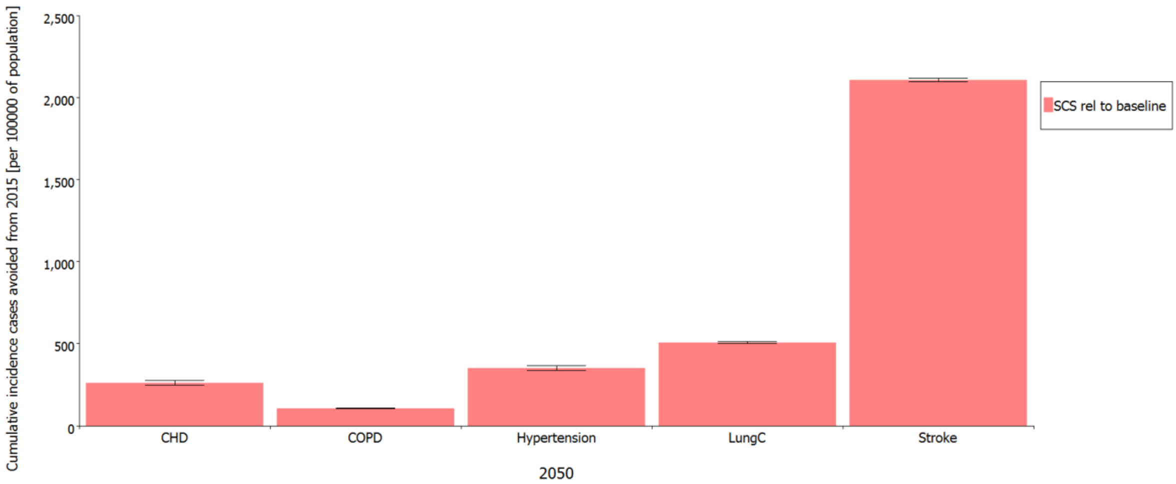


Figure 280. Cumulative incidence cases avoided (per 100,000) relative to baseline

Table 171. Prevalence cases avoided for each intervention relative to baseline, per 100,000

Scenario	Year	CHD	COPD	Hypertension	Lung cancer	Stroke
	2015	2 [+-7]	0 [+-1]	2 [+-10]	0 [+-1]	1 [+-4]
	2020	5 [+-7]	1 [+-1]	2 [+-11]	2 [+-1]	24 [+-4]
SCS relative to baseline	2025	8 [+-7]	2 [+-1]	0 [+-11]	12 [+-1]	85 [+-4]
	2030	11 [+-7]	8 [+-1]	-7 [+-11]	22 [+-1]	185 [+-4]
	2035	13 [+-8]	13 [+-1]	-21 [+-11]	36 [+-1]	315 [+-6]
	2040	5 [+-8]	19 [+-1]	-45 [+-13]	48 [+-1]	465 [+-6]
	2045	-4 [+-8]	25 [+-1]	-57 [+-13]	57 [+-1]	603 [+-6]
	2050	-14 [+-10]	29 [+-1]	-59 [+-13]	70 [+-1]	718 [+-6]

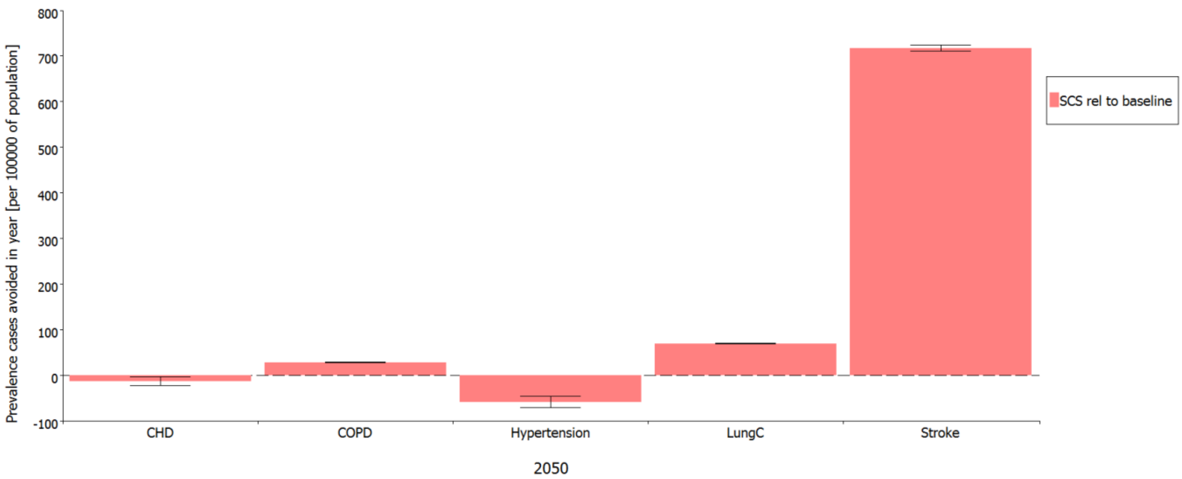


Figure 281. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 172 and Figure 282 present the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to be observed in stroke (7.7m zloty per 100,000 population in 2050).

Table 173 and Figure 283 present the indirect costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest indirect costs avoided are expected to be observed in stroke (14.1m zloty per 100,000 population in 2050).

Figure 284 and Figure 285 present the QALYs that can be *gained* (per 100,000 population) with the SCS intervention, relative to the baseline. For both males and females, the SCS intervention is expected to lead to increasing gains in QALYs over time.

In Figure 286, the negative ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SCS intervention is cost effective (the SCS intervention *dominates* the baseline scenario). The positive ICER value in 2020 (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that the SCS may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Poland.

Table 172 Direct healthcare costs (zloty millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	0.01741 [+-0.00281]	0.000582 [+-0.000003]	0.001009 [+-0.000782]	0.000271 [+-0.000003]	0.007874 [+-0.004366]
	2020	0.029755 [+-0.002621]	0.002849 [+-0.000004]	0.00065 [+-0.000668]	0.004206 [+-0.000004]	1.117516 [+-0.004542]
	2025	0.038113 [+-0.002401]	0.004713 [+-0.000004]	-0.000087 [+-0.00056]	0.015058 [+-0.000005]	3.095779 [+-0.004518]
	2030	0.041536 [+-0.002179]	0.011404 [+-0.000004]	-0.001407 [+-0.000471]	0.022488 [+-0.000005]	5.271477 [+-0.004307]
	2035	0.038563 [+-0.001969]	0.015256 [+-0.000004]	-0.003428 [+-0.000399]	0.027946 [+-0.000004]	7.030365 [+-0.003964]
	2040	0.011845 [+-0.001757]	0.017214 [+-0.000004]	-0.005557 [+-0.000338]	0.029037 [+-0.000004]	8.127449 [+-0.003502]
	2045	-0.00705 [+-0.001541]	0.017102 [+-0.000003]	-0.00556 [+-0.000286]	0.027451 [+-0.000003]	8.26899 [+-0.002966]
	2050	-0.0196 [+-0.001333]	0.016198 [+-0.000003]	-0.004492 [+-0.000238]	0.026153 [+-0.000002]	7.706539 [+-0.002452]

Table 173 Indirect costs (zloty millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	0.036316 [+-0.005862]	0.002822 [+-0.000016]	0.001238 [+-0.00096]	0.000593 [+-0.000006]	0.014374 [+-0.007962]
	2020	0.062073 [+-0.005467]	0.013819 [+-0.000018]	0.000798 [+-0.00082]	0.009182 [+-0.00001]	2.038391 [+-0.008285]
	2025	0.079506 [+-0.005006]	0.022853 [+-0.000021]	-0.000107 [+-0.000687]	0.032875 [+-0.000011]	5.646774 [+-0.00824]
	2030	0.086643 [+-0.004545]	0.055297 [+-0.000022]	-0.001725 [+-0.000577]	0.049096 [+-0.000011]	9.615295 [+-0.007856]
	2035	0.080444 [+-0.004108]	0.073977 [+-0.000021]	-0.004205 [+-0.000489]	0.061015 [+-0.000009]	12.82352 [+-0.00723]
	2040	0.024704 [+-0.003666]	0.083472 [+-0.000018]	-0.006817 [+-0.000415]	0.063395 [+-0.000008]	14.82463 [+-0.006388]
	2045	-0.01471 [+-0.003215]	0.082931 [+-0.000016]	-0.006822 [+-0.00035]	0.059931 [+-0.000006]	15.08282 [+-0.005409]
	2050	-0.04088 [+-0.00278]	0.078544 [+-0.000013]	-0.005511 [+-0.000291]	0.0571 [+-0.000005]	14.05689 [+-0.004473]

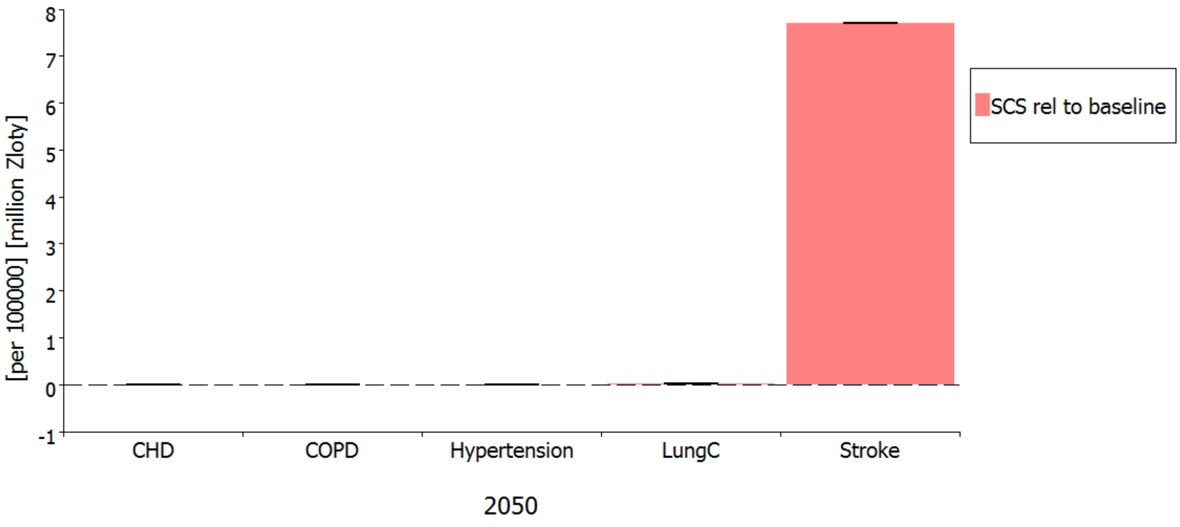


Figure 282. Direct healthcare costs (zloty millions) avoided (per 100,000), relative to baseline

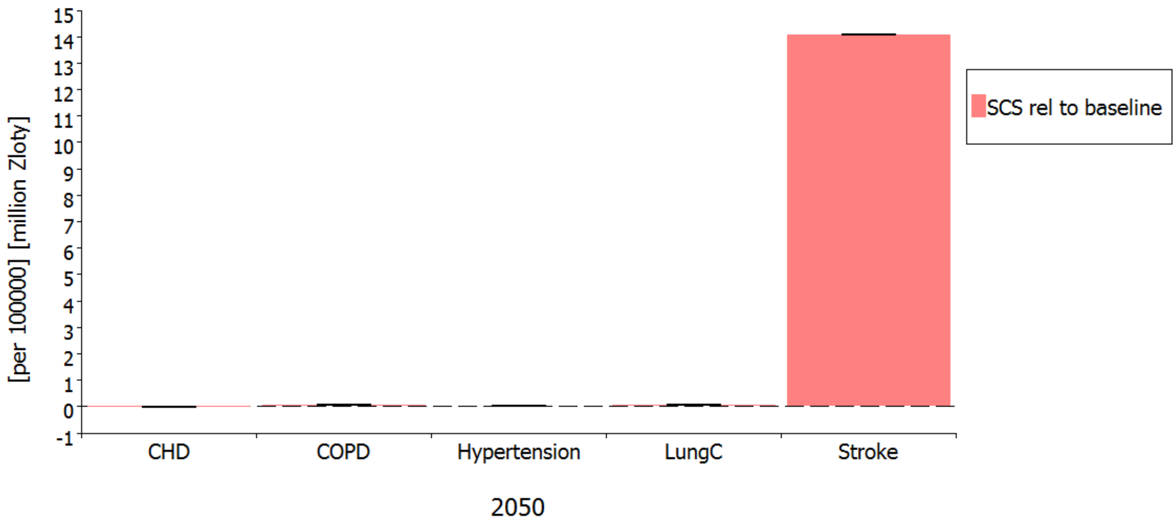


Figure 283. Indirect costs avoided (zloty millions) avoided (per 100,000), relative to baseline

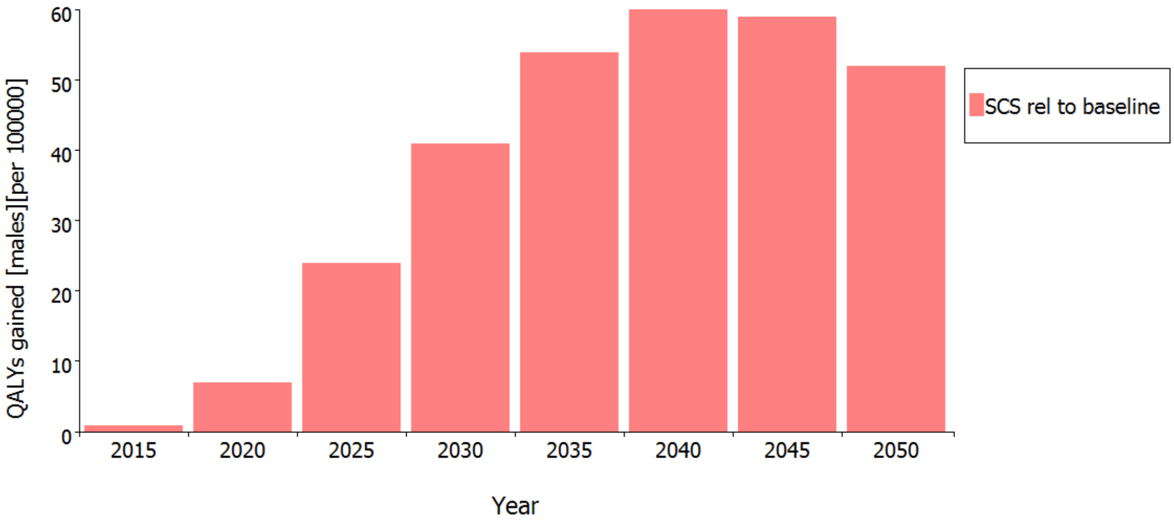


Figure 284. QALYs gained (per 100,000) relative to baseline (males)

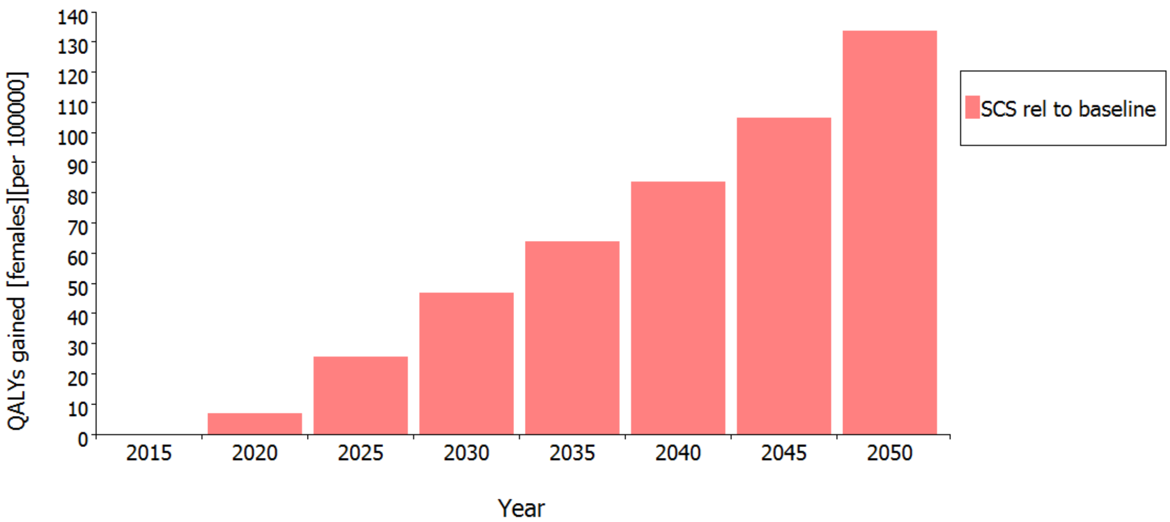


Figure 285. QALYS gained (per 100,000) relative to baseline (females)

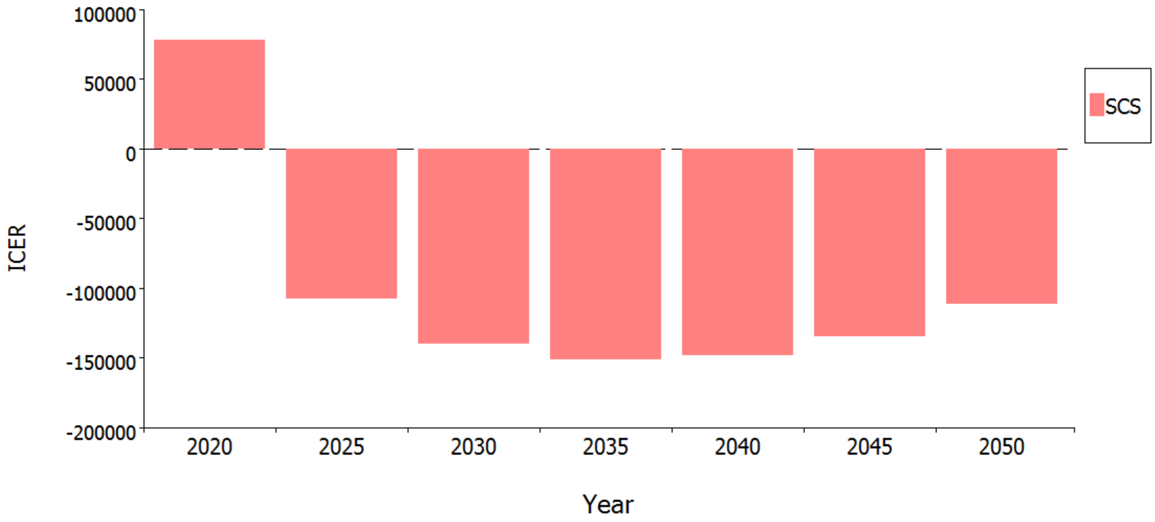


Figure 286. ICER

Portugal

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index (BMI; kg/m^2) are presented in Table 174 and for smoking prevalence by age and sex are presented in Table 175. Data were also collected by personal communication where possible.

Data were disaggregated by education level where available to explore future prevalence of each risk factor by sub-groups.

Table 174. References used in the model for BMI prevalence

Reference	Year	Sample size M	Sample size F	Age group	Measured/ Self-reported	National/ Regional
Marques-Vidal et al, Ten-year trends in overweight and obesity 1995-2005; 2011[1]	1996	38504		18-75	Self-reported	National
Marques-Vidal et al, Ten-year trends in overweight and obesity 1995-2005; 2011[1]	1999	38688		18-75	Self-reported	National
WHO; Carmo et al, Overweight and obesity in Portugal, 2008	2004	8116		18-64	Both	National
World Health Survey[1]	2003	1030		18-100	Self-reported	National
Marques-Vidal et al, Ten-year trends in overweight and obesity 1995-2005; 2011[1]	2006	25348		18-75	Self-reported	National
Luís B. Sardinha et al., Prevalence of Overweight, Obesity, and Abdominal Obesity in a Representative Sample of Portuguese Adults, 2012	2009	3961	5484	1 8- >75	Self-reported	National

[1] Surveys used for BMI trends by education level.

Table 175. References used in the model for smoking prevalence

Reference	Year	Sample size	Age group	National/ Subnational
European Health interview survey (Eurostat.ec.europa.eu)	2002	10540	20-100	National
E-cor study (Pers comm Mafalda Bourbon)	2013	1690	20-100	National

Disease data

Disease data sources are detailed in appendix A7. Data on incidence, prevalence, survival and mortality were needed stratified by sex and age. If available, country specific data were used. When the required data were not available for the country, proxy or calculated data were used. For Portugal, UK proxy data were used for CHD incidence and prevalence and COPD incidence. Diabetes statistics for Portugal and pre-diabetes remission data were used to estimate pre-diabetes incidence (Brown M Jaccard A 2015, appendix B4). Survival for CHD, COPD and stroke was estimated within the programme using prevalence and mortality data (see technical appendix B4 for details). Dutch data were used as proxy for direct costs of COPD, hypertension and pre-diabetes; for indirect costs for diabetes and hypertension and for utility weights for CHD, COPD and stroke accounting for exchange rates and purchasing price parities (appendix B5). UK data was used as proxy for COPD indirect costs, diabetes utility weights and hypertension utility weights.

Intervention data

Table 176 and Table 177 present the intervention input data for each of the interventions modelled:

Table 176. BMI Intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (Euro)
Baseline	None	-	-
MCLI regain	2.2	100	110
MCLI no regain	2.2	0	110
SSB	0.01	0	0

Table 177. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	59% (Finland proxy)
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 209 (Netherlands proxy)

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Section 2: Results of risk factor projections to 2050

BMI projections by age and sex

Table 178 presents the prevalence of normal weight, over-weight and obese (according to BMI) in the adult population by sex. Overall, in both Portuguese males and females, obesity prevalence is projected to increase reaching 53% and 37% respectively by 2050. Overweight prevalence is projected to decline. The proportion of healthy weight males and females is projected to decline over the next 35 years.

Figure 287 to Figure 291 present BMI-group projections to 2050 for males 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence described above is expected among males across all age groups. Among males40 to 79 years old, obesity prevalence could surpass 55% by 2050. The proportion of healthy weight males is predicted to decline in all age groups.

Figure 293 to Figure 298 present the BMI-group projections to 2050 for females 20-79 years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence is expected among all age groups except among the youngest (20-29 year olds) in whom it is predicted to decline slightly by 2050. The largest increase in obesity prevalence is projected among 60 to 79 year olds in whom obesity prevalence is expected to exceed 50% by 2050. Overweight prevalence is projected to remain stable or decline across age groups. The proportion of healthy weight females is predicted to decline in all age groups.

Table 178. Normal weight, overweight and obesity prevalence amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI	BMI<25	+/- 95% CI	BMI 25-29.9	+/- 95% CI	BMI≥30	+/- 95% CI
2015	32.0	4.4	46.0	4.7	22.0	3.6	42.0	4.1	37.0	4.1	21.0	3.3	37.0	4.2	42.0	4.4	21.0	3.4
2020	28.0	5.8	46.0	6.2	26.0	4.7	39.0	5.4	38.0	5.5	23.0	4.3	34.0	5.6	42.0	5.8	24.0	4.5
2025	25.0	7.2	45.0	7.7	30.0	5.9	36.0	6.7	38.0	6.8	25.0	5.4	31.0	7.0	42.0	7.3	27.0	5.7
2030	22.0	8.6	44.0	9.2	34.0	7.1	34.0	8.1	38.0	8.1	28.0	6.5	28.0	8.4	41.0	8.7	31.0	6.8
2035	19.0	10.1	42.0	10.7	39.0	8.2	32.0	9.4	38.0	9.5	30.0	7.6	26.0	9.8	40.0	10.1	34.0	7.9
2040	16.0	11.5	40.0	12.3	44.0	9.4	30.0	10.8	38.0	10.9	32.0	8.7	23.0	11.2	39.0	11.6	38.0	9.1
2045	14.0	13.0	38.0	13.8	48.0	10.6	28.0	12.1	37.0	12.2	35.0	9.8	21.0	12.6	38.0	13.0	41.0	10.2
2050	11.0	14.4	36.0	15.4	53.0	11.8	27.0	13.5	36.0	13.6	37.0	10.9	19.0	14.0	36.0	14.5	45.0	11.3

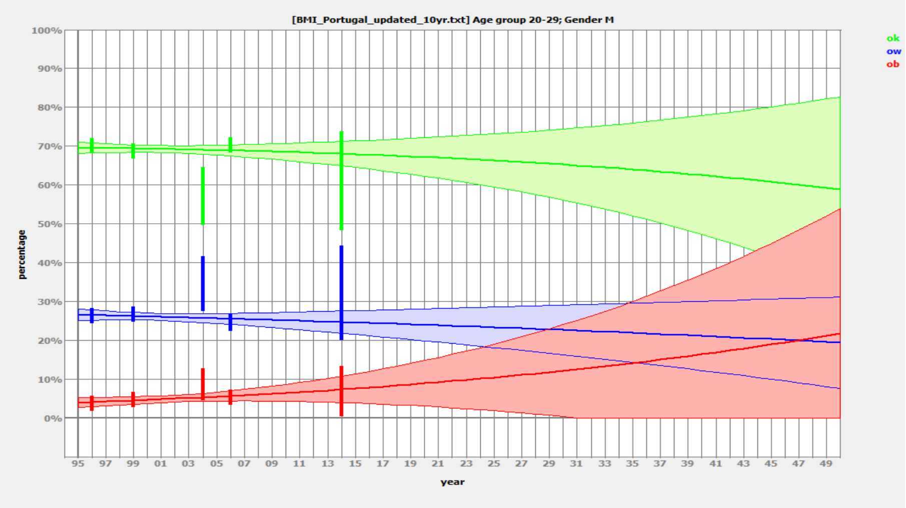


Figure 287. Projected BMI-group in 20-29 year old males

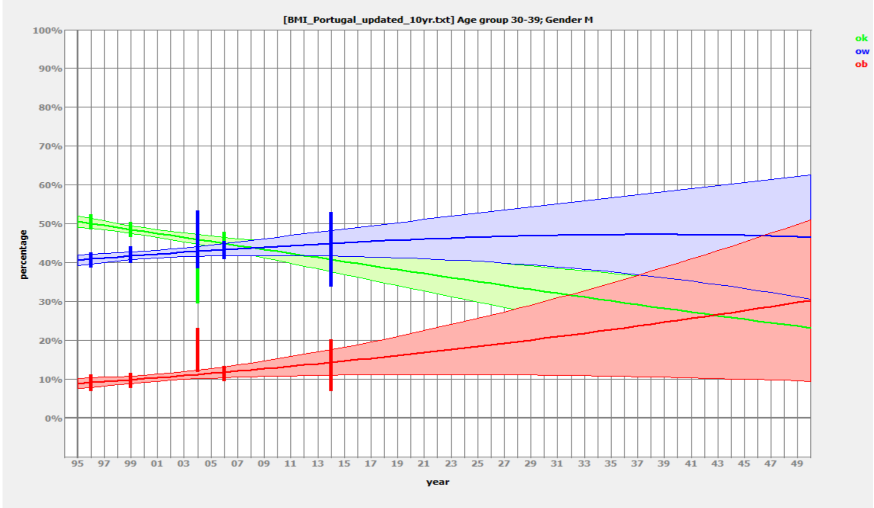


Figure 288. Projected BMI-group in 30-39 year old males

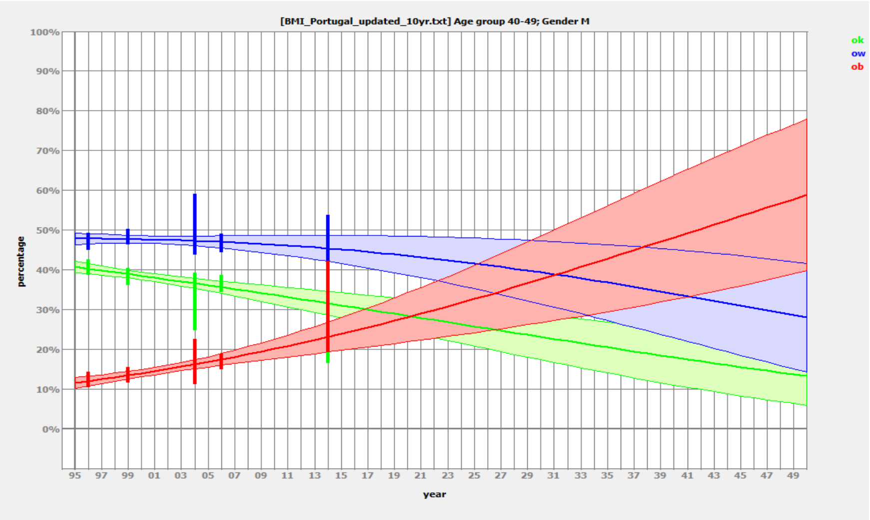


Figure 289. Projected BMI-group in 40-49 year old males

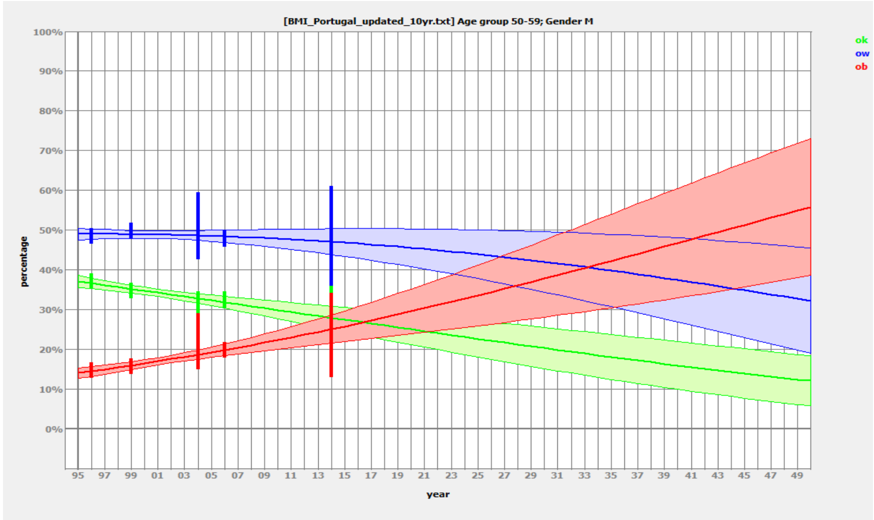


Figure 290. Projected BMI-group in 50-59 year old males

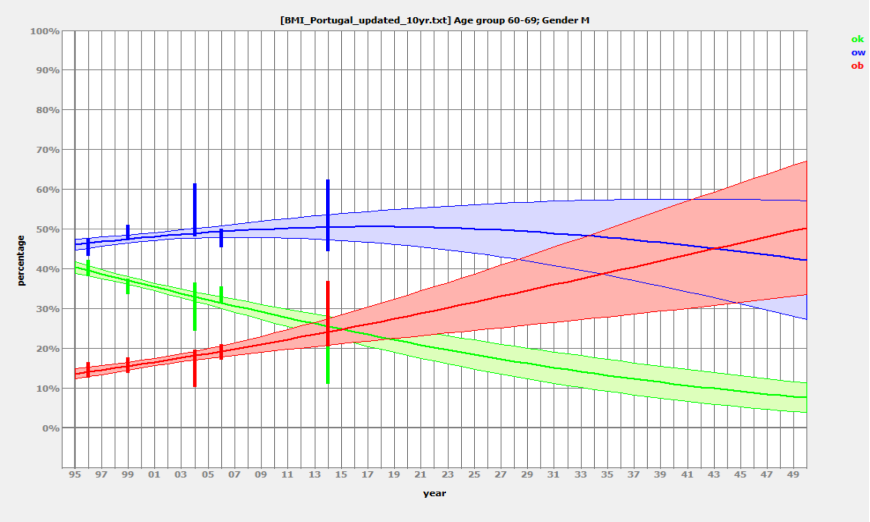


Figure 291. Projected BMI-group in 60-69 year old males

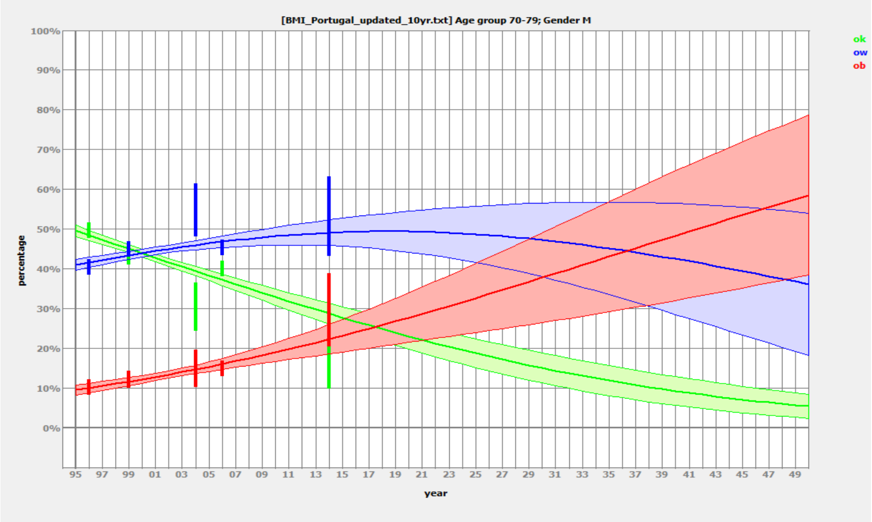


Figure 292. Projected BMI-group in 70-79 year old males

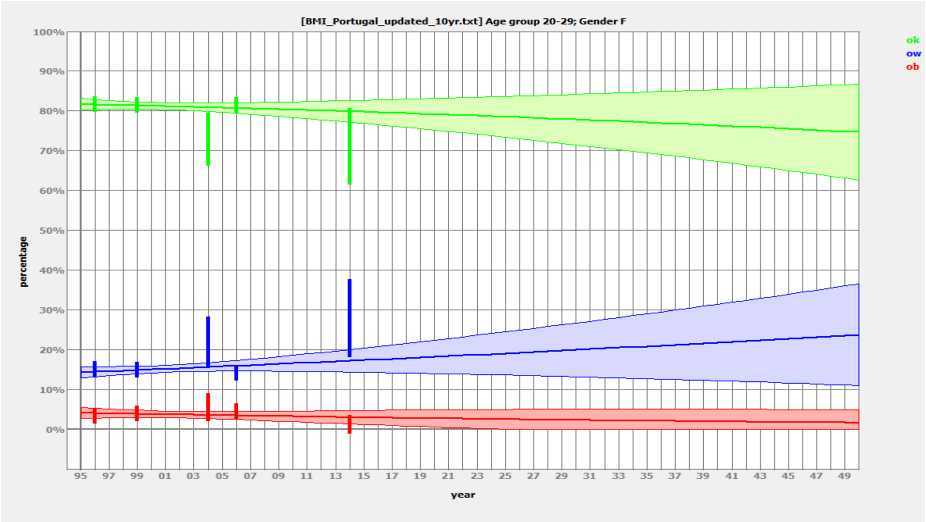


Figure 293. Projected BMI-group in 20-29 year old females

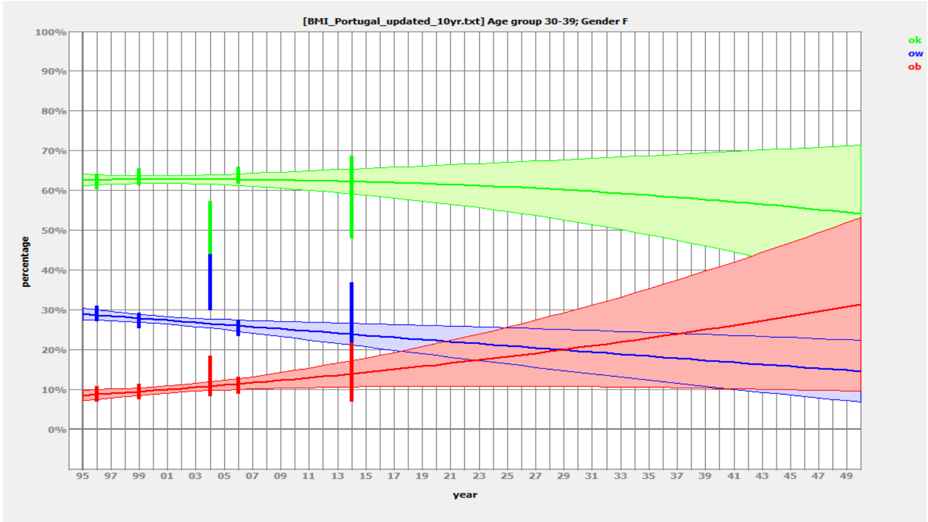


Figure 294. Projected BMI-group in 30-39 year old females

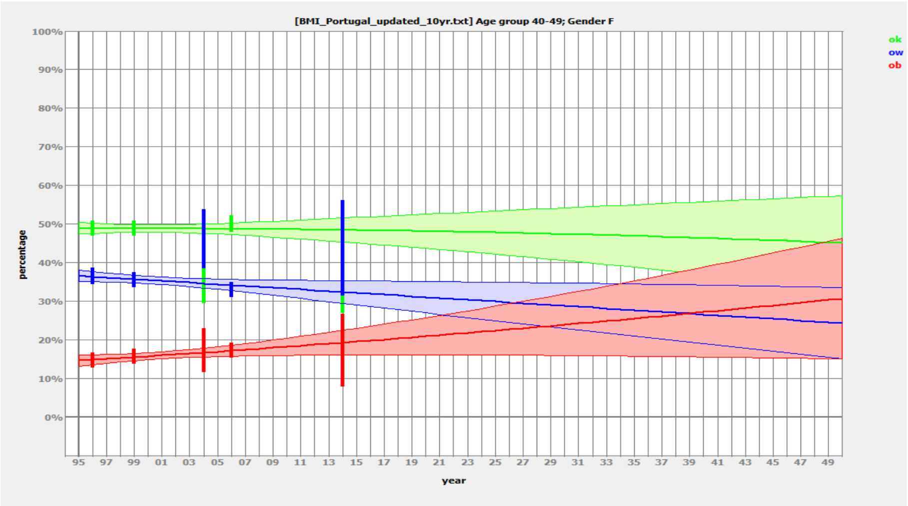


Figure 295. Projected BMI-group in 40-49 year old females

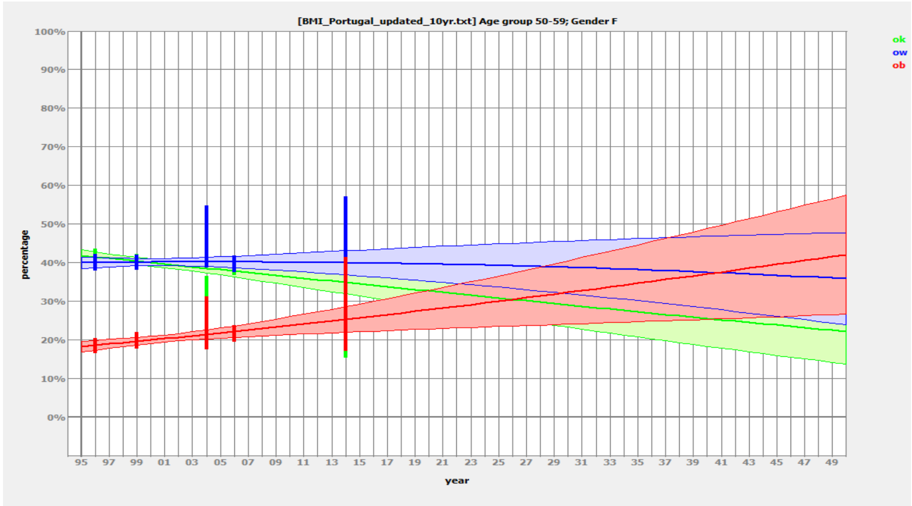


Figure 296. Projected BMI-group in 50-59 year old females

Figure 297. Projected BMI-group in 60-69 year old females

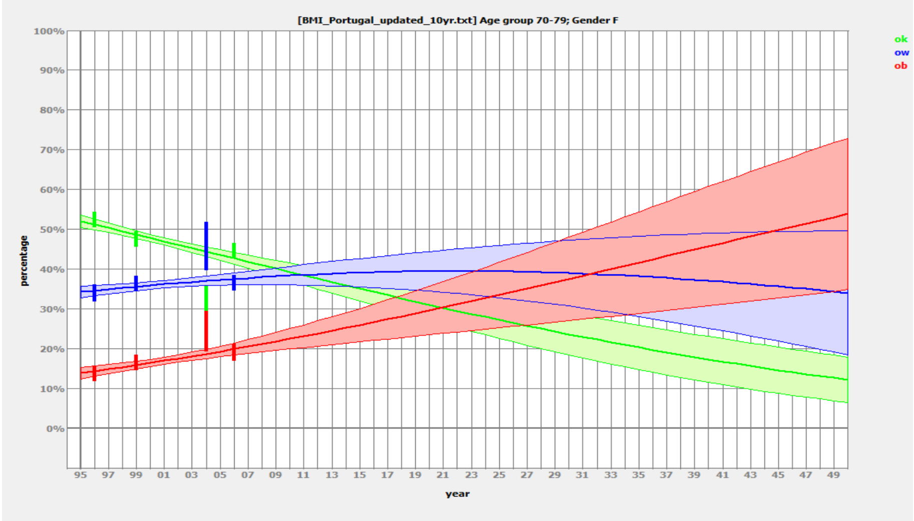


Figure 298. Projected BMI-group in 70-79 year old females

BMI projections by education level

Education was divided into two groups: 1) below tertiary education 2) tertiary education and above. Tertiary education was defined as 'post-secondary education'.

Males

Historically (1996 to 2006), overweight prevalence was lower among males with tertiary education compared to males with less than tertiary education, but overweight is currently higher amongst more educated males (Figure 299). Overweight prevalence is projected to remain higher among males with tertiary education levelling off in 2028, while a decline in the prevalence of overweight is expected among males with less than tertiary education (Figure 299). There is overlap of confidence intervals for the projections therefore future monitoring of these trends is recommended.

Obesity prevalence is expected to increase in both more and less educated Portuguese male over the next 40 years (Figure 300). Absolute inequalities were small from the late 1990s to 2008, with a difference in obesity prevalence between the two education groups of approximately 5%. From 2008 onwards, obesity prevalence in both education groups is projected to converge, absolute and relative inequalities are projected to disappear. By 2050 males with less than tertiary education are projected to have lower obesity prevalence than those with tertiary education however the difference in prevalence is small and the confidence intervals overlapping (appendix E6).

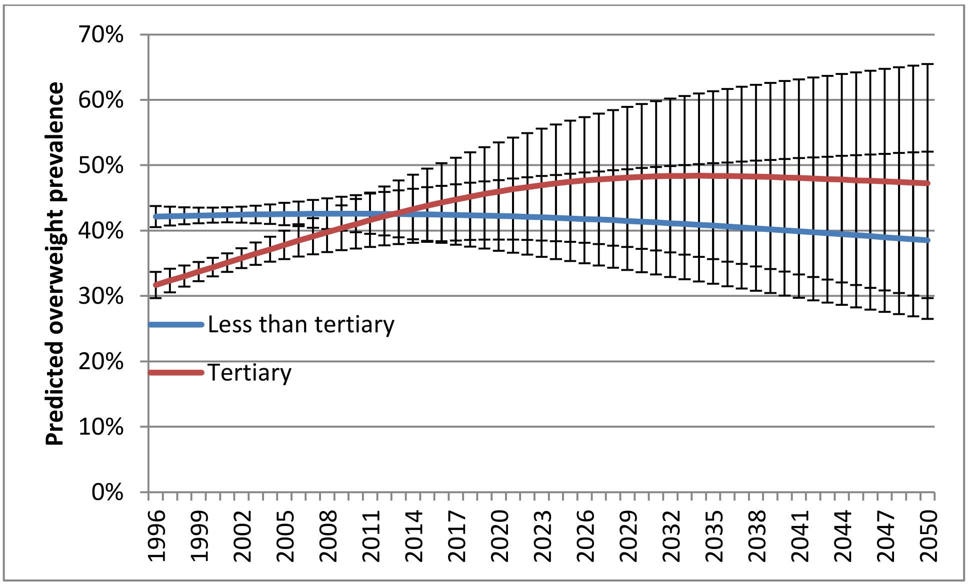


Figure 299. Overweight projections by education level among males

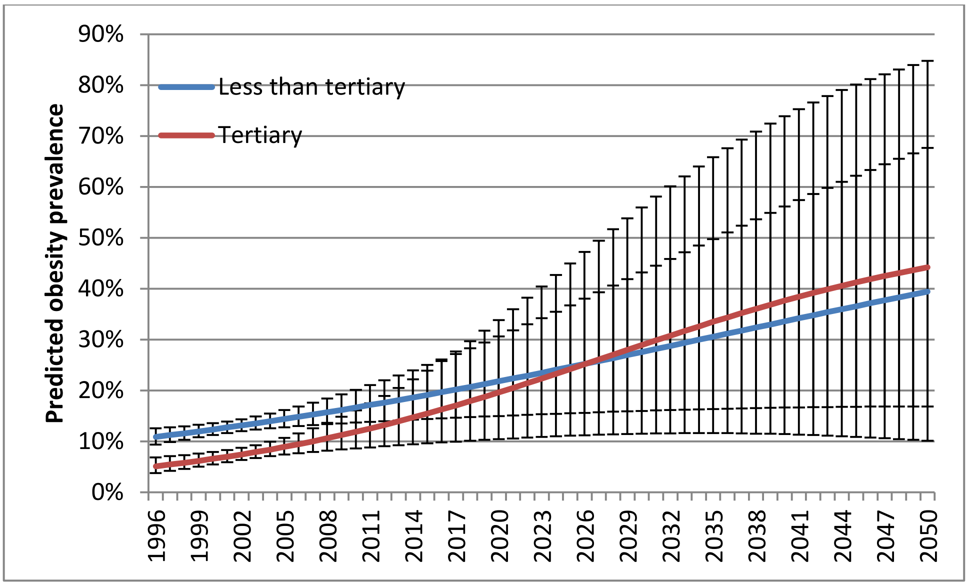


Figure 300. Obesity projections by education level among males

Females

Inequalities in overweight prevalence were large among Portuguese females between 1996 and 2011. Less educated Portuguese females had a higher prevalence of overweight compared to more educated Portuguese females (Figure 301). However, while overweight prevalence is projected to decline among females with less than tertiary education, it is projected to increase among female with tertiary education. Inequalities between education groups are projected to narrow to 2020. After 2020, if the trend is unaltered, Portuguese females with tertiary education are likely to have a much higher prevalence of overweight compared to Portuguese female with less than tertiary education (Figure 301). However, there is overlap between confidence intervals so more data are necessary to determine the significance of this trend.

Inequalities in obesity prevalence among Portuguese females follow a similar trend to overweight. Obesity prevalence was approximately 10% higher among less educated females from 1996 to 2010 (Figure 302 and appendix E6) but the rate of increase in obesity was faster among females with tertiary education than females with less than tertiary education. For this reason, obesity prevalence is converging in the two education groups and there is a chance that Portuguese females with tertiary education will have higher obesity prevalence than Portuguese females with less than tertiary education in 20 years' time if trends go unchecked (Figure 302). Again, overlap between confidence intervals mean more data are necessary to determine the significance of this trend.

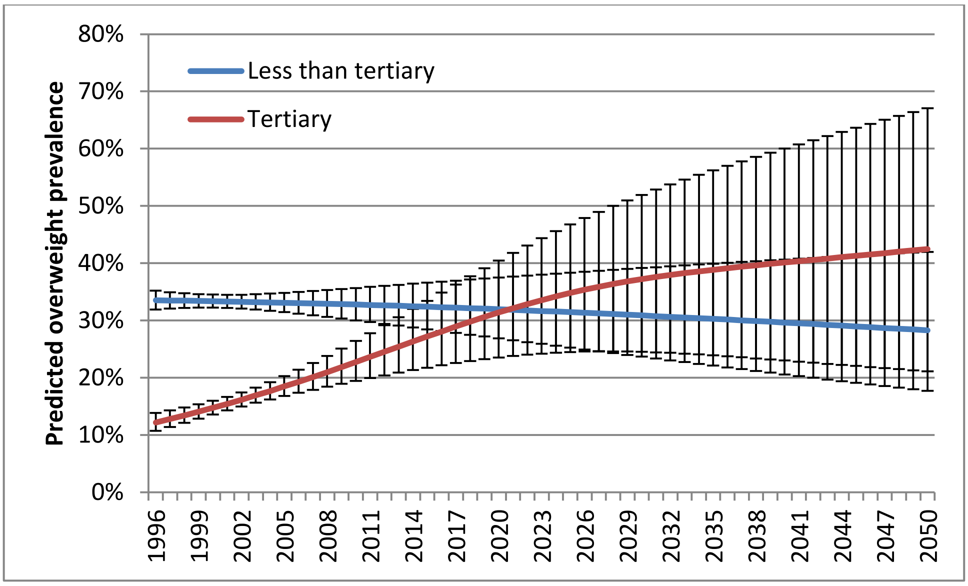


Figure 301. Overweight prevalence by education level among females

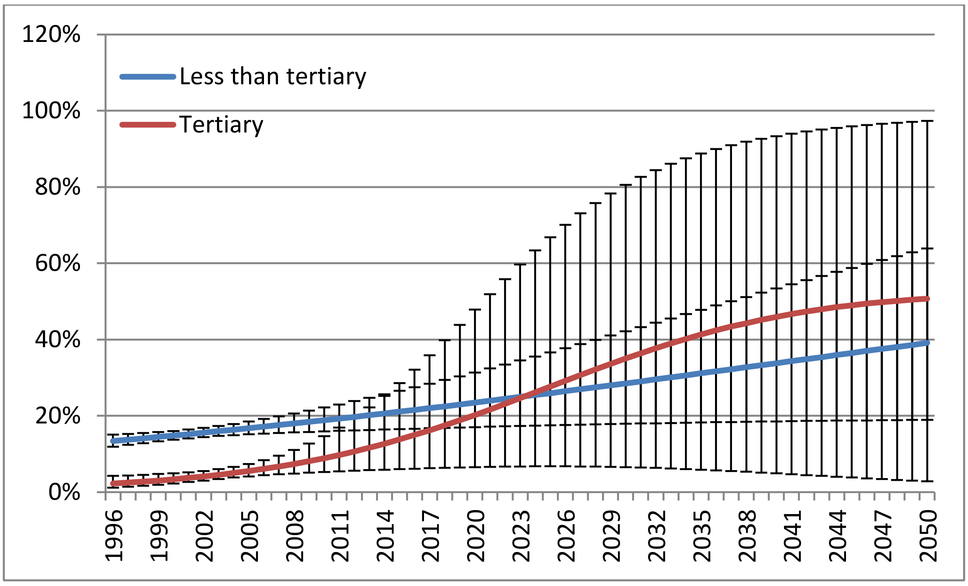


Figure 302. Obesity prevalence by education level among females

Smoking projections by sex and age

Table 179 presents smoking prevalence projections to 2050 for males and females aged 20 to 100; data were not available by education group for Portugal. Smoking prevalence is projected to decline among Portuguese males. Among Portuguese female, smoking prevalence is projected to increase substantially. Figure 303 to Figure 307 present the projected prevalence of current smokers (blue) and never and ex-smokers (green) of males and females 20-69 years old. The simulation was projected to 2050 and the graphical representations are stratified into 10-year age groups. Based on the data available (two time-points), smoking prevalence is projected to decline among 30 to 49 year olds and among 60 to 69 year olds. The largest decline in smoking prevalence is predicted to be among 40 to 49 year olds; from 50% in 2001 to approximately 10% in 2050. Smoking prevalence is projected to increase in males aged 20 to 29 years old and to remain stable among 50 to 59 year olds.

Among females, Figure 308 to Figure 312, smoking prevalence is projected to increase substantially in all age groups except among 60 to 69 year olds. According to these projections, smoking prevalence could surpass 50% among females if rates follow the projected trajectory. There are limitations to these projections given that they are based on two data points only. As more data becomes available, it will be necessary to monitor and update the smoking prevalence trends.

Table 179. Smoker prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-	Non-smokers	95% CI +/-	Smokers	95% CI +/-
2015	69.0	12.9	31.0	12.9	80.0	10.7	20.0	10.7	75.0	11.8	25.0	11.8
2020	71.0	18.0	29.0	18.0	73.0	14.9	27.0	14.9	72.0	16.5	28.0	16.5
2025	72.0	23.2	28.0	23.2	66.0	19.1	34.0	19.1	69.0	21.3	31.0	21.3
2030	73.0	28.5	27.0	28.5	58.0	23.4	42.0	23.4	65.0	26.0	35.0	26.0
2035	74.0	33.7	26.0	33.7	51.0	27.7	49.0	27.7	62.0	30.8	38.0	30.8
2040	75.0	39.0	25.0	39.0	44.0	31.9	56.0	31.9	59.0	35.6	41.0	35.6
2045	76.0	44.3	24.0	44.3	38.0	36.2	62.0	36.2	56.0	40.4	44.0	40.4
2050	76.0	49.5	24.0	49.5	33.0	40.5	67.0	40.5	54.0	45.2	46.0	45.2

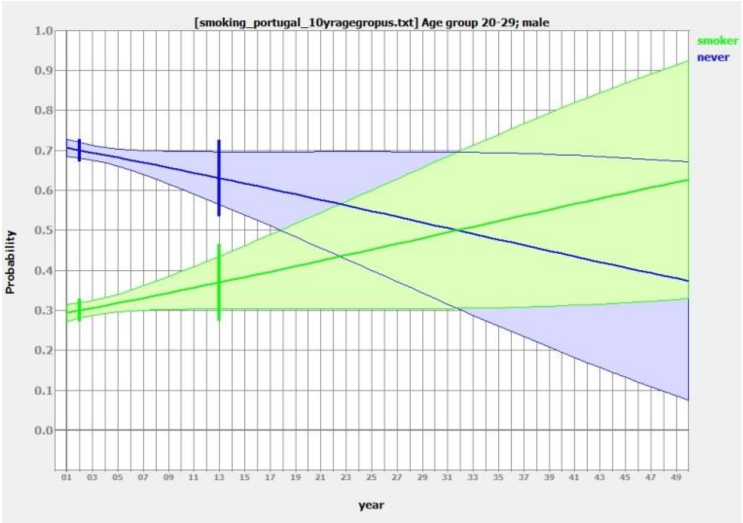


Figure 303 Smoking prevalence projections among 20 to 29 year old males

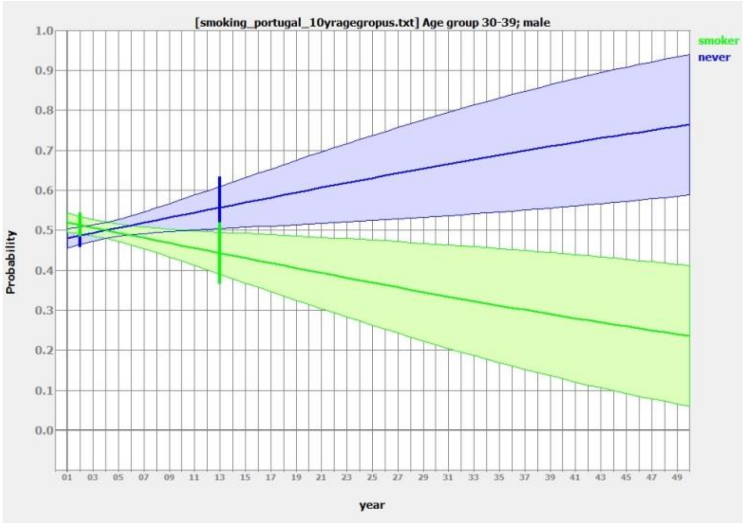


Figure 304 Smoking prevalence projections among 30-39 year old males

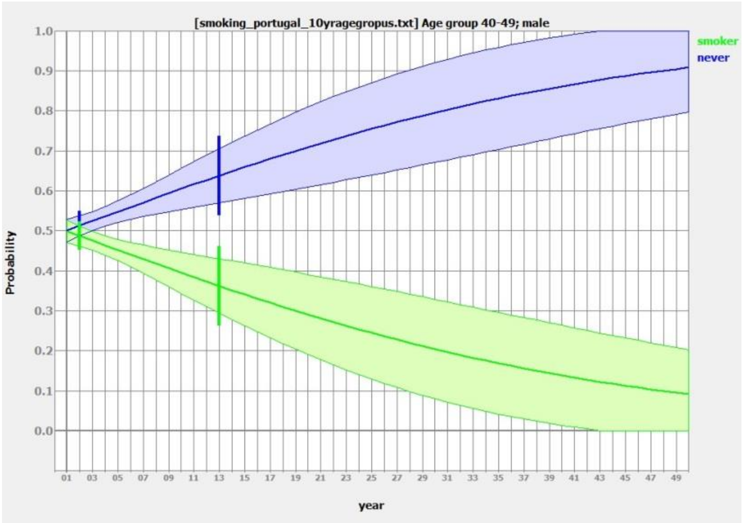


Figure 305 Smoking prevalence projections among 40 to 49 year old males

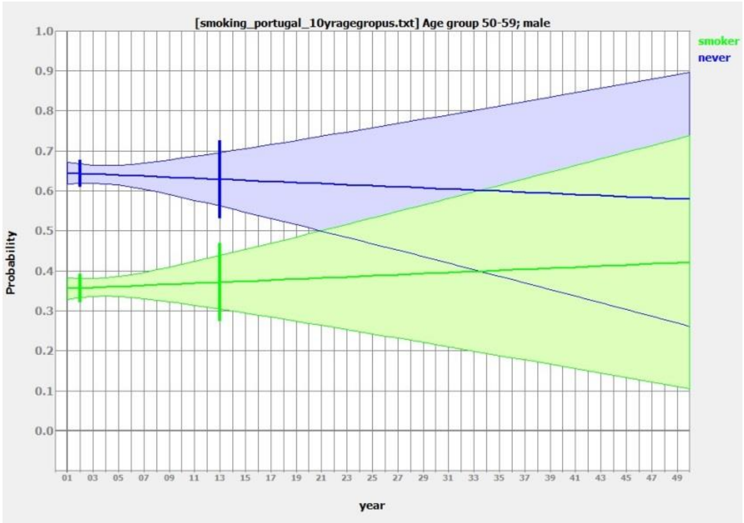


Figure 306 Smoking prevalence projections among 50 to 59 year old males

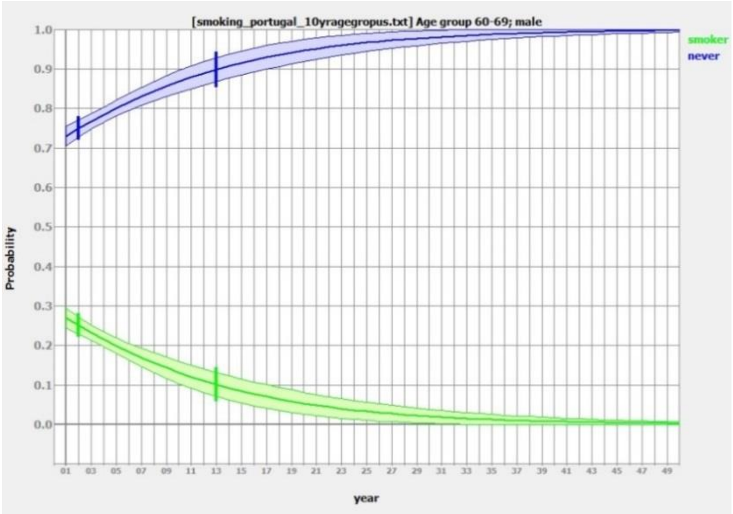


Figure 307 Smoking prevalence projections among 60 to 69 year old males

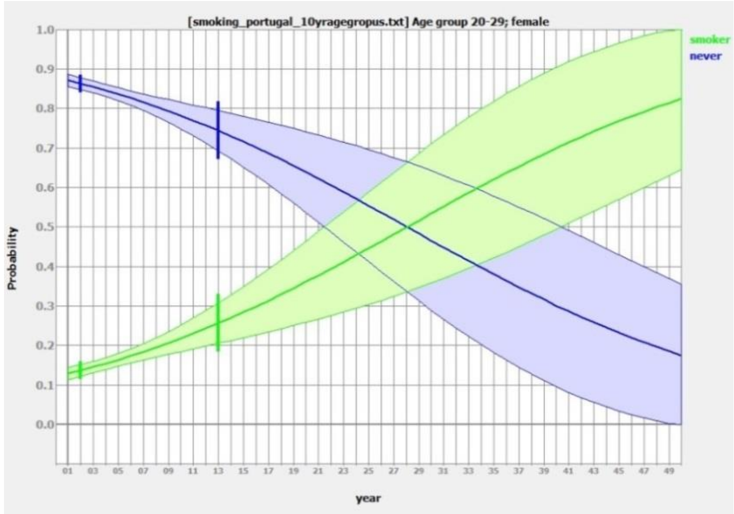


Figure 308 Smoking prevalence projections among 20 to 29 year old females

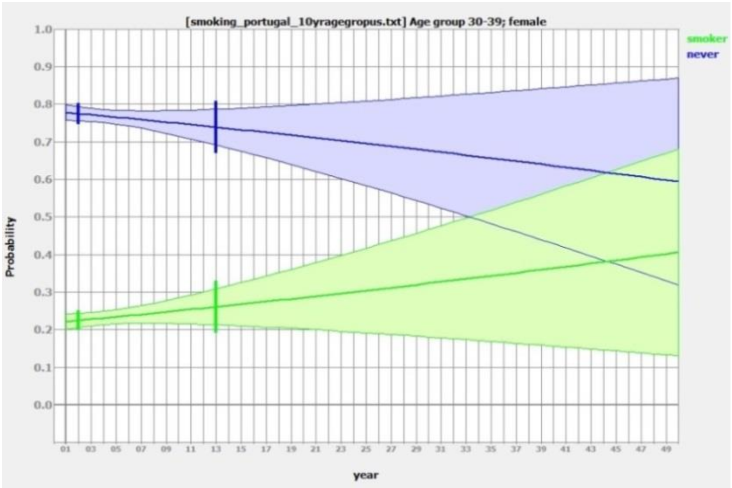


Figure 309 Smoking prevalence projections among 30 to 39 year old females

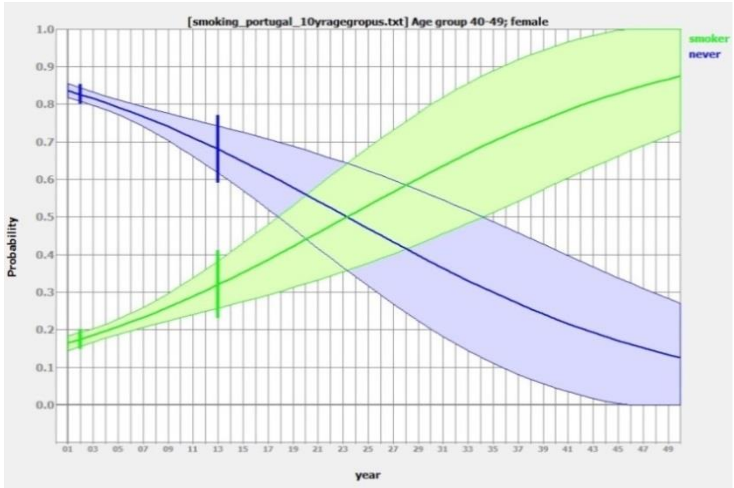


Figure 310 Smoking prevalence projections among 40 to 49 year old females

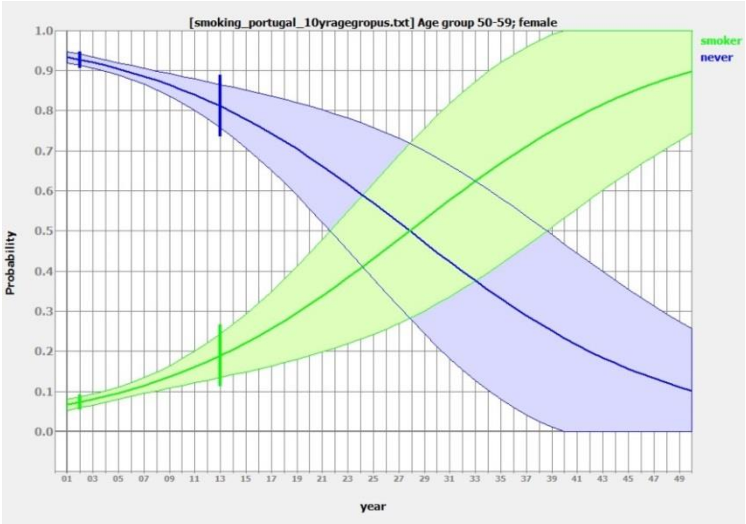


Figure 311 Smoking prevalence projections among 50 to 59 year old females

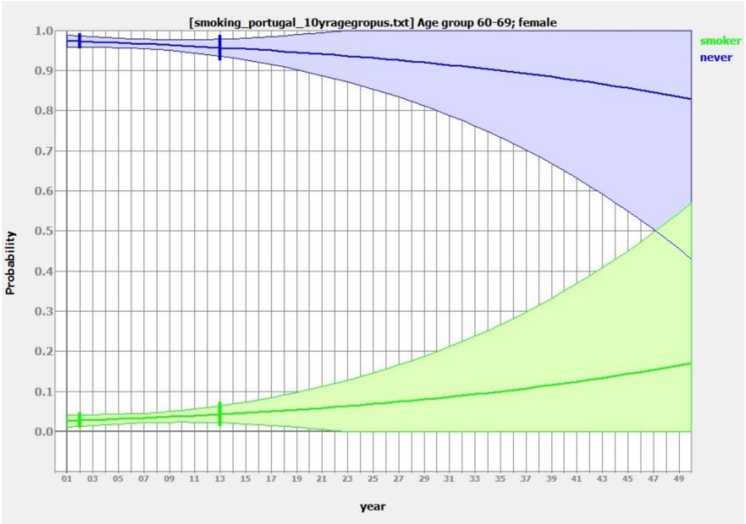


Figure 312 Smoking prevalence projections among 60 to 69 year old females

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in Table 180. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

Table 180 presents the intervention input data for each of the interventions modelled.

Table 180. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (Euro)
Baseline	None	-	-
MCLI regain	2.2	100	110
MCLI no regain	2.2	0	110
SSB	0.01	0	0

Multi-component lifestyle interventions (MCLI)

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain –** these results are presented in appendix E1.

Impact on disease incidence and prevalence

Table 181 presents the incidence cases per 100,000 to 2050 for baseline (no intervention) and each MCLI intervention scenario. For each disease and intervention scenario incidence cases increase over time (except hypertension which begins to decreases in 2035), but the interventions are effective in reducing incidence over time. Table 182 presents the cumulative incidence cases per 100,000 to 2050 for baseline and each intervention.

Table 183 and Figure 313 both present the cumulative incidence cases *avoided* per 100,000 for baseline and each intervention (the table presents data for all years while the figure presents 2050 projections). Each table/figure indicates that both MCLI interventions would result in a lower cumulative incidence of all diseases by 2050 compared to baseline. MCLI (no regain) would result in the avoidance of 393 cumulative incidence cases of CHD per 100,000 relative to baseline by 2050. Even when MCLI is modelled with weight regain there is a positive effect, with the avoidance of 296, 700 and 524 cumulative incidence cases of CHD, hypertension and type 2 diabetes per 100,000 respectively.

Table 181. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	158 [+-1]	1111 [+-3]	865 [+-3]	324 [+-2]	488 [+-2]
	2020	176 [+-1]	1200 [+-3]	931 [+-3]	354 [+-2]	526 [+-2]
	2025	192 [+-1]	1273 [+-3]	994 [+-3]	393 [+-2]	568 [+-2]
	2030	212 [+-1]	1285 [+-3]	1047 [+-3]	433 [+-2]	613 [+-2]
	2035	231 [+-1]	1235 [+-3]	1093 [+-3]	460 [+-2]	661 [+-2]
	2040	252 [+-1]	1210 [+-3]	1131 [+-3]	477 [+-2]	710 [+-2]
	2045	272 [+-2]	1201 [+-3]	1156 [+-3]	495 [+-2]	757 [+-3]
	2050	292 [+-2]	1213 [+-3]	1172 [+-3]	509 [+-2]	789 [+-3]
MCLI (annual, with regain)	2015	157 [+-1]	1103 [+-3]	861 [+-3]	324 [+-2]	485 [+-2]
	2020	174 [+-1]	1190 [+-3]	915 [+-3]	352 [+-2]	522 [+-2]
	2025	188 [+-1]	1258 [+-3]	974 [+-3]	386 [+-2]	560 [+-2]
	2030	205 [+-1]	1262 [+-3]	1024 [+-3]	420 [+-2]	605 [+-2]
	2035	223 [+-1]	1219 [+-3]	1062 [+-3]	443 [+-2]	654 [+-2]
	2040	243 [+-1]	1191 [+-3]	1100 [+-3]	460 [+-2]	701 [+-2]
	2045	261 [+-2]	1187 [+-3]	1127 [+-3]	474 [+-2]	743 [+-3]
	2050	279 [+-2]	1202 [+-3]	1140 [+-3]	489 [+-2]	777 [+-3]
MCLI (annual, with no regain)	2015	157 [+-1]	1104 [+-3]	861 [+-3]	324 [+-2]	486 [+-2]
	2020	171 [+-1]	1181 [+-3]	910 [+-3]	349 [+-2]	519 [+-2]
	2025	186 [+-1]	1252 [+-3]	970 [+-3]	383 [+-2]	556 [+-2]
	2030	202 [+-1]	1261 [+-3]	1024 [+-3]	417 [+-2]	605 [+-2]
	2035	220 [+-1]	1222 [+-3]	1064 [+-3]	442 [+-2]	651 [+-2]
	2040	241 [+-1]	1195 [+-3]	1101 [+-3]	459 [+-2]	699 [+-2]
	2045	259 [+-2]	1192 [+-3]	1125 [+-3]	474 [+-2]	742 [+-3]
	2050	277 [+-2]	1201 [+-3]	1142 [+-3]	489 [+-2]	779 [+-3]

Table 182. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	158 [+-1]	1111 [+-3]	865 [+-3]	324 [+-2]	488 [+-2]
	2020	1013 [+-3]	6961 [+-7]	5399 [+-6]	2043 [+-4]	3056 [+-5]
	2025	1966 [+-4]	13316 [+-9]	10335 [+-9]	3975 [+-5]	5871 [+-7]
	2030	3040 [+-5]	20058 [+-11]	15747 [+-10]	6165 [+-7]	9003 [+-8]
	2035	4258 [+-6]	26973 [+-13]	21647 [+-12]	8612 [+-8]	12519 [+-9]
	2040	5648 [+-7]	34091 [+-14]	28057 [+-13]	11299 [+-9]	16463 [+-11]
	2045	7227 [+-8]	41580 [+-15]	35015 [+-14]	14238 [+-10]	20879 [+-12]
	2050	9013 [+-9]	49654 [+-15]	42577 [+-15]	17460 [+-12]	25804 [+-13]
MCLI (annual, with regain)	2015	157 [+-1]	1103 [+-3]	861 [+-3]	324 [+-2]	485 [+-2]
	2020	1001 [+-3]	6896 [+-7]	5341 [+-6]	2029 [+-4]	3042 [+-5]
	2025	1937 [+-4]	13171 [+-9]	10189 [+-8]	3927 [+-5]	5832 [+-7]
	2030	2982 [+-5]	19798 [+-11]	15480 [+-10]	6058 [+-7]	8929 [+-8]
	2035	4158 [+-6]	26602 [+-13]	21223 [+-12]	8424 [+-8]	12405 [+-9]
	2040	5497 [+-7]	33602 [+-14]	27461 [+-13]	11013 [+-9]	16288 [+-11]
	2045	7009 [+-8]	40987 [+-15]	34222 [+-14]	13839 [+-10]	20632 [+-12]
	2050	8717 [+-9]	48954 [+-15]	41574 [+-15]	16936 [+-11]	25477 [+-13]
MCLI (annual, with no regain)	2015	157 [+-1]	1104 [+-3]	861 [+-3]	324 [+-2]	486 [+-2]
	2020	995 [+-3]	6873 [+-7]	5333 [+-6]	2020 [+-4]	3031 [+-5]
	2025	1915 [+-4]	13110 [+-9]	10164 [+-8]	3902 [+-5]	5808 [+-7]
	2030	2946 [+-5]	19729 [+-11]	15451 [+-10]	6017 [+-7]	8888 [+-8]
	2035	4107 [+-6]	26541 [+-13]	21194 [+-12]	8370 [+-8]	12347 [+-9]
	2040	5428 [+-7]	33545 [+-14]	27426 [+-13]	10950 [+-9]	16224 [+-11]
	2045	6925 [+-8]	40928 [+-15]	34194 [+-14]	13767 [+-10]	20559 [+-12]
	2050	8620 [+-9]	48897 [+-15]	41544 [+-15]	16855 [+-11]	25395 [+-13]

Table 183. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	1 [+-1]	8 [+-4]	4 [+-4]	0 [+-3]	3 [+-3]
	2020	12 [+-4]	65 [+-10]	58 [+-8]	14 [+-6]	14 [+-7]
	2025	29 [+-6]	145 [+-13]	146 [+-12]	48 [+-7]	39 [+-10]
	2030	58 [+-7]	260 [+-16]	267 [+-14]	107 [+-10]	74 [+-11]
	2035	100 [+-8]	371 [+-18]	424 [+-17]	188 [+-11]	114 [+-13]
	2040	151 [+-10]	489 [+-20]	596 [+-18]	286 [+-13]	175 [+-16]
	2045	218 [+-11]	593 [+-21]	793 [+-20]	399 [+-14]	247 [+-17]
	2050	296 [+-13]	700 [+-21]	1003 [+-21]	524 [+-16]	327 [+-18]
MCLI (annual, with no regain), relative to baseline	2015	1 [+-1]	7 [+-4]	4 [+-4]	0 [+-3]	2 [+-3]
	2020	18 [+-4]	88 [+-10]	66 [+-8]	23 [+-6]	25 [+-7]
	2025	51 [+-6]	206 [+-13]	171 [+-12]	73 [+-7]	63 [+-10]
	2030	94 [+-7]	329 [+-16]	296 [+-14]	148 [+-10]	115 [+-11]
	2035	151 [+-8]	432 [+-18]	453 [+-17]	242 [+-11]	172 [+-13]
	2040	220 [+-10]	546 [+-20]	631 [+-18]	349 [+-13]	239 [+-16]
	2045	302 [+-11]	652 [+-21]	821 [+-20]	471 [+-14]	320 [+-17]
	2050	393 [+-13]	757 [+-21]	1033 [+-21]	605 [+-16]	409 [+-18]

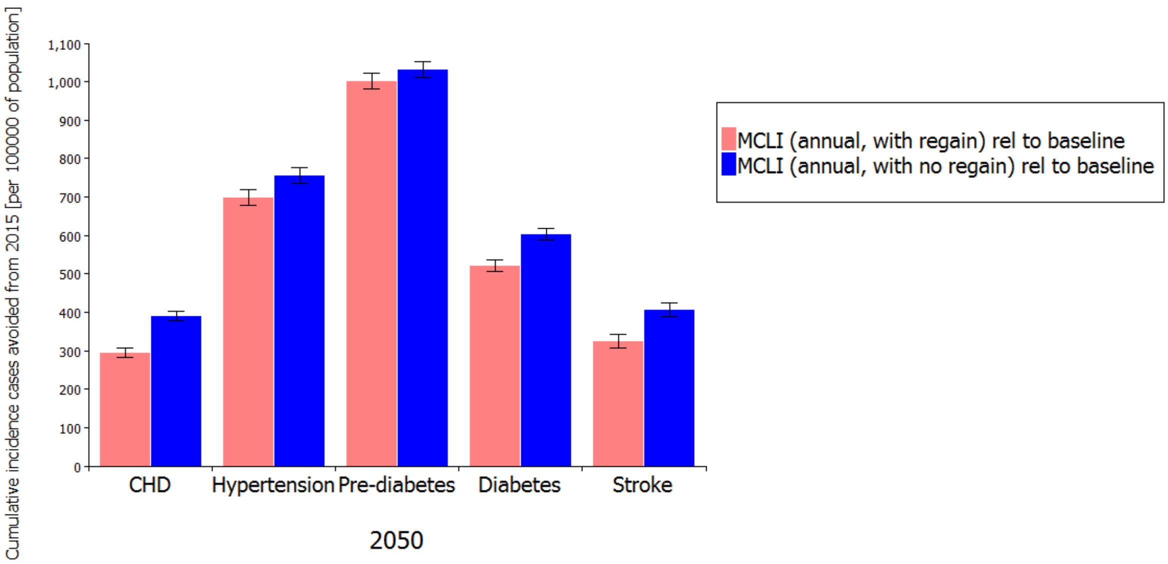


Figure 313. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 184. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain) relative to baseline	2015	0 [+-4]	4 [+-18]	0 [+-11]	2 [+-10]	-1 [+-8]
	2020	10 [+-4]	59 [+-18]	40 [+-11]	13 [+-10]	7 [+-8]
	2025	18 [+-4]	129 [+-20]	82 [+-11]	44 [+-10]	22 [+-10]
	2030	30 [+-4]	222 [+-20]	131 [+-11]	88 [+-11]	41 [+-10]
	2035	47 [+-4]	303 [+-20]	165 [+-11]	149 [+-11]	58 [+-10]
	2040	56 [+-6]	377 [+-20]	186 [+-13]	213 [+-13]	87 [+-11]
	2045	71 [+-6]	423 [+-21]	202 [+-13]	275 [+-13]	114 [+-11]
	2050	83 [+-6]	462 [+-21]	215 [+-13]	325 [+-13]	137 [+-11]
MCLI (annual, with no regain) relative to baseline	2015	1 [+-4]	2 [+-18]	1 [+-11]	0 [+-10]	-5 [+-8]
	2020	15 [+-4]	80 [+-18]	46 [+-11]	18 [+-10]	13 [+-8]
	2025	34 [+-4]	185 [+-20]	95 [+-11]	62 [+-10]	36 [+-9]
	2030	46 [+-4]	274 [+-20]	136 [+-11]	117 [+-11]	62 [+-10]
	2035	63 [+-4]	337 [+-20]	166 [+-11]	184 [+-11]	82 [+-10]
	2040	74 [+-6]	399 [+-20]	189 [+-13]	247 [+-13]	103 [+-11]
	2045	86 [+-6]	443 [+-21]	197 [+-13]	309 [+-13]	129 [+-11]
	2050	96 [+-6]	474 [+-21]	206 [+-13]	358 [+-13]	148 [+-11]

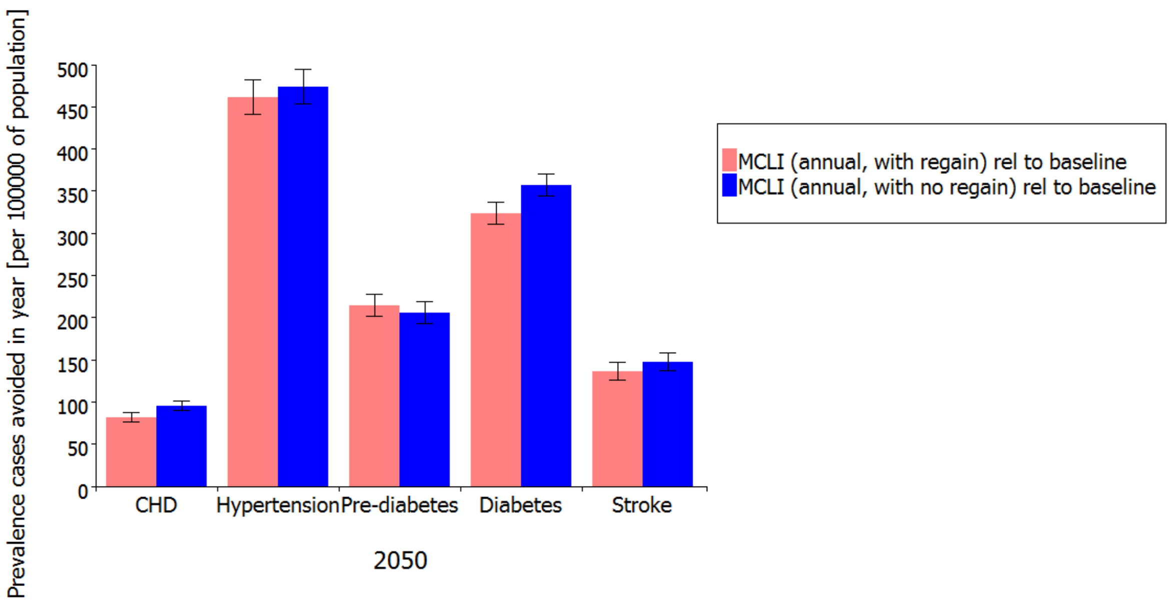


Figure 314. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 185 and Figure 315 present the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to be observed in stroke for both MCLI interventions (€0.50m and €0.54m per 100,000 population in 2050 for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Table 186 and Figure 316 present the indirect costs that can be avoided (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to be observed in stroke (€1.15m and €1.24m per 100,000 population in 2050 for the *MCLI (weight regain)* and *MCLI (no weight regain)* scenarios, respectively).

Figure 317 and Figure 318 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the baseline. For both males and females, both variations of the MCLI interventions are expected to lead to increasing gains in QALYs over time.

In Figure 319 the positive ICER values in 2020 and 2025 (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both the MCLI scenarios may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Portugal. The negative ICER values thereafter (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates both MCLI scenarios are cost effective (the MCLI intervention scenarios *dominate* the baseline scenario)..

Table 185 Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	-0.00037 [+-0.000103]	0.000378 [+-0.000665]	0.000019 [+-0.000054]	0.002707 [+-0.000969]	-0.01183 [+-0.008128]
	2020	0.020415 [+-0.000095]	0.00496 [+-0.000558]	0.001915 [+-0.000045]	0.014465 [+-0.000836]	0.104797 [+-0.007332]
	2025	0.029516 [+-0.000086]	0.008575 [+-0.000472]	0.003114 [+-0.000037]	0.04033 [+-0.000736]	0.271393 [+-0.006552]
	2030	0.038721 [+-0.000077]	0.011514 [+-0.000402]	0.003892 [+-0.000032]	0.064562 [+-0.00066]	0.401356 [+-0.005876]
	2035	0.047859 [+-0.000069]	0.012338 [+-0.000338]	0.003852 [+-0.000027]	0.084706 [+-0.000594]	0.444012 [+-0.005294]
	2040	0.044555 [+-0.000062]	0.012043 [+-0.000281]	0.003402 [+-0.000023]	0.095568 [+-0.000532]	0.515541 [+-0.004746]
	2045	0.044204 [+-0.000055]	0.010562 [+-0.000232]	0.002896 [+-0.000019]	0.096352 [+-0.000469]	0.53376 [+-0.004205]
	2050	0.040573 [+-0.000048]	0.00906 [+-0.000191]	0.002418 [+-0.000016]	0.089294 [+-0.000407]	0.500134 [+-0.003665]

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with no regain), relative to baseline	2015	0.001947 [+-0.000103]	0.000259 [+-0.000665]	0.000081 [+-0.000054]	-0.00058 [+-0.00097]	-0.09743 [+-0.008133]
	2020	0.030873 [+-0.000095]	0.006776 [+-0.000557]	0.002216 [+-0.000045]	0.021333 [+-0.000836]	0.199844 [+-0.007326]
	2025	0.055575 [+-0.000086]	0.01229 [+-0.000472]	0.003582 [+-0.000037]	0.057522 [+-0.000735]	0.442993 [+-0.006541]
	2030	0.060572 [+-0.000076]	0.014264 [+-0.000401]	0.004035 [+-0.000032]	0.085312 [+-0.000658]	0.608826 [+-0.005861]
	2035	0.063928 [+-0.000069]	0.013724 [+-0.000338]	0.003866 [+-0.000027]	0.104631 [+-0.000593]	0.62809 [+-0.00528]
	2040	0.058085 [+-0.000062]	0.012735 [+-0.000281]	0.003447 [+-0.000023]	0.110787 [+-0.00053]	0.613487 [+-0.004738]
	2045	0.053309 [+-0.046824]	0.011072 [+-0.000232]	0.002817 [+-0.000019]	0.108149 [+-0.000468]	0.602604 [+-0.004199]
	2050	0.046824 [+-0.000048]	0.009289 [+-0.000191]	0.002319 [+-0.000016]	0.098388 [+-0.000406]	0.54039 [+-0.003662]

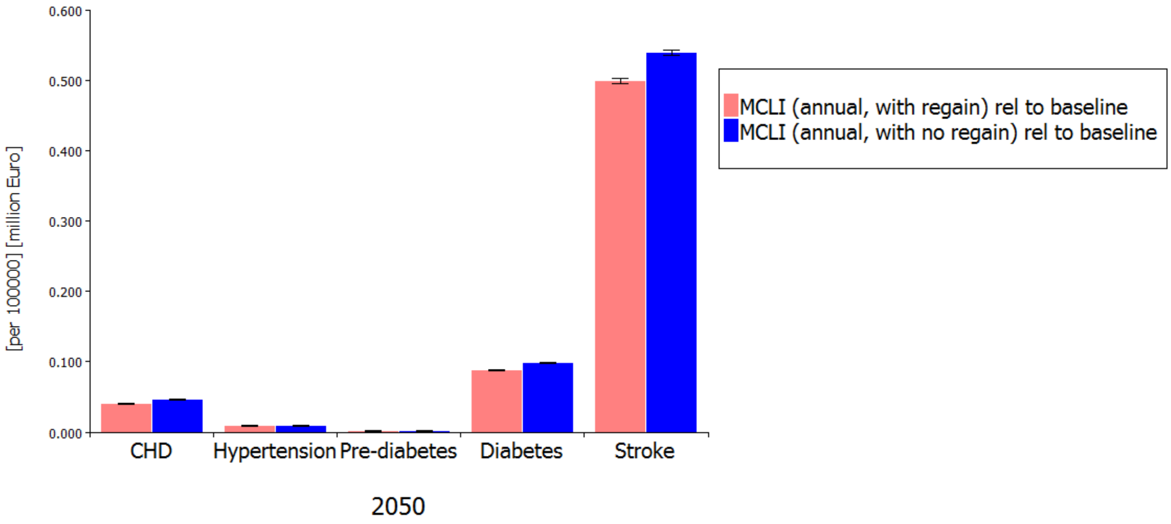


Figure 315. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Table 186. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
MCLI (annual, with regain), relative to baseline	2015	-0.00089 [+-0.000246]	0.000514 [+-0.000904]	0 [+-0]	0.001372 [+-0.000491]	-0.02721 [+-0.0187]
	2020	0.048873 [+-0.000229]	0.006735 [+-0.000757]	0 [+-0]	0.007332 [+-0.000424]	0.241104 [+-0.016869]
	2025	0.070662 [+-0.000206]	0.011643 [+-0.000642]	0 [+-0]	0.020442 [+-0.000373]	0.62439 [+-0.015076]
	2030	0.092696 [+-0.000185]	0.015635 [+-0.000545]	0 [+-0]	0.032725 [+-0.000334]	0.923401 [+-0.013519]
	2035	0.114572 [+-0.000166]	0.016753 [+-0.000459]	0 [+-0]	0.042935 [+-0.000302]	1.021545 [+-0.012182]
	2040	0.106662 [+-0.000149]	0.016352 [+-0.000382]	0 [+-0]	0.04844 [+-0.000269]	1.186119 [+-0.01092]
	2045	0.105824 [+-0.000132]	0.014343 [+-0.000315]	0 [+-0]	0.048838 [+-0.000238]	1.228027 [+-0.009675]
	2050	0.09713 [+-0.000116]	0.012303 [+-0.00026]	0 [+-0]	0.045261 [+-0.000207]	1.150665 [+-0.008432]
Scenario	**Year**	**CHD**	**Hypertension**	**Pre-diabetes**	**Diabetes**	**Stroke**
MCLI (annual, with no regain), relative to baseline	2015	0.004661 [+-0.000246]	0.000352 [+-0.000904]	0 [+-0]	-0.00029 [+-0.000491]	-0.22417 [+-0.018712]
	2020	0.073909 [+-0.000228]	0.009201 [+-0.000757]	0 [+-0]	0.010813 [+-0.000424]	0.459793 [+-0.016855]
	2025	0.133045 [+-0.000205]	0.016688 [+-0.000641]	0 [+-0]	0.029156 [+-0.000373]	1.019211 [+-0.015049]
	2030	0.145007 [+-0.000183]	0.019369 [+-0.000544]	0 [+-0]	0.043242 [+-0.000333]	1.400742 [+-0.013485]
	2035	0.15304 [+-0.000164]	0.018636 [+-0.000459]	0 [+-0]	0.053034 [+-0.000301]	1.445061 [+-0.012149]
	2040	0.139052 [+-0.000148]	0.017293 [+-0.000382]	0 [+-0]	0.056154 [+-0.000269]	1.411461 [+-0.010901]
	2045	0.127622 [+-0.112095]	0.015034 [+-0.000315]	0 [+-0]	0.054817 [+-0.000237]	1.386429 [+-0.009661]
	2050	0.112095 [+-0.000115]	0.012613 [+-0.00026]	0 [+-0]	0.04987 [+-0.000206]	1.243286 [+-0.008424]

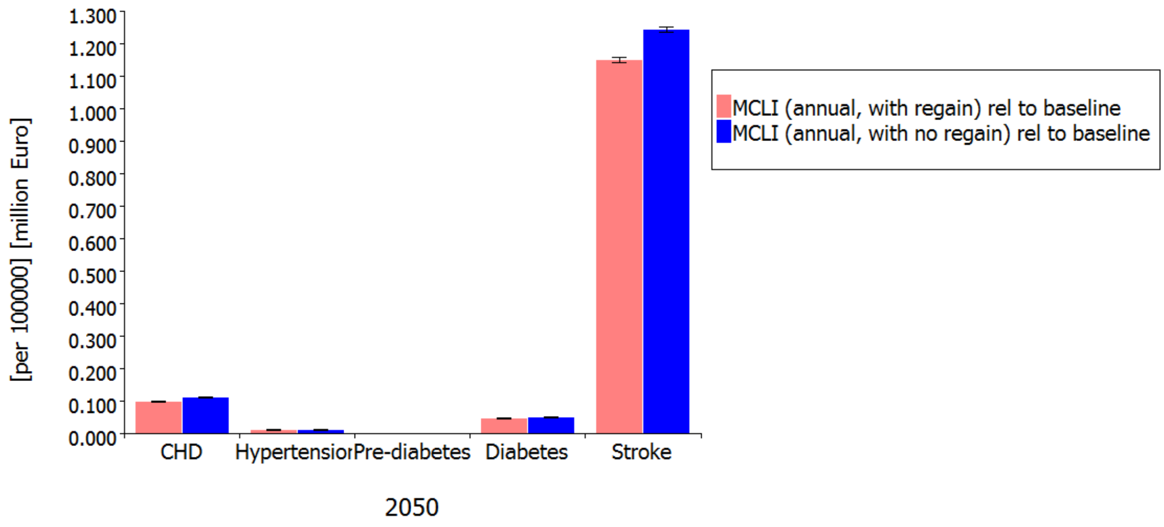


Figure 316. Indirect costs (€ millions) avoided (per 100,000) relative to baseline

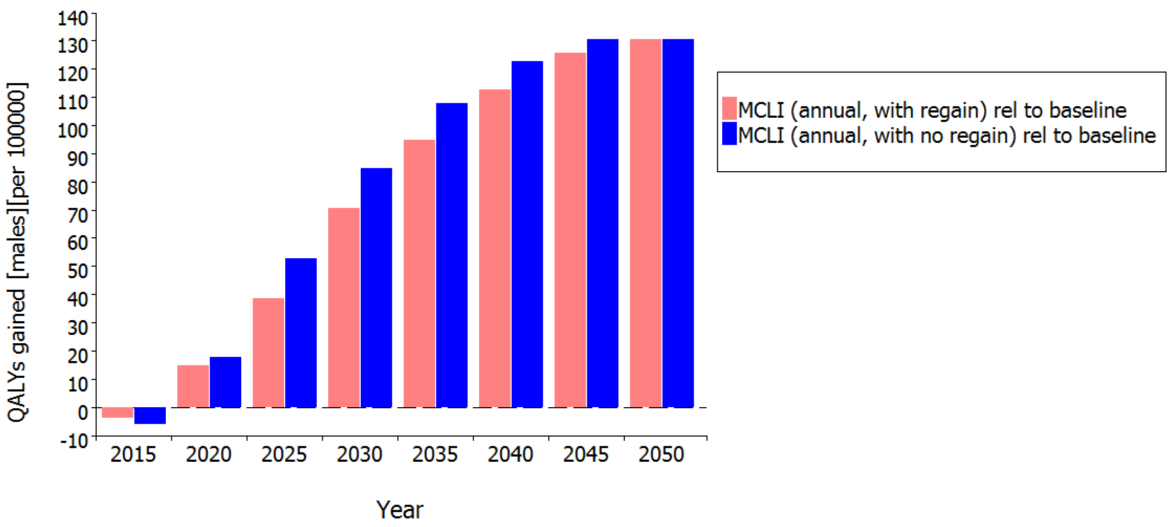


Figure 317. QALYS gained (per 100,000) relative to baseline (males)

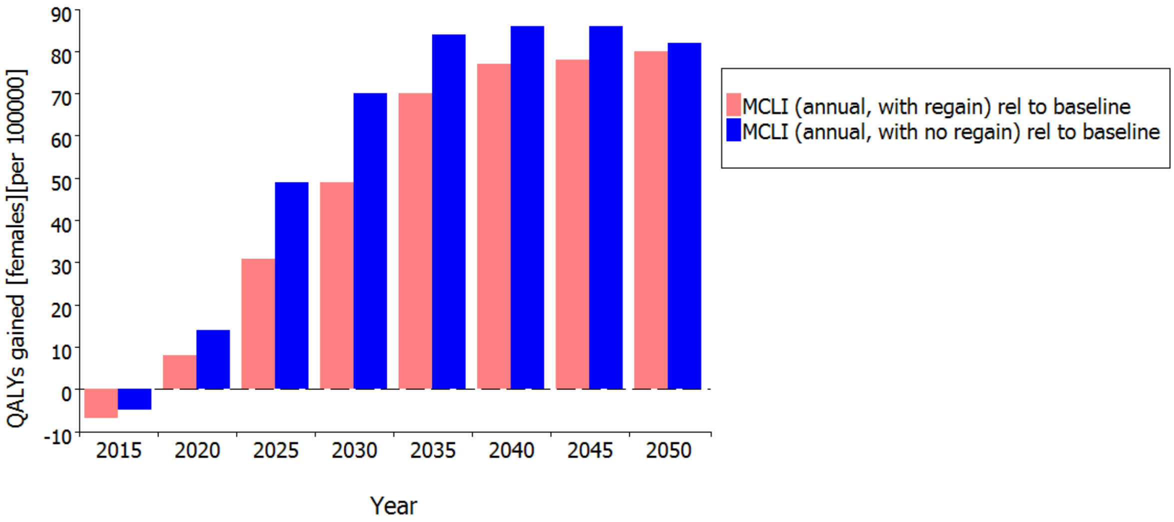


Figure 318. QALYS gained (per 100,000) relative to baseline (females)

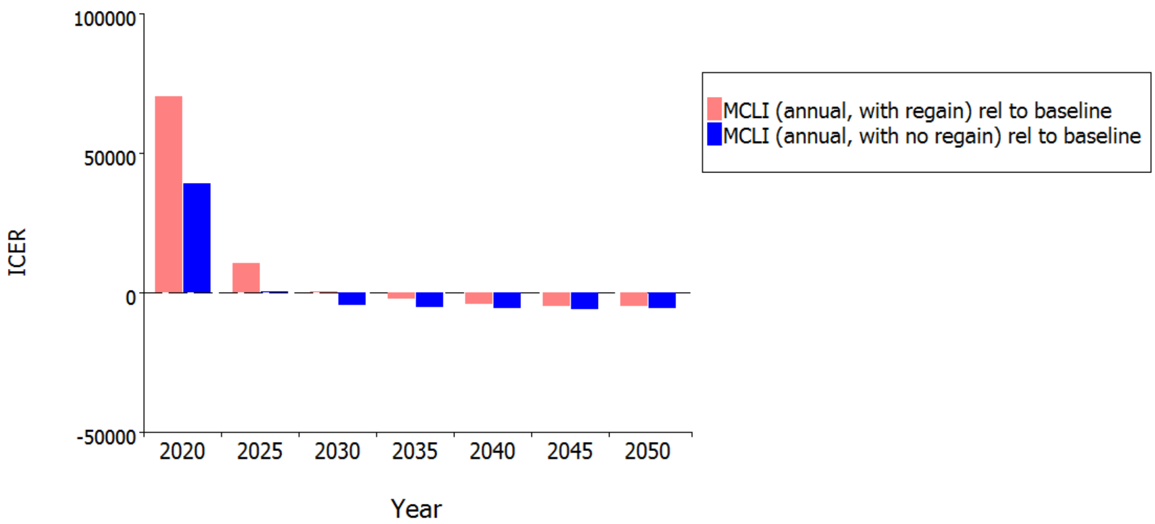


Figure 319. ICER

Sugar sweetened beverage (SSB) tax intervention

Impact on disease incidence and prevalence

Table 187 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios.

Table 188 presents the cumulative incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Cumulative incidence is lower for all diseases in the SSB scenario compared to baseline by 2050.

Table 189 and Figure 320 present the cumulative incidence cases avoided (per 100,000) from 2015 to 2050 for each intervention relative to baseline. The SSB scenario is predicted to reduce the cumulative incidence of pre-diabetes (25 cases avoided per 100,000 compared to baseline by 2050), hypertension (18 cases avoided per 100,000 compared to baseline by 2050) and diabetes (14 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on incidence of each disease as a result of an SSB tax relative to baseline by 2050.

Table 190 and Figure 321 present the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. The SSB scenario is predicted to reduce prevalence cases however there are large uncertainties around the estimates.

Table 187. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	158 [+-1]	1111 [+-2]	866 [+-2]	325 [+-1]	487 [+-1]
	2020	176 [+-1]	1199 [+-2]	930 [+-2]	355 [+-1]	526 [+-1]
	2025	192 [+-1]	1273 [+-2]	993 [+-2]	394 [+-1]	568 [+-1]
	2030	212 [+-1]	1282 [+-2]	1049 [+-2]	432 [+-1]	614 [+-2]
	2035	231 [+-1]	1237 [+-2]	1092 [+-2]	459 [+-1]	661 [+-2]
	2040	252 [+-1]	1209 [+-2]	1131 [+-2]	478 [+-1]	710 [+-2]
	2045	274 [+-1]	1203 [+-2]	1156 [+-2]	495 [+-1]	756 [+-2]
	2050	292 [+-1]	1215 [+-2]	1174 [+-2]	507 [+-2]	791 [+-2]
SSB	2015	158 [+-1]	1110 [+-2]	866 [+-2]	325 [+-1]	488 [+-1]
	2020	175 [+-1]	1199 [+-2]	929 [+-2]	355 [+-1]	526 [+-1]
	2025	192 [+-1]	1273 [+-2]	992 [+-2]	393 [+-1]	567 [+-1]
	2030	211 [+-1]	1282 [+-2]	1049 [+-2]	432 [+-1]	613 [+-2]
	2035	230 [+-1]	1237 [+-2]	1092 [+-2]	459 [+-1]	661 [+-2]
	2040	252 [+-1]	1209 [+-2]	1130 [+-2]	477 [+-1]	710 [+-2]
	2045	274 [+-1]	1203 [+-2]	1155 [+-2]	495 [+-1]	756 [+-2]
	2050	291 [+-1]	1215 [+-2]	1173 [+-2]	507 [+-2]	791 [+-2]

Table 188. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
Baseline	2015	158 [+-1]	1111 [+-2]	866 [+-2]	325 [+-1]	487 [+-1]
	2020	1012 [+-2]	6958 [+-5]	5396 [+-4]	2043 [+-3]	3053 [+-3]
	2025	1964 [+-3]	13312 [+-7]	10331 [+-6]	3975 [+-4]	5867 [+-5]
	2030	3038 [+-3]	20050 [+-8]	15746 [+-7]	6165 [+-5]	8998 [+-6]
	2035	4254 [+-4]	26968 [+-9]	21645 [+-8]	8615 [+-6]	12514 [+-7]
	2040	5641 [+-5]	34085 [+-10]	28052 [+-9]	11302 [+-7]	16456 [+-8]
	2045	7220 [+-5]	41575 [+-10]	35013 [+-10]	14241 [+-7]	20870 [+-9]
	2050	9004 [+-6]	49648 [+-11]	42574 [+-11]	17459 [+-8]	25792 [+-9]
SSB	2015	158 [+-1]	1110 [+-2]	866 [+-2]	325 [+-1]	488 [+-1]
	2020	1011 [+-2]	6953 [+-5]	5391 [+-4]	2042 [+-3]	3053 [+-3]
	2025	1963 [+-3]	13302 [+-7]	10322 [+-6]	3973 [+-4]	5865 [+-5]
	2030	3036 [+-3]	20037 [+-8]	15734 [+-7]	6160 [+-5]	8996 [+-6]
	2035	4251 [+-4]	26953 [+-9]	21629 [+-8]	8608 [+-6]	12511 [+-7]
	2040	5637 [+-5]	34068 [+-10]	28033 [+-9]	11292 [+-7]	16451 [+-8]
	2045	7216 [+-5]	41557 [+-10]	34991 [+-10]	14229 [+-7]	20865 [+-9]
	2050	8998 [+-6]	49630 [+-11]	42549 [+-11]	17445 [+-8]	25785 [+-9]

Table 189. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	0 [+-1]	1 [+-3]	0 [+-3]	0 [+-1]	-1 [+-1]
	2020	1 [+-3]	5 [+-7]	5 [+-6]	1 [+-4]	0 [+-4]
	2025	1 [+-4]	10 [+-10]	9 [+-8]	2 [+-6]	2 [+-7]
	2030	2 [+-4]	13 [+-11]	12 [+-10]	5 [+-7]	2 [+-8]
	2035	3 [+-6]	15 [+-13]	16 [+-11]	7 [+-8]	3 [+-10]
	2040	4 [+-7]	17 [+-14]	19 [+-13]	10 [+-10]	5 [+-11]
	2045	4 [+-7]	18 [+-14]	22 [+-14]	12 [+-10]	5 [+-13]
	2050	6 [+-8]	18 [+-16]	25 [+-16]	14 [+-11]	7 [+-13]

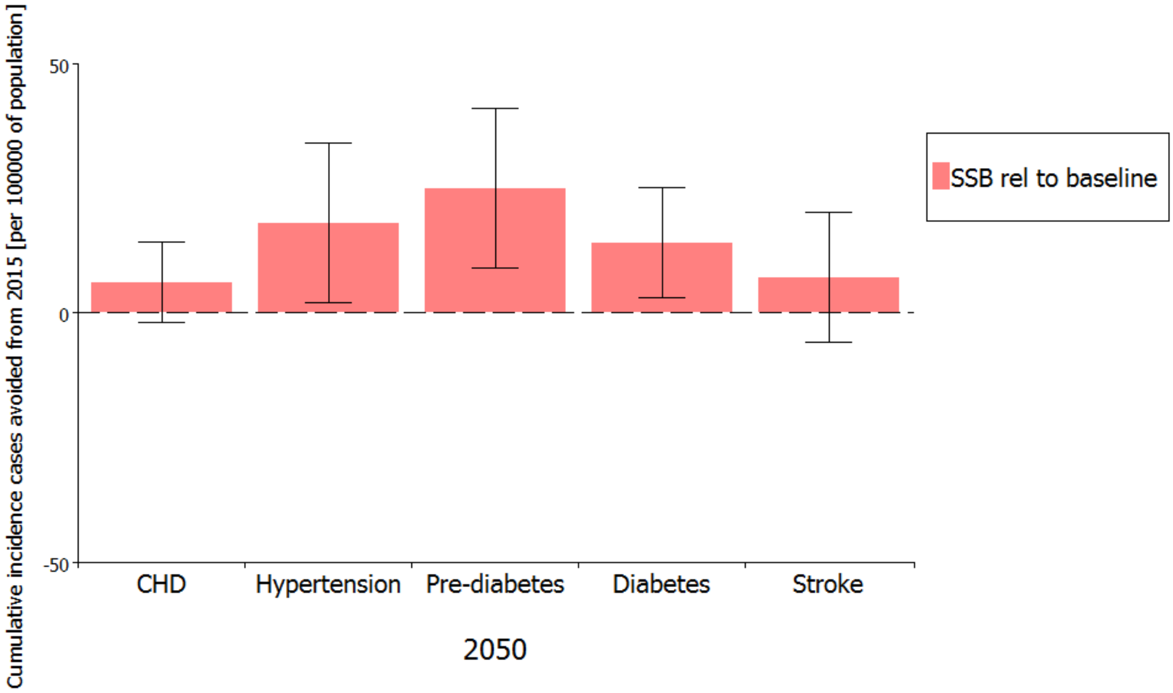


Figure 320. Cumulative incidence cases avoided (per 100,000) relative to baseline

Table 190. Prevalence cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	0 [+-3]	1 [+-13]	0 [+-7]	0 [+-7]	0 [+-6]
	2020	0 [+-3]	6 [+-13]	2 [+-7]	1 [+-7]	0 [+-6]
	2025	0 [+-3]	9 [+-14]	4 [+-8]	3 [+-7]	1 [+-7]
	2030	0 [+-3]	13 [+-14]	5 [+-8]	4 [+-8]	2 [+-7]
	2035	1 [+-3]	14 [+-14]	4 [+-8]	5 [+-8]	2 [+-7]
	2040	1 [+-4]	15 [+-14]	4 [+-8]	8 [+-8]	2 [+-7]
	2045	1 [+-4]	13 [+-14]	3 [+-8]	9 [+-8]	2 [+-8]
	2050	1 [+-4]	12 [+-16]	3 [+-10]	8 [+-10]	3 [+-8]

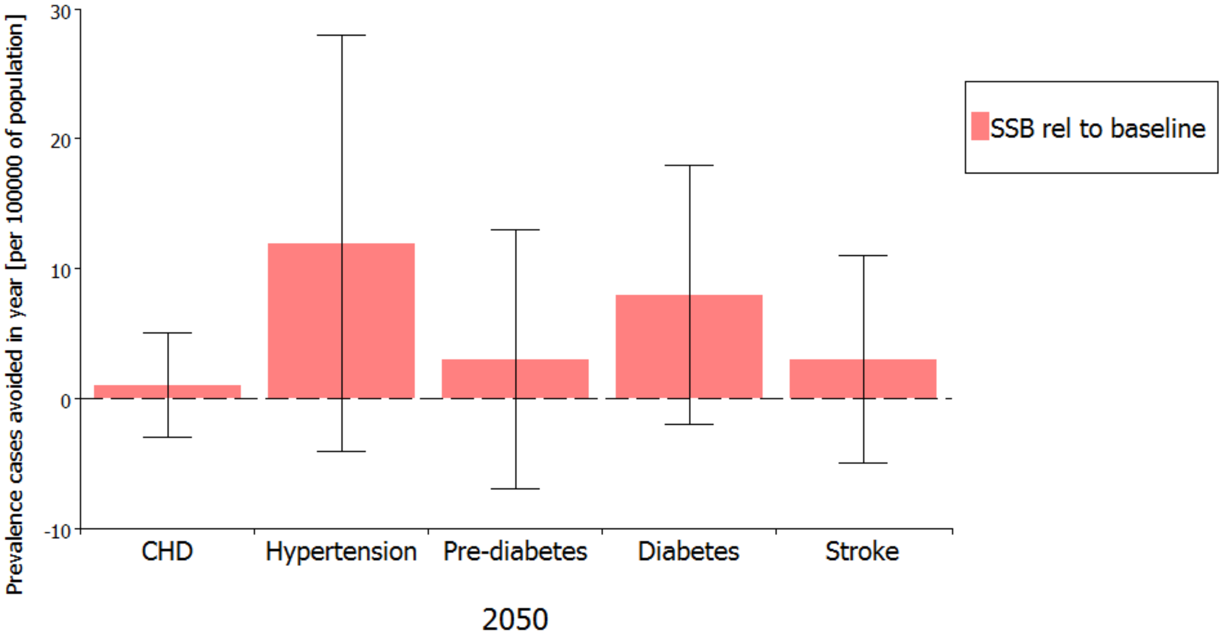


Figure 321. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 191 and Figure 322 presents the direct healthcare costs that can be *avoided* (per 100,000 population) with the SSB intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to be observed in stroke (€0.009m per 100,000 population in 2050).

Table 192 and Figure 323 presents the indirect costs that can be *avoided* (per 100,000 population) with the SSB intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to be observed in stroke (€0.02m per 100,000 population in 2050), followed by CHD (€0.014m per 100,000 population in 2050) and diabetes (€0.012m per 100,000 population in 2050).

Figure 324 and Figure 325 present the QALYs that can be gained (per 100,000 population) with the SSB intervention, relative to the baseline. For both males and females, the SSB tax intervention is expected to lead to remain steady and marginal over time.

In Figure 326, the negative ICER values (which in this case is comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SSB tax intervention is cost effective (the SSB tax intervention scenario *dominates* the baseline scenario).

Table 191. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	-0.00014 [+-0.000072]	0.000107 [+-0.000471]	-0.000011 [+-0.000038]	0.000407 [+-0.000686]	0.001312 [+-0.005747]
	2020	0.000499 [+-0.000068]	0.000504 [+-0.000395]	0.000137 [+-0.000033]	0.001418 [+-0.000593]	0.010384 [+-0.005187]
	2025	0.000834 [+-0.000062]	0.000601 [+-0.000335]	0.000176 [+-0.000027]	0.002287 [+-0.000523]	0.012138 [+-0.004646]
	2030	0.000607 [+-0.000055]	0.000634 [+-0.000284]	0.000154 [+-0.000023]	0.002925 [+-0.00047]	0.014835 [+-0.004175]
	2035	0.000654 [+-0.000049]	0.000548 [+-0.00024]	0.000107 [+-0.00002]	0.003333 [+-0.000426]	0.015381 [+-0.003767]
	2040	0.000734 [+-0.000045]	0.000455 [+-0.000199]	0.000083 [+-0.000016]	0.003363 [+-0.000382]	0.012264 [+-0.003384]
	2045	0.000664 [+-0.00004]	0.000329 [+-0.000165]	0.000053 [+-0.000014]	0.003005 [+-0.000338]	0.011143 [+-0.003003]
	2050	0.000611 [+-0.000035]	0.000225 [+-0.000136]	0.000035 [+-0.000011]	0.002444 [+-0.000294]	0.009924 [+-0.002622]

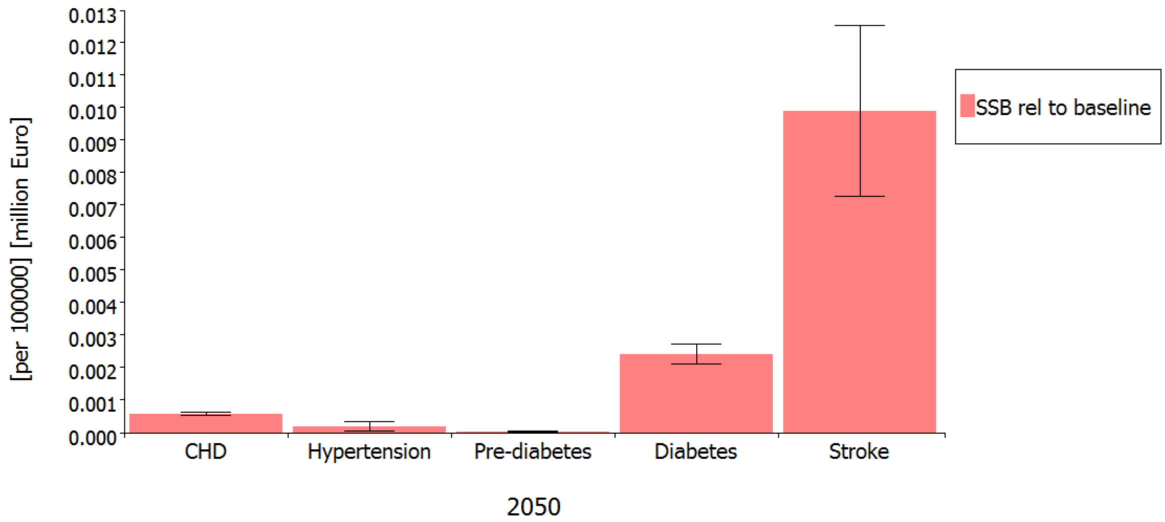


Figure 322. Direct healthcare costs (€ millions) avoided (per 100,000) relative to baseline

Table 192. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Pre-diabetes	Diabetes	Stroke
SSB relative to baseline	2015	-0.00033 [+-0.000174]	0.000145 [+-0.000639]	0 [+-0]	0.000206 [+-0.000348]	0.003021 [+-0.013223]
	2020	0.001194 [+-0.000163]	0.000685 [+-0.000536]	0 [+-0]	0.000719 [+-0.0003]	0.02388 [+-0.011934]
	2025	0.001997 [+-0.000147]	0.000816 [+-0.000454]	0 [+-0]	0.001159 [+-0.000264]	0.027939 [+-0.01069]
	2030	0.001453 [+-0.000133]	0.00086 [+-0.000386]	0 [+-0]	0.001483 [+-0.000238]	0.034119 [+-0.009605]
	2035	0.001565 [+-0.00012]	0.000745 [+-0.000325]	0 [+-0]	0.001689 [+-0.000216]	0.035385 [+-0.008666]
	2040	0.001758 [+-0.000107]	0.000616 [+-0.000272]	0 [+-0]	0.001704[+-0.000194]	0.028214 [+-0.007783]
	2045	0.001591 [+-0.000096]	0.000446 [+-0.000225]	0 [+-0]	0.001523 [+-0.000171]	0.025627 [+-0.006908]
	2050	0.001462 [+-0.000085]	0.000305 [+-0.000184]	0 [+-0]	0.001239 [+-0.000148]	0.022835 [+-0.006032]

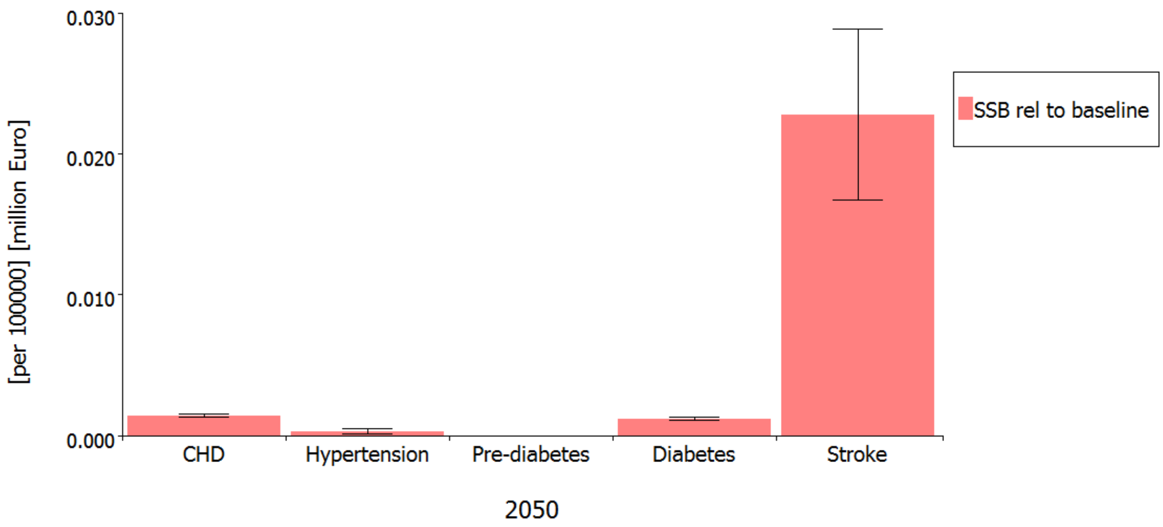


Figure 323. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

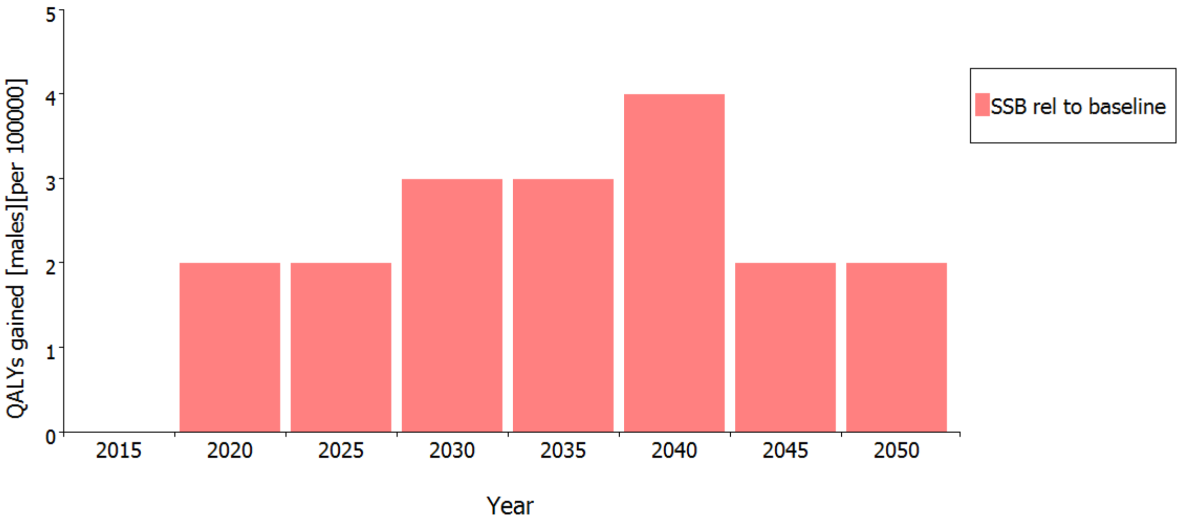


Figure 324. QALYS gained (per 100,000) relative to baseline (males)

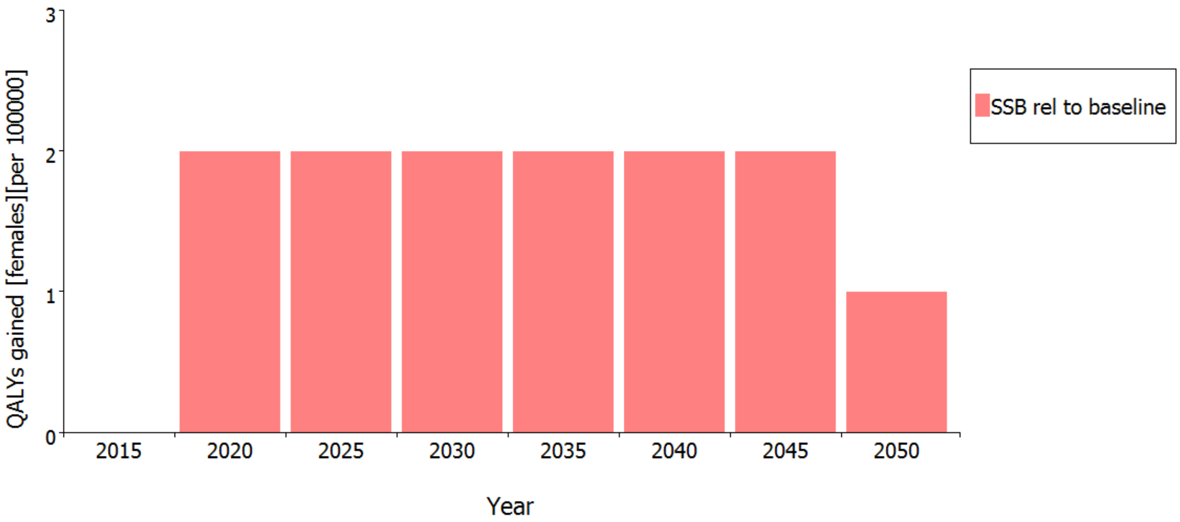


Figure 325. QALYS gained (per 100,000), relative to baseline (Females)

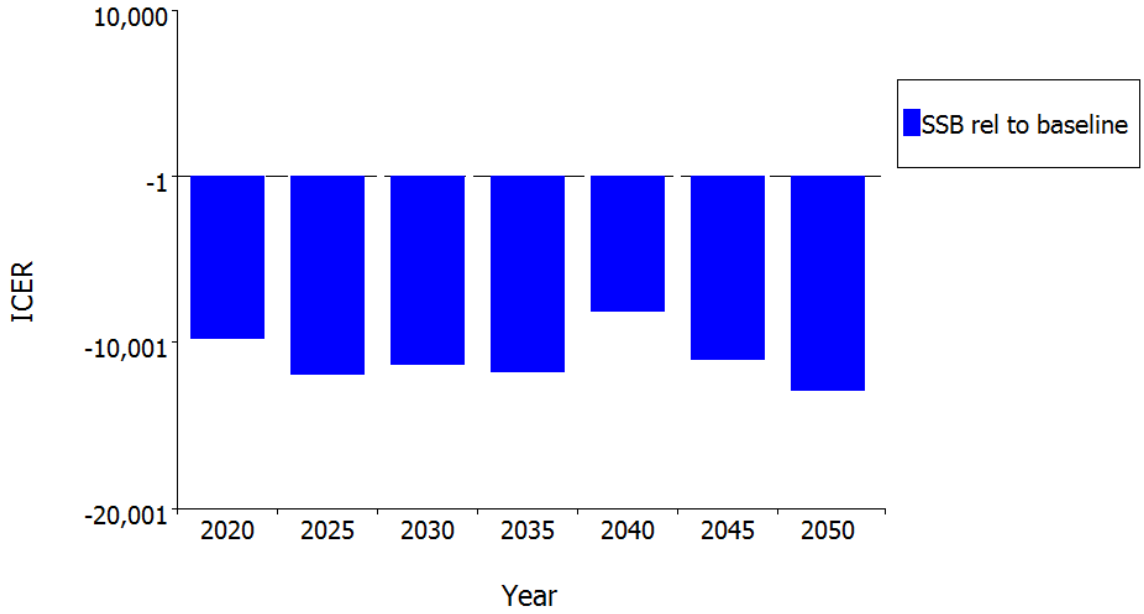


Figure 326. ICER

Smoking intervention results

Smoking cessation services (SCS)

Table 193 presents the input data for the SCS intervention.

Table 193. SCS Intervention input data

Variable	**Value**
Reach	
Willingness to quit smoking (%)	59% (Finland proxy)
Accessibility of the intervention (%)	50% (Netherlands proxy)
Overall reach (%)	30%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34% (UK proxy)
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	€ 209 (Netherlands proxy)

Impact on disease incidence and prevalence

Table 194 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SCS scenarios. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios. With the exception of CHD, the SCS scenario results in fewer cases each disease per 100,000 in 2050 compared to baseline.

Table 195 presents the cumulative incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SCS scenarios. Cumulative incidence is lower for all diseases in the SCS scenario compared to baseline by 2050

Table 196 and Figure 327 present the cumulative incidence cases avoided (per 100,000) from 2015 to 2050 for each intervention relative to baseline. The SCS scenario is predicted to reduce the cumulative incidence of all diseases, where the largest effect is observed for stroke (3137 cases avoided per 100,000 compared to baseline by 2050) followed by COPD (877 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on incidence of each disease as a result of a SCS relative to baseline by 2050.

Table 197 and Figure 328 present the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. The SCS scenario is predicted to reduce prevalence cases per 100,000 compared to baseline for all diseases by 2050, with the greatest effect observed for stroke (1829 prevalence cases avoided per 100,000 compared to baseline) followed by COPD (574 prevalence cases avoided per 100,000 compared to baseline). The graph illustrates the predicted impact on prevalence of each disease as a result of a SCS relative to baseline by 2050.

Table 194. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
Baseline	2015	154 [+-1]	148 [+-1]	1209 [+-2]	37 [+-0]	481 [+-1]
	2020	170 [+-1]	169 [+-1]	1259 [+-2]	41 [+-0]	541 [+-1]
	2025	189 [+-1]	196 [+-1]	1297 [+-2]	47 [+-0]	605 [+-2]
	2030	210 [+-1]	231 [+-1]	1266 [+-2]	54 [+-0]	689 [+-2]
	2035	234 [+-1]	274 [+-1]	1196 [+-2]	63 [+-1]	781 [+-2]
	2040	260 [+-1]	312 [+-1]	1163 [+-2]	71 [+-1]	859 [+-2]
	2045	283 [+-1]	341 [+-1]	1122 [+-2]	79 [+-1]	924 [+-2]
	2050	296 [+-1]	362 [+-1]	1126 [+-2]	83 [+-1]	963 [+-2]
SCS	2015	155 [+-1]	149 [+-1]	1211 [+-2]	37 [+-0]	482 [+-1]
	2020	169 [+-1]	167 [+-1]	1257 [+-2]	41 [+-0]	532 [+-1]
	2025	187 [+-1]	191 [+-1]	1290 [+-2]	45 [+-0]	578 [+-1]
	2030	208 [+-1]	220 [+-1]	1257 [+-2]	49 [+-0]	638 [+-2]
	2035	232 [+-1]	254 [+-1]	1185 [+-2]	55 [+-0]	703 [+-2]
	2040	259 [+-1]	281 [+-1]	1142 [+-2]	59 [+-0]	746 [+-2]
	2045	279 [+-1]	294 [+-1]	1105 [+-2]	60 [+-1]	764 [+-2]
	2050	296 [+-1]	297 [+-1]	1107 [+-2]	60 [+-1]	764 [+-2]

Table 195. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
Baseline	2015	154 [+-1]	148 [+-1]	1209 [+-2]	37 [+-0]	481 [+-1]
	2020	981 [+-2]	950 [+-2]	7431 [+-5]	235 [+-1]	3084 [+-3]
	2025	1909 [+-3]	1889 [+-3]	13971 [+-7]	463 [+-1]	6046 [+-5]
	2030	2967 [+-3]	3024 [+-3]	20721 [+-8]	733 [+-2]	9492 [+-6]
	2035	4194 [+-4]	4412 [+-4]	27523 [+-9]	1058 [+-2]	13548 [+-7]
	2040	5620 [+-5]	6083 [+-5]	34499 [+-10]	1442 [+-2]	18255 [+-8]
	2045	7251 [+-5]	8021 [+-6]	41744 [+-10]	1889 [+-3]	23610 [+-9]
	2050	9085 [+-6]	10209 [+-7]	49491 [+-11]	2397 [+-3]	29588 [+-10]
SCS	2015	155 [+-1]	149 [+-1]	1211 [+-2]	37 [+-0]	482 [+-1]
	2020	979 [+-2]	948 [+-2]	7429 [+-5]	234 [+-1]	3061 [+-3]
	2025	1903 [+-3]	1868 [+-3]	13950 [+-7]	452 [+-1]	5919 [+-5]
	2030	2955 [+-3]	2957 [+-3]	20658 [+-8]	702 [+-2]	9153 [+-6]
	2035	4170 [+-4]	4260 [+-4]	27385 [+-9]	988 [+-2]	12852 [+-7]
	2040	5579 [+-5]	5780 [+-5]	34230 [+-10]	1313 [+-2]	17018 [+-8]
	2045	7188 [+-5]	7487 [+-6]	41299 [+-10]	1671 [+-3]	21570 [+-9]
	2050	8991 [+-6]	9332 [+-6]	48819 [+-11]	2052 [+-3]	26451 [+-9]

Table 196. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	-1 [+-1]	-1 [+-1]	-2 [+-3]	0 [+-0]	-1 [+-1]
	2020	2 [+-3]	2 [+-3]	2 [+-7]	1 [+-1]	23 [+-4]
	2025	6 [+-4]	21 [+-4]	21 [+-10]	11 [+-1]	127 [+-7]
	2030	12 [+-4]	67 [+-4]	63 [+-11]	31 [+-3]	339 [+-8]
	2035	24 [+-6]	152 [+-6]	138 [+-13]	70 [+-3]	696 [+-10]
	2040	41 [+-7]	303 [+-7]	269 [+-14]	129 [+-3]	1237 [+-11]
	2045	63 [+-7]	534 [+-8]	445 [+-14]	218 [+-4]	2040 [+-13]
	2050	94 [+-8]	877 [+-9]	672 [+-16]	345 [+-4]	3137 [+-13]

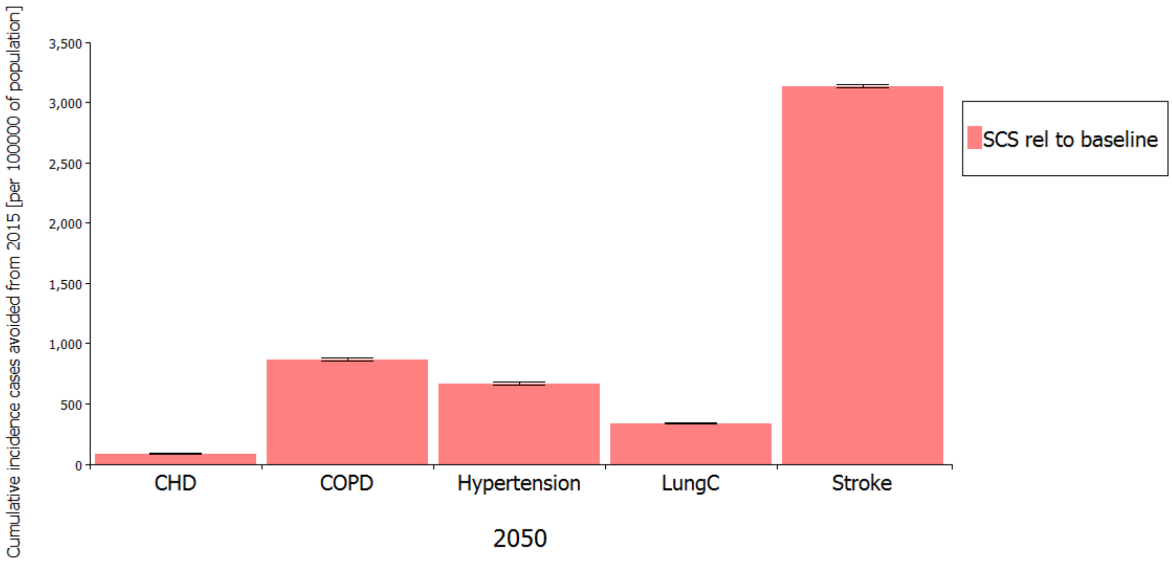


Figure 327. Cumulative incidence cases avoided (per 100,000) relative to baseline

Table 197. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	-1 [+-3]	-5 [+-4]	1 [+-13]	0 [+-1]	1 [+-6]
	2020	3 [+-3]	-1 [+-4]	2 [+-14]	0 [+-1]	24 [+-6]
	2025	5 [+-3]	17 [+-4]	14 [+-14]	5 [+-1]	111 [+-7]
	2030	7 [+-3]	54 [+-4]	29 [+-14]	11 [+-1]	275 [+-7]
	2035	12 [+-3]	118 [+-6]	49 [+-14]	20 [+-1]	524 [+-7]
	2040	17 [+-4]	225 [+-6]	73 [+-14]	30 [+-1]	855 [+-8]
	2045	20 [+-4]	376 [+-6]	81 [+-14]	43 [+-1]	1308 [+-8]
	2050	18 [+-4]	574 [+-6]	44 [+-16]	59 [+-1]	1829 [+-9]

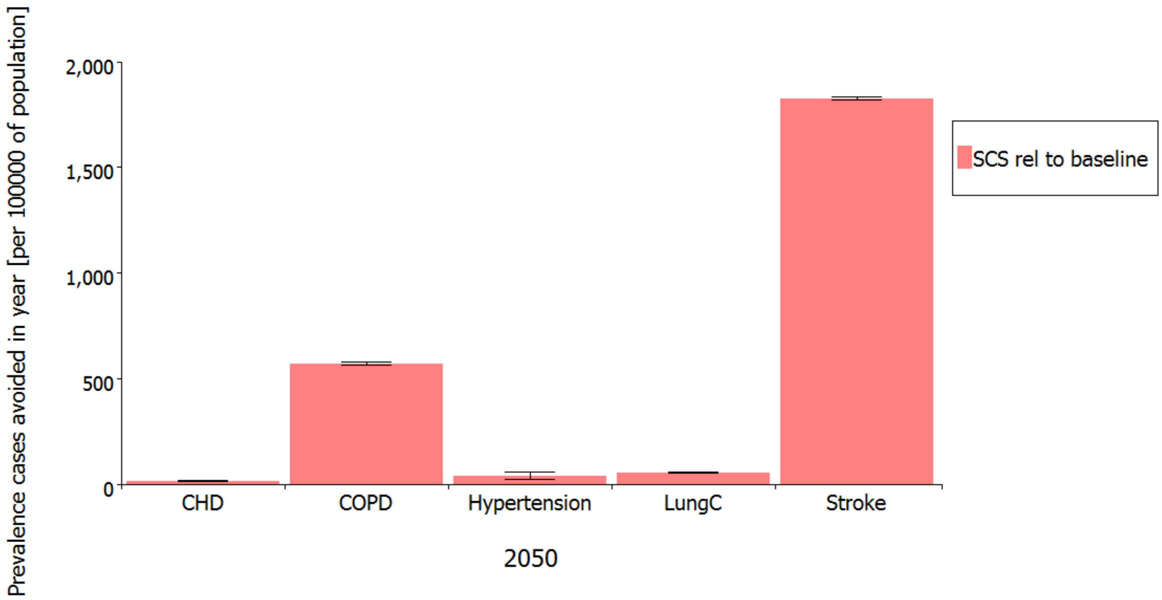


Figure 328. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 198 and Figure 329 present the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that largest direct healthcare costs *avoided* is expected to be observed in stroke (€6.7m per 100,000 population in 2050).

Table 199 and Figure 330 present the indirect costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* were highest is expected to be observed in stroke (€15.4m per 100,000 population in 2050).

Figure 331 and Figure 332 present the QALYs that can be gained (per 100,000 population) with the SCS intervention, relative to the baseline. For both males and females, the SSB tax intervention is expected to lead to increasing gains in QALYs over time.

Figure 333 the positive ICER value in 2020 (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that the SCS may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in Portugal. The negative ICER values thereafter (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that SCS is cost effective (the SCS intervention scenario *dominates* the baseline scenario).

Table 198. Direct healthcare costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	-0.00366 [+-0.000066]	-0.005332[+-0.000074]	0.000098 [+-0.000516]	-0.000072[+-0]	0.019356 [+-0.00488]
	2020	0.005232 [+-0.000064]	-0.000969 [+-0.000069]	0.000209 [+-0.000431]	0.000263 [+-0]	0.381416 [+-0.004691]
	2025	0.007637 [+-0.000057]	0.010398 [+-0.000066]	0.000886 [+-0.000363]	0.001455 [+-0]	1.369629 [+-0.004451]
	2030	0.009061 [+-0.000052]	0.026652 [+-0.000065]	0.001502 [+-0.000304]	0.002448 [+-0]	2.667793 [+-0.004231]
	2035	0.011898 [+-0.000048]	0.045699 [+-0.000064]	0.002006 [+-0.000252]	0.00332 [+-0]	3.990181 [+-0.004035]
	2040	0.013229 [+-0.000044]	0.068306 [+-0.000064]	0.002354 [+-0.000206]	0.003988 [+-0]	5.098476 [+-0.003784]
	2045	0.012367 [+-0.00004]	0.089438 [+-0.000061]	0.002029 [+-0.000168]	0.004576[+-0]	6.108051 [+-0.003437]
	2050	0.008659 [+-0.000035]	0.106886 [+-0.000056]	0.000859 [+-0.000135]	0.004861 [+-0]	6.69021[+-0.003014]

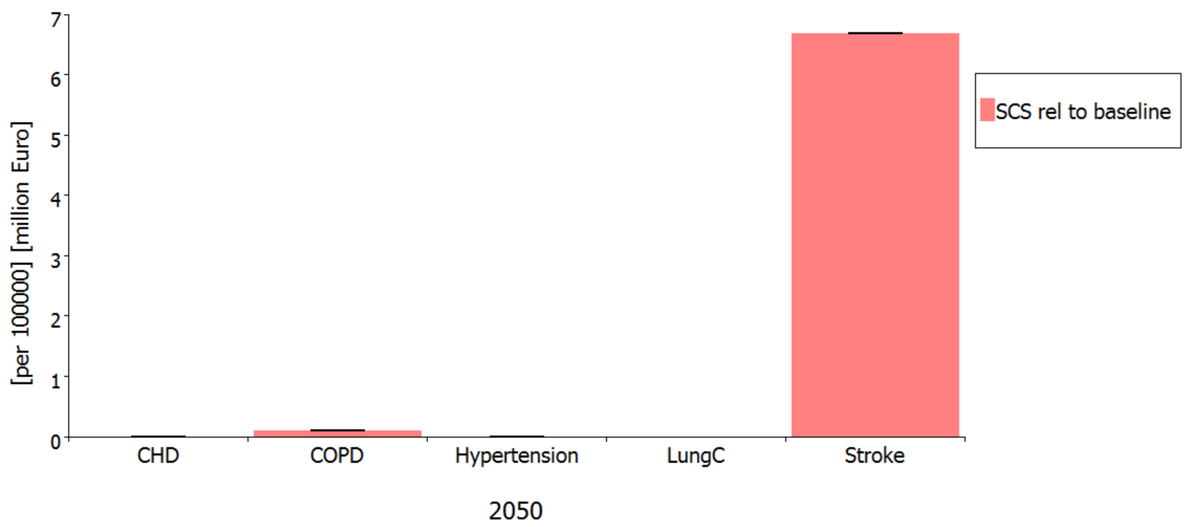


Figure 329. Direct health-care costs (€ millions) avoided (per 100,000), relative to baseline

Table 199. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD	Hypertension	Lung Cancer	Stroke
SCS relative to baseline	2015	-0.00877 [+-0.00016]	-0.025864 [+-0.000361]	0.000134 [+-0.0007]	-0.00053 [+-0.000001]	0.044525 [+-0.011229]
	2020	0.012524 [+-0.000151]	-0.004699 [+-0.000337]	0.000284 [+-0.000585]	0.001954 [+-0.000003]	0.877533 [+-0.010794]
	2025	0.018282 [+-0.000137]	0.050436 [+-0.000321]	0.001202 [+-0.000492]	0.010801 [+-0.000003]	3.151123 [+-0.010241]
	2030	0.02169 [+-0.000125]	0.129282 [+-0.000315]	0.00204 [+-0.000413]	0.018172 [+-0.000002]	6.137848 [+-0.009735]
	2035	0.028483 [+-0.000115]	0.22167 [+-0.000314]	0.002725 [+-0.000342]	0.024654 [+-0.000002]	9.18029 [+-0.009284]
	2040	0.031668 [+-0.000105]	0.331329 [+-0.00031]	0.003196 [+-0.000281]	0.029606 [+-0.000002]	11.73017 [+-0.008706]
	2045	0.029605 [+-0.000094]	0.433832 [+-0.000298]	0.002757 [+-0.000228]	0.033977 [+-0.000001]	14.05292 [+-0.007908]
	2050	0.02073 [+-0.000083]	0.518465 [+-0.000272]	0.001166 [+-0.000184]	0.03609 [+-0.000001]	15.3923 [+-0.006935]

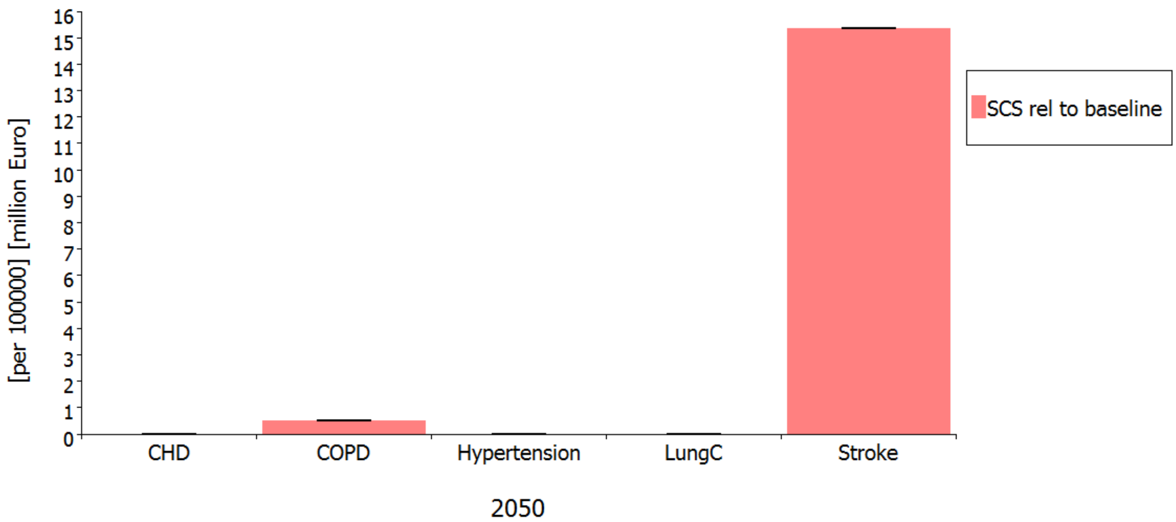


Figure 330. Indirect costs (€ millions) avoided (per 100,000), relative to baseline

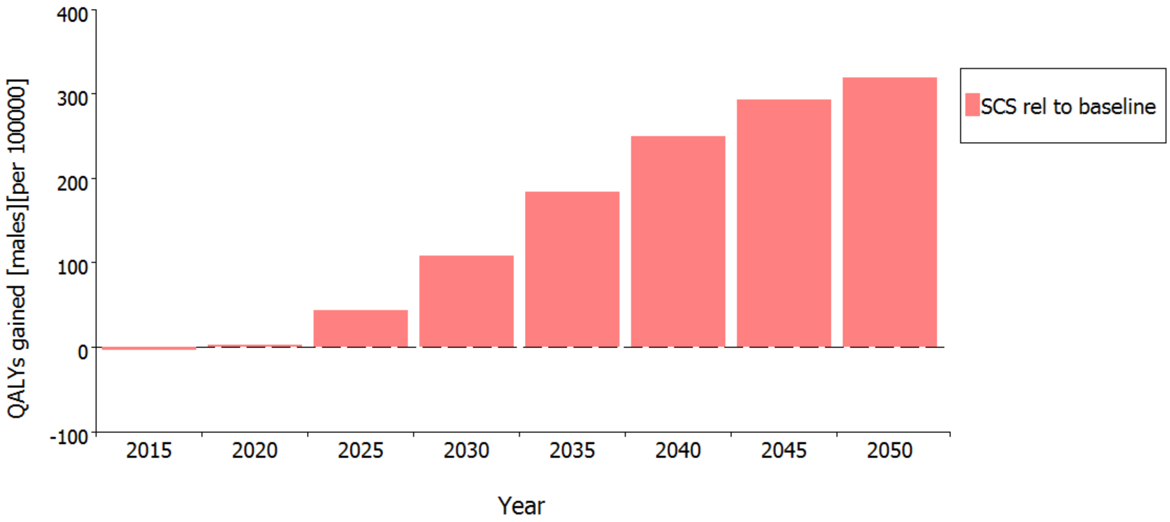


Figure 331. QALYS gained (per 100,000) relative to baseline (males)

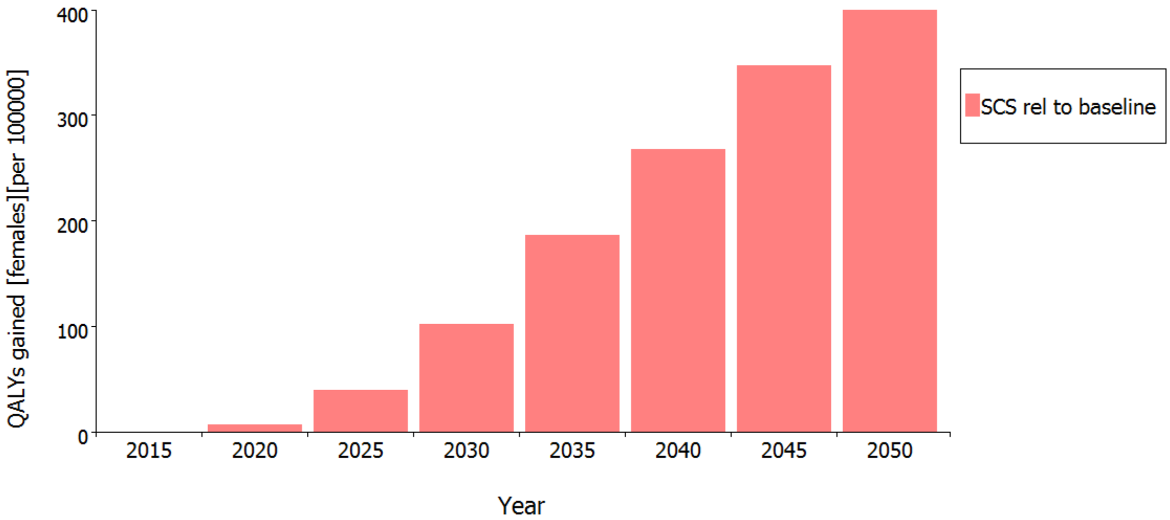


Figure 332. QALYS gained (per 100,000), relative to baseline (females)

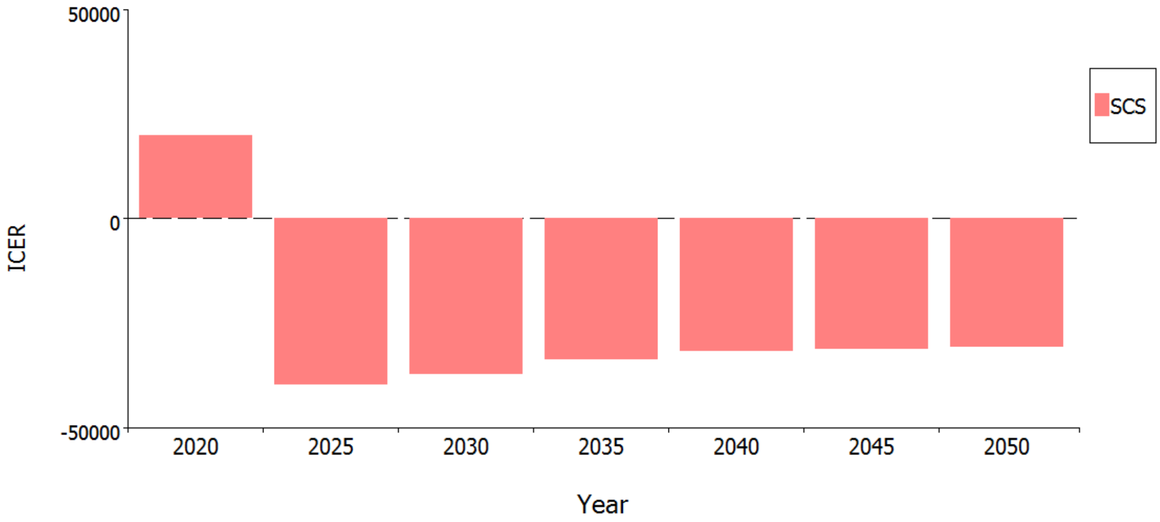


Figure 333. ICER

United Kingdom

Section 1: Results of data collection

Risk factor data

References for data collected on body mass index by age and sex (BMI; kg/m^2) in the UK are presented in Table 200 and for smoking prevalence by age and sex are presented in Table 201.

Data were disaggregated by education level and income group where available to explore future prevalence of each risk factor by sub-groups.

Table 200. References used in the model for BMI prevalence

Reference	Year	Sample size	Age group	Measured/ Self-reported	National/ Regional
Health Survey for England	2000-2013	4396-14,838	20+	Measured	National

Table 201. References used in the model for smoking prevalence

Reference	Year	Sample size	Age group	Measured/ Self-reported	National/ Regional
General Lifestyle Survey	2000-2011	13,969-22,409	20+	Measured	National

Disease data

A table of disease references can be found in appendix A8. The UK was one of the few EConDA countries where we could explore multi-stage COPD since we were provided access to the Whitehall dataset.

Intervention data

Table 202 to Table 204 presents the intervention input data for each of the interventions modelled. More detail about the development of each intervention is provided appendix C1-4.

Table 202. BMI intervention input data

Intervention	BMI reduction	% BMI regain	Cost of intervention (£)
Baseline	None	-	-
MCLI regain	0.7	100	92
MCLI no regain	0.7	0	92
SSB	0.01	0	0

Table 203 SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	68%
Accessibility of the intervention (%)	50% (NL proxy)
Overall reach (%)	34%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	£164

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Table 204 COPD treatment input data

Parameter	Assumption
Who is treated and for how long?	COPD stage 3+ patients get the treatment, for the rest of their life as an add-on to existing treatment.
Age of those treated	There is no minimum age.
Costs of treatment	**£377** per case/year
Probability of remission	If a COPD patient is in stage 3 in the first year of their treatment, they have a probability of remission to stage 2. This one-off probability is estimated to be **0.121**.
Relative risk of moving from stage 3+ to stage 2	The RR of going from the Moderate to Severe disease stage is **0.90**.
Relative risk of moving from stage 2 to stage 3 following treatment	If a COPD patient is in stage 2 and treated a reduced risk of transitioning to stage 3 is assumed. This risk ratio of going from stage 3 to 2 is **0.90**.

Section 2: Risk factor projections to 2050

BMI projections by age and sex

Table 205 presents the prevalence of normal weight, over-weight and obese (according to BMI) in the adult population, by sex. The Health Survey for England from 2000 to 2013 was used as a proxy for the UK population. Overall, in both British males and females, obesity prevalence is projected to increase reaching 49% and 45% respectively by 2050. Overweight prevalence is projected to decline. The proportion of healthy weight males and females is projected to decline over the next 35 years.

Figure 334 to Figure 340 present BMI-group projections to 2050 for males 20-80+ years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence described above is expected among males across most age groups, with the exception of 30-39 year old males where there appears to be a slight flattening of the trend. Among males 40 to 80+ years old, obesity prevalence could surpass 60% by 2050. The proportion of healthy weight males is predicted to decline in most age groups.

Figure 341 to Figure 347 present the BMI-group projections to 2050 for females 20-80+ years (normal weight=<25 kg/m^2, in green; overweight=25-29.9 kg/m^2, in blue; obesity=≥30 kg/m^2, in red) by 10-year age groups. The increase in obesity prevalence is expected among all age groups. The largest increase is projected among 70 to 79 year olds in whom obesity prevalence is expected to reach 70% in 2050. Overweight prevalence is projected to remain stable or decline across age groups. The proportion of healthy weight females is predicted to decline in all age groups with the exception of 60-69 year olds where there is an increase.

Table 205. Normal weight, overweight and obesity amongst 20-100 year old males and females, projected to 2050

	Male						Female						Both					
Year	BMI<25	95% CI	BMI 25-29.9	95% CI	BMI≥30	95% CI	BMI<25	95% CI	BMI 25-29.9	95% CI	BMI≥30	95% CI	BMI<25	95% CI	BMI 25-29.9	95% CI	BMI≥30	95% CI
2015	27.0	2.6	44.0	2.9	29.0	2.8	37.0	2.6	34.0	2.6	29.0	2.6	32.0	2.6	39.0	2.8	29.0	2.7
2020	26.0	3.7	43.0	4.3	32.0	4.4	35.0	3.8	34.0	3.9	31.0	4.1	30.0	3.7	38.0	4.1	32.0	4.3
2025	24.0	4.7	41.0	5.7	35.0	6.1	34.0	5.0	33.0	5.1	33.0	5.7	29.0	4.8	37.0	5.4	34.0	5.9
2030	23.0	5.6	39.0	7.2	38.0	7.8	32.0	6.1	33.0	6.4	36.0	7.4	27.0	5.9	36.0	6.8	37.0	7.6
2035	22.0	6.5	38.0	8.6	41.0	9.5	30.0	7.2	32.0	7.7	38.0	9.1	26.0	6.9	35.0	8.2	39.0	9.3
2040	21.0	7.4	36.0	10.0	44.0	11.1	29.0	8.2	31.0	9.0	40.0	10.9	25.0	7.8	34.0	9.5	42.0	11.0
2045	19.0	8.2	34.0	11.3	47.0	12.6	27.0	9.1	31.0	10.3	42.0	12.6	23.0	8.6	32.0	10.8	44.0	12.6
2050	19.0	8.9	32.0	12.5	49.0	14.0	25.0	9.9	30.0	11.5	45.0	14.3	22.0	9.4	31.0	12.0	47.0	14.2

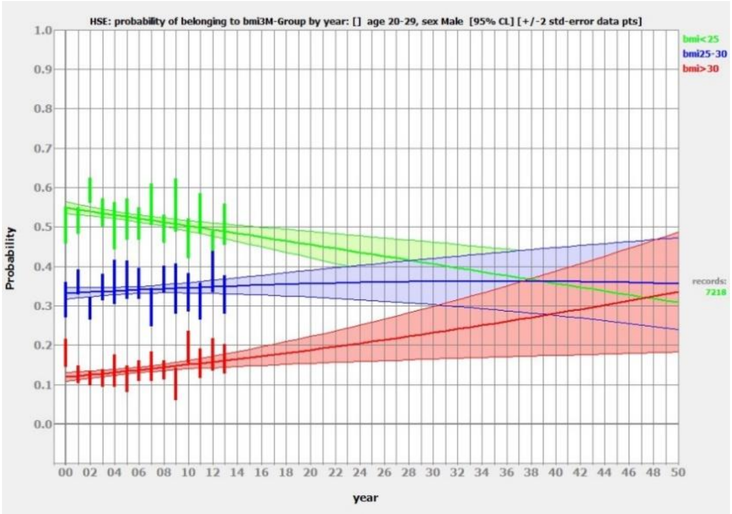


Figure 334. Projected BMI-group in 20-29 year old males

Figure 335 Projected BMI-group in 30-39 year old males

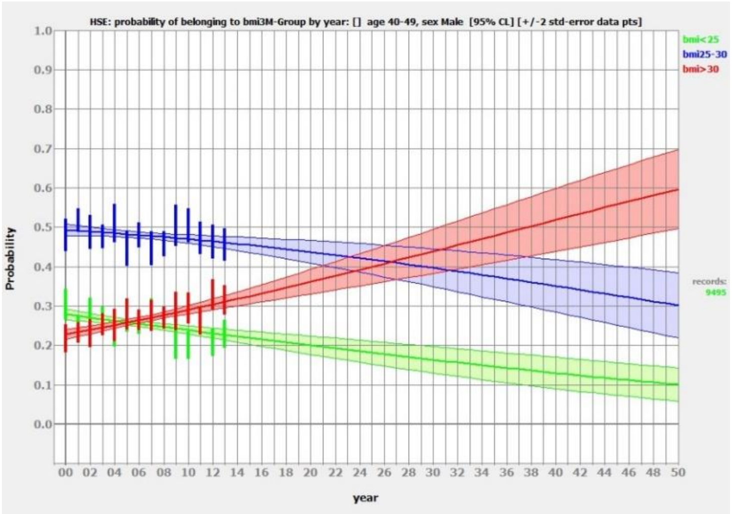


Figure 336 Projected BMI-group in 40-49 year old males

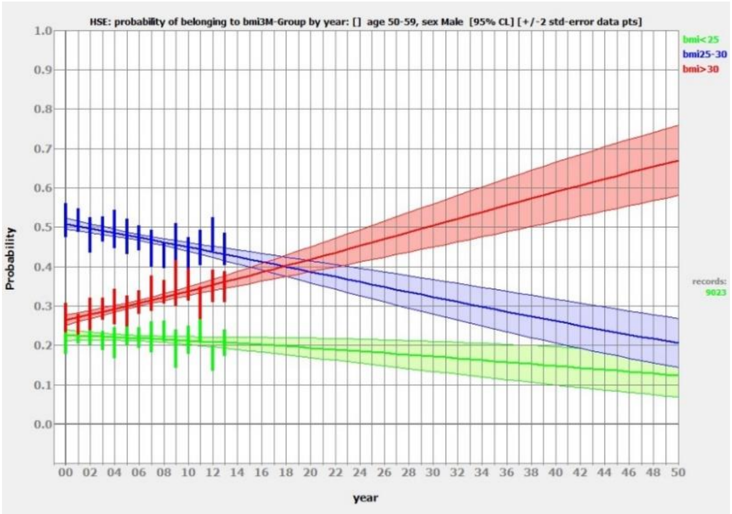


Figure 337 Projected BMI-group in 50-59 year old males

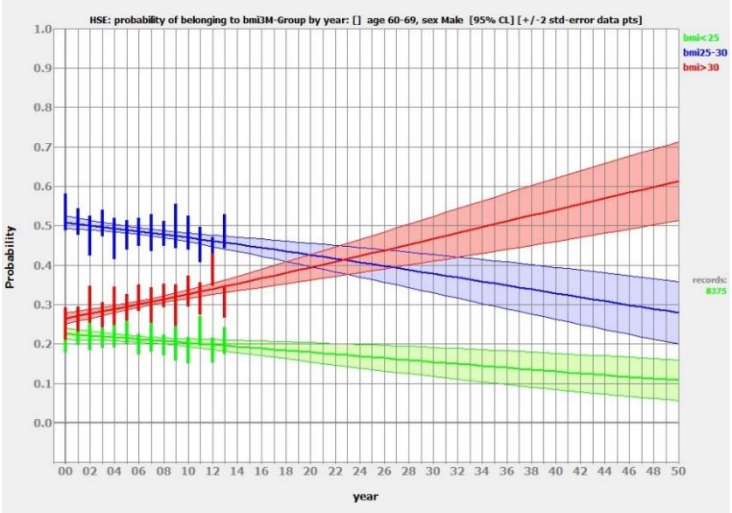


Figure 338 Projected BMI-group in 60-69 year old males

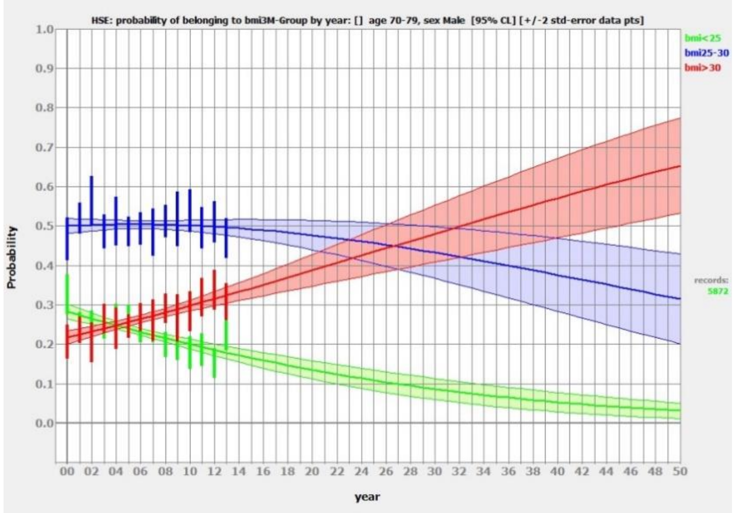


Figure 339 Projected BMI-group in 70-79y year old males

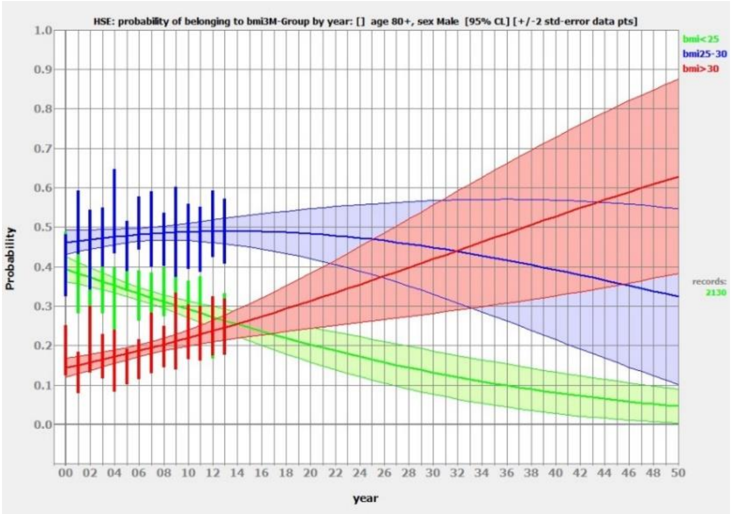


Figure 340 Projected BMI-group in 80+ year old males

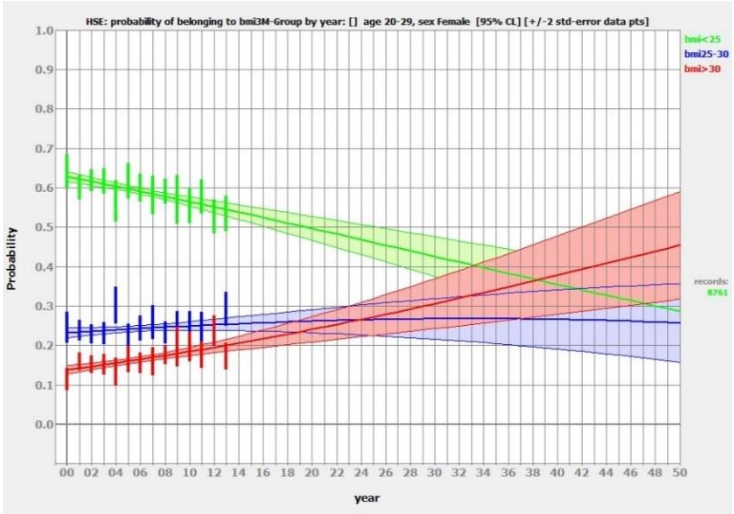


Figure 341 Projected BMI-group in 20-29 year old females

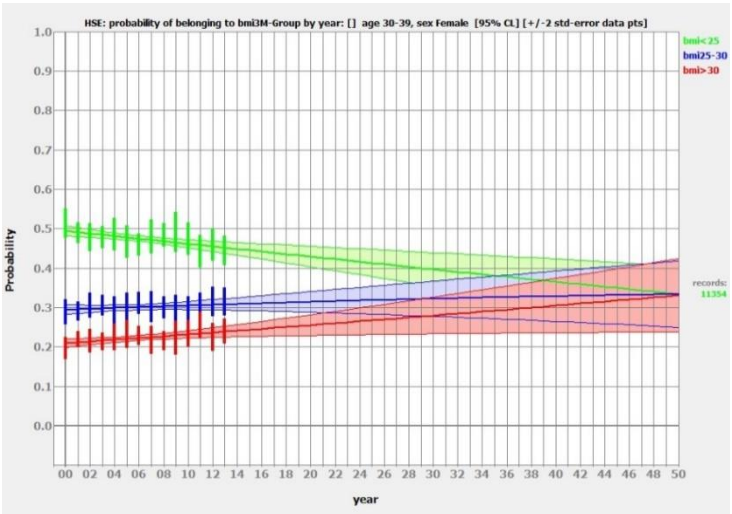


Figure 342 Projected BMI-group in 30-39 year old females

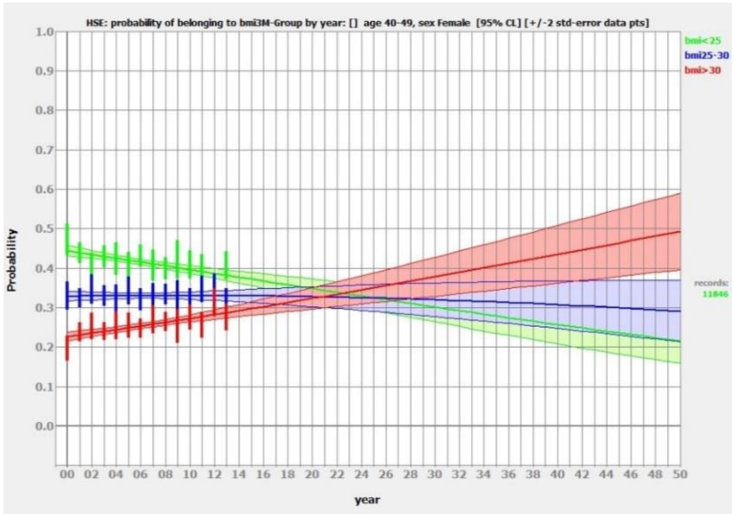


Figure 343 Projected BMI-group in 40-49 year old females

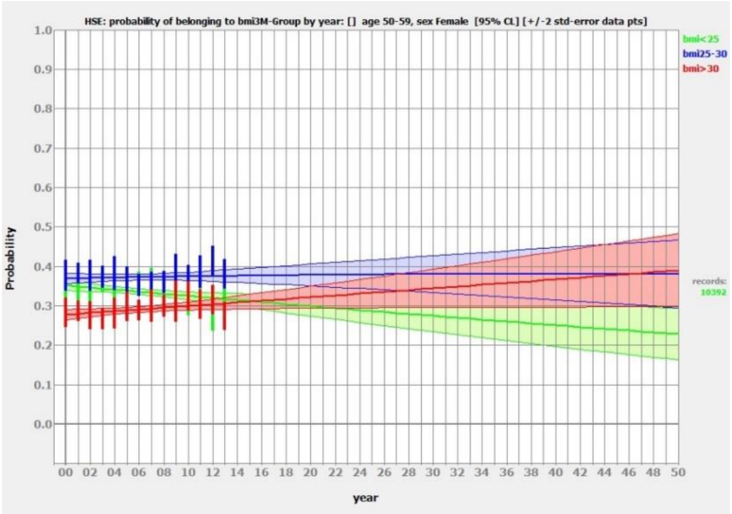


Figure 344 Projected BMI-group in 50-59 year old females

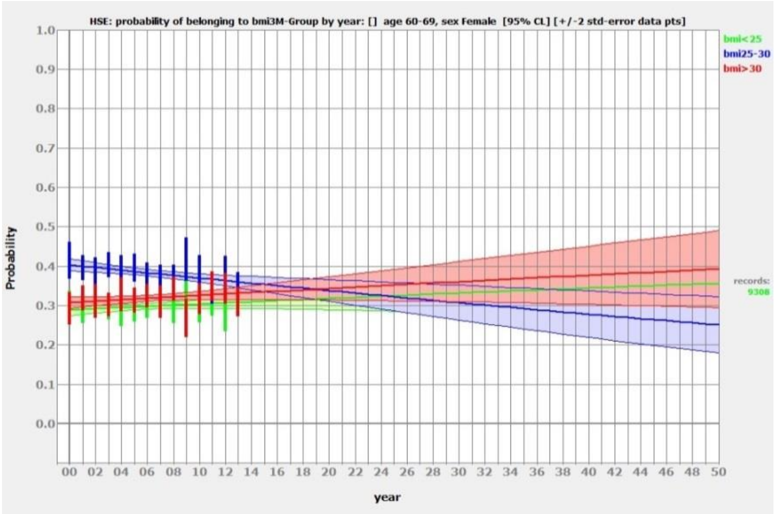


Figure 345 Projected BMI-group in 60-69 year old females

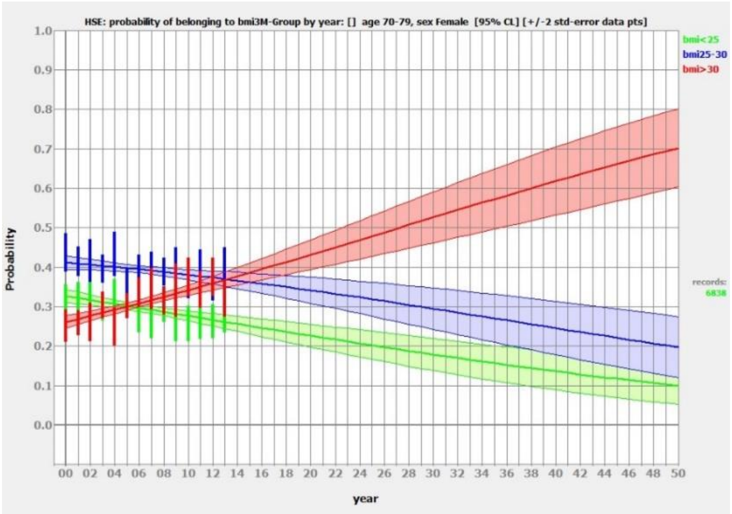


Figure 346. Projected BMI-group in 70-79 year old females

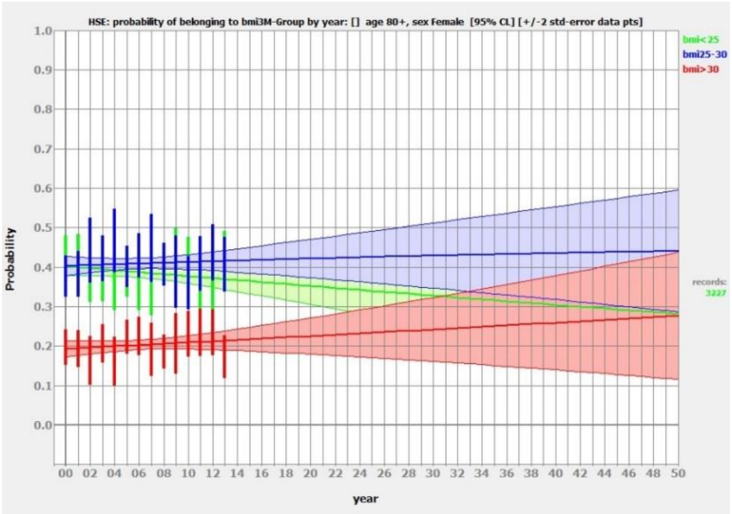


Figure 347 Projected BMI-group in 80+ year old females

BMI projections by education level

Education was divided into two groups: 1) below tertiary education 2) tertiary education and above. Tertiary education was defined as 'post-secondary education'.

Males

In the recent past (2000 to 2015), overweight prevalence has been higher among males with tertiary education compared to males with less than tertiary education (Figure 348). Overweight prevalence is projected to remain higher and largely unchanged among males with tertiary education while a decline in the prevalence of overweight is expected among males with less than tertiary education (Figure 348).

Inequalities in obesity among males living in England are projected to increase (Figure 349). Obesity prevalence is projected to increase at a faster rate among males with less than tertiary education compared to males with tertiary education (Figure 349). By 2050 males with less than tertiary education are projected to have obesity prevalence 60% higher than those with tertiary education (appendix E7). Obesity prevalence may surpass 60% in 2050 among males with less than tertiary education if trends go unchecked (Figure 349).

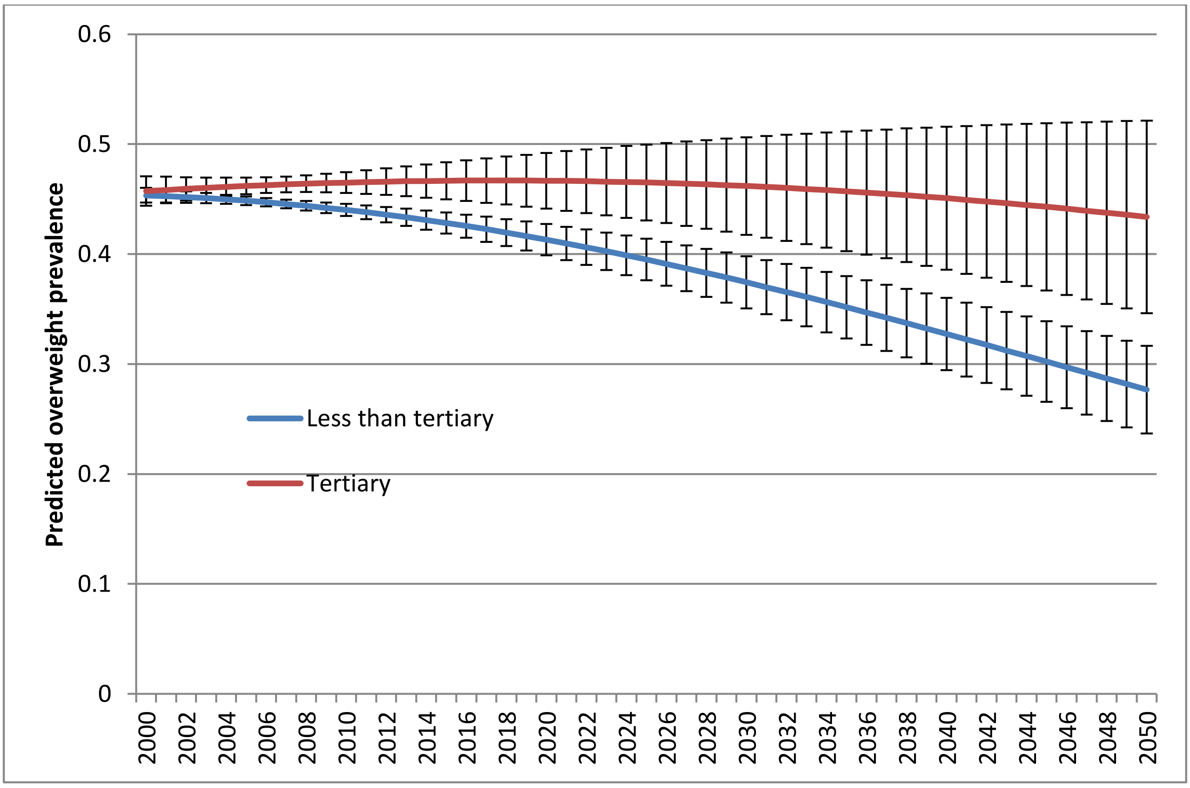


Figure 348 Overweight prevalence by education level among males

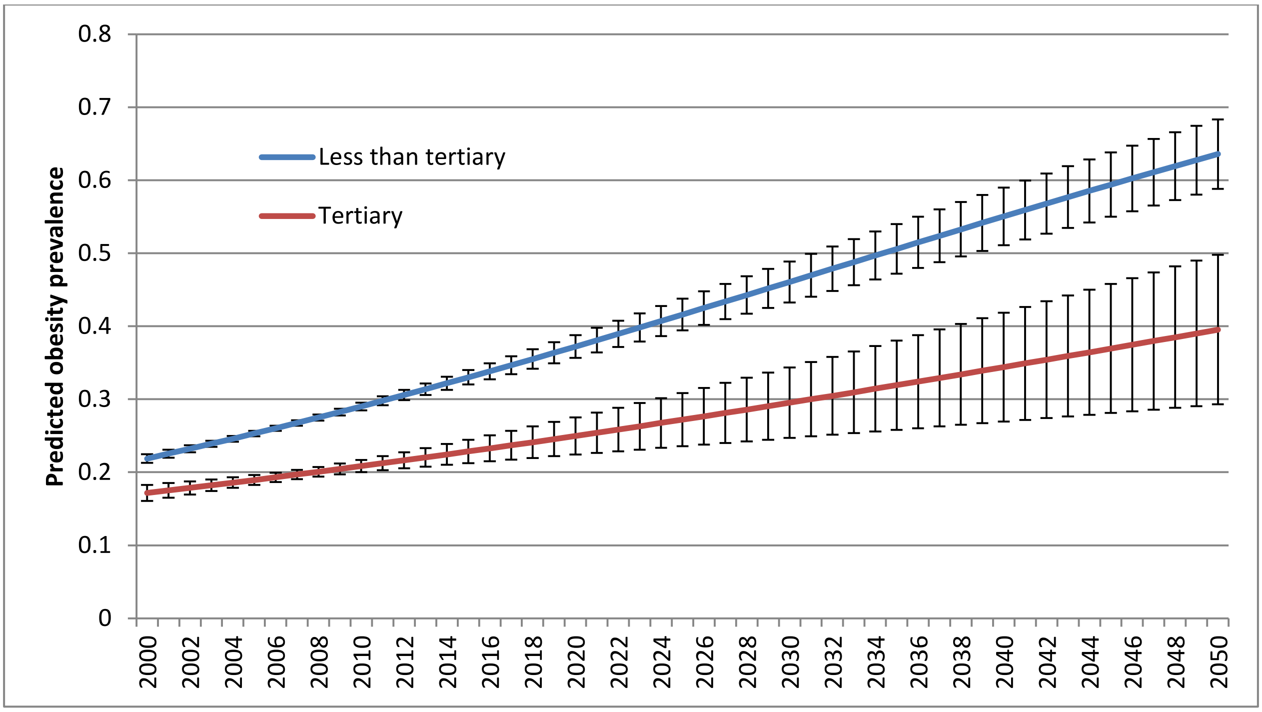


Figure 349 Obesity prevalence by education level among males

Females

There was a narrowing of inequalities in overweight prevalence in the period 2000 to 2015. This was due to overweight prevalence increasing among females with tertiary education, while remaining constant among those with less than tertiary education (Figure 350). The projections suggest that this trend will continue and that females with tertiary education will have a higher prevalence overweight compared to females with less than tertiary education by 2050. However, there is overlap between error bars so more data are necessary to determine the significance of this trend.

Obesity prevalence is predicted to increase in both females with tertiary education and those with less than tertiary education (Figure 351). Relative inequalities may narrow slightly due to a faster rate of increase in obesity prevalence among more compared to less educated females. Absolute inequalities will remain stable. The gap in obesity prevalence between the more and less educated females will be 10% by 2050 based on these projections. Again, overlap between error bars mean more data are necessary to determine the significance of this trend.

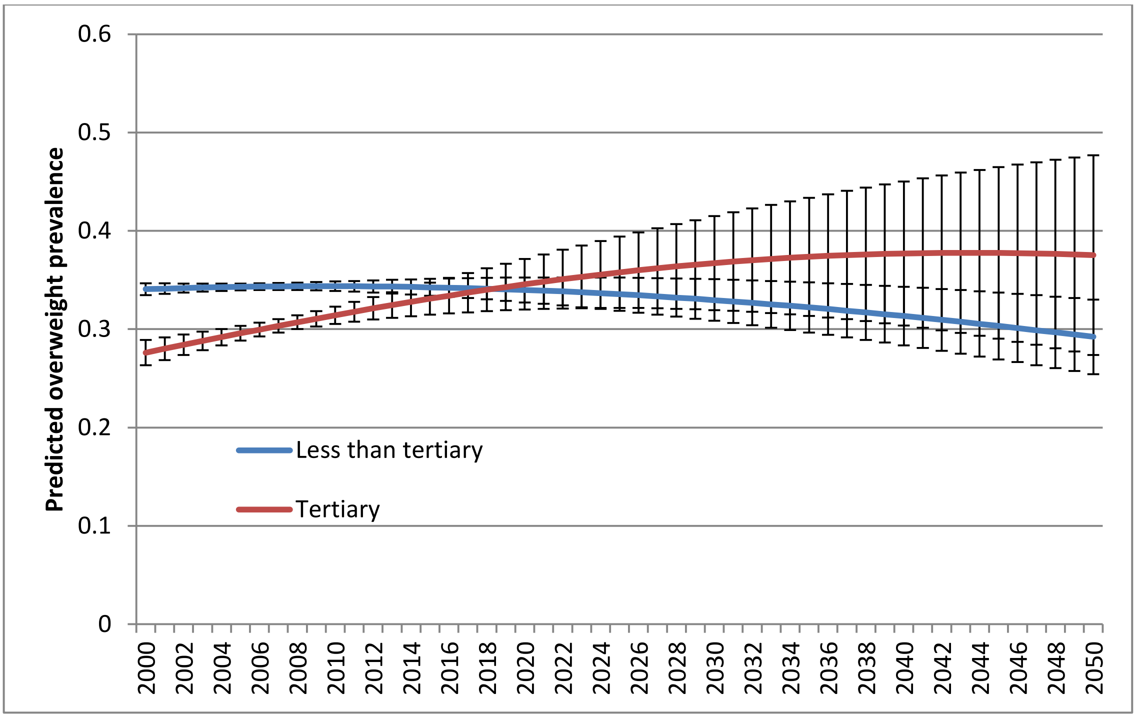


Figure 350 Overweight prevalence by education level among females

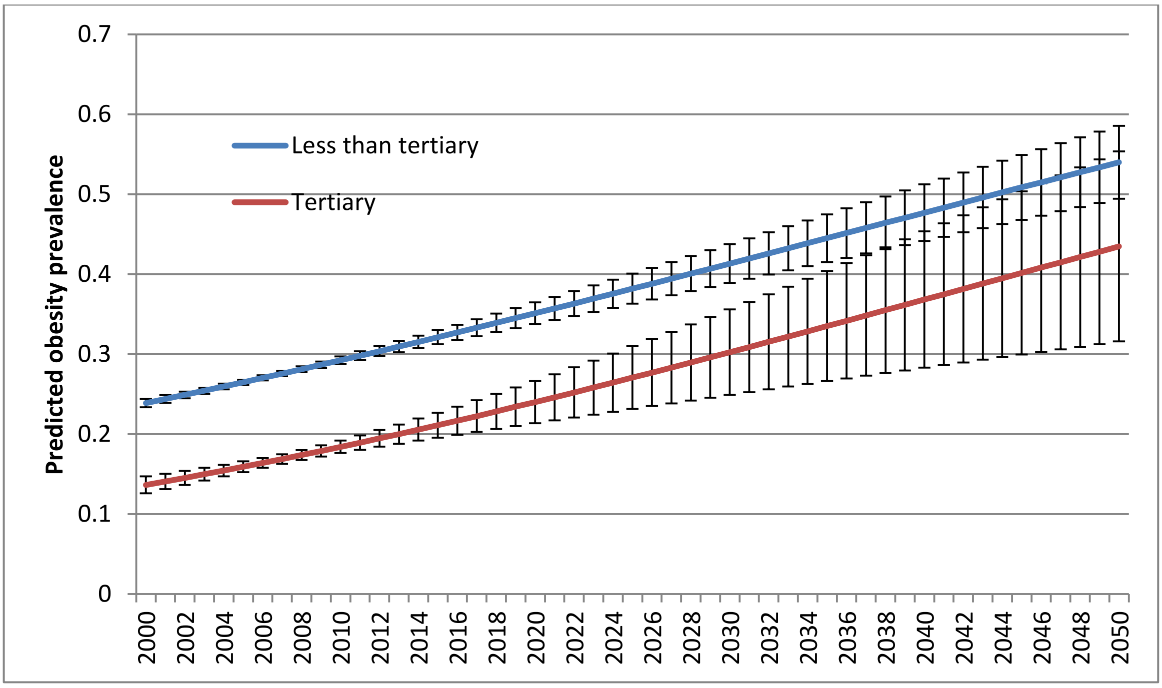


Figure 351 Obesity prevalence by education level among females

Smoking projections by sex and age

Table 206 presents smoking prevalence projections to 2050 for males and females aged 20 to 100. Smoking prevalence is projected to decline in both males and females. Based on these projections smoking prevalence could decline to 7% by 2050.

The decline in smoking prevalence is expected across all age groups among both males and females (Figure 352 to Figure 365). The largest change is projected among 20 to 29 year old males in whom the prevalence of smoking will decline from approximately 40% in 2000 to less than 10% in 2050 (Figure 352). Similarly large declines in smoking prevalence are projected for 20 to 39 year old females (Figure 359 and Figure 361).

Table 206 Smoker prevalence among 20 to 100 year old males and females, projected to 2050

	Male				Female				Both sexes			
Year	**Non-smokers**	**95% CI +/-**	**Smokers**	**95% CI +/-**	**Non-smokers**	**95% CI +/-**	**Smokers**	**95% CI +/-**	**Non-smokers**	**95% CI +/-**	**Smokers**	**95% CI +/-**
2015	82.0	0.7	18.0	0.7	83.0	0.6	17.0	0.6	83.0	0.7	17.0	0.7
2020	84.0	1.1	16.0	1.1	85.0	0.9	15.0	0.9	85.0	1.0	15.0	1.0
2025	86.0	1.7	14.0	1.7	87.0	1.5	13.0	1.5	87.0	1.6	13.0	1.6
2030	88.0	2.3	12.0	2.3	89.0	2.0	11.0	2.0	88.0	2.1	12.0	2.1
2035	89.0	2.7	11.0	2.7	90.0	2.4	10.0	2.4	90.0	2.6	10.0	2.6
2040	91.0	3.0	9.0	3.0	91.0	2.7	9.0	2.7	91.0	2.9	9.0	2.9
2045	92.0	3.2	8.0	3.2	92.0	3.0	8.0	3.0	92.0	3.1	8.0	3.1
2050	93.0	3.4	7.0	3.4	93.0	3.1	7.0	3.1	93.0	3.3	7.0	3.3

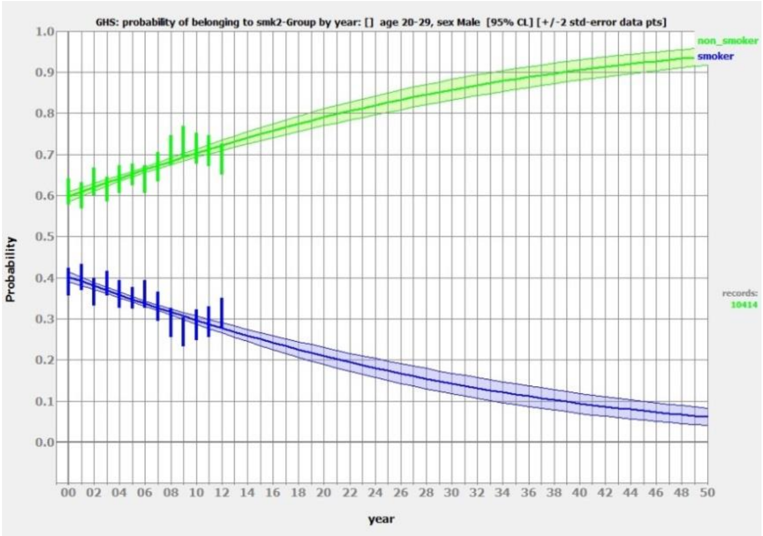


Figure 352 Smoking prevalence projections among males aged 20 to 29

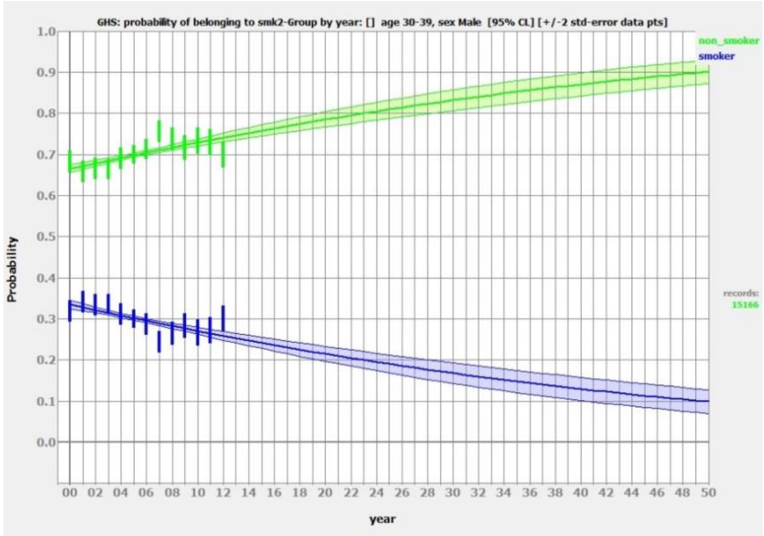


Figure 353 Smoking prevalence projections among males aged 30 to 39

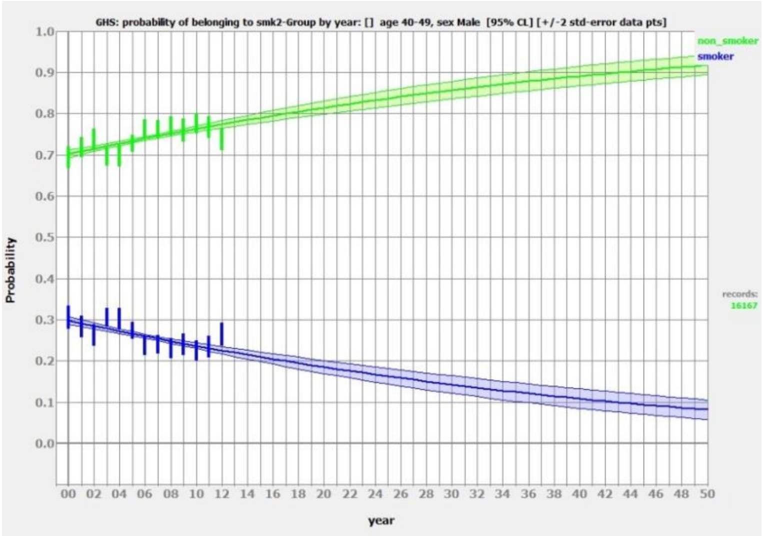


Figure 354 Smoking prevalence projections among males aged 40 to 49

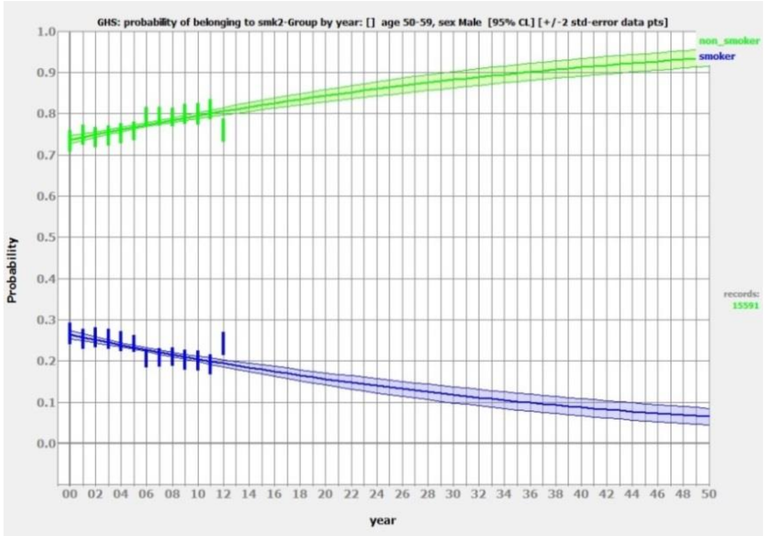


Figure 355 Smoking prevalence projections among males aged 50 to 59

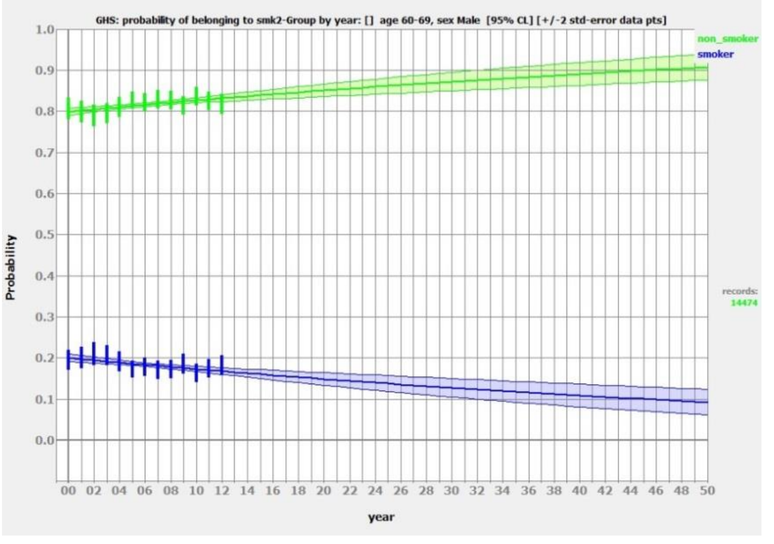


Figure 356 Smoking prevalence projections among males aged 60 to 69

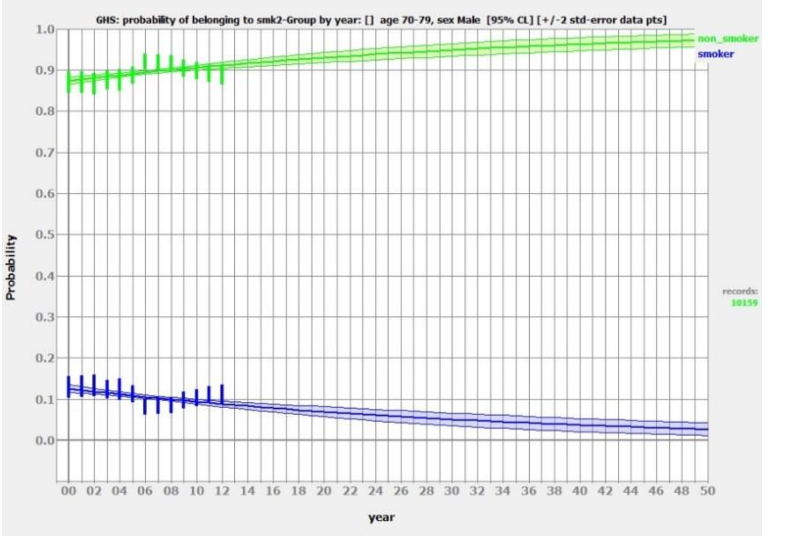


Figure 357 Smoking prevalence projections among males aged 70 to 79

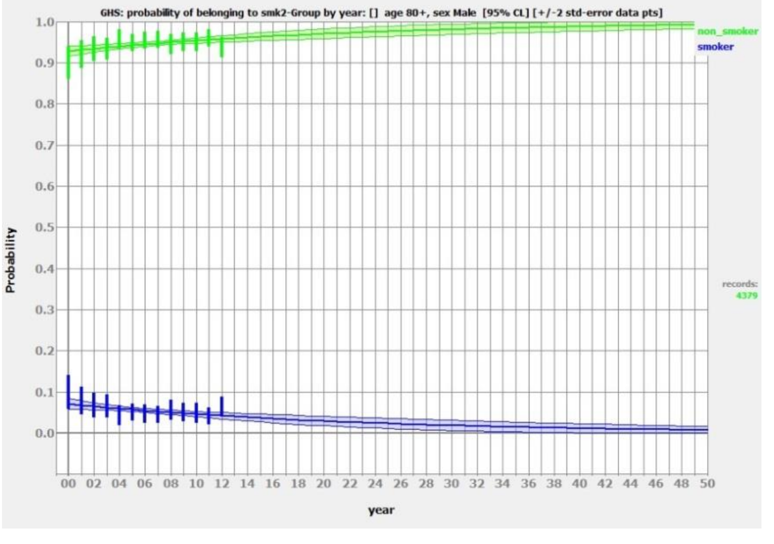


Figure 358 Smoking prevalence projections among males aged 80+

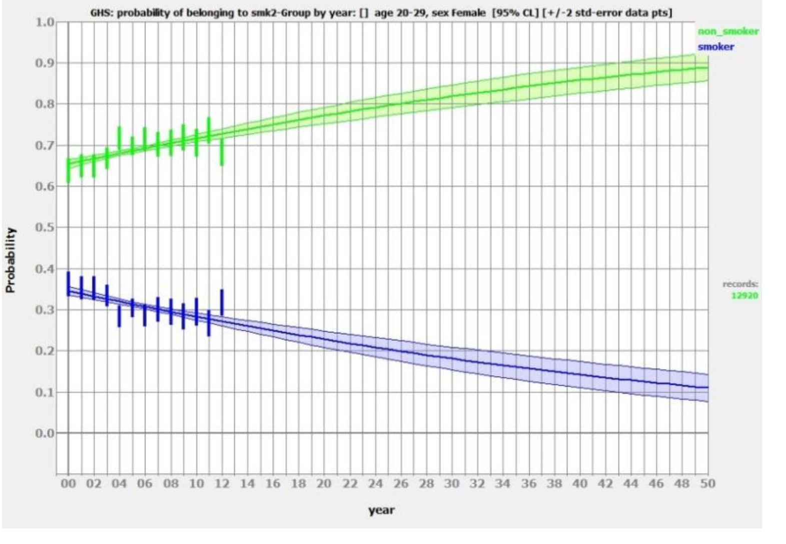


Figure 359 Smoking prevalence projections among females aged 20 to 29

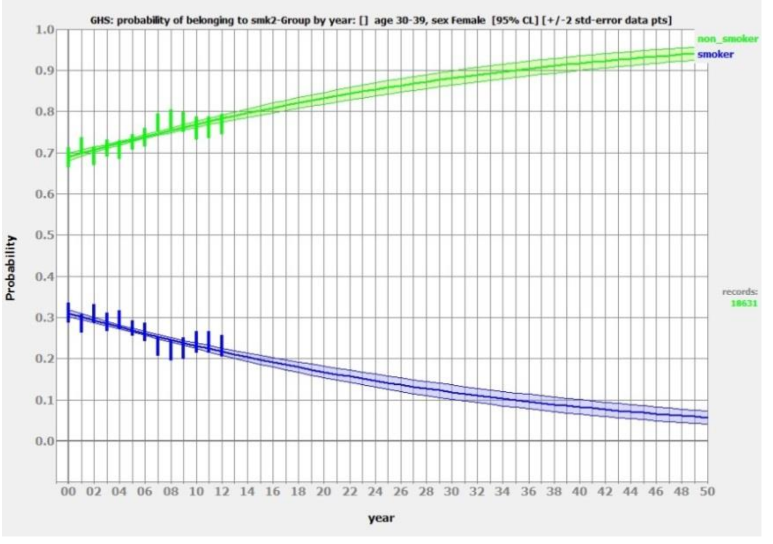


Figure 360 Smoking prevalence projections among females aged 30 to 39

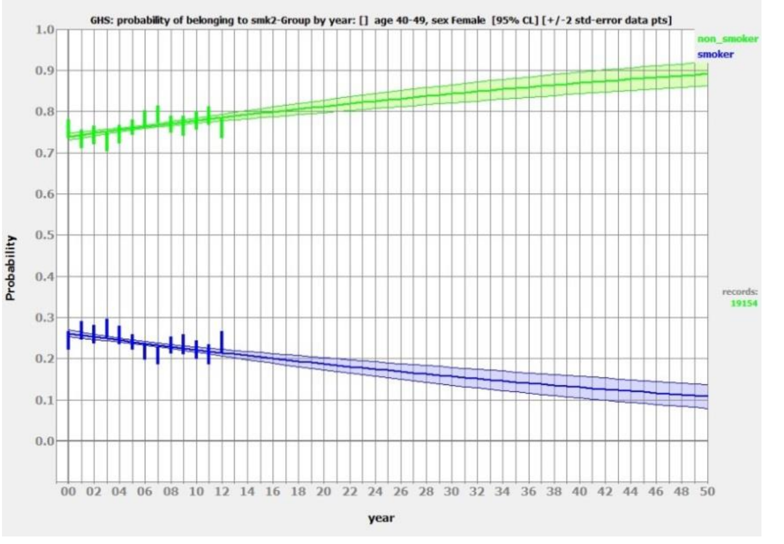


Figure 361 Smoking prevalence projections among females aged 40 to 49

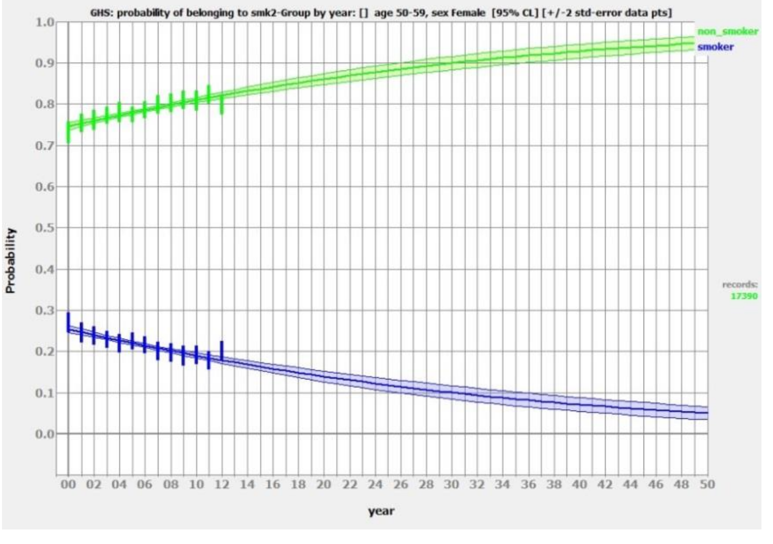


Figure 362 Smoking prevalence projections among females aged 50 to 59

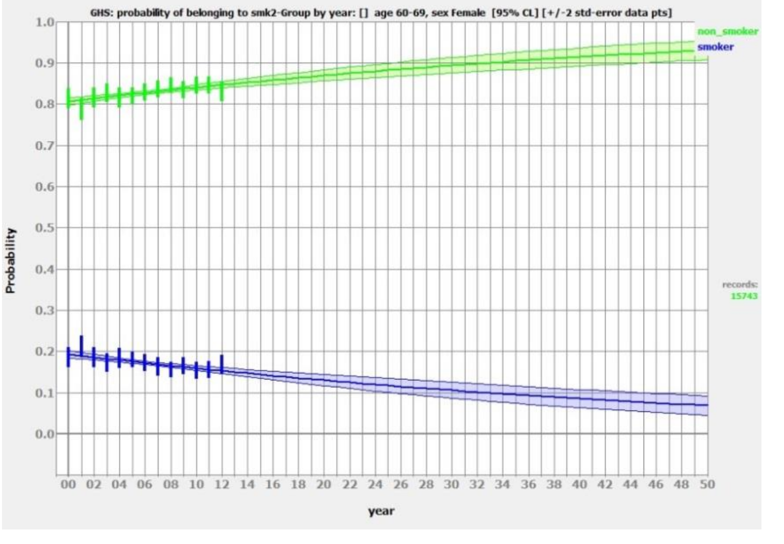


Figure 363 Smoking prevalence projections among females aged 60 to 69

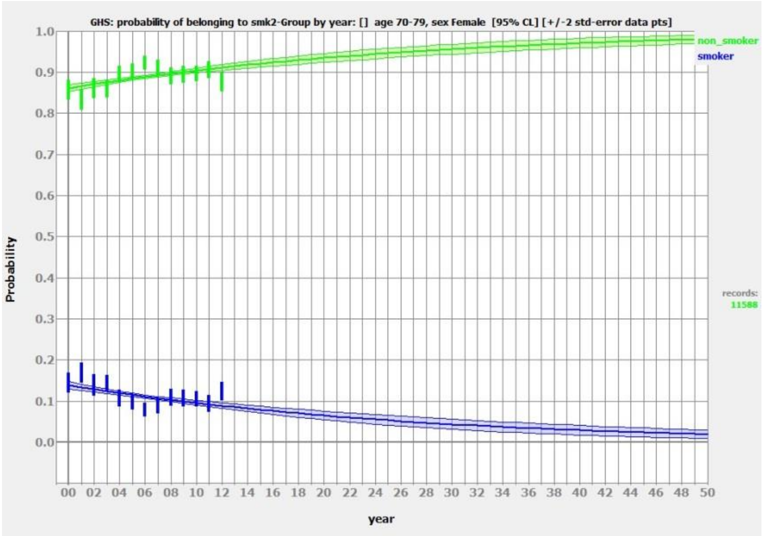


Figure 364 Smoking prevalence projections among females aged 70 to 79

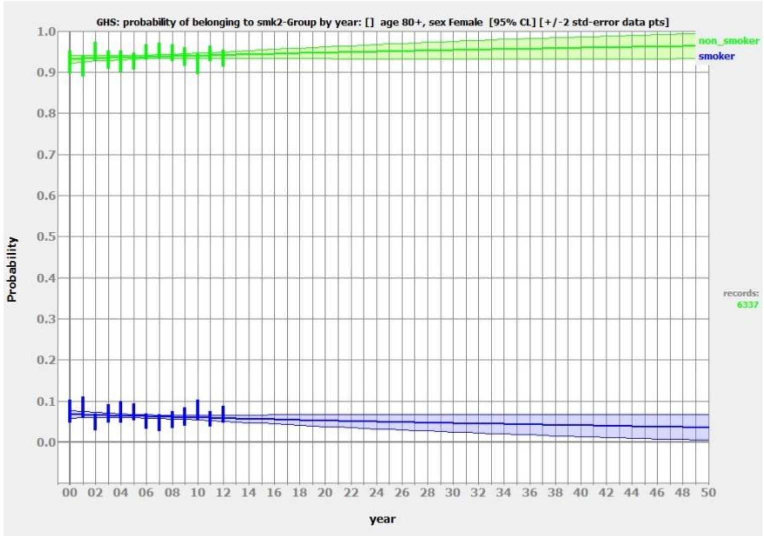


Figure 365 Smoking prevalence projections among females aged 80+

Smoking projections by education level

Males

Males with less than tertiary education, defined as lower than degree level, smoke significantly more than males educated to degree level or above. In 2015, smoking prevalence was 2.7 times higher among males with less than tertiary education compared to males with tertiary education (appendix E7). Relative inequalities in smoking prevalence are projected to increase (Figure 366) so that by 2050 the prevalence of smoking among males with less than tertiary education may be six times higher than that among males with tertiary education (appendix E7). Absolute inequalities however will decline, from an estimated 15% difference in prevalence in 2015 to an 8% difference by 2050 as shown in Figure 366.

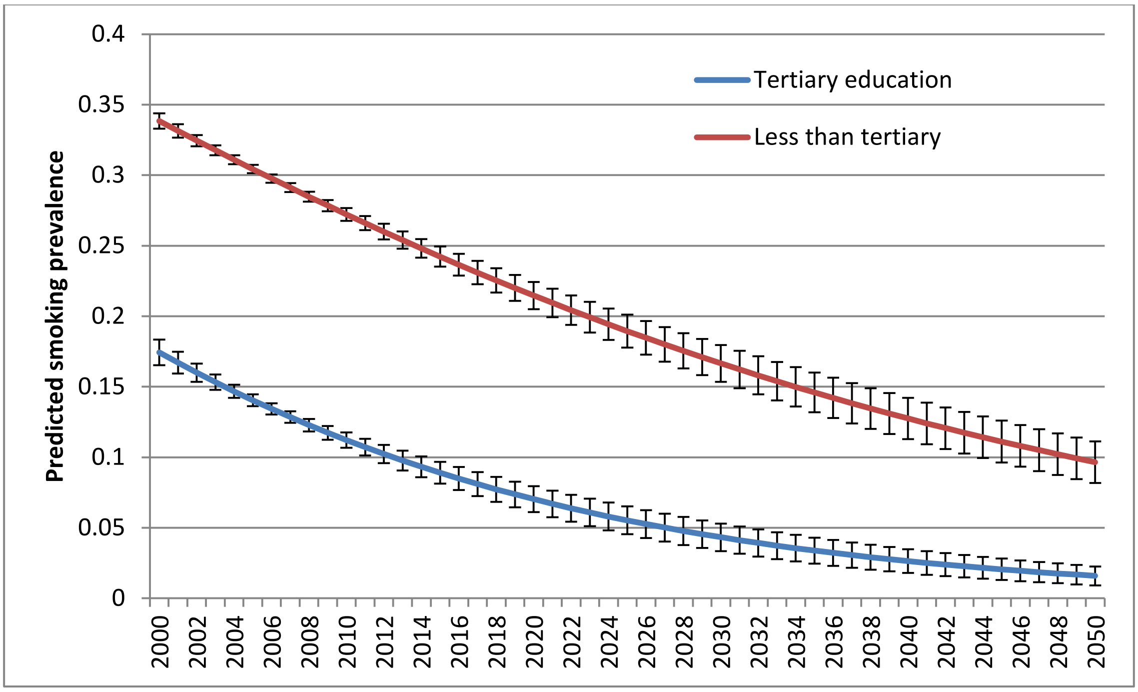


Figure 366 Smoking prevalence projections by education level among males

Females

A similar pattern of inequalities is projected among females by differing levels of education. In 2015, smoking prevalence among females with less than tertiary education was 2.7 times higher than it was among females with tertiary education. It is projected that by 2050, this ratio will have increased to 7.5 (appendix E7). Smoking prevalence is projected to decrease both among higher and lower educated females, although the pace of the decline among those with less than tertiary education is not fast enough to close the gap completely (Figure 367). Absolute inequalities are projected to decline at a slower rate than among men; from 14% prevalence difference in 2015 to 10% prevalence difference in 2050.

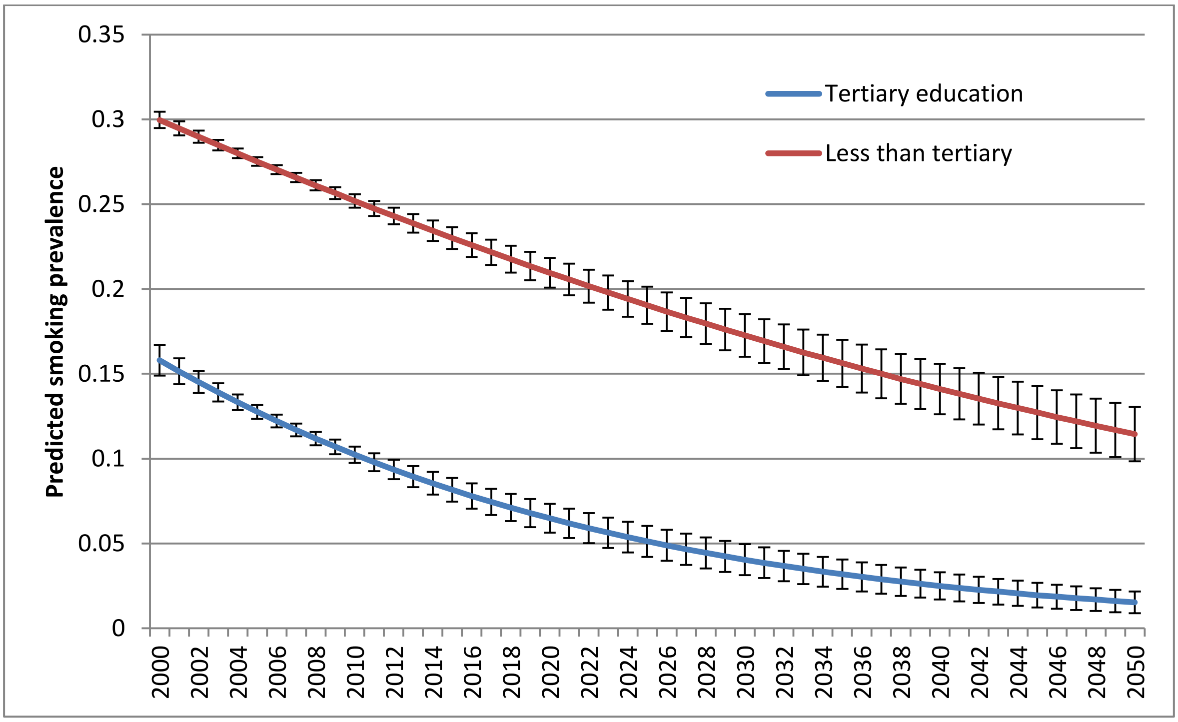


Figure 367 Smoking prevalence projections by education level among females

Section 3: Results of the microsimulation modelling and intervention testing

BMI intervention results

The BMI interventions tested (multi-component lifestyle interventions/MCLIs, and a sugar sweetened beverage tax/SSB) and their related input data are presented in
Table 207. Fifty million simulations were run for the MCLI interventions. For the SSB tax, due to the small associated BMI reduction identified in the literature, 100 million simulations were run. This provides more accurate results.

The BMI interventions tested and related input data are presented in
Table 207.

Table 207. Input data for each BMI intervention modelled

Intervention	BMI reduction	% BMI regain	Cost of intervention (£)
Baseline	None	-	-
MCLI annual regain	0.7	100	91.87
MCLI annual no regain	0.7	0	91.87
SSB	0.05	0	0

MCLI: Multi-component lifestyle interventions; SSB: Sugar sweetened beverage tax

Multi-component lifestyle interventions

Three different combinations of multi-component lifestyle interventions (MCLI) were run as described at the start of section 3.

1. **MCLI, annual, with regain**
2. **MCLI, annual, with no regain**
3. **MCLI, not annual, with no regain –** these results are presented in appendix E1.

Impact on disease incidence and prevalence

Table 208 presents the incidence cases per 100,000 to 2050 for baseline (no intervention) and each MCLI intervention scenario. For each disease and intervention scenario incidence cases increase over time, but the interventions are effective in reducing incidence over time.

Table 209 presents the cumulative incidence cases per 100,000 to 2050 for baseline and each intervention.

Table 210 presents and Figure 368 the cumulative cases *avoided* per 100,000 for baseline and each intervention (the table presents data for all years whilst the figure presents 2050 projections). Each table/figure indicates that both MCLI interventions would result in a lower cumulative incidence of all diseases by 2050 compared to baseline. For example, MCLI (no regain) would result in the avoidance of 102 cumulative incidence cases of CHD per 100,000 relative to baseline by 2050. Even when MCLI is modelled with weight regain there is a positive effect, with the avoidance of 75, 242 and 162 cumulative incidence cases of CHD, hypertension and type 2 diabetes per 100,000 respectively.

Table 211 and Figure 369 present the prevalence cases avoided for each intervention relative to baseline, per 100,000 (the table presents data for all years; the figure presents 2050 projections). The table indicates that each MCLI intervention would result in a reduced number of prevalence cases per 100,000 compared to baseline for all diseases by 2050, and for each five year increment from 2030 to 2050. For both MCLI interventions the largest number of prevalence cases avoided per 100,000 is observed for hypertension (185/100,000 and 219/100,000 for MCLI regain and no-regain scenarios respectively), followed by diabetes (117/100,000 and 135/100,000 respectively).

Table 208. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Prediabetes	Diabetes
Baseline	2015	150 [+-1]	837 [+-3]	123 [+-1]	807 [+-2]	399 [+-2]
	2020	162 [+-1]	864 [+-3]	130 [+-1]	843 [+-3]	416 [+-2]
	2025	178 [+-1]	891 [+-3]	142 [+-1]	884 [+-3]	439 [+-2]
	2030	191 [+-1]	907 [+-3]	150 [+-1]	924 [+-3]	462 [+-2]
	2035	206 [+-1]	923 [+-3]	162 [+-1]	962 [+-3]	487 [+-2]
	2040	218 [+-1]	933 [+-3]	169 [+-1]	980 [+-3]	507 [+-2]
	2045	230 [+-1]	940 [+-3]	176 [+-1]	990 [+-3]	522 [+-2]
	2050	241 [+-1]	942 [+-3]	178 [+-1]	1007 [+-3]	529 [+-2]
MCLI (annual, with regain)	2015	149 [+-1]	835 [+-3]	123 [+-1]	806 [+-2]	397 [+-2]
	2020	162 [+-1]	863 [+-3]	130 [+-1]	840 [+-3]	415 [+-2]
	2025	176 [+-1]	883 [+-3]	141 [+-1]	877 [+-3]	436 [+-2]
	2030	189 [+-1]	898 [+-3]	151 [+-1]	918 [+-3]	456 [+-2]
	2035	204 [+-1]	915 [+-3]	160 [+-1]	958 [+-3]	480 [+-2]
	2040	216 [+-1]	926 [+-3]	169 [+-1]	973 [+-3]	499 [+-2]
	2045	228 [+-1]	930 [+-3]	175 [+-1]	983 [+-3]	517 [+-2]
	2050	237 [+-1]	935 [+-3]	178 [+-1]	1002 [+-3]	526 [+-2]
MCLI (annual, with no regain)	2015	149 [+-1]	834 [+-3]	123 [+-1]	805 [+-2]	398 [+-2]
	2020	161 [+-1]	858 [+-3]	130 [+-1]	840 [+-3]	413 [+-2]
	2025	176 [+-1]	879 [+-3]	141 [+-1]	879 [+-3]	435 [+-2]
	2030	190 [+-1]	896 [+-3]	150 [+-1]	919 [+-3]	455 [+-2]
	2035	204 [+-1]	916 [+-3]	160 [+-1]	959 [+-3]	479 [+-2]
	2040	215 [+-1]	927 [+-3]	169 [+-1]	977 [+-3]	500 [+-2]
	2045	228 [+-1]	930 [+-3]	175 [+-1]	983 [+-3]	516 [+-2]
	2050	237 [+-1]	935 [+-3]	177 [+-1]	1003 [+-3]	526 [+-2]

Table 209. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Prediabetes	Diabetes
Baseline	2015	150 [+-1]	837 [+-3]	123 [+-1]	807 [+-2]	399 [+-2]
	2020	927 [+-3]	5068 [+-6]	752 [+-2]	4908 [+-6]	2428 [+-4]
	2025	1776 [+-4]	9428 [+-8]	1430 [+-3]	9193 [+-8]	4552 [+-6]
	2030	2704 [+-4]	13929 [+-9]	2164 [+-4]	13733 [+-9]	6815 [+-7]
	2035	3727 [+-5]	18598 [+-11]	2962 [+-5]	18565 [+-11]	9238 [+-8]
	2040	4830 [+-6]	23408 [+-12]	3821 [+-5]	23595 [+-12]	11814 [+-9]
	2045	6006 [+-7]	28319 [+-12]	4727 [+-6]	28759 [+-13]	14509 [+-10]
	2050	7266 [+-7]	33365 [+-13]	5676 [+-6]	34103 [+-13]	17320 [+-11]
MCLI (annual, with regain)	2015	149 [+-1]	835 [+-3]	123 [+-1]	806 [+-2]	397 [+-2]
	2020	926 [+-3]	5052 [+-6]	751 [+-2]	4897 [+-6]	2418 [+-4]
	2025	1771 [+-4]	9384 [+-8]	1428 [+-3]	9161 [+-8]	4532 [+-6]
	2030	2693 [+-4]	13846 [+-9]	2161 [+-4]	13677 [+-9]	6771 [+-7]
	2035	3703 [+-5]	18478 [+-11]	2954 [+-5]	18480 [+-11]	9165 [+-8]
	2040	4791 [+-6]	23240 [+-12]	3808 [+-5]	23475 [+-12]	11708 [+-9]
	2045	5950 [+-7]	28114 [+-12]	4708 [+-6]	28604 [+-13]	14374 [+-10]
	2050	7191 [+-7]	33123 [+-13]	5650 [+-6]	33922 [+-13]	17158 [+-11]
MCLI (annual, with no regain)	2015	149 [+-1]	834 [+-3]	123 [+-1]	805 [+-2]	398 [+-2]
	2020	922 [+-3]	5040 [+-6]	749 [+-2]	4892 [+-6]	2413 [+-4]
	2025	1763 [+-4]	9350 [+-8]	1424 [+-3]	9156 [+-8]	4517 [+-6]
	2030	2680 [+-4]	13797 [+-9]	2155 [+-4]	13674 [+-9]	6750 [+-7]
	2035	3688 [+-5]	18425 [+-11]	2948 [+-5]	18482 [+-11]	9140 [+-8]
	2040	4770 [+-6]	23192 [+-12]	3802 [+-5]	23484 [+-12]	11684 [+-9]
	2045	5927 [+-7]	28064 [+-12]	4700 [+-6]	28618 [+-13]	14347 [+-10]
	2050	7164 [+-7]	33071 [+-13]	5641 [+-6]	33940 [+-13]	17127 [+-11]

Table 210. Cumulative incidence cases avoided (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Prediabetes	Diabetes
MCLI (annual, with regain)	2015	1 [+-1]	2 [+-4]	0 [+-1]	1 [+-3]	2 [+-3]
	2020	1 [+-4]	16 [+-8]	1 [+-3]	11 [+-8]	10 [+-6]
	2025	5 [+-6]	44 [+-11]	2 [+-4]	32 [+-11]	20 [+-8]
	2030	11 [+-6]	83 [+-13]	3 [+-6]	56 [+-13]	44 [+-10]
	2035	24 [+-7]	120 [+-16]	8 [+-7]	85 [+-16]	73 [+-11]
	2040	39 [+-8]	168 [+-17]	13 [+-7]	120 [+-17]	106 [+-13]
	2045	56 [+-10]	205 [+-17]	19 [+-8]	155 [+-18]	135 [+-14]
	2050	75 [+-10]	242 [+-18]	26 [+-8]	181 [+-18]	162 [+-16]
MCLI (annual, with no regain)	2015	1 [+-1]	3 [+-4]	0 [+-1]	2 [+-3]	1 [+-3]
	2020	5 [+-4]	28 [+-8]	3 [+-3]	16 [+-8]	15 [+-6]
	2025	13 [+-6]	78 [+-11]	6 [+-4]	37 [+-11]	35 [+-8]
	2030	24 [+-6]	132 [+-13]	9 [+-6]	59 [+-13]	65 [+-10]
	2035	39 [+-7]	173 [+-16]	14 [+-7]	83 [+-16]	98 [+-11]
	2040	60 [+-8]	216 [+-17]	19 [+-7]	111 [+-17]	130 [+-13]
	2045	79 [+-10]	255 [+-17]	27 [+-8]	141 [+-18]	162 [+-14]
	2050	102 [+-10]	294 [+-18]	35 [+-8]	163 [+-18]	193 [+-16]

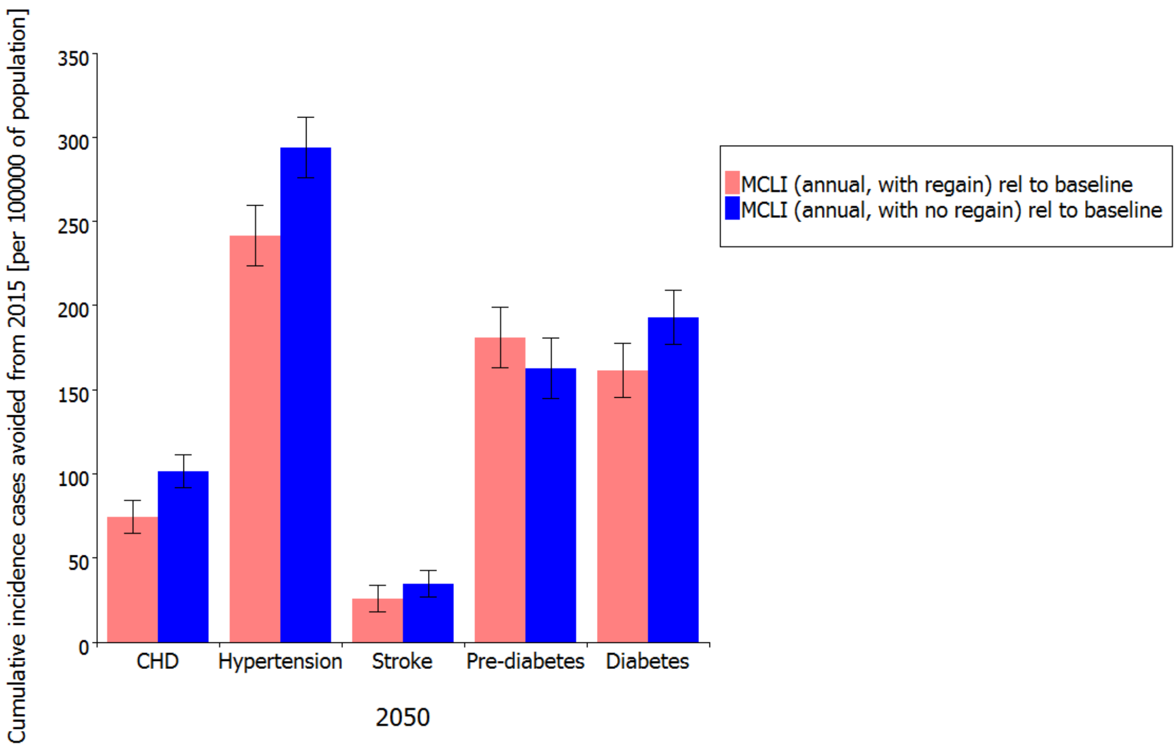


Figure 368. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 211. Prevalence cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Prediabetes	Diabetes
MCLI (annual, with regain)	2015	-3 [+-4]	-5 [+-17]	-2 [+-4]	3 [+-10]	1 [+-11]
	2020	-3 [+-4]	13 [+-17]	-1 [+-4]	7 [+-10]	11 [+-11]
	2025	1 [+-6]	42 [+-17]	1 [+-4]	20 [+-10]	22 [+-11]
	2030	6 [+-6]	83 [+-17]	3 [+-4]	23 [+-10]	42 [+-13]
	2035	16 [+-6]	107 [+-17]	5 [+-4]	31 [+-10]	60 [+-13]
	2040	21 [+-6]	142 [+-17]	8 [+-4]	32 [+-10]	86 [+-13]
	2045	28 [+-6]	169 [+-18]	9 [+-4]	36 [+-10]	105 [+-13]
	2050	35 [+-6]	185 [+-18]	9 [+-4]	32 [+-10]	117 [+-13]
MCLI (annual, with no regain)	2015	-2 [+-4]	2 [+-17]	1 [+-4]	7 [+-10]	7 [+-11]
	2020	3 [+-4]	29 [+-17]	2 [+-4]	11 [+-10]	22 [+-11]
	2025	9 [+-6]	77 [+-17]	5 [+-4]	20 [+-10]	40 [+-11]
	2030	16 [+-6]	127 [+-17]	7 [+-4]	21 [+-10]	63 [+-13]
	2035	24 [+-6]	152 [+-17]	6 [+-4]	25 [+-10]	80 [+-13]
	2040	32 [+-6]	180 [+-17]	8 [+-4]	26 [+-10]	104 [+-13]
	2045	37 [+-6]	204 [+-18]	10 [+-4]	30 [+-10]	122 [+-13]
	2050	46 [+-6]	219 [+-18]	10 [+-4]	26 [+-10]	135 [+-13]

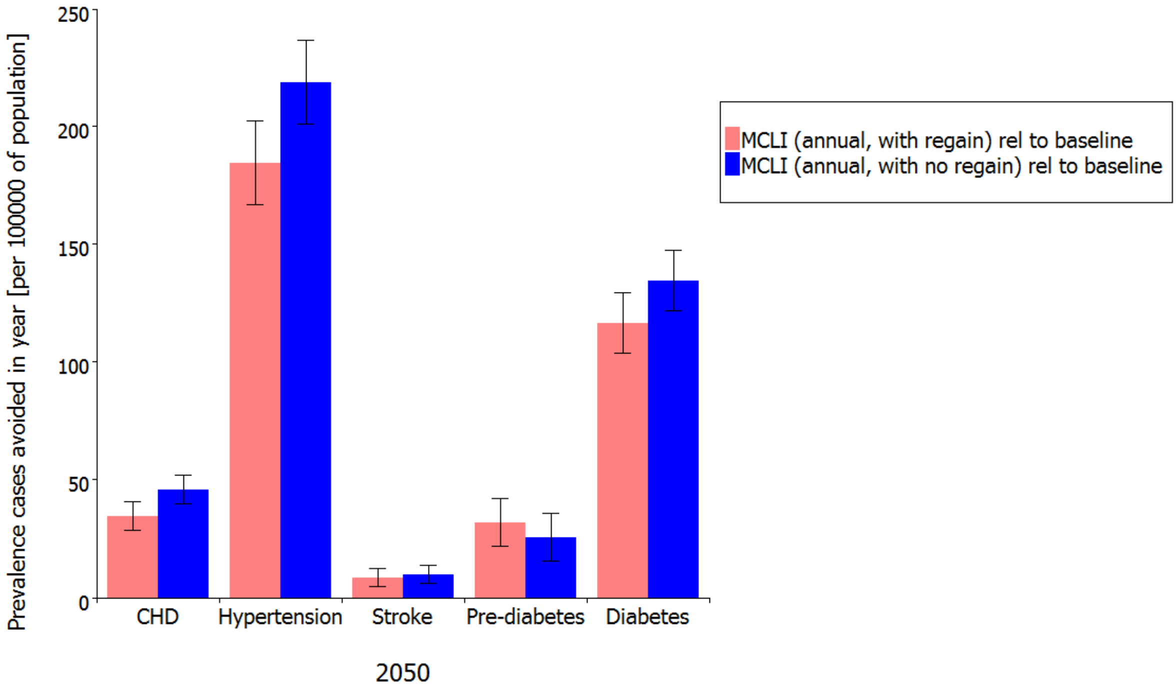


Figure 369. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 212 and Figure 370 present the direct healthcare costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest direct health-care costs *avoided* is expected to be observed in diabetes for both MCLI interventions (£0.12m and £0.10m per 100,000 for the *MCLI (no weight regain)* and *MCLI (weight regain)* scenarios, respectively).

Table 213 and Figure 371 present the indirect costs that can be *avoided* (per 100,000 population) for a given intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* are expected to be observed in diabetes for both MCLI interventions (£0.05m and £0.06m per 100,000 population for the *MCLI (no weight regain)* and *MCLI (weight regain)* scenarios, respectively).

Figure 372 and Figure 373 present the QALYs that can be *gained* (per 100,000 population) for a given intervention, relative to the baseline. For both males and females, both variations of the MCLI interventions are expected to lead to increasing gains in QALYs over time.

Figure 374 the positive ICER values (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that both versions of the MCLI scenarios may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in the UK. A cost effectiveness threshold is required to determine whether or not the interventions are cost effective when ICER values are positive. However, since no cost effectiveness thresholds have been assigned in this project, we cannot categorically determine whether or not this set of interventions is cost effective. Over time, however, the ICER is expected to approach near zero, indicating that the interventions are likely to become cost effective.

Table 212. Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
MCLI (annual, with regain), relative to baseline	2015	-0.00362 [+-0.000102]	-0.000747 [+-0.000642]	-0.006006 [+-0.000099]	0.000184 [+-0.000041]	0.004726 [+-0.003158]
	2020	-0.00295 [+-0.000096]	0.001722 [+-0.000566]	-0.00157 [+-0.000095]	0.00044 [+-0.000035]	0.025833 [+-0.002807]
	2025	0.001043 [+-0.000092]	0.00491 [+-0.0005]	0.000984 [+-0.000089]	0.001039 [+-0.000031]	0.044487 [+-0.002508]
	2030	0.005891 [+-0.000086]	0.008061 [+-0.000442]	0.004745 [+-0.000082]	0.000978 [+-0.000028]	0.071787 [+-0.002252]
	2035	0.011926 [+-0.000081]	0.008699 [+-0.000389]	0.006357 [+-0.000075]	0.001086 [+-0.000024]	0.086678 [+-0.002023]
	2040	0.013948 [+-0.000074]	0.009752 [+-0.00034]	0.008252 [+-0.000069]	0.000954 [+-0.000021]	0.103736 [+-0.001807]
	2045	0.014817 [+-0.000067]	0.009769 [+-0.000296]	0.008104 [+-0.000062]	0.000894 [+-0.000018]	0.107335 [+-0.001604]
	2050	0.015684 [+-0.00006]	0.009005 [+-0.000255]	0.006783 [+-0.000053]	0.000685 [+-0.000016]	0.100542 [+-0.00141]
MCLI (annual, with no regain), relative to baseline	2015	-0.00234 [+-0.000102]	0.00036 [+-0.000642]	0.002144 [+-0.000099]	0.000438 [+-0.00004]	0.019531 [+-0.003157]
	2020	0.003748 [+-0.000096]	0.003929 [+-0.000565]	0.005692 [+-0.000095]	0.000687 [+-0.000035]	0.053627 [+-0.002804]
	2025	0.010087 [+-0.000091]	0.008883 [+-0.000499]	0.007892 [+-0.000089]	0.001006 [+-0.000031]	0.08107 [+-0.002505]
	2030	0.014392 [+-0.000086]	0.012275 [+-0.000441]	0.009746 [+-0.000082]	0.000904 [+-0.000028]	0.106323 [+-0.002249]
	2035	0.018321 [+-0.00008]	0.012332 [+-0.000389]	0.008227 [+-0.000075]	0.000874 [+-0.000024]	0.115063 [+-0.002021]
	2040	0.021058 [+-0.000074]	0.012351 [+-0.000339]	0.008785 [+-0.000069]	0.000762 [+-0.000021]	0.12576 [+-0.001806]
	2045	0.019679 [+-0.020693]	0.011771 [+-0.000296]	0.008306 [+-0.000062]	0.000746 [+-0.000018]	0.124437 [+-0.001602]
	2050	0.020693 [+-0.00006]	0.010643 [+-0.000255]	0.007906 [+-0.000053]	0.000542 [+-0.000016]	0.116171 [+-0.001409]

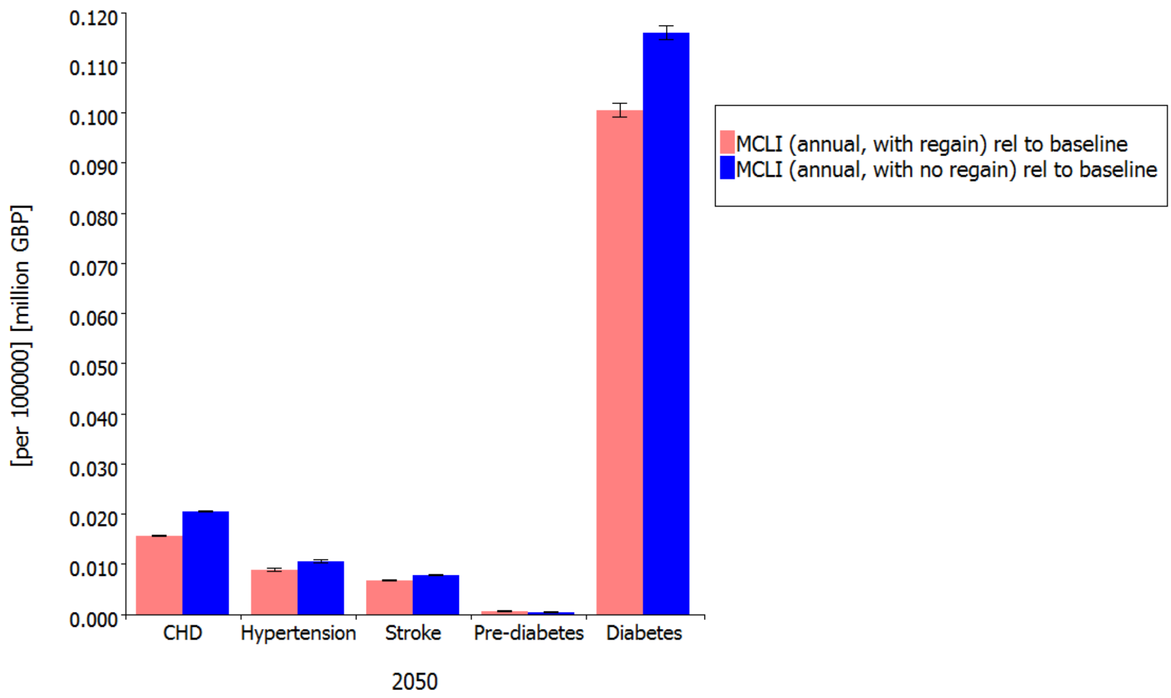


Figure 370. Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

Table 213. Indirect costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
MCLI (annual, with regain), relative to baseline	2015	-0.00981 [+-0.000275]	-0.001162 [+-0.001]	-0.023766 [+-0.000391]	0 [+-0]	0.002395 [+-0.001601]
	2020	-0.00798 [+-0.000261]	0.002681 [+-0.00088]	-0.006213 [+-0.000375]	0 [+-0]	0.013095 [+-0.001422]
	2025	0.002825 [+-0.000247]	0.007642 [+-0.000778]	0.003895 [+-0.000352]	0 [+-0]	0.022549 [+-0.001271]
	2030	0.015962 [+-0.000233]	0.012546 [+-0.000687]	0.018775 [+-0.000325]	0 [+-0]	0.036386 [+-0.001142]
	2035	0.032312 [+-0.000218]	0.01354 [+-0.000605]	0.025155 [+-0.000298]	0 [+-0]	0.043934 [+-0.001025]
	2040	0.03779 [+-0.0002]	0.015179 [+-0.00053]	0.03265 [+-0.000271]	0 [+-0]	0.05258 [+-0.000916]
	2045	0.040149 [+-0.000182]	0.015205 [+-0.00046]	0.032068 [+-0.000243]	0 [+-0]	0.054405 [+-0.000812]
	2050	0.042497 [+-0.000163]	0.014016 [+-0.000396]	0.026841 [+-0.000211]	0 [+-0]	0.050962 [+-0.000715]
MCLI (annual, with no regain), relative to baseline	2015	-0.00635 [+-0.000275]	0.00056 [+-0.001]	0.008484 [+-0.00039]	0 [+-0]	0.0099 [+-0.0016]
	2020	0.010154 [+-0.00026]	0.006115 [+-0.00088]	0.022522 [+-0.000374]	0 [+-0]	0.027182 [+-0.001421]
	2025	0.02733 [+-0.000247]	0.013825 [+-0.000777]	0.031226 [+-0.000351]	0 [+-0]	0.041092 [+-0.001269]
	2030	0.038997 [+-0.000232]	0.019105 [+-0.000687]	0.038563 [+-0.000324]	0 [+-0]	0.053892 [+-0.001141]
	2035	0.049639 [+-0.000217]	0.019194 [+-0.000605]	0.032555 [+-0.000297]	0 [+-0]	0.058321 [+-0.001025]
	2040	0.057054 [+-0.000199]	0.019223 [+-0.00053]	0.034759 [+-0.000271]	0 [+-0]	0.063743 [+-0.000915]
	2045	0.053322 [+-0.05607]	0.01832 [+-0.000459]	0.032868 [+-0.000243]	0 [+-0]	0.063073 [+-0.000812]
	2050	0.05607 [+-0.000163]	0.016567 [+-0.000395]	0.031284 [+-0.000211]	0 [+-0]	0.058883 [+-0.000714]

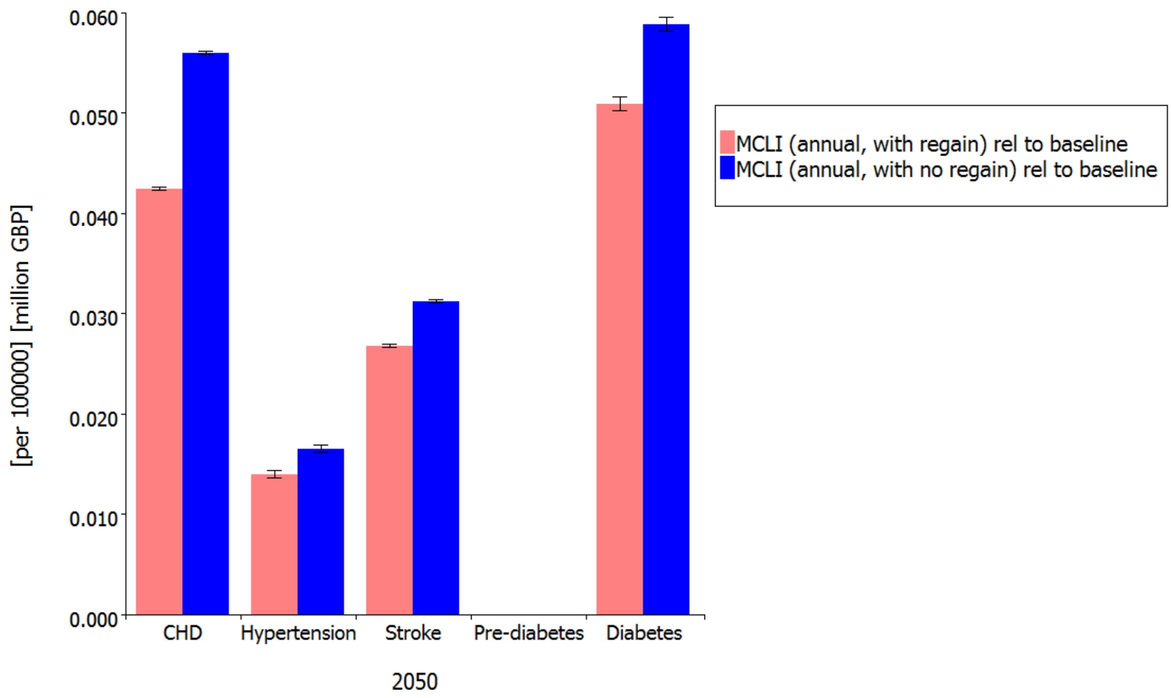


Figure 371. Indirect costs (£ millions) avoided (per 100,000), relative to baseline

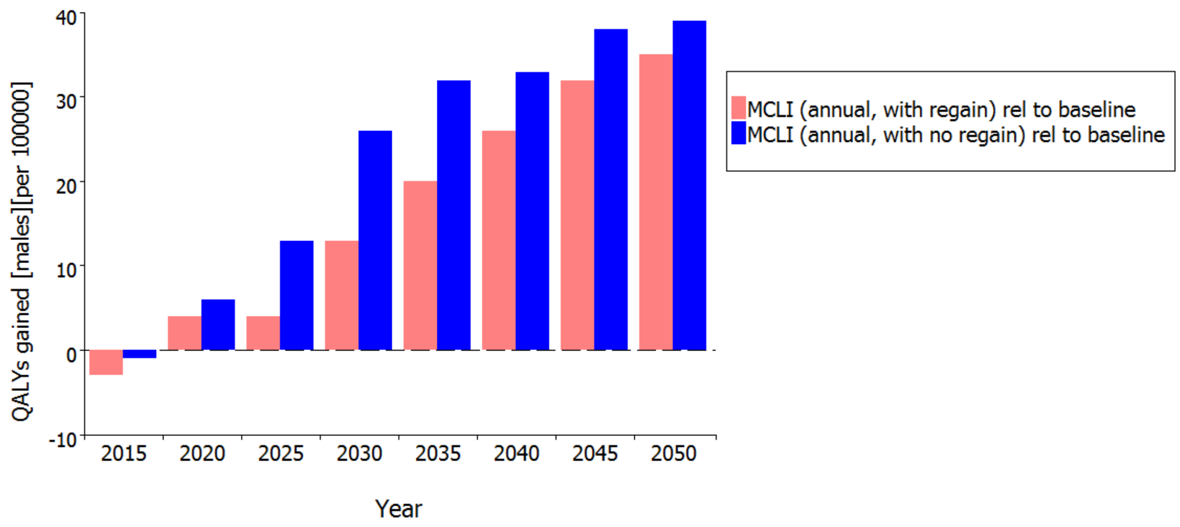


Figure 372. QALYS gained (per 100,000) relative to baseline (males)

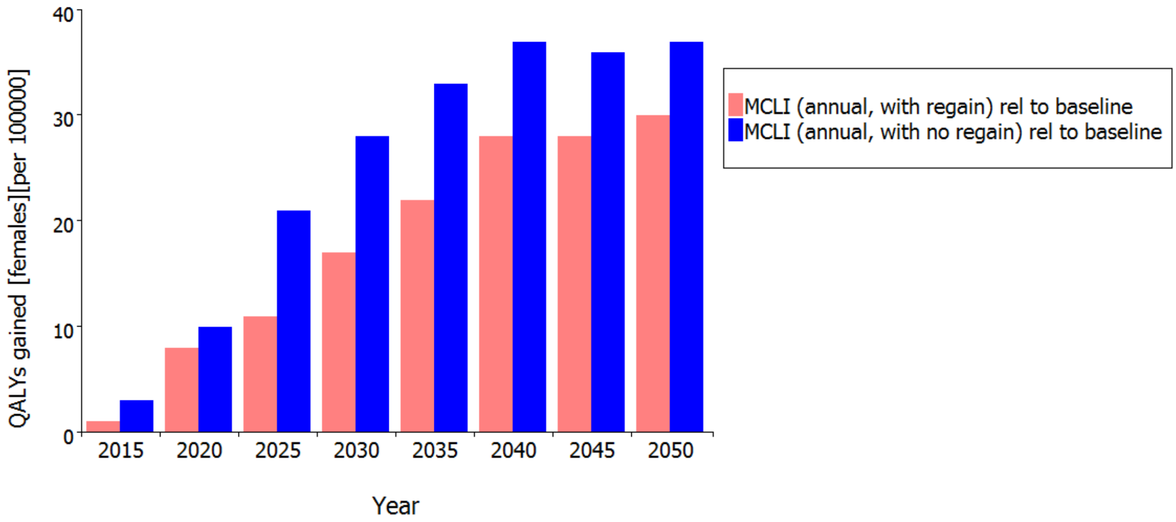


Figure 373. QALYS gained (per 100,000) relative to baseline (females)

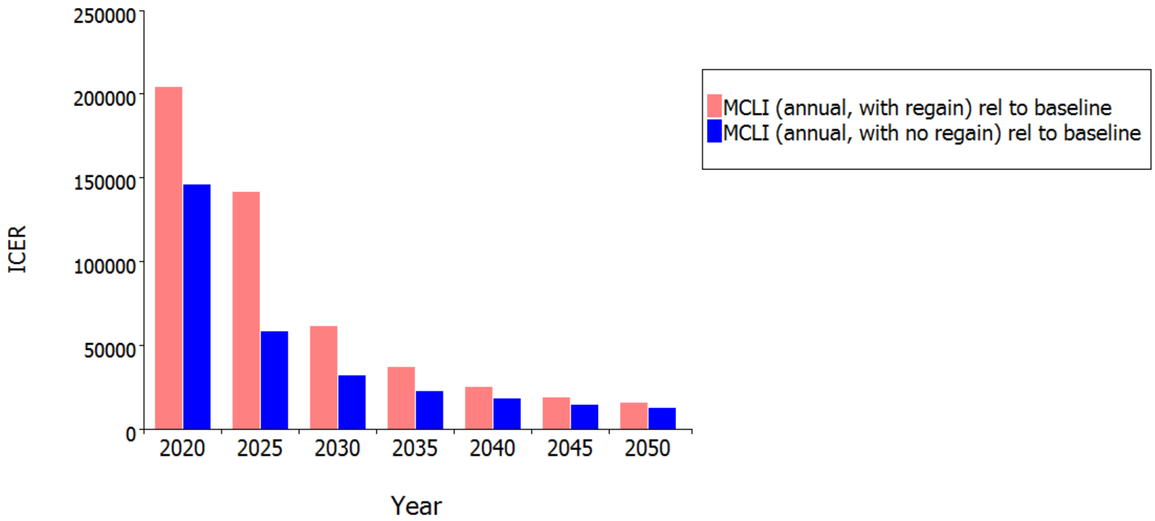


Figure 374. ICER

Sugar Sweetened Beverage (SSBs) tax intervention

Impact on disease incidence and prevalence

Table 214 presents the incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Incidence is predicted to increase for all diseases for each 5 year increment in both scenarios. The SSB scenario results in fewer cases of pre-diabetes and diabetes per 100,000 in 2050 compared to baseline; there are no differences between scenarios for other diseases in 2050.

Table 215 presents the cumulative incidence cases per 100,000 from 2015 to 2050 for baseline (no intervention) and SSB scenarios. Cumulative incidence is lower for all diseases in the SSB scenario compared to baseline by 2050.

Table 216 and Figure 375 present the cumulative incidence cases avoided (per 100,000) from 2015 to 2050 for each intervention relative to baseline. The SSB scenario is predicted to reduce the cumulative incidence of all diseases, where the largest effect is observed for pre-diabetes (87 cases avoided per 100,000 compared to baseline by 2050) followed by hypertension (73 cases avoided per 100,000 compared to baseline by 2050). The graph illustrates the predicted impact on incidence of each disease as a result of an SSB tax relative to baseline by 2050.

Table 217 and Figure 376 present the prevalence cases avoided (per 100,000) for each intervention relative to baseline in 5 year increments from 2015 to 2050. The SSB scenario is predicted to reduce prevalence cases per 100,000 compared to baseline for all diseases by 2050, with the greatest effect observed for hypertension (45 prevalence cases avoided per 100,000 compared to baseline) followed by diabetes (35 prevalence cases avoided per 100,000 compared to baseline).

Table 214. Incidence cases (per 100,000)

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
Baseline	2015	150 [+-1]	836 [+-2]	122 [+-1]	806 [+-2]	398 [+-1]
	2020	163 [+-1]	864 [+-2]	130 [+-1]	841 [+-2]	417 [+-1]
	2025	178 [+-1]	891 [+-2]	142 [+-1]	883 [+-2]	439 [+-1]
	2030	191 [+-1]	907 [+-2]	150 [+-1]	924 [+-2]	462 [+-1]
	2035	206 [+-1]	923 [+-2]	161 [+-1]	962 [+-2]	487 [+-1]
	2040	218 [+-1]	932 [+-2]	170 [+-1]	980 [+-2]	507 [+-1]
	2045	230 [+-1]	938 [+-2]	176 [+-1]	989 [+-2]	521 [+-1]
	2050	241 [+-1]	941 [+-2]	178 [+-1]	1007 [+-2]	530 [+-1]
SSB	2015	150 [+-1]	834 [+-2]	122 [+-1]	805 [+-2]	398 [+-1]
	2020	162 [+-1]	860 [+-2]	130 [+-1]	837 [+-2]	415 [+-1]
	2025	177 [+-1]	888 [+-2]	142 [+-1]	880 [+-2]	437 [+-1]
	2030	191 [+-1]	905 [+-2]	150 [+-1]	922 [+-2]	460 [+-1]
	2035	205 [+-1]	922 [+-2]	161 [+-1]	960 [+-2]	485 [+-1]
	2040	217 [+-1]	931 [+-2]	170 [+-1]	978 [+-2]	505 [+-1]
	2045	229 [+-1]	938 [+-2]	176 [+-1]	988 [+-2]	520 [+-1]
	2050	240 [+-1]	941 [+-2]	178 [+-1]	1006 [+-2]	529 [+-1]

Table 215. Cumulative incidence cases (per 100,000)

Scenario	year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
Baseline	2015	150 [+-1]	836 [+-2]	122 [+-1]	806 [+-2]	398 [+-1]
	2020	929 [+-2]	5068 [+-4]	753 [+-2]	4904 [+-4]	2428 [+-3]
	2025	1779 [+-3]	9429 [+-6]	1430 [+-2]	9187 [+-6]	4552 [+-4]
	2030	2708 [+-3]	13928 [+-7]	2166 [+-3]	13728 [+-7]	6814 [+-5]
	2035	3730 [+-4]	18597 [+-8]	2963 [+-3]	18557 [+-8]	9238 [+-6]
	2040	4832 [+-4]	23405 [+-8]	3822 [+-4]	23587 [+-8]	11813 [+-6]
	2045	6007 [+-5]	28316 [+-9]	4729 [+-4]	28750 [+-9]	14506 [+-7]
	2050	7265 [+-5]	33361 [+-9]	5676 [+-5]	34098 [+-9]	17321 [+-7]
SSB	2015	150 [+-1]	834 [+-2]	122 [+-1]	805 [+-2]	398 [+-1]
	2020	927 [+-2]	5047 [+-4]	752 [+-2]	4885 [+-4]	2422 [+-3]
	2025	1774 [+-3]	9392 [+-6]	1429 [+-2]	9153 [+-6]	4536 [+-4]
	2030	2701 [+-3]	13880 [+-7]	2163 [+-3]	13678 [+-7]	6788 [+-5]
	2035	3720 [+-4]	18539 [+-8]	2960 [+-3]	18494 [+-8]	9202 [+-6]
	2040	4819 [+-4]	23340 [+-8]	3818 [+-4]	23514 [+-8]	11768 [+-6]
	2045	5991 [+-5]	28247 [+-9]	4723 [+-4]	28669 [+-9]	14454 [+-7]
	2050	7246 [+-5]	33288 [+-9]	5669 [+-5]	34011 [+-9]	17262 [+-7]

Table 216. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	0 [+-1]	2 [+-3]	0 [+-1]	1 [+-3]	0 [+-1]
	2020	2 [+-3]	21 [+-6]	1 [+-3]	19 [+-6]	6 [+-4]
	2025	5 [+-4]	37 [+-8]	1 [+-3]	34 [+-8]	16 [+-6]
	2030	7 [+-4]	48 [+-10]	3 [+-4]	50 [+-10]	26 [+-7]
	2035	10 [+-6]	58 [+-11]	3 [+-4]	63 [+-11]	36 [+-8]
	2040	13 [+-6]	65 [+-11]	4 [+-6]	73 [+-11]	45 [+-8]
	2045	16 [+-7]	69 [+-13]	6 [+-6]	81 [+-13]	52 [+-10]
	2050	19 [+-7]	73 [+-13]	7 [+-7]	87 [+-13]	59 [+-10]

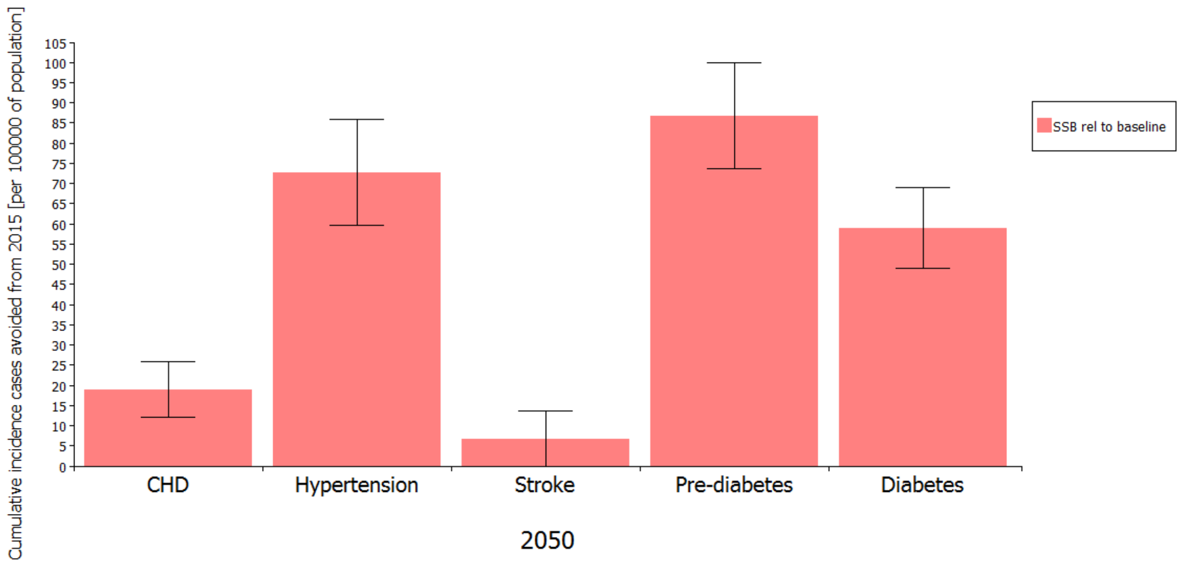


Figure 375. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 217. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB compared to baseline	2015	0 [+-3]	1 [+-11]	0 [+-3]	2 [+-7]	-1 [+-8]
	2020	2 [+-3]	19 [+-11]	0 [+-3]	13 [+-7]	6 [+-8]
	2025	3 [+-4]	34 [+-11]	1 [+-3]	18 [+-7]	14 [+-8]
	2030	5 [+-4]	43 [+-13]	1 [+-3]	19 [+-7]	21 [+-8]
	2035	6 [+-4]	49 [+-13]	2 [+-3]	18 [+-7]	29 [+-8]
	2040	6 [+-4]	50 [+-13]	1 [+-3]	15 [+-7]	33 [+-8]
	2045	6 [+-4]	49 [+-13]	2 [+-3]	11 [+-7]	35 [+-8]
	2050	7 [+-4]	45 [+-13]	2 [+-3]	7 [+-7]	35 [+-10]

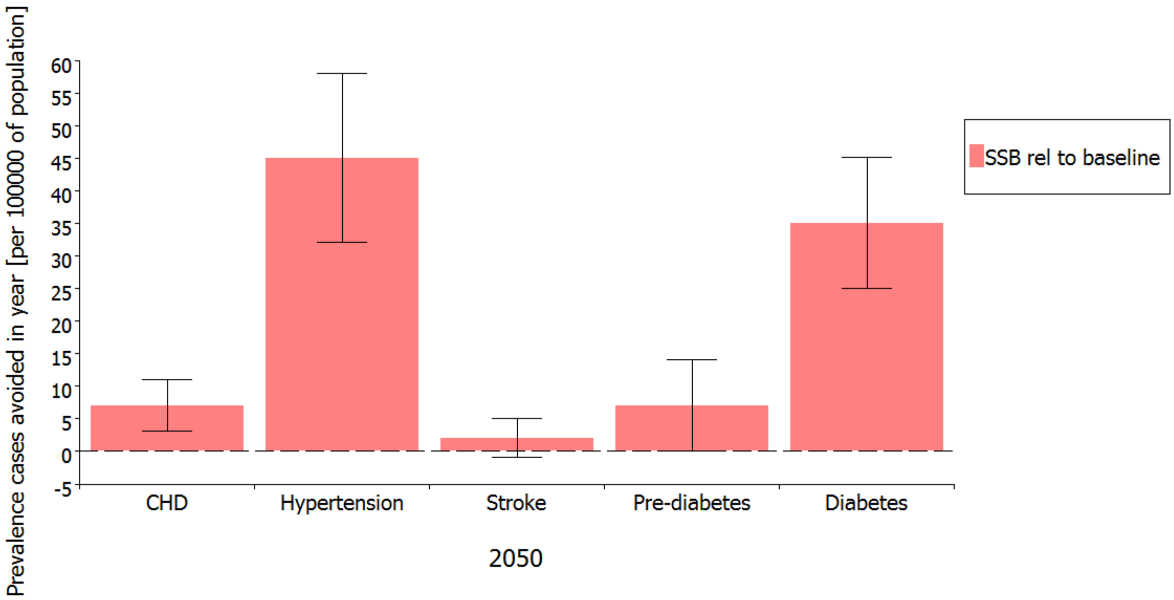


Figure 376. Prevalence cases avoided (per 100,000) relative to baseline

Impact on disease incidence and prevalence

Figure 377 and Table 218 present the direct healthcare costs that can be avoided (per 100,000 population) with the SSB tax intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to be observed in diabetes (£0.03m per 100,000 population in 2050).

Figure 378 and

Table 219 present the indirect costs that can be avoided (per 100,000 population) with the SSB intervention, relative to the baseline. The graph reveals that the largest indirect costs *avoided* is expected to be observed in diabetes (£0.015m per 100,000 population in 2050), followed by CHD (£0.008m per 100,000 population in 2050).

Figure 379 and Figure 380 present the QALYs that can be *gained* (per 100,000 population) with the SSB tax intervention, relative to the baseline. For both males and females, the SSB tax interventions is expected to lead to increasing gains in QALYs between 2015 and 2035, and then start decreasing thereafter.

In Figure 381, the negative ICER values (which in this case is comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that the SSB tax intervention is cost effective (the SSB tax intervention scenario *dominate* the baseline scenario).

Table 218. Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertension	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	0.000537 [+ 0.000072]	0.000214 [+-0.000454]	-0.000821 [+-0.000069]	0.000126 [+-0.000028]	-0.000746 [+-0.002233]
	2020	0.002529 [+-0.000068]	0.002683 [+-0.0004]	0.001399 [+-0.000066]	0.000767 [+-0.000025]	0.013947 [+-0.001985]
	2025	0.003657 [+-0.000065]	0.003953 [+-0.000354]	0.002042 [+-0.000064]	0.000894 [+-0.000022]	0.028097 [+-0.001774]
	2030	0.003915 [+-0.000061]	0.004181 [+-0.000313]	0.001897 [+-0.000058]	0.00079 [+-0.00002]	0.036631 [+-0.001595]
	2035	0.004338 [+-0.000057]	0.00399 [+-0.000276]	0.0021 [+-0.000054]	0.000614 [+-0.000017]	0.040777 [+-0.001434]
	2040	0.003874 [+-0.000052]	0.003452 [+-0.000241]	0.001847 [+-0.000048]	0.000435 [+-0.000016]	0.039703 [+-0.001282]
	2045	0.003516 [+-0.003009]	0.002816 [+-0.000209]	0.001971 [+-0.000044]	0.000254 [+-0.000013]	0.036118 [+-0.001138]
	2050	0.003009 [+-0.000042]	0.002164 [+-0.00018]	0.001534 [+-0.000038]	0.000146 [+-0.000011]	0.030495 [+-0.001002]

Table 219. Indirect costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	Hypertensions	Stroke	Pre-diabetes	Diabetes
SSB relative to baseline	2015	0.001455 [+-0.000194]	0.000332 [+-0.000707]	-0.003247 [+-0.000276]	0 [+-0]	-0.000379 [+-0.001132]
	2020	0.00685 [+-0.000184]	0.004177 [+-0.000622]	0.005537 [+-0.000264]	0 [+-0]	0.007069 [+-0.001006]
	2025	0.009909 [+-0.000175]	0.006153 [+-0.00055]	0.008078 [+-0.000249]	0 [+-0]	0.014242 [+-0.000899]
	2030	0.010607 [+-0.000165]	0.006507 [+-0.000486]	0.007507 [+-0.00023]	0 [+-0]	0.018567 [+-0.000808]
	2035	0.011754 [+-0.000155]	0.006209 [+-0.000429]	0.00831 [+-0.000211]	0 [+-0]	0.020669 [+-0.000727]
	2040	0.010497 [+-0.000142]	0.005373 [+-0.000375]	0.007311 [+-0.000192]	0 [+-0]	0.020124 [+-0.00065]
	2045	0.009526 [+-0.008153]	0.004383 [+-0.000326]	0.007796 [+-0.000173]	0 [+-0]	0.018307 [+-0.000577]
	2050	0.008153 [+-0.000116]	0.003367 [+-0.000281]	0.006066 [+-0.00015]	0 [+-0]	0.015457 [+-0.000508]

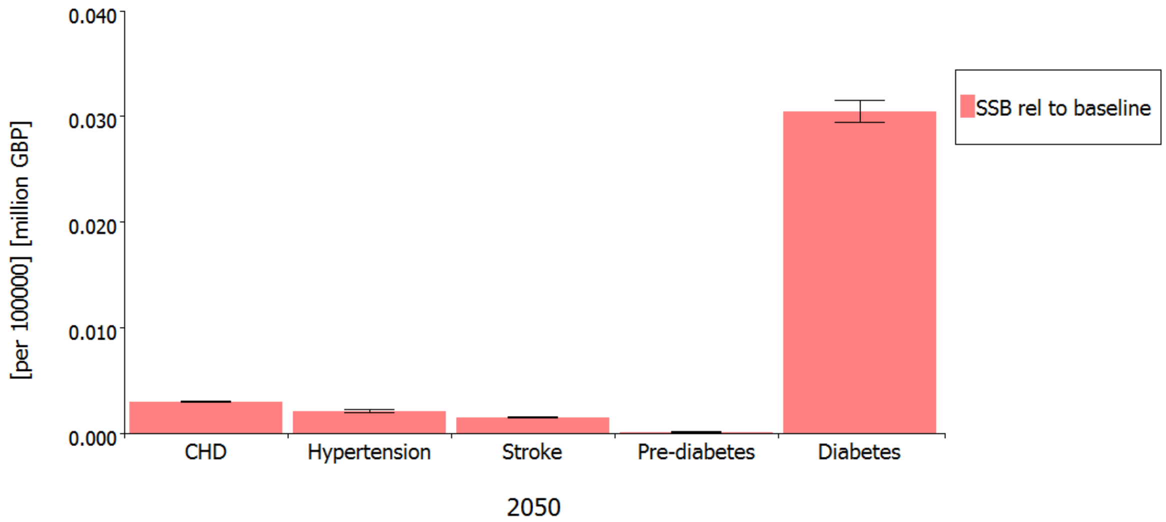


Figure 377. Direct healthcare costs (£ millions) avoided (per 100,000) relative to baseline

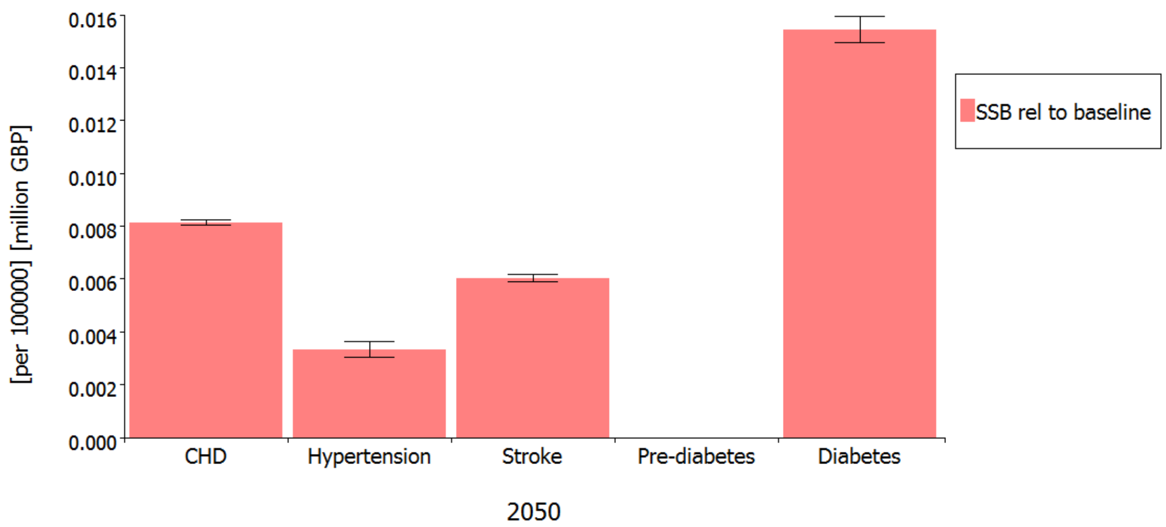


Figure 378. Indirect costs avoided (£ millions) avoided (per 100,000) relative to baseline

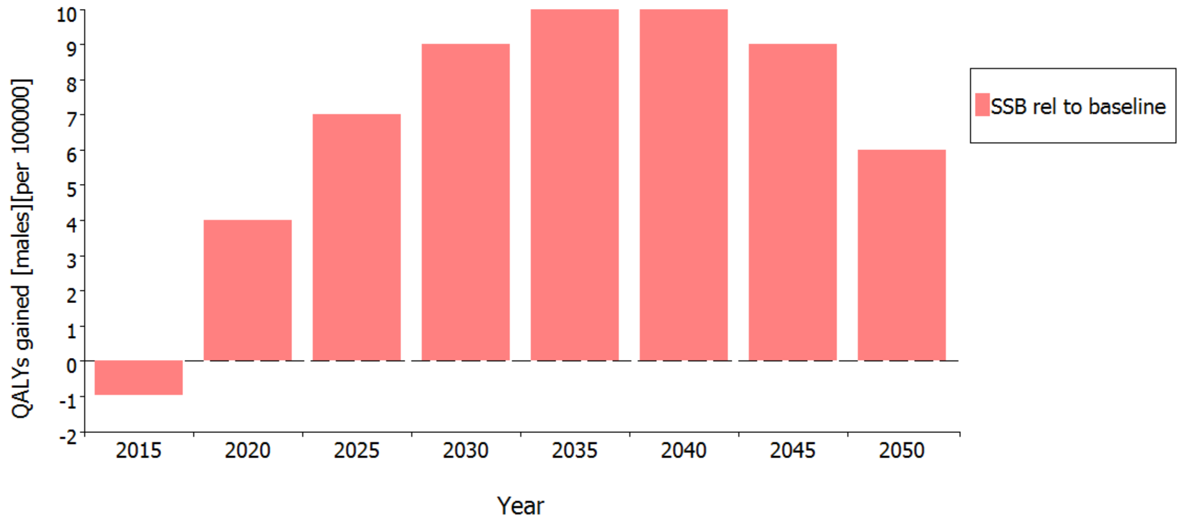


Figure 379. QALYS gained (per 100,000) relative to baseline (males)

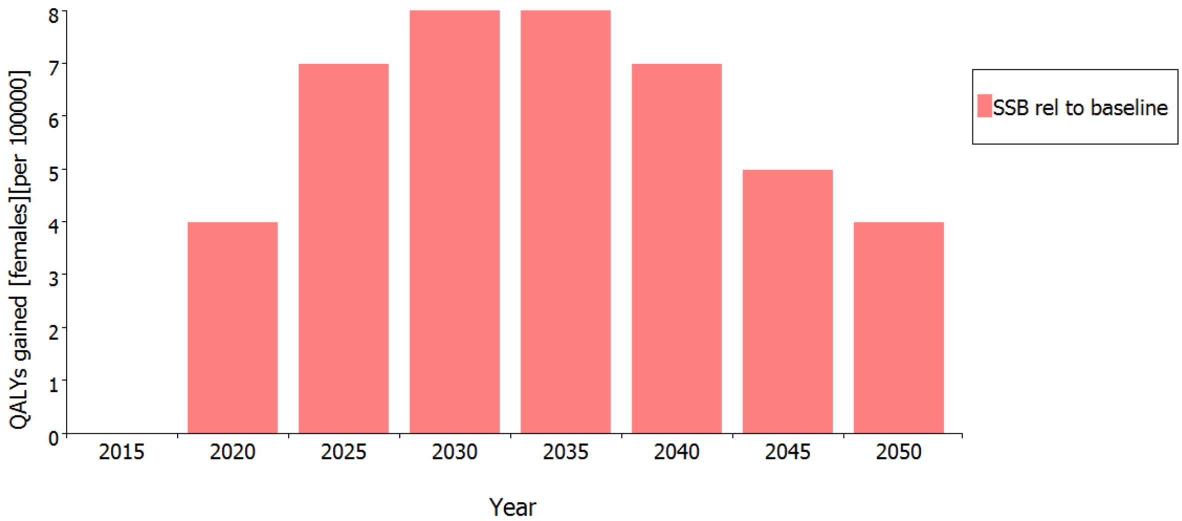


Figure 380. QALYS gained (per 100,000) relative to baseline (females)

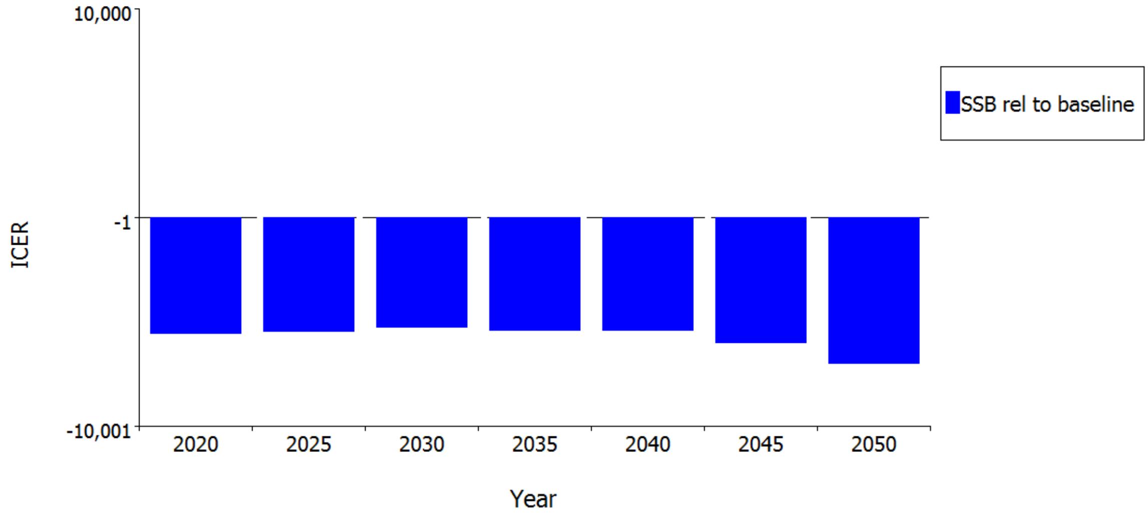


Figure 381. ICER

Smoking intervention results

This section presents the results of the smoking cessation services intervention followed by the results of the hypothetical treatment for COPD which acts on individuals in stage 3+ COPD moving to stage 2. Input data for SCS is presented in Table 220. A multi-stage COPD model was available for Finland so results for COPD stage 1, 2 and 3+ are presented and a hypothetical treatment run. The input data and assumptions for this treatment is presented in Table 221.

Table 220. SCS intervention input data

Variable	Value
Reach	
Willingness to quit smoking (%)	68%
Accessibility of the intervention (%)	50% (NL proxy)
Overall reach (%)	34%
Impact of the intervention	
Type of pharmacological drug	Varenicline
12-month abstinence rate (%) *	34%
Long-term relapse rate (%) **	0%
Outcome criteria ±	Continuous
Validation method ¶	Biochemical
Cost	
Cost (cost/quit-attempt)	£164

Grey shading indicates the use of proxy data (more information available in appendix C4) * as a % of the service users; ** as a % of the service users (>1 and <5 years post cessation); ± either point prevalence or continuous abstinence; ¶ either self-reported or validated by biochemical testing

Table 221. COPD treatment intervention input data

Parameter	Assumption
Who is treated and for how long?	COPD stage 3+ patients get the treatment, for the rest of their life as an add-on to existing treatment.
Age of those treated	There is no minimum age.
Costs of treatment	**£377** per case/year
Probability of remission	If a COPD patient is in stage 3 in the first year of their treatment, they have a probability of remission to stage 2. This one-off probability is estimated to be **0.121**.
Relative risk of moving from stage 3+ to stage 2	The RR of going from the Moderate to Severe disease stage is **0.90**.
Relative risk of moving from stage 2 to stage 3 following treatment	If a COPD patient is in stage 2 and treated a reduced risk of transitioning to stage 3 is assumed. This risk ratio of going from stage 3 to 2 is **0.90**.

Smoking cessation services (SCS)

Impact on disease incidence and prevalence

Table 222 presents the incidence cases per 100,000 to 2050 for baseline and each scenario. Incidence cases increase for CHD, stroke and lung cancer, slightly increase for COPD stages and decrease for hypertension. These results are discussed further in the discussion and appendix E8 and E9.

Table 223 presents the cumulative incidence cases per 100,000 of the baseline (no intervention) and SCS intervention scenarios. Cumulative incidence is expected to be lower across all diseases in the SCS intervention scenario relative to baseline.

Table 224 and Figure 382 present the cumulative incidence cases *avoided* for the SCS intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The intervention would have its largest effect on COPD stage 1 and stroke with 304 and 280 cumulative incidence cases *avoided* per 100,000 by 2050, respectively.

Table 225 and Figure 383 presents the prevalence cases avoided for the SCS intervention scenario relative to baseline – presented in terms of per 100,000 (the table presents data for all years while the figure presents projections for the year 2050 only). A smoking cessation intervention is predicted to result in the avoidance of 151 cases of COPD stage 1 and 108 cases of stroke.

Table 222. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
Baseline	2015	151 [+-1]	393 [+-1]	186 [+-1]	35 [+-0]	930 [+-2]	123 [+-1]	60 [+-0]
	2020	157 [+-1]	395 [+-1]	192 [+-1]	36 [+-0]	935 [+-2]	128 [+-1]	66 [+-0]
	2025	166 [+-1]	401 [+-1]	200 [+-1]	38 [+-0]	937 [+-2]	135 [+-1]	70 [+-1]
	2030	173 [+-1]	406 [+-1]	207 [+-1]	40 [+-0]	931 [+-2]	141 [+-1]	71 [+-1]
	2035	182 [+-1]	408 [+-1]	212 [+-1]	41 [+-0]	926 [+-2]	148 [+-1]	73 [+-1]
	2040	184 [+-1]	407 [+-1]	213 [+-1]	42 [+-0]	921 [+-2]	153 [+-1]	74 [+-1]
	2045	187 [+-1]	405 [+-1]	215 [+-1]	43 [+-0]	912 [+-2]	155 [+-1]	73 [+-1]
	2050	190 [+-1]	404 [+-1]	214 [+-1]	43 [+-0]	899 [+-2]	154 [+-1]	71 [+-1]
SCS	2015	150 [+-1]	394 [+-1]	187 [+-1]	35 [+-0]	930 [+-2]	122 [+-1]	61 [+-0]
	2020	157 [+-1]	394 [+-1]	193 [+-1]	36 [+-0]	934 [+-2]	125 [+-1]	64 [+-0]
	2025	166 [+-1]	394 [+-1]	198 [+-1]	38 [+-0]	934 [+-2]	130 [+-1]	66 [+-0]
	2030	173 [+-1]	398 [+-1]	205 [+-1]	39 [+-0]	929 [+-2]	133 [+-1]	66 [+-0]
	2035	181 [+-1]	397 [+-1]	210 [+-1]	40 [+-0]	921 [+-2]	137 [+-1]	65 [+-0]
	2040	183 [+-1]	396 [+-1]	211 [+-1]	40 [+-0]	916 [+-2]	141 [+-1]	64 [+-0]
	2045	188 [+-1]	393 [+-1]	210 [+-1]	40 [+-0]	907 [+-2]	145 [+-1]	62 [+-0]
	2050	190 [+-1]	393 [+-1]	210 [+-1]	40 [+-0]	896 [+-2]	145 [+-1]	59 [+-0]

Table 223. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
Baseline	2015	151 [+-1]	393 [+-1]	186 [+-1]	35 [+-0]	930 [+-2]	123 [+-1]	60 [+-0]
	2020	918 [+-2]	2356 [+-3]	1132 [+-2]	213 [+-1]	5562 [+-4]	746 [+-2]	377 [+-1]
	2025	1724 [+-3]	4331 [+-4]	2110 [+-3]	399 [+-1]	10210 [+-6]	1406 [+-2]	715 [+-2]
	2030	2581 [+-3]	6359 [+-5]	3133 [+-3]	596 [+-1]	14894 [+-7]	2105 [+-3]	1071 [+-2]
	2035	3491 [+-4]	8446 [+-5]	4207 [+-4]	805 [+-2]	19641 [+-8]	2845 [+-3]	1441 [+-2]
	2040	4439 [+-4]	10555 [+-6]	5310 [+-4]	1023 [+-2]	24431 [+-8]	3628 [+-4]	1820 [+-3]
	2045	5412 [+-4]	12685 [+-7]	6435 [+-5]	1244 [+-2]	29245 [+-9]	4436 [+-4]	2205 [+-3]
	2050	6425 [+-5]	14851 [+-7]	7585 [+-5]	1473 [+-2]	34111 [+-9]	5264 [+-4]	2591 [+-3]
SCS	2015	150 [+-1]	394 [+-1]	187 [+-1]	35 [+-0]	930 [+-2]	122 [+-1]	61 [+-0]
	2020	917 [+-2]	2350 [+-3]	1132 [+-2]	212 [+-1]	5556 [+-4]	740 [+-2]	374 [+-1]
	2025	1722 [+-3]	4298 [+-4]	2109 [+-3]	396 [+-1]	10194 [+-6]	1377 [+-2]	700 [+-2]
	2030	2573 [+-3]	6285 [+-5]	3127 [+-3]	588 [+-1]	14859 [+-7]	2041 [+-3]	1029 [+-2]
	2035	3476 [+-4]	8318 [+-5]	4188 [+-4]	789 [+-2]	19579 [+-8]	2733 [+-3]	1362 [+-2]
	2040	4418 [+-4]	10370 [+-6]	5274 [+-4]	996 [+-2]	24338 [+-8]	3457 [+-4]	1695 [+-3]
	2045	5389 [+-4]	12439 [+-6]	6377 [+-5]	1207 [+-2]	29115 [+-9]	4207 [+-4]	2023 [+-3]
	2050	6399 [+-5]	14547 [+-7]	7503 [+-5]	1422 [+-2]	33942 [+-9]	4984 [+-4]	2347 [+-3]

Table 224. Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
SCS relative to baseline	2015	1 [+-1]	-1 [+-1]	-1 [+-1]	0 [+-0]	0 [+-3]	1 [+-1]	-1 [+-0]
	2020	1 [+-3]	6 [+-4]	0 [+-3]	1 [+-1]	6 [+-6]	6 [+-3]	3 [+-1]
	2025	2 [+-4]	33 [+-6]	1 [+-4]	3 [+-1]	16 [+-8]	29 [+-3]	15 [+-3]
	2030	8 [+-4]	74 [+-7]	6 [+-4]	8 [+-1]	35 [+-10]	64 [+-4]	42 [+-3]
	2035	15 [+-6]	128 [+-7]	19 [+-6]	16 [+-3]	62 [+-11]	112 [+-4]	79 [+-3]
	2040	21 [+-6]	185 [+-8]	36 [+-6]	27 [+-3]	93 [+-11]	171 [+-6]	125 [+-4]
	2045	23 [+-6]	246 [+-9]	58 [+-7]	37 [+-3]	130 [+-13]	229 [+-6]	182 [+-4]
	2050	26 [+-7]	304 [+-10]	82 [+-7]	51 [+-3]	169 [+-13]	280 [+-6]	244 [+-4]

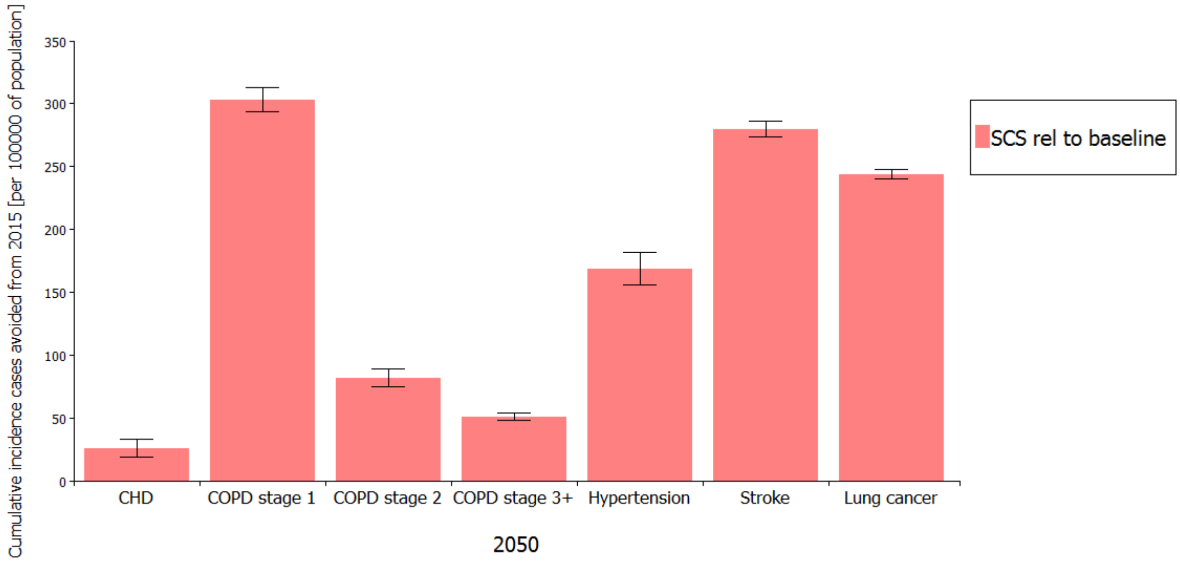


Figure 382. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 225. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
SCS relative to baseline	2015	0 [+-3]	2 [+-7]	-1 [+-4]	0 [+-1]	-1 [+-13]	1 [+-3]	-1 [+-1]
	2020	2 [+-3]	9 [+-7]	-1 [+-4]	1 [+-1]	6 [+-13]	6 [+-3]	3 [+-1]
	2025	4 [+-3]	31 [+-7]	-4 [+-4]	3 [+-1]	7 [+-13]	22 [+-3]	7 [+-1]
	2030	8 [+-4]	62 [+-7]	-4 [+-4]	7 [+-1]	14 [+-13]	47 [+-3]	12 [+-1]
	2035	9 [+-4]	95 [+-7]	1 [+-4]	11 [+-1]	21 [+-13]	73 [+-3]	18 [+-1]
	2040	10 [+-4]	122 [+-7]	5 [+-4]	16 [+-1]	19 [+-13]	98 [+-3]	22 [+-1]
	2045	6 [+-4]	141 [+-7]	10 [+-4]	20 [+-1]	19 [+-13]	110 [+-3]	27 [+-1]
	2050	3 [+-4]	151 [+-7]	12 [+-4]	26 [+-1]	14 [+-13]	108 [+-3]	29 [+-1]

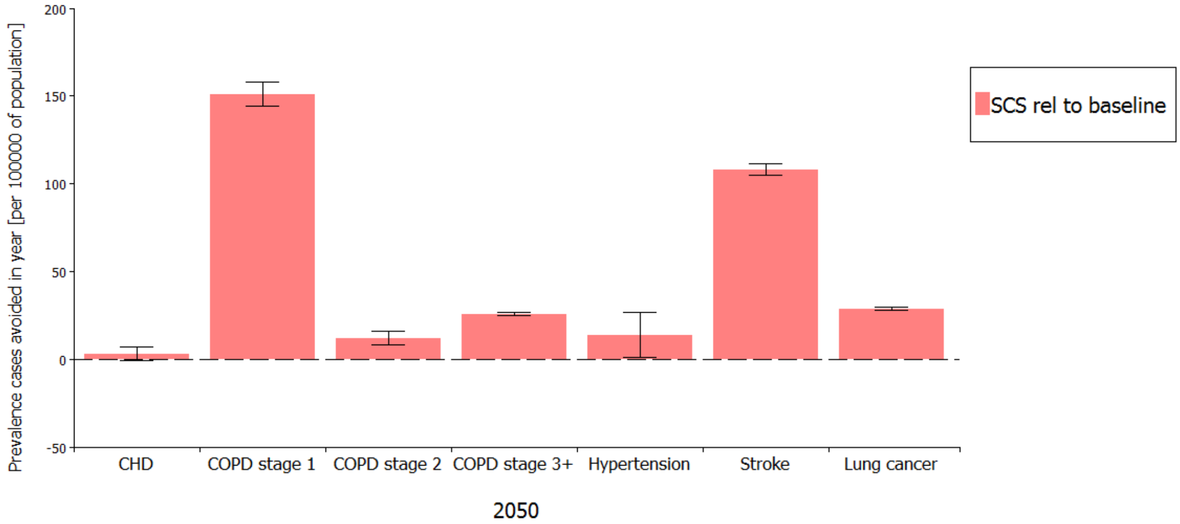


Figure 383. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 226 and Figure 384 present the direct healthcare costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest direct healthcare costs *avoided* is expected to occur in stroke (£0.08 million per 100,000 population 2050).

Table 227 and Figure 385 presents the indirect costs that can be *avoided* (per 100,000 population) with the SCS intervention, relative to the baseline. The graph reveals that the largest indirect costs avoided is expected to occur in stroke (£0.33 million per 100,000 population in 2050).

Figure 386 and Figure 387 present the QALYs that can be *gained* (per 100,000 population) with the SCS intervention, relative to the baseline. For both males and females, an SCS intervention does appear to be effective in increasing the gains in QALYs over time.

In Figure 388, the positive ICER value in 2020 (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *positive* 'cost avoided' values in the numerator) indicates that the SCS may or may not be cost effective, depending on what cost effectiveness threshold value is chosen in the UK. The negative ICER values thereafter (which in this case happens to be comprised of *positive* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator) indicates that SCS intervention is cost effective (the SCS intervention scenario *dominates* the baseline scenario)..

Table 226. Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
SCS relative to baseline	2015	-0.00007 [+-0.000072]	0.00148 [+-0.000279]	-0.00055 [+-0.000173]	-0.001718 [+-0.000024]	-0.000189 [+-0.000512]	0.002409 [+-0.000066]	-0.000266 [+-0]
	2020	0.002475 [+-0.000066]	0.004637 [+-0.000242]	-0.001685 [+-0.000153]	0.002983 [+-0.000024]	0.00085 [+-0.000448]	0.012007 [+-0.000064]	0.001306 [+-0]
	2025	0.004692 [+-0.000061]	0.014018 [+-0.000209]	-0.004323 [+-0.000137]	0.011 [+-0.000023]	0.000808 [+-0.000392]	0.039701 [+-0.00006]	0.002847 [+-0]
	2030	0.006739 [+-0.000055]	0.023682 [+-0.000179]	-0.003426 [+-0.000122]	0.019892 [+-0.000021]	0.00133 [+-0.000342]	0.071017 [+-0.000053]	0.004657 [+-0]
	2035	0.007521 [+-0.000049]	0.030643 [+-0.000153]	0.000724 [+-0.000108]	0.027259 [+-0.000018]	0.001673 [+-0.000296]	0.094051 [+-0.000046]	0.005592 [+-0]
	2040	0.006266 [+-0.000042]	0.032876 [+-0.000129]	0.003006 [+-0.000095]	0.033749 [+-0.000016]	0.001335 [+-0.000255]	0.105317 [+-0.00004]	0.005828 [+-0]
	2045	0.003076 [+-0.000037]	0.031989 [+-0.000109]	0.005299 [+-0.000081]	0.035695 [+-0.000013]	0.001101 [+-0.000216]	0.099579 [+-0.000035]	0.005848 [+-0]
	2050	0.001534 [+-0.000031]	0.028905 [+-0.000091]	0.00525 [+-0.000069]	0.038646 [+-0.000012]	0.000677 [+-0.000183]	0.082629 [+-0.000029]	0.005301 [+-0]

Table 227. Indirect costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
SCS relative to baseline	2015	-0.00019 [+-0.000195]	0.001269 [+-0.000239]	-0.000201 [+-0.000064]	-0.000192 [+-0.000003]	-0.000295 [+-0.000796]	0.00953 [+-0.000263]	-0.000748 [+-0.000001]
	2020	0.006705 [+-0.000181]	0.003976 [+-0.000207]	-0.000617 [+-0.000057]	0.000333 [+-0.000003]	0.001324 [+-0.000697]	0.047512 [+-0.000255]	0.003665 [+-0.000003]
	2025	0.012712 [+-0.000165]	0.012022 [+-0.000179]	-0.001581 [+-0.000049]	0.001227 [+-0.000003]	0.001258 [+-0.000611]	0.157092 [+-0.000236]	0.007996 [+-0.000002]
	2030	0.018259 [+-0.000149]	0.02031 [+-0.000153]	-0.001254 [+-0.000045]	0.002219 [+-0.000003]	0.002071 [+-0.000532]	0.281011 [+-0.00021]	0.013079 [+-0.000001]
	2035	0.020378 [+-0.000133]	0.02628 [+-0.000132]	0.000265 [+-0.00004]	0.003042 [+-0.000001]	0.002603 [+-0.000461]	0.372159 [+-0.000184]	0.015702 [+-0.000001]
	2040	0.016979 [+-0.000116]	0.028194 [+-0.00011]	0.0011 [+-0.000034]	0.003766 [+-0.000001]	0.002078 [+-0.000396]	0.416736 [+-0.000161]	0.016367 [+-0.000001]
	2045	0.008334 [+-0.0001]	0.027434 [+-0.000093]	0.001938 [+-0.00003]	0.003983 [+-0.000001]	0.001714 [+-0.000337]	0.39403 [+-0.000138]	0.016425 [+-0.000001]
	2050	0.004157 [+-0.000086]	0.024789 [+-0.000078]	0.001921 [+-0.000025]	0.004312 [+-0.000001]	0.001054 [+-0.000285]	0.326959 [+-0.000117]	0.014886 [+-0.000001]

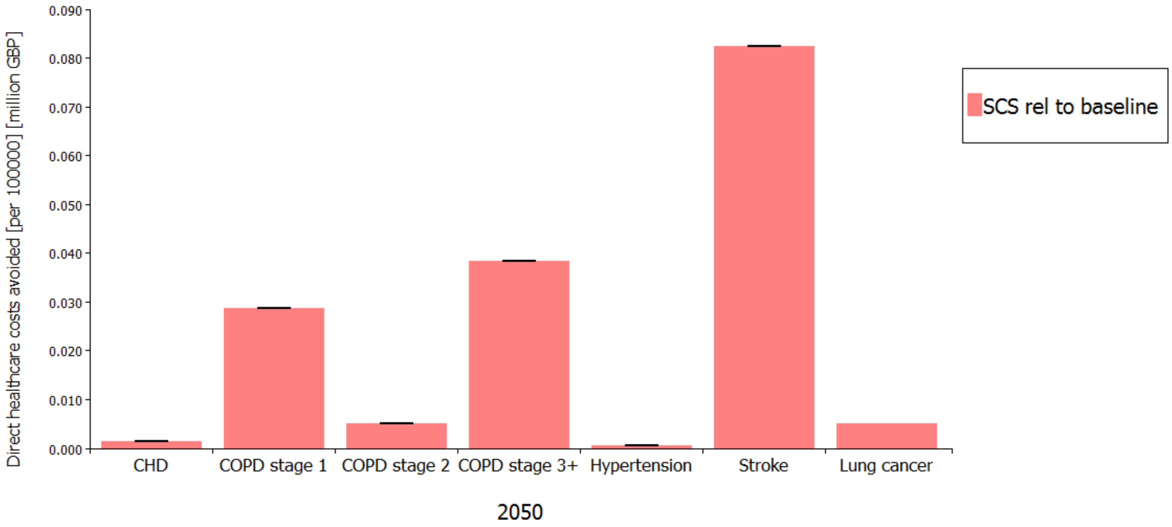


Figure 384. Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

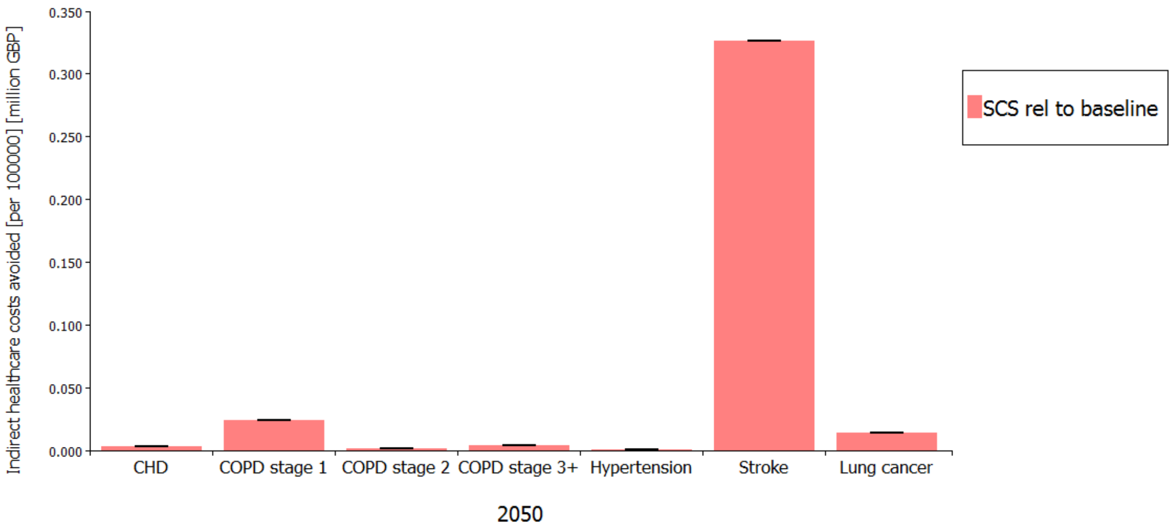


Figure 385. Indirect costs (£ millions) avoided (per 100,000), relative to baseline

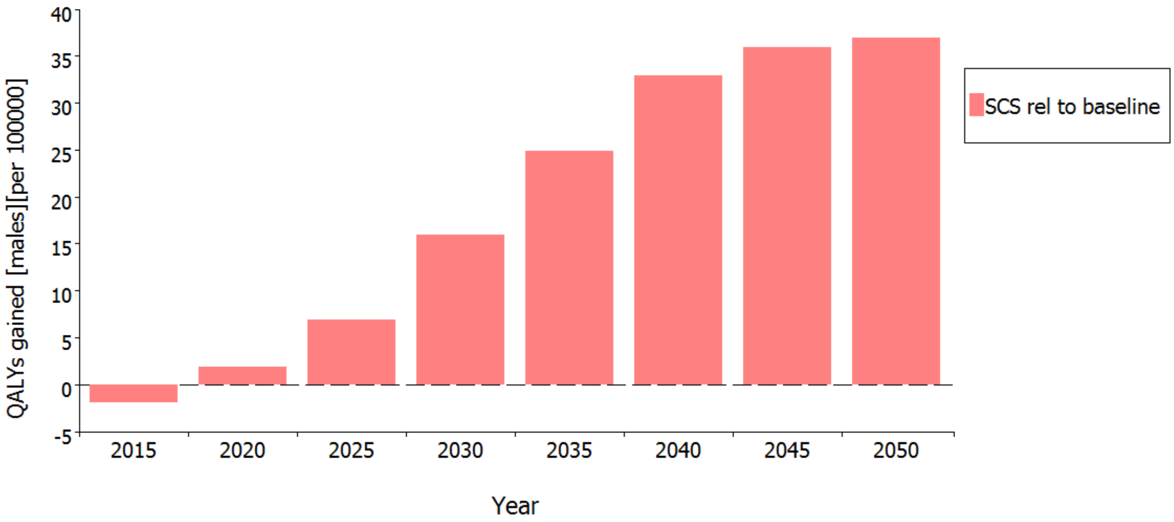


Figure 386. QALYS gained (per 100,000), relative to baseline (males)

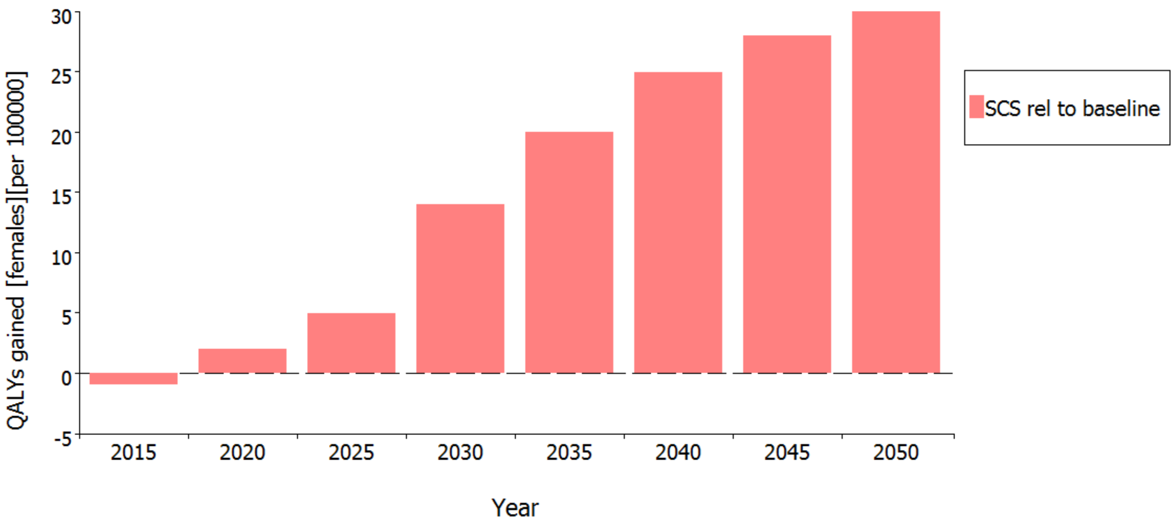


Figure 387. QALYS gained (per 100,000), relative to baseline (females)

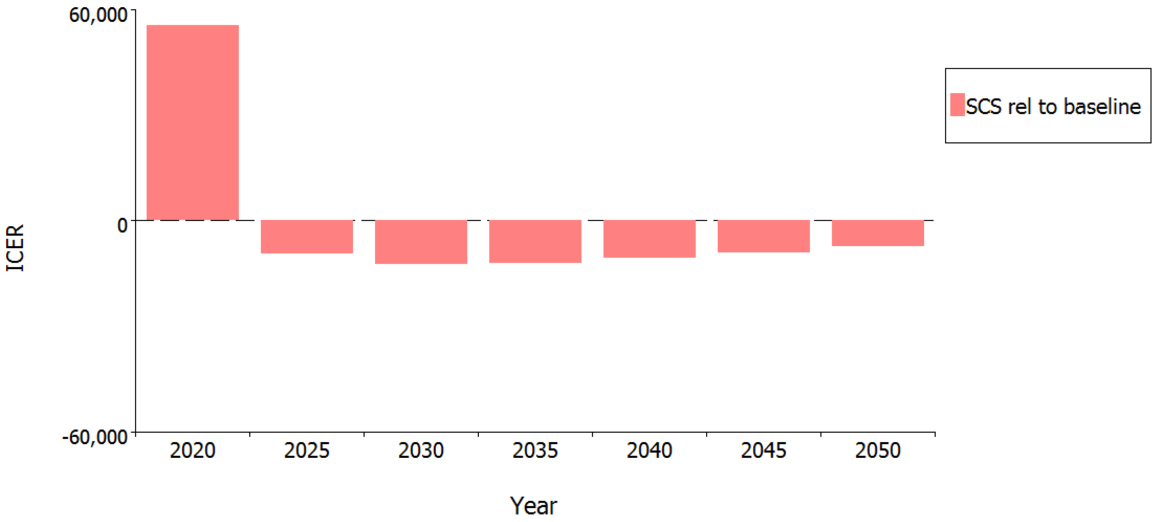


Figure 388. ICER

COPD treatment

Impact on disease incidence and prevalence

Table 228 presents the incidence cases per 100,000 for the baseline (no intervention) and COPD treatment intervention scenarios. Incidence cases increase over time for each disease with the exception of hypertension which decreases over time. These results are discussed further in the discussion and appendix E8 and E9.

Table 230 and Figure 389 present the cumulative incidence cases *avoided* for the COPD treatment relative to baseline – presented in terms of per 100,000 population (the table presents data for all years while the figure presents projections for the year 2050 only). The intervention did not have any significant effects on diseases other than COPD stage 1 (11/100,000 avoided). For COPD stage 2 and 3 cumulative incidence cases were shown to increase as a result of the intervention (rather than decrease). However, this is because the treatment moves individuals back to stage 2 and reduces their risk of moving into stage 3. However, individuals can move forward again to stage 3 so are counted in this group again. Observing the prevalence gains is important (Figure 390). This shows that there are 195 prevalence cases per 100,000 are avoided as a result of treating individuals in COPD stage 3+. As a result of the intervention, these individuals move back to COPD stage2+ resulting in prevalence gains in this COPD stage 2. These results are described in more detail in the discussion section.

Table 228. Incidence cases (per 100,000)

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
Baseline	2015	151 [+-1]	394 [+-1]	187 [+-1]	35 [+-0]	930 [+-2]	123 [+-1]	61 [+-0]
	2020	158 [+-1]	395 [+-1]	193 [+-1]	36 [+-0]	934 [+-2]	128 [+-1]	66 [+-0]
	2025	167 [+-1]	401 [+-1]	200 [+-1]	38 [+-0]	935 [+-2]	136 [+-1]	70 [+-1]
	2030	174 [+-1]	406 [+-1]	207 [+-1]	40 [+-0]	930 [+-2]	142 [+-1]	72 [+-1]
	2035	184 [+-1]	408 [+-1]	212 [+-1]	42 [+-0]	926 [+-2]	149 [+-1]	74 [+-1]
	2040	186 [+-1]	407 [+-1]	214 [+-1]	42 [+-0]	920 [+-2]	154 [+-1]	74 [+-1]
	2045	189 [+-1]	404 [+-1]	215 [+-1]	43 [+-0]	909 [+-2]	156 [+-1]	73 [+-1]
	2050	191 [+-1]	403 [+-1]	215 [+-1]	43 [+-0]	897 [+-2]	155 [+-1]	72 [+-1]
COPD Treatment	2015	150 [+-1]	394 [+-1]	218 [+-1]	35 [+-0]	930 [+-2]	123 [+-1]	61 [+-0]
	2020	158 [+-1]	396 [+-1]	217 [+-1]	38 [+-0]	936 [+-2]	128 [+-1]	66 [+-0]
	2025	166 [+-1]	401 [+-1]	222 [+-1]	41 [+-0]	937 [+-2]	136 [+-1]	70 [+-1]
	2030	174 [+-1]	407 [+-1]	228 [+-1]	43 [+-0]	931 [+-2]	142 [+-1]	72 [+-1]
	2035	183 [+-1]	407 [+-1]	234 [+-1]	45 [+-0]	926 [+-2]	149 [+-1]	73 [+-1]
	2040	186 [+-1]	406 [+-1]	236 [+-1]	46 [+-0]	917 [+-2]	154 [+-1]	74 [+-1]
	2045	190 [+-1]	406 [+-1]	237 [+-1]	46 [+-0]	908 [+-2]	157 [+-1]	73 [+-1]
	2050	192 [+-1]	403 [+-1]	237 [+-1]	46 [+-0]	898 [+-2]	156 [+-1]	72 [+-1]

Table 229. Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
Baseline	2015	151 [+-1]	394 [+-1]	187 [+-1]	35 [+-0]	930 [+-2]	123 [+-1]	61 [+-0]
	2020	918 [+-2]	2356 [+-3]	1135 [+-2]	213 [+-1]	5557 [+-4]	746 [+-2]	377 [+-1]
	2025	1728 [+-3]	4331 [+-4]	2113 [+-3]	400 [+-1]	10198 [+-6]	1407 [+-2]	714 [+-2]
	2030	2589 [+-3]	6359 [+-5]	3137 [+-3]	598 [+-1]	14875 [+-7]	2109 [+-3]	1070 [+-2]
	2035	3505 [+-4]	8446 [+-5]	4212 [+-4]	808 [+-2]	19616 [+-8]	2853 [+-3]	1441 [+-2]
	2040	4459 [+-4]	10558 [+-6]	5317 [+-4]	1026 [+-2]	24397 [+-8]	3640 [+-4]	1822 [+-3]
	2045	5438 [+-4]	12686 [+-7]	6443 [+-5]	1249 [+-2]	29196 [+-9]	4452 [+-4]	2208 [+-3]
	2050	6457 [+-5]	14854 [+-7]	7596 [+-5]	1477 [+-2]	34054 [+-9]	5286 [+-4]	2598 [+-3]
COPD treatment	2015	150 [+-1]	394 [+-1]	218 [+-1]	35 [+-0]	930 [+-2]	123 [+-1]	61 [+-0]
	2020	919 [+-2]	2355 [+-3]	1294 [+-2]	219 [+-1]	5560 [+-4]	746 [+-2]	376 [+-1]
	2025	1727 [+-3]	4328 [+-4]	2382 [+-3]	416 [+-1]	10206 [+-6]	1408 [+-2]	714 [+-2]
	2030	2588 [+-3]	6356 [+-5]	3514 [+-4]	628 [+-2]	14883 [+-7]	2111 [+-3]	1070 [+-2]
	2035	3505 [+-4]	8440 [+-5]	4701 [+-4]	853 [+-2]	19621 [+-8]	2856 [+-3]	1441 [+-2]
	2040	4458 [+-4]	10549 [+-6]	5918 [+-5]	1089 [+-2]	24395 [+-8]	3644 [+-4]	1824 [+-3]
	2045	5440 [+-4]	12676 [+-7]	7160 [+-5]	1329 [+-2]	29195 [+-9]	4457 [+-4]	2210 [+-3]
	2050	6463 [+-5]	14843 [+-7]	8431 [+-5]	1576 [+-2]	34047 [+-9]	5292 [+-4]	2600 [+-3]

Table 230 Cumulative incidence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
COPD treatment relative to baseline	2015	1 [+-1]	0 [+-1]	-31 [+-1]	0 [+-0]	0 [+-3]	0 [+-1]	0 [+-0]
	2020	-1 [+-3]	1 [+-4]	-159 [+-3]	-6 [+-1]	-3 [+-6]	0 [+-3]	1 [+-1]
	2025	1 [+-4]	3 [+-6]	-269 [+-4]	-16 [+-1]	-8 [+-8]	-1 [+-3]	0 [+-3]
	2030	1 [+-4]	3 [+-7]	-377 [+-5]	-30 [+-2]	-8 [+-10]	-2 [+-4]	0 [+-3]
	2035	0 [+-6]	6 [+-7]	-489 [+-6]	-45 [+-3]	-5 [+-11]	-3 [+-4]	0 [+-3]
	2040	1 [+-6]	9 [+-8]	-601 [+-6]	-63 [+-3]	2 [+-11]	-4 [+-6]	-2 [+-4]
	2045	-2 [+-6]	10 [+-10]	-717 [+-7]	-80 [+-3]	1 [+-13]	-5 [+-6]	-2 [+-4]
	2050	-6 [+-7]	11 [+-10]	-835 [+-7]	-99 [+-3]	7 [+-13]	-6 [+-6]	-2 [+-4]

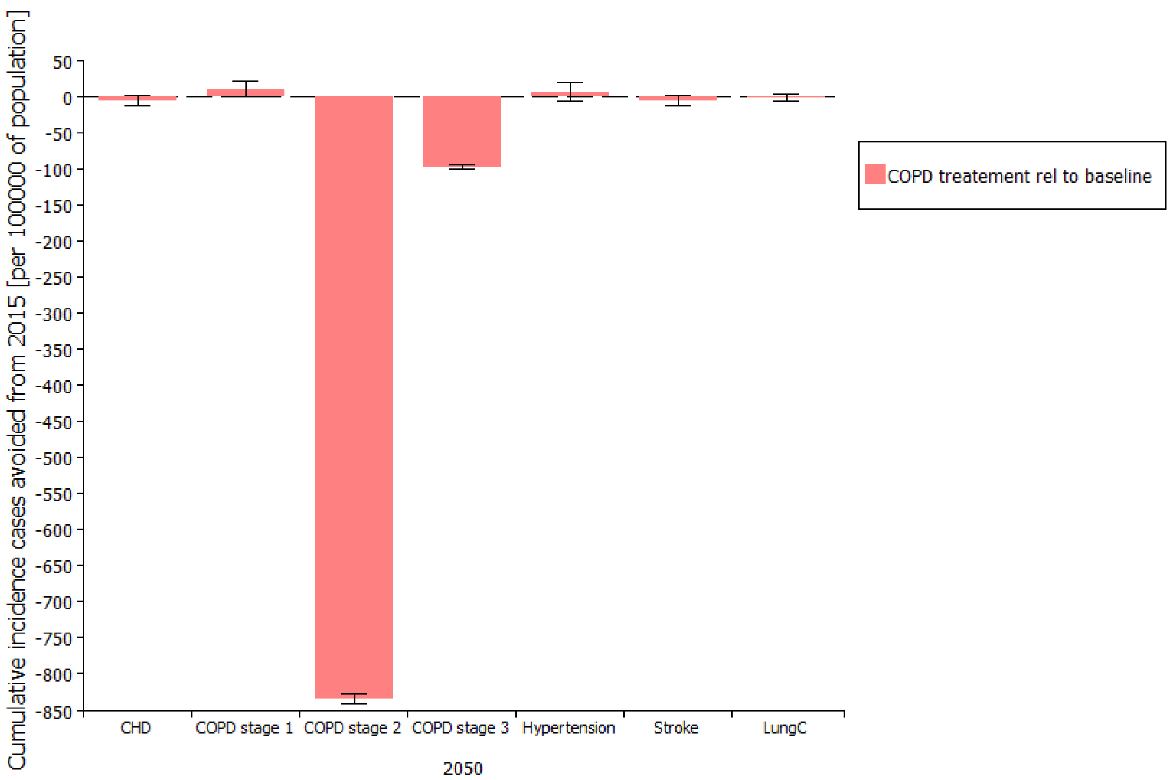


Figure 389. Cumulative incidence cases avoided (per 100,000), relative to baseline

Table 231. Prevalence cases avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
COPD treatment relative to baseline	2015	3 [+-3]	-1 [+-7]	-29 [+-4]	29 [+-1]	5 [+-13]	-1 [+-3]	0 [+-1]
	2020	2 [+-3]	0 [+-7]	-126 [+-4]	118 [+-1]	-2 [+-13]	0 [+-3]	1 [+-1]
	2025	2 [+-3]	1 [+-7]	-179 [+-4]	157 [+-1]	-17 [+-13]	-2 [+-3]	0 [+-1]
	2030	0 [+-4]	2 [+-7]	-210 [+-4]	177 [+-1]	-19 [+-13]	-2 [+-3]	0 [+-1]
	2035	-1 [+-4]	5 [+-7]	-231 [+-4]	187 [+-1]	-21 [+-13]	-1 [+-3]	0 [+-1]
	2040	-3 [+-4]	3 [+-7]	-239 [+-5]	192 [+-1]	-20 [+-13]	-2 [+-3]	-1 [+-1]
	2045	-6 [+-4]	1 [+-7]	-243 [+-5]	195 [+-1]	-24 [+-13]	-3 [+-3]	0 [+-1]
	2050	-6 [+-4]	0 [+-7]	-247 [+-5]	195 [+-1]	-23 [+-13]	-4 [+-3]	0 [+-1]

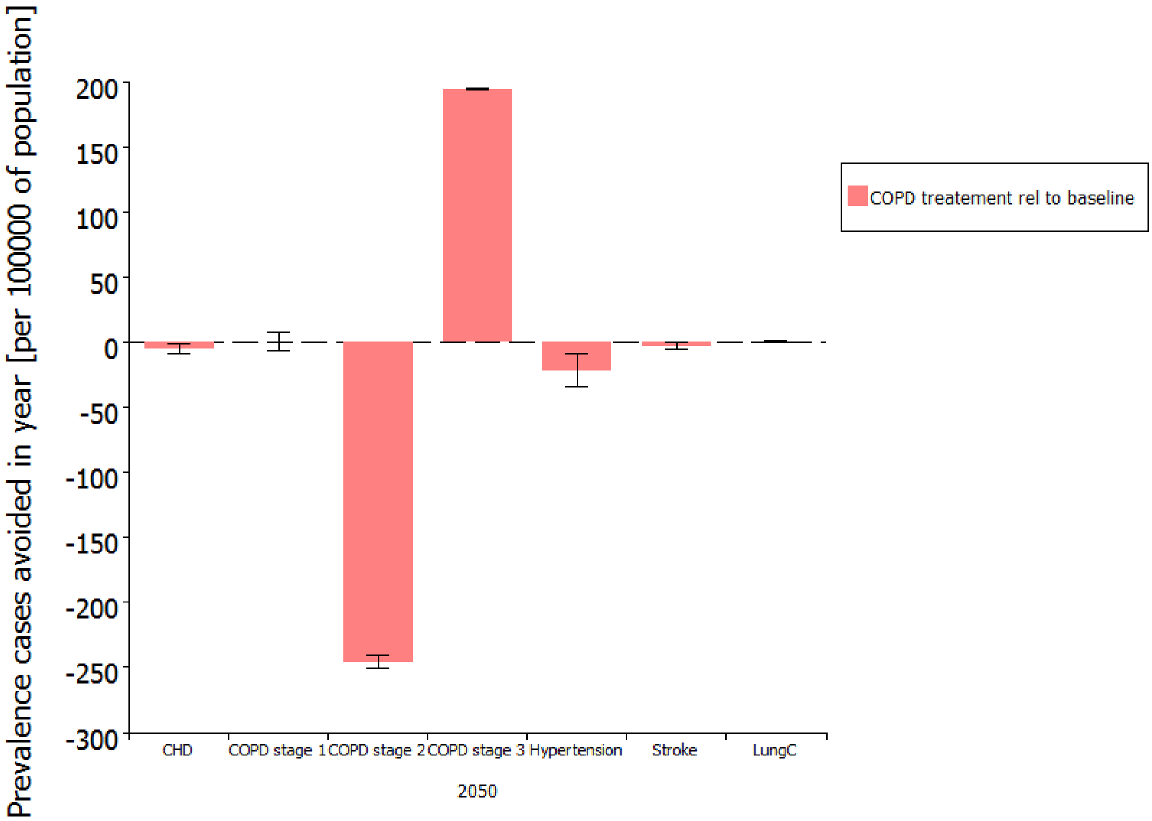


Figure 390. Prevalence cases avoided (per 100,000), relative to baseline

Impact on costs, QALYs and ICERs

Table 232 and Figure 391 present the direct healthcare costs that can be avoided (£GBP, millions) avoided per 100,000 population for the COPD treatment intervention relative to baseline. The graph shows that the greatest benefit, in terms of costs avoided, occurs for COPD stage 3 (£0.29M per 100,000 population in 2050). A similar pattern of results was found for indirect costs with the largest costs avoided occurring for COPD stage 3 (£0.032M per 100,000 population in 2050) (Table 233 and Figure 392). Figure 393 and Figure 394 present QALYs gained.

In Figure 395, the positive ICER values (which in this case happens to be comprised of *negative* 'QALY gained' values in the denominator and *negative* 'cost avoided' values in the numerator, indicates that the screening is not cost effective. The negative ICER in 2050 (which in this case happens to be comprised of positive QALY gained values in denominator and negative cost avoided in the numerator) indicates that the screening intervention may or may not be cost-effective.

Table 232. Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
COPD treatment relative to baseline	2015	0.004467 [+-0.000072]	-0.000234 [+-0.00028]	-0.043289 [+-0.000174]	0.140808 [+-0.000023]	0.000767 [+-0.000512]	-0.00059 [+-0.000066]	0.00002 [+-0]
	2020	0.001963 [+-0.000066]	-0.000196 [+-0.000242]	-0.158724 [+-0.000159]	0.488377 [+-0.000019]	-0.000272 [+-0.000448]	-0.00069 [+-0.000065]	0.000262 [+-0.000001]
	2025	0.001564 [+-0.000062]	0.000258 [+-0.000209]	-0.190051 [+-0.000144]	0.547466 [+-0.000017]	-0.001925 [+-0.000393]	-0.00339 [+-0.000061]	-0.00011 [+-0.000001]
	2030	-0.00018 [+-0.000055]	0.000575 [+-0.000181]	-0.188237 [+-0.00013]	0.517121 [+-0.000016]	-0.001883 [+-0.000343]	-0.00286 [+-0.000055]	-0.000097 [+-0]
	2035	-0.00062 [+-0.000049]	0.001394 [+-0.000155]	-0.17394 [+-0.000115]	0.462037 [+-0.000014]	-0.001709 [+-0.000297]	-0.00089 [+-0.000049]	0.000196 [+-0]
	2040	-0.00174 [+-0.000044]	0.000753 [+-0.000132]	-0.151182 [+-0.000101]	0.398909 [+-0.000013]	-0.001355 [+-0.000255]	-0.00224 [+-0.000044]	-0.0001 [+-0]
	2045	-0.00282 [+-0.000037]	0.000084 [+-0.00011]	-0.129943 [+-0.000087]	0.341194 [+-0.000011]	-0.00139 [+-0.000218]	-0.00316 [+-0.000038]	0.000017 [+-0]
	2050	-0.00251 [+-0.000033]	-0.000057 [+-0.000092]	-0.110946 [+-0.000074]	0.287563 [+-0.00001]	-0.001141 [+-0.000184]	-0.00294 [+-0.000031]	-0.00015 [+-0]

Table 233. Indirect costs (£ millions) avoided (per 100,000), relative to baseline

Scenario	Year	CHD	COPD stage 1	COPD stage 2	COPD stage 3+	Hypertension	Stroke	Lung cancer
COPD treatment relative to baseline	2015	0.012103 [+-0.000196]	-0.0002 [+-0.000239]	-0.015836 [+-0.000064]	0.015712 [+-0.000003]	0.001193 [+-0.000796]	-0.00233 [+-0.000263]	0.000058 [+-0.000001]
	2020	0.005319 [+-0.000182]	-0.000168 [+-0.000208]	-0.058064 [+-0.000059]	0.054497 [+-0.000002]	-0.000423 [+-0.000699]	-0.00274 [+-0.000257]	0.000735 [+-0.000003]
	2025	0.004237 [+-0.000167]	0.000222 [+-0.00018]	-0.069525 [+-0.000053]	0.06109 [+-0.000002]	-0.002996 [+-0.000612]	-0.0134 [+-0.000241]	-0.0003 [+-0.000003]
	2030	-0.00048 [+-0.000151]	0.000492 [+-0.000154]	-0.068861 [+-0.000047]	0.057703 [+-0.000002]	-0.002932 [+-0.000534]	-0.0113 [+-0.000218]	-0.00027 [+-0.000001]
	2035	-0.00169 [+-0.000134]	0.001196 [+-0.000133]	-0.063631 [+-0.000042]	0.051557 [+-0.000002]	-0.00266 [+-0.000462]	-0.00353 [+-0.000194]	0.000552 [+-0.000001]
	2040	-0.0047 [+-0.000117]	0.000646 [+-0.000113]	-0.055306 [+-0.000037]	0.044513 [+-0.000001]	-0.002109 [+-0.000397]	-0.00885 [+-0.000173]	-0.00028 [+-0.000001]
	2045	-0.00765 [+-0.000102]	0.000072 [+-0.000095]	-0.047536 [+-0.000032]	0.038072 [+-0.000001]	-0.002163 [+-0.000338]	-0.01248 [+-0.000149]	0.000046 [+-0.000001]
	2050	-0.0068 [+-0.000087]	-0.000049 [+-0.000079]	-0.040586 [+-0.000027]	0.032088 [+-0.000001]	-0.001774 [+-0.000286]	-0.01164 [+-0.000125]	-0.00041 [+-0.000001]

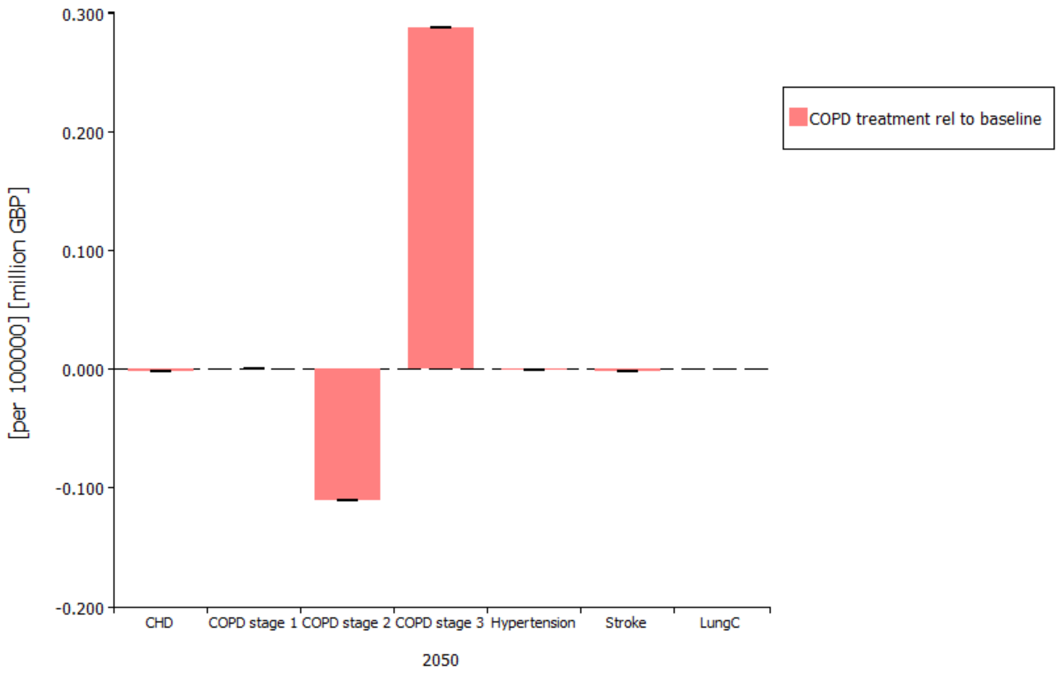


Figure 391 Direct healthcare costs (£ millions) avoided (per 100,000), relative to baseline

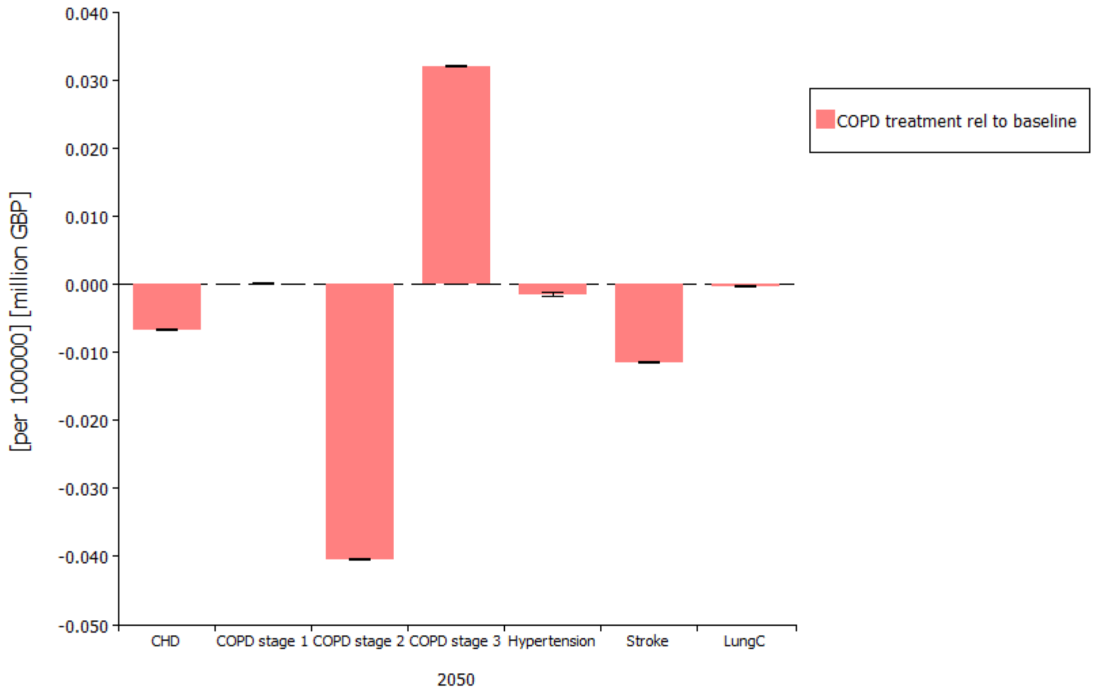


Figure 392 Indirect costs (£ millions) avoided (per 100,000), relative to baseline

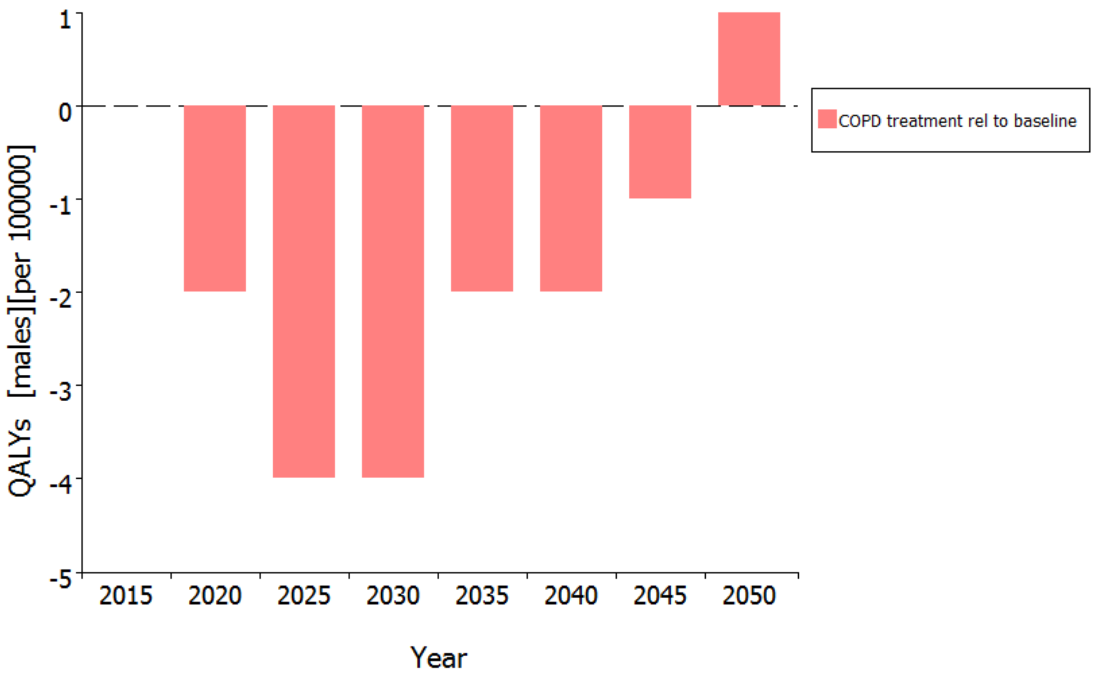


Figure 393 QALYS gained (per 100,000), relative to baseline (males)

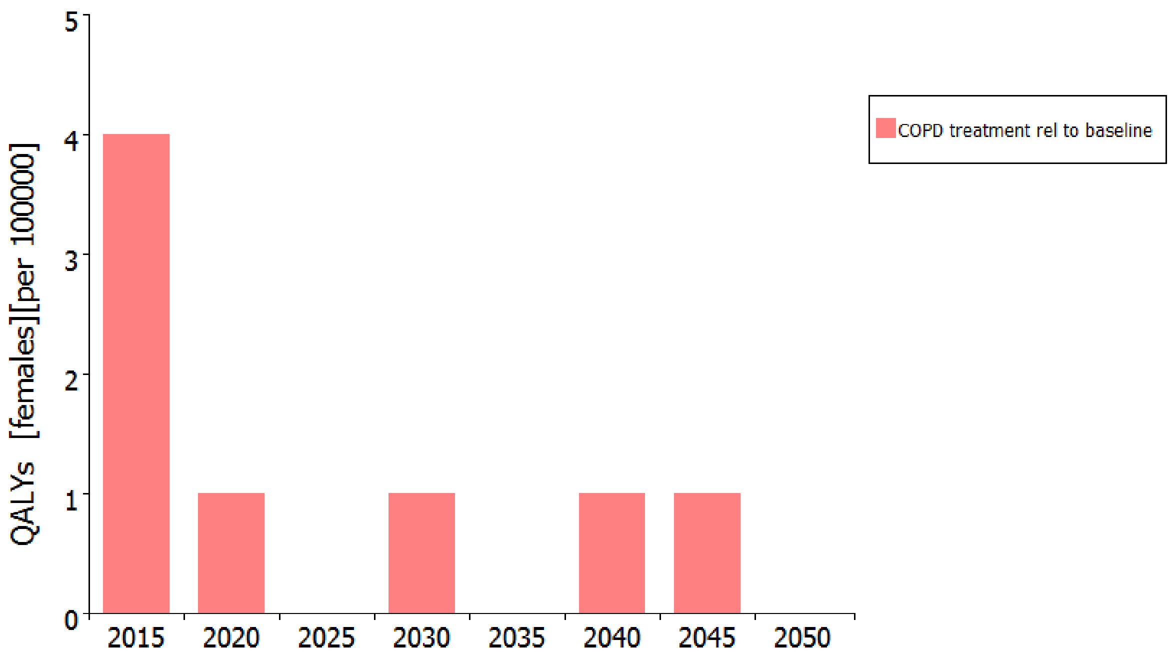


Figure 394 QALYS gained (per 100,000), relative to baseline (females)

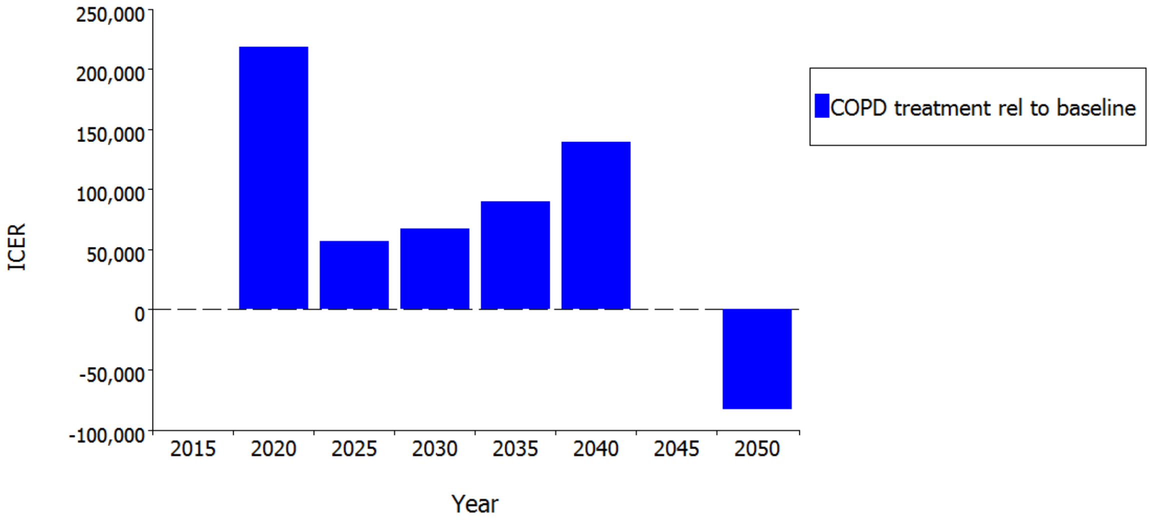


Figure 395 ICER

CKD Screening

Impact on disease incidence and prevalence

Table 234 presents the incidence cases per 100,000 of the baseline (no intervention) and screening intervention scenarios. Incidence is predicted to increase across all diseases except CKD stage 2 and 5 over time in both scenarios.

Table 235 presents the cumulative (2015 to 2050) incidence cases per 100,000 of the baseline (no intervention) and the screening scenario. Cumulative incidence is expected to be lower for all diseases except CKD stage 1 and 2 in the screening scenario relative to baseline.

Table 236 and Figure 396 present the cumulative incidence cases *avoided* for the screening intervention relative to baseline – presented in terms of per 100,000 population (the table presents data for all years whilst the figure presents projections for the year 2050 only). The screening scenario is predicted to reduce the cumulative incidence across all diseases, except for CKD stage 1 and 2. The largest cumulative incidence cases avoided were observed for CKD stage 3a (2,605 per 100,000). There were also large incidence gain for CKD stage 2 (-2,673 per 100,000) as screened individuals who are positive for albumin are treated and have a reduced chance of progressing through more advanced CKD stages.

Table 237 and Figure 397 present the prevalence cases *avoided* for the screening scenario relative to baseline – presented in terms of 100,000 population. Results indicate that screening intervention scenario would result in lower prevalence of all diseases except CKD stage 1 when compared to the baseline scenario. The largest prevalence cases avoided per 100,000 can be observed for CKD stage 2 (160 per 100,000). The largest prevalence cases gained per 100,000 can be observed for CKD stage 1 (270 per 100,000).

Table 234 Incidence cases (per 100,000)

Scenario	Year	CHD	CKD stage 1	CKD stage 2	CKD stage 3a	CKD stage 3b	CKD stage 4	CKD stage 5	Stroke
Baseline	2015	153 [+-1]	169 [+-1]	3205 [+-5]	4446 [+-6]	1159 [+-3]	118 [+-1]	16 [+-0]	122 [+-1]
	2020	160 [+-1]	169 [+-1]	3047 [+-5]	4690 [+-6]	1225 [+-3]	119 [+-1]	15 [+-0]	127 [+-1]
	2025	169 [+-1]	180 [+-1]	2954 [+-5]	4935 [+-6]	1327 [+-3]	127 [+-1]	14 [+-0]	135 [+-1]
	2030	177 [+-1]	182 [+-1]	2855 [+-5]	5147 [+-6]	1396 [+-3]	134 [+-1]	13 [+-0]	142 [+-1]
	2035	186 [+-1]	180 [+-1]	2749 [+-4]	5401 [+-6]	1468 [+-3]	134 [+-1]	14 [+-0]	150 [+-1]
	2040	194 [+-1]	174 [+-1]	2641 [+-4]	5609 [+-6]	1540 [+-3]	131 [+-1]	15 [+-0]	155 [+-1]
	2045	196 [+-1]	171 [+-1]	2537 [+-4]	5710 [+-6]	1590 [+-3]	130 [+-1]	14 [+-0]	159 [+-1]
	2050	202 [+-1]	170 [+-1]	2441 [+-4]	5714 [+-6]	1608 [+-4]	133 [+-1]	13 [+-0]	160 [+-1]
Screening	2015	152 [+-1]	169 [+-1]	3202 [+-5]	4443 [+-6]	1162 [+-3]	119 [+-1]	15 [+-0]	123 [+-1]
	2020	161 [+-1]	170 [+-1]	3096 [+-5]	4650 [+-6]	1215 [+-3]	117 [+-1]	15 [+-0]	127 [+-1]
	2025	169 [+-1]	182 [+-1]	3036 [+-5]	4859 [+-6]	1307 [+-3]	124 [+-1]	14 [+-0]	136 [+-1]
	2030	177 [+-1]	182 [+-1]	2951 [+-5]	5065 [+-6]	1369 [+-3]	132 [+-1]	13 [+-0]	142 [+-1]
	2035	186 [+-1]	182 [+-1]	2840 [+-5]	5317 [+-6]	1438 [+-3]	132 [+-1]	14 [+-0]	149 [+-1]
	2040	192 [+-1]	177 [+-1]	2725 [+-4]	5524 [+-6]	1509 [+-3]	129 [+-1]	14 [+-0]	155 [+-1]
	2045	197 [+-1]	173 [+-1]	2615 [+-4]	5623 [+-6]	1563 [+-3]	129 [+-1]	14 [+-0]	160 [+-1]
	2050	203 [+-1]	173 [+-1]	2509 [+-4]	5625 [+-6]	1579 [+-3]	131 [+-1]	13 [+-0]	159 [+-1]

Table 235 Cumulative incidence cases (per 100,000)

Scenario	Year	CHD	CKD stage 1	CKD stage 2	CKD stage 3a	CKD stage 3b	CKD stage 4	CKD stage 5	Stroke
Baseline	2015	153 [+-1]	169 [+-1]	3205 [+-5]	4446 [+-6]	1159 [+-3]	118 [+-1]	16 [+-0]	122 [+-1]
	2020	931 [+-3]	997 [+-3]	18593 [+-11]	27221 [+-12]	7088 [+-7]	705 [+-2]	94 [+-1]	744 [+-2]
	2025	1752 [+-4]	1879 [+-4]	33378 [+-13]	51163 [+-14]	13462 [+-9]	1315 [+-3]	166 [+-1]	1400 [+-3]
	2030	2623 [+-4]	2788 [+-5]	47858 [+-14]	76463 [+-12]	20306 [+-11]	1972 [+-4]	231 [+-1]	2098 [+-4]
	2035	3555 [+-5]	3712 [+-5]	62113 [+-13]	103433 [+-0]	27632 [+-12]	2655 [+-4]	301 [+-2]	2842 [+-5]
	2040	4536 [+-6]	4624 [+-6]	76053 [+-12]	131987 [+-0]	35430 [+-13]	3338 [+-5]	375 [+-2]	3634 [+-5]
	2045	5553 [+-6]	5524 [+-6]	89662 [+-8]	161669 [+-0]	43628 [+-14]	4017 [+-5]	452 [+-2]	4459 [+-6]
	2050	6626 [+-7]	6441 [+-7]	103122 [+-0]	192191 [+-0]	52185 [+-14]	4725 [+-6]	525 [+-2]	5313 [+-6]
Screening	2015	152 [+-1]	169 [+-1]	3202 [+-5]	4443 [+-6]	1162 [+-3]	119 [+-1]	15 [+-0]	123 [+-1]
	2020	929 [+-3]	998 [+-3]	18737 [+-11]	27095 [+-12]	7064 [+-7]	702 [+-2]	91 [+-1]	745 [+-2]
	2025	1748 [+-4]	1890 [+-4]	33871 [+-13]	50736 [+-14]	13357 [+-9]	1303 [+-3]	160 [+-1]	1399 [+-3]
	2030	2617 [+-4]	2805 [+-5]	48809 [+-14]	75642 [+-12]	20085 [+-11]	1949 [+-4]	226 [+-1]	2095 [+-4]
	2035	3545 [+-5]	3748 [+-5]	63530 [+-13]	102181 [+-0]	27264 [+-12]	2623 [+-4]	296 [+-1]	2837 [+-5]
	2040	4520 [+-6]	4675 [+-6]	77918 [+-11]	130293 [+-0]	34904 [+-13]	3296 [+-5]	370 [+-2]	3625 [+-5]
	2045	5537 [+-6]	5588 [+-6]	91947 [+-8]	159527 [+-0]	42952 [+-14]	3968 [+-5]	446 [+-2]	4451 [+-6]
	2050	6605 [+-7]	6517 [+-7]	105795 [+-0]	189586 [+-0]	51360 [+-14]	4668 [+-6]	519 [+-2]	5303 [+-6]

Table 236 Cumulative cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	CKD stage 1	CKD stage 2	CKD stage 3a	CKD stage 3b	CKD stage 4	CKD stage 5	Stroke
	2015	1 [+-1]	0 [+-1]	3 [+-7]	3 [+-8]	-3 [+-4]	-1 [+-1]	1 [+-0]	-1 [+-1]
	2020	2 [+-4]	-1 [+-4]	-144 [+-16]	126 [+-17]	24 [+-10]	3 [+-3]	3 [+-1]	-1 [+-3]
	2025	4 [+-6]	-11 [+-6]	-493 [+-18]	427 [+-20]	105 [+-13]	12 [+-4]	6 [+-1]	1 [+-4]
Screening, relative to baseline	2030	6 [+-6]	-17 [+-7]	-951 [+-20]	821 [+-17]	221 [+-16]	23 [+-6]	5 [+-1]	3 [+-6]
	2035	10 [+-7]	-36 [+-7]	-1417 [+-18]	1252 [+-0]	368 [+-17]	32 [+-6]	5 [+-2]	5 [+-7]
	2040	16 [+-8]	-51 [+-8]	-1865 [+-16]	1694 [+-0]	526 [+-18]	42 [+-7]	5 [+-3]	9 [+-7]
	2045	16 [+-8]	-64 [+-8]	-2285 [+-11]	2142 [+-0]	676 [+-20]	49 [+-7]	6 [+-3]	8 [+-8]
	2050	21 [+-10]	-76 [+-10]	-2673 [+-0]	2605 [+-0]	825 [+-20]	57 [+-8]	6 [+-3]	10 [+-8]

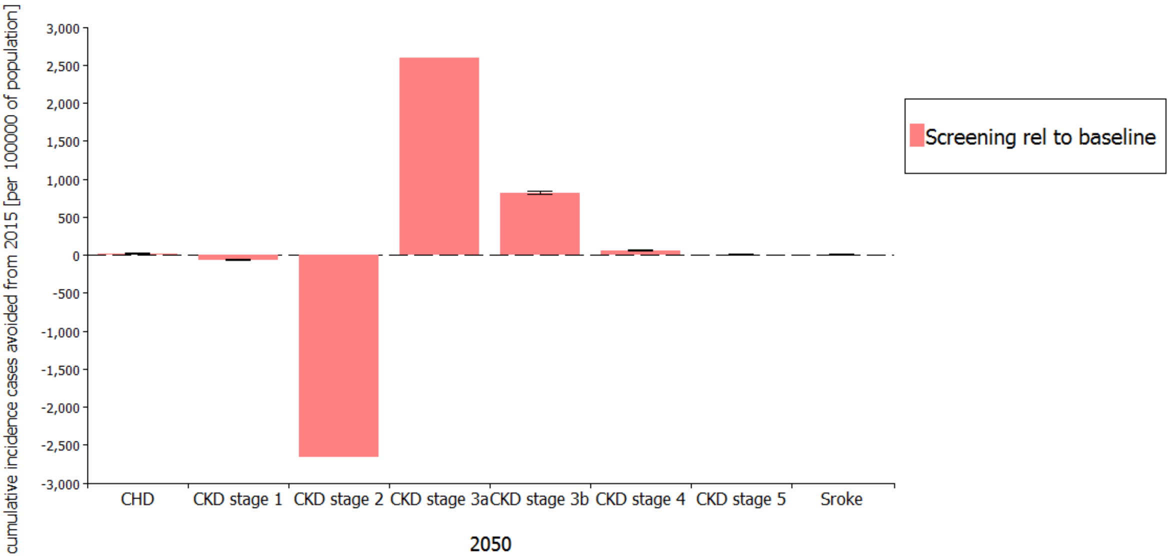


Figure 396: Cumulative incidence cases avoided (per 100,000) relative to baseline

Table 237 Prevalence cases avoided (per 100,000) relative to baseline

Scenario	Year	CHD	CKD stage 1	CKD stage 2	CKD stage 3a	CKD stage 3b	CKD stage 4	CKD stage 5	Stroke
Screening	2015	-1 [+-4]	0 [+-7]	2 [+-7]	3 [+-8]	-3 [+-4]	0 [+-1]	1 [+-0]	0 [+-4]
	2020	0 [+-4]	-92 [+-6]	40 [+-7]	39 [+-8]	10 [+-4]	2 [+-1]	0 [+-0]	0 [+-4]
	2025	1 [+-4]	-150 [+-6]	59 [+-7]	73 [+-8]	19 [+-4]	2 [+-1]	1 [+-0]	0 [+-4]
	2030	4 [+-6]	-189 [+-7]	82 [+-7]	79 [+-8]	26 [+-4]	1 [+-1]	0 [+-0]	2 [+-4]
	2035	5 [+-6]	-233 [+-7]	117 [+-7]	79 [+-8]	28 [+-4]	2 [+-1]	0 [+-0]	2 [+-4]
	2040	8 [+-6]	-258 [+-7]	146 [+-7]	81 [+-8]	28 [+-4]	1 [+-1]	0 [+-0]	4 [+-4]
	2045	3 [+-6]	-264 [+-7]	153 [+-7]	83 [+-8]	27 [+-4]	1 [+-1]	0 [+-0]	1 [+-4]
	2050	6 [+-6]	-270 [+-7]	160 [+-7]	84 [+-8]	27 [+-4]	3 [+-1]	0 [+-0]	-2 [+-4]

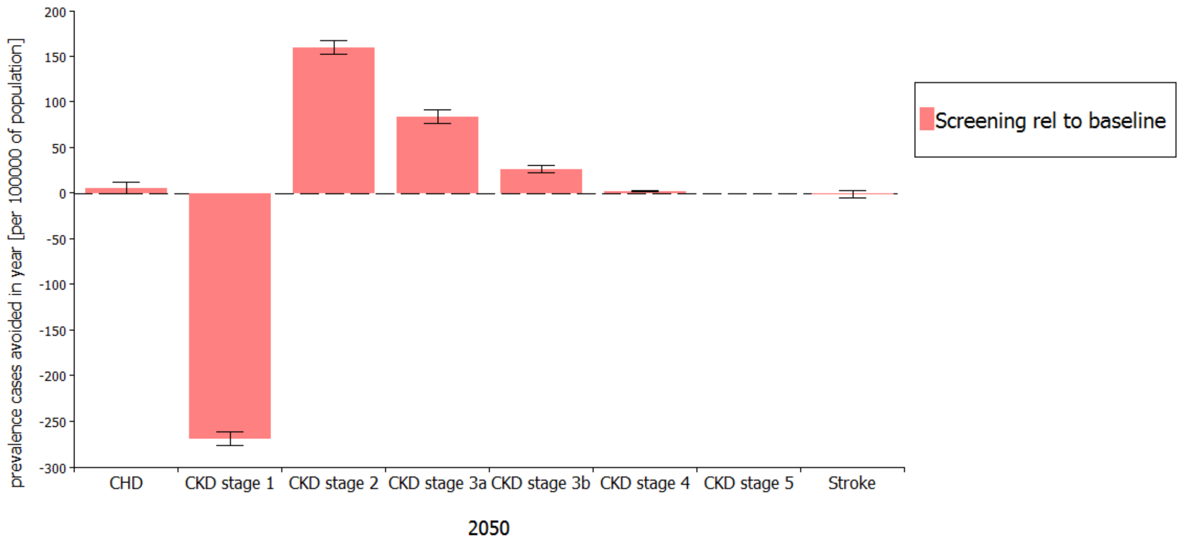


Figure 397: Prevalence cases avoided (per 100,000) relative to baseline

Impact on costs, QALYs and ICERs

Table 238 and Figure 398 present the direct healthcare costs (£ millions) *avoided* per 100,000 population for the screening scenario relative to baseline (the table presents data for all years whilst the figure presents projections for the year 2050 only). The graph reveals that the greatest benefit, in terms of direct healthcare costs *avoided*, occurs in CKD stage 2 (£0.006 million per 100,000 population in 2050).

Table 239 and Figure 399 present the indirect costs (£GBP millions) *avoided* per 100,000 population for the screening scenario relative to baseline (the table presents data for all years whilst the figure presents projections for the year 2050 only). The graph reveals that the greatest benefit, in terms of indirect costs *avoided*, occurs in CKD stage 2 (£0.20 million per 100,000 population in 2050).

Figure 400 And Figure 401 present the QALYs *gained* per 100,000 population for the screening scenario relative to baseline for males and females. For both males and females, the screening intervention results in small differences in the QALYs per 100,000 ranging between 0 and 1.

In Figure 402, ICERs were plotted where possible (i.e. QALY gains not equal to 0). When positive ICERs are observed (which in this case happens to be comprised of positive 'QALY gained' values in the denominator and positive 'cost avoided' values in the numerator) indicates that the screening may or may not be cost effective (depending on what cost effectiveness threshold value is chosen in the UK). When a negative ICER is observed in 2045 (which in this case happens to be comprised of negative QALY gained values in denominator and positive cost avoided in the numerator) indicates that the screening intervention is not cost-effective.

Table 238 Direct healthcare costs (£ millions) avoided (per 100,000) relative to baseline

Scenario	Year	CHD	CKD stage 1	CKD stage 2	CKD stage 3a	CKD stage 3b	CKD stage 4	CKD stage 5	Stroke
COPD treatment relative to baseline	2015	-0.000429 [+-0.000092]	-0.000092 [+-0.000024]	0.000376 [+-0.00003]	0.000464 [+-0.000068]	-0.000704 [+-0.000011]	-0.000143 [+-0]	0.02123 [+-0.000006]	0.000651 [+-0.000082]
	2020	0.000523 [+-0.000092]	-0.010425 [+-0.00002]	0.004479 [+-0.000025]	0.006631 [+-0.000062]	0.002214 [+-0.00001]	0.000383 [+-0]	0.039869 [+-0.000004]	-0.00033 [+-0.000088]
	2025	0.002024 [+-0.000088]	-0.01423 [+-0.000018]	0.005578 [+-0.000023]	0.010399 [+-0.000054]	0.003549 [+-0.00001]	0.000366 [+-0]	0.01277 [+-0.000003]	0.000318 [+-0.000085]
	2030	0.004156 [+-0.000081]	-0.015125 [+-0.000015]	0.006585 [+-0.00002]	0.00939 [+-0.000049]	0.004046 [+-0.000008]	0.000246 [+-0]	-0.010284 [+-0.000003]	0.003345 [+-0.000078]
	2035	0.003332 [+-0.000074]	-0.015652 [+-0.000013]	0.007882 [+-0.000017]	0.008002 [+-0.000045]	0.003695 [+-0.000008]	0.000277 [+-0]	0.001411 [+-0.000003]	0.002263 [+-0.000069]
	2040	0.005132 [+-0.000066]	-0.014627 [+-0.000011]	0.008238 [+-0.000015]	0.006867 [+-0.00004]	0.003122 [+-0.000007]	0.000177 [+-0]	0.00127 [+-0.000001]	0.005038 [+-0.000062]
	2045	0.001764 [+-0.000058]	-0.01263 [+-0.000009]	0.007323 [+-0.000013]	0.005944 [+-0.000035]	0.002509 [+-0.000007]	0.000071 [+-0]	0.002702 [+-0.000001]	0.001025 [+-0.000055]
	2050	0.002734 [+-0.00005]	-0.010857 [+-0.000008]	0.006402 [+-0.000011]	0.005051 [+-0.000029]	0.002087 [+-0.000006]	0.000172 [+-0]	0.002339 [+-0.000001]	-0.00159 [+-0.000047]

Table 239 Indirect cost (£ millions) avoided (per 100,000) relative to baseline

Scenario	Year	CHD	CKD stage 1	CKD stage 2	CKD stage 3a	CKD stage 3b	CKD stage 4	CKD stage 5	Stroke
COPD treatment relative to baseline	2015	-0.001162 [+-0.000247]	-0.00281 [+-0.000735]	0.01158 [+-0.0009]	0.009512 [+-0.001399]	-0.01111 [+-0.000185]	-0.002258 [+-0.000006]	0.001302 [+-0]	0.002573 [+-0.000325]
	2020	0.001417 [+-0.000249]	-0.320632 [+-0.000608]	0.137744 [+-0.000779]	0.13596 [+-0.001255]	0.034956 [+-0.000166]	0.006053 [+-0.000006]	0.002445 [+-0]	-0.001307 [+-0.000348]
	2025	0.005484 [+-0.000238]	-0.437613 [+-0.000531]	0.171547 [+-0.000688]	0.213202 [+-0.001127]	0.056048 [+-0.000156]	0.005787 [+-0.000004]	0.000783 [+-0]	0.001261 [+-0.000335]
	2030	0.01126 [+-0.00022]	-0.465165 [+-0.000462]	0.202507 [+-0.000603]	0.192528 [+-0.001006]	0.063885 [+-0.000141]	0.003899 [+-0.000004]	-0.000631 [+-0]	0.013236 [+-0.000308]
	2035	0.009027 [+-0.0002]	-0.48137 [+-0.000399]	0.242389 [+-0.000523]	0.164075 [+-0.000911]	0.058353 [+-0.000128]	0.004375 [+-0.000004]	0.000087 [+-0]	0.008954 [+-0.000276]
	2040	0.013905 [+-0.000178]	-0.449839 [+-0.000338]	0.25333 [+-0.000449]	0.140791 [+-0.000813]	0.049282 [+-0.000116]	0.002792 [+-0.000003]	0.000078 [+-0]	0.019936 [+-0.000248]
	2045	0.004777 [+-0.000156]	-0.388423 [+-0.000283]	0.22521 [+-0.000384]	0.121869 [+-0.000704]	0.039614 [+-0.000103]	0.001128 [+-0.000003]	0.000166 [+-0]	0.004054 [+-0.000218]
	2050	0.007409 [+-0.000136]	-0.333902 [+-0.000239]	0.19689 [+-0.000326]	0.103571 [+-0.000595]	0.03296 [+-0.000088]	0.002708 [+-0.000003]	0.000143 [+-0]	-0.006292 [+-0.000187]

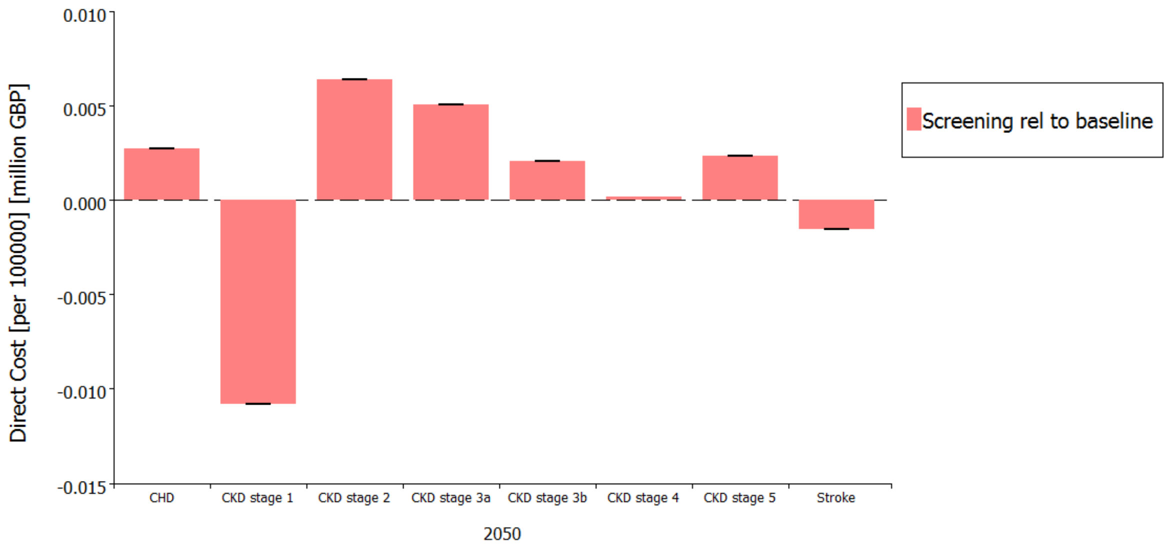


Figure 398: Direct healthcare costs (£ millions) avoided (per 100,000) relative to baseline

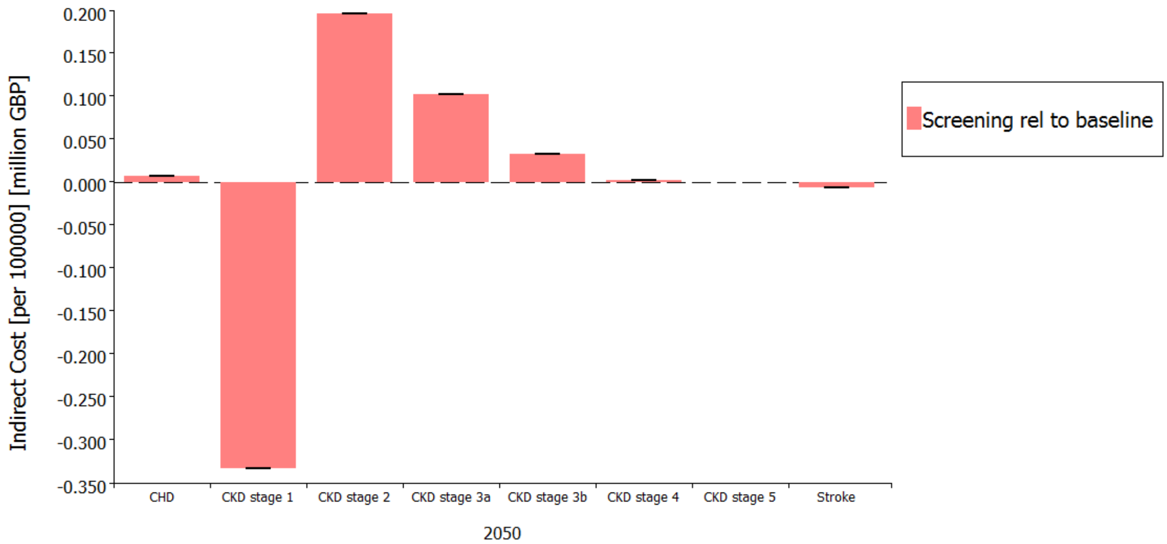


Figure 399: Indirect costs (£ millions) avoided (per 100,000) relative to baseline

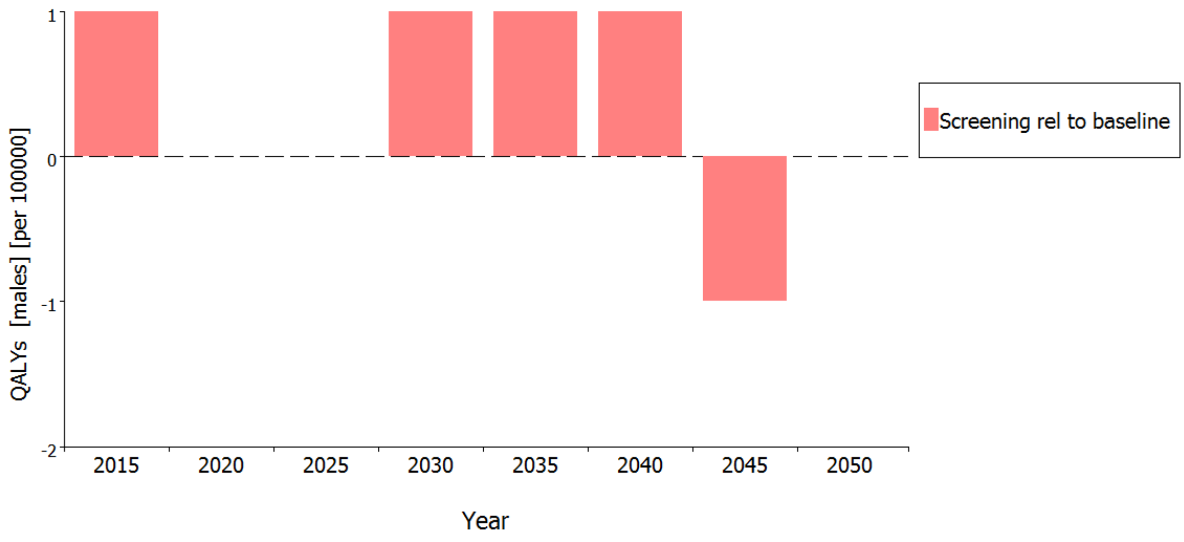


Figure 400: QALYs gained (per 100,000) relative to baseline (males)

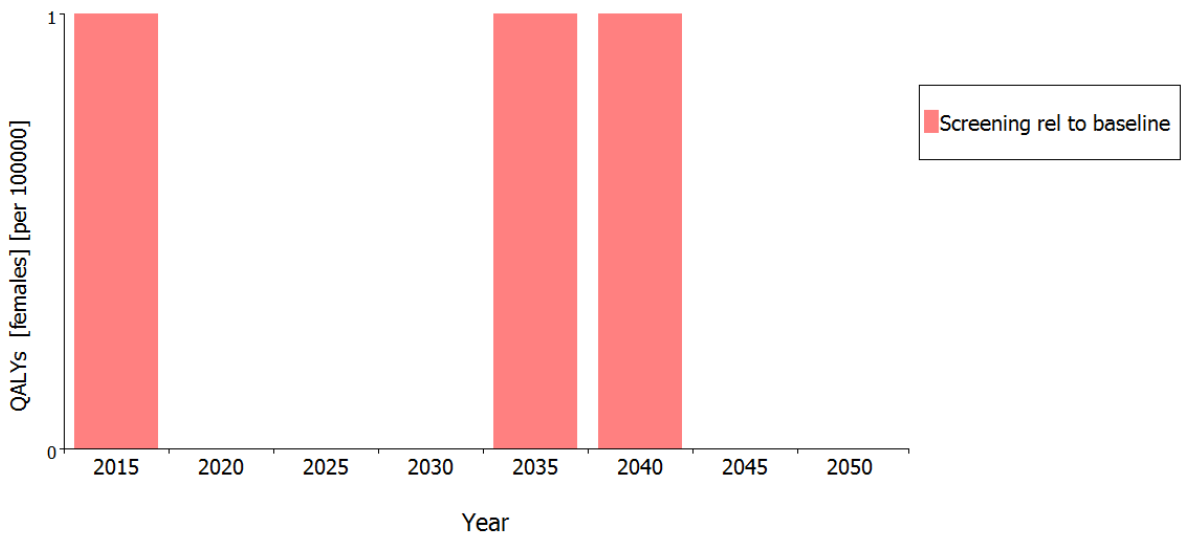


Figure 401: QALYs gained (per 100,000) relative to baseline (females)

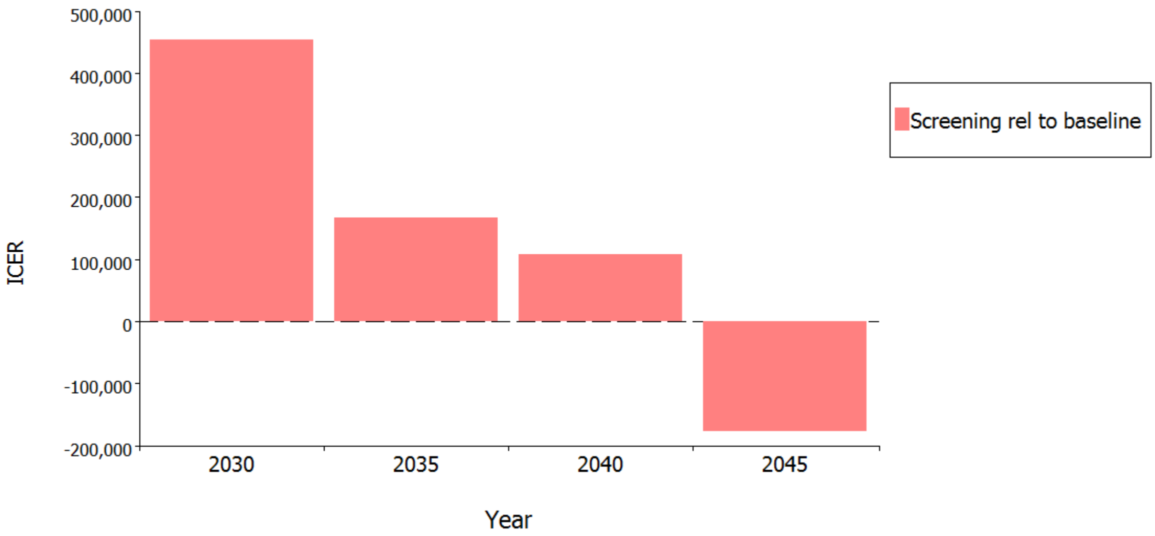


Figure 402 ICER

Discussion

Work package 5 developed epidemiological disease models to quantify the future burden of chronic diseases in 8 EU countries by 2050. Work package 6 built on these disease models to test the impact of interventions to prevent, screen and treat chronic diseases within the same model.

The EConDA models build on existing models in a number of ways:

- They take account of the **dynamic** nature of changing risk factors over time.
- They include **multi-stage** diseases so that the burden of disease by stage can be quantified and so that the point at which to intervene can be better specified.
- They have the ability to test **prevention, screening** and **treatment** interventions within the same computer model.
- They provide a range of outputs including future disease incidence, prevalence, mortality, QALYs, direct healthcare and indirect costs, and measures of cost-effectiveness.

Key findings

General comments
Primary prevention interventions are cost effective when a time horizon longer than 10 years is taken into account
Community and policy level interventions are effective in increasing quality of life over time.
Economic analysis of chronic diseases should take a societal perspective in order to take account of costs beyond healthcare.
The EConDA tool can be downloaded so that users can test interventions themselves: www.econdaproject.eu/tools.php

BMI model findings	*Smoking model findings*
Obesity prevalence is projected to increase in nearly all of the countries that were modelled	Smoking prevalence is forecast to decrease across all of the countries that were modelled
In some countries the most educated are predicted to be more obese than the less educated and in other countries the reverse is true.	There is a social gradient such that a greater number of individuals in the less educated group smoke. This is predicted to persist through to 2050.
Increasing obesity prevalence is projected to result in increases in chronic diseases such as type 2 diabetes and coronary heart disease over time, resulting in widespread effects on the economy of the health system and wider society.	Smoking cessation services (SCS) reduce the future burden of smoking-related diseases and are cost-effective.
Significant health and economic gains can be achieved with even small changes in BMI.	SCS are projected to have the largest epidemiological impact on COPD and stroke in absolute terms
By its nature, a sugar sweetened beverage (SSB) tax is more cost-effective than weight loss programmes.	SCS are more cost-effective and result in greater gains in quality-adjusted life years when compared to treatment of a single smoking-related disease.
Introducing a 20% SSB tax will have an important impact on major chronic diseases – such as CHD and type 2 diabetes – which, in turn, will result in the avoidance of both direct and indirect costs over time.	SCSs that are provided free of charge will have an important impact on major chronic diseases resulting in the avoidance of both direct and indirect costs over time.

BMI model results

Prevalence of obesity and overweight

The prevalence of body mass index (BMI)-groups (normal weight, overweight, obese) was projected to 2050 for each of the modelled countries. Results showed that, across all 8 countries, the prevalence of obesity was projected to increase in the total adult population by 2050. It was predicted that, by 2050, the prevalence of obesity would reach between 20% in the Netherlands and 47% in the UK, and that the prevalence of overweight would range between 13% in Greece and 49% in Bulgaria – with all other countries somewhere in between. Since there was considerable variation in data availability and quality across countries, it was not deemed appropriate to compare epidemiological and economic results between countries. Apart from the UK, no country had annually-measured BMI data. Research shows that self-reported weight data often underestimate the true level of obesity and overweight in a population (97). In their review, Visscher and colleagues concluded that the difference between measured and self-reported obesity prevalence varied widely, ranging from a difference in prevalence of 0.0% to 49.6%. Therefore, self-reported data must be treated with caution. Because of the wide variation we were unable to apply a conversion factor to correct for self-reported data.

Table 240 illustrates the quality of data by country. Quality was assessed across the following set of criteria:

- Number of data points
- Availability of measured (rather than self-reported) data
- Availability of nationally representative (rather than regional) data
- Disclosure of sample size
- Accessibility of data in terms of cost

Table 240. Quantifying the quality of BMI data, by country

Country	Data Points	Measured	National	Sample Size	Freely available	Total
Bulgaria	4	1	4	4	4	**17**
Finland	16	0	16	16	16	**64**
Greece	9	0	9	9	1	**28**
Lithuania	9	0	9	9	9	**36**
Netherlands	15	0	15	0	15	**45**
Poland	5	0	4	4.5	5	**18.5**
Portugal	5	0	5	3	5	**18**
England (UK)	14	14	14	14	14	**70**

When exploring trends by age and sex group, there were some exceptions to the upward trend. For example, a levelling in obesity was observed in the UK males aged 30-39 years, 20-29 year old females in

Portugal, 30-49 year old females in Poland, 20-49 year old females, 30-49 year old males in Bulgaria and 30-49 year old females in Lithuania. Although encouraging, the reason for this apparent levelling off of the upward trend is unclear and further work should monitor these trends over time. It should be noted that there are large errors around some of these projection estimates, inherent in dealing with insufficient data.

Education level was used as the sole indicator of socio-economic position (SEP) in the EConDA project. The reason for this was that obesity prevalence was seldom presented by other SEP indicators, such as income or occupation, in the data sources used. Education is not prone to recall bias, and its meaning is more consistent across countries than other indicators. Education may affect health directly by affecting an individual's receptivity to health education messages and thus making him or her more prone to healthier behaviours (98). Education may also affect health indirectly by influencing employment prospects, types of occupation and income (99).

In developed countries, there tends to be an inverse association between socioeconomic position (SEP) and obesity (100). Based on the level of economic development of EConDA countries, this association was expected. Further, it was expected that more educated groups would be protected from increasing obesity prevalence. This is based on the social determinants of health framework and previous research in other health areas which has demonstrated that socioeconomic advantage is linked to better health and nutrition outcomes (101). More advantaged individuals may have more flexibility in their choice of diet and activity patterns, compared to disadvantaged groups that are more constrained.

However, the expected inequality patterns (inverse association between education and obesity, and faster increases in obesity prevalence among the more disadvantaged groups) were only observed in Lithuania and Poland for women, and in Finland, UK (obesity), Lithuania and Poland (overweight) for men. For example in Lithuania, a reversal of the social gradient in overweight prevalence was observed. Overweight prevalence is projected to increase among men with less than tertiary education while it is projected to decrease among men with tertiary education. Inequalities are projected to emerge and increase. Among Lithuanian women, obesity prevalence is projected to increase significantly among women with less than tertiary education and remain stable for women with tertiary education. Inequalities in obesity prevalence are projected to increase markedly over the next 35 years.

The projected increase in obesity prevalence by education level was not as expected for the Netherlands, Portugal and the UK among women, and for Netherlands and Portugal among men. In these countries, obesity prevalence is projected to increase more rapidly among the more educated group (men and women educated to tertiary level). This pattern has previously been described in Mexico and the USA (30, 102). A potential explanation for this is that the obesogenic environment in these countries may be diminishing the effect of protective factors such as high levels of education. Further, women and men with tertiary education may lead more sedentary lifestyles due to the nature of their jobs, and may accrue an increased risk of obesity.

It was not possible to run the microsimulation by social group due to insufficient samples in each sub group following division of the sample population by age, sex, risk factor and education group. However, inequalities in obesity will be translated into inequalities in morbidity and mortality. Based on the trends projected for EConDA countries, it would be expected that inequalities in morbidity and mortality associated with obesity would increase in Lithuania and Poland among men and women, increase in Finland and the UK among men, decrease in Netherlands and Portugal among men and women, and decrease in the UK among women only.

Impact of MCLI on chronic disease burden

The simulation model predicted the future impact of changing trends in BMI by age and sex on a range of specified chronic diseases. Results reveal that, without intervention, the incidence of each disease is predicted to increase in each country by 2050 as a result of dynamic changes in BMI. Therefore, implementing interventions that are both effective and cost-effective are important to reduce this burden not just to the individual, but to the health system and society at large over the coming years.

We first tested the impact of multi-component lifestyle interventions (MCLI) on the future disease burden via its impact on BMI. Such weight loss programmes were observed to have an important impact on disease outcomes, but only under certain circumstances:

- The MCLI is made available to obese individuals throughout the entire simulation period – little or no impact of on disease is observed when the intervention is implemented in the first year of the simulation only (Appendix E1).
- The weight loss following the MCLI is maintained in individuals over time – smaller, although still important effects, were observed when weight loss was regained over the 5 years following the end of the weight loss programme.

The largest effects of the *MCLI with weight regain* intervention were observed for pre-diabetes (e.g. 1,003/100,000 cases avoided by 2050 in Portugal) and CHD (325/100,000 avoided by 2050 in Greece). These effects were magnified when the intervention was run *without weight regain,* thus demonstrating the importance of maintaining weight loss on the future burden of BMI-related diseases. Such weight maintenance programmes might involve daily self-weighing, dietary restriction and adherence to the 'ten top tips programme'(103, 104).

These findings neatly demonstrate the nature of the multi-stage diabetes model. Both versions of the MCLI intervention (*with* and *without weight regain*) result in the reduction of prevalence of pre-diabetes and diabetes, whereby weight loss not only reduces incidence of pre-diabetes and diabetes but can also reduce the likelihood of individuals with pre-diabetes entering the diabetes state. Preventing progression of chronic disease is just as important, given the high cost burden associated with type 2 diabetes and its related co-morbidities.

It was not deemed appropriate to compare results across countries, since the input parameters for each risk disease and intervention differed across the 8 EConDA countries. The MCLI has the largest impact on Portugal, probably because the MCLI included for Portugal had the largest impact on BMI (reduction of 2.2 BMI points).

Impact of MCLIs on costs

When an MCLI intervention is introduced, the extent to which direct healthcare costs can be avoided increases markedly over time. Across all the European nations in the model, MCLIs are shown to have the largest impact on stroke and CHD in terms of avoidances in direct healthcare costs. Stroke featured in 5 of the EConDA countries as the disease with the largest avoidances in direct healthcare costs, whereas CHD featured as the top disease in 2 of the EConDA countries (

Table 241). Stroke is comparatively more expensive to treat than CHD or type 2 diabetes, and is common among developed countries – thus, as expected, the largest avoidances in direct healthcare costs can be achieved through decreasing the prevalence of the most costly diseases.

In 4 of the EConDA countries, MCLIs are expected to have the largest impact on CHD in terms of avoidances in indirect costs (

Table 241). Indirect costs are essentially a function of the quality of life of individuals in the model. Thus, one may assume that MCLIs would have the largest impact on stroke in terms of avoidances in indirect costs, since stroke tends to be associated with the lowest quality of life amongst the EConDA group of modelled diseases. However, results revealed that CHD was associated with the largest avoidance in indirect cost – possibly because CHD is a more common disease, and because the likelihood of contraction of CHD is more sensitive than stroke to changes in the prevalence of excess weight.

Table 241. Diseases associated with the highest amount of cost that can be avoided in 2050 following introduction of an MCLI

Country	Diseases associated with the highest amount of cost that can be avoided in 2050	
	Direct healthcare costs	Indirect costs
Bulgaria	1 Stroke 2 CHD	1 Stroke 2 CHD
Finland	1 Stroke 2 T2DM	1 T2DM 2 Stroke
Greece	1 Stroke 2 CHD	1 CHD 2 Stroke
Lithuania	1 CHD 2 Stroke	1 CHD 2 Stroke
Netherlands	1 Stroke 2 CHD	1 CHD 2 Stroke
Poland	1 CHD 2 Stroke	1 CHD 2 T2DM
Portugal	1 Stroke 2 CHD	1 Stroke 2 CHD
UK	1 T2DM 2 CHD	1 T2DM 2 CHD

1: Disease with the most amount of costs that can be avoided in 2050; 2: Disease with the second most amount of costs that can be avoided in 2050

Impact of MCLIs on QALYs

Across all the European nations in the model, both versions of the MCLIs are expected to result in increases in QALYs over time. However, no discernible effect was observed when the MCLI was implemented as a one-off intervention at the start year of the simulation. This is as expected, since a QALY is a function of the prevalence of chronic disease in the microsimulation model, and as discussed earlier, MCLIs are indeed expected to markedly reduce the epidemiological burden of chronic diseases over time, especially if weight loss can be maintained. Results reveal that gains in QALY during the first few years of the MCLI intervention are small, but gradually rise over time. This is a characteristic of the preventative nature of the intervention as well as the nature of the association between the risk factor and the chronic diseases in terms of the latent period. Towards the end of the 35-year simulation period, the gain in QALY noticeably plateaus in some countries, owing to the effect of discounting – whereby future health outcomes accrue less weight than immediate health outcomes (105).

The *MCLI with no weight regain* intervention is predicted to result in greater increases of QALYs over time compared to the *MCLI with weight regain* intervention, further confirming the importance of imposing public health programs or mechanisms that encourage weight loss in individuals to be maintained over a longer time horizon.

What remains unclear is the *extent* to which the gains in QALYs are as a result of increases in the quality of life of individuals as opposed to simply increases in the length of life. This has wide economic implications, since simply living longer will not in itself lead to increases in productivity if the majority of individuals' life expectancies in a nation already surpass the national retirement age – improvements in the quality of life will have more direct effects on the productivity of the work force (through reduced absenteeism and presenteeism).

Cost effectiveness of MCLIs

Results indicate that the ICERs of MCLIs are expected to be positive in value for 7 of the 8 EConDA countries during the 35-year time horizon. Additionally, it was decided that a cost effectiveness threshold would not be used for the analysis of ICERs in this project, owing to the lack of the use of CE thresholds in many of these countries. Because of this, it was not possible to categorically determine whether or not MCLI interventions are cost-effective in these 7 countries – a cost effectiveness (CE) threshold is required to determine the cost effectiveness of interventions for cases where ICER figures are positive in value.

The ICERs of MCLIs in these 7 countries are predicted to become increasingly negative in value over time, so it is possible to infer that MCLIs, in general, do become cost effective in the longer run. This demonstrates the importance of assessing cost effectiveness over a long time horizon, especially in the case of public health interventions, whereby marked benefits only become evident later on. For Portugal, the ICER figures were predominantly negative in value across the 35-year time horizon, indicating that the MCLI intervention was found to be categorically cost effective.

A one-off MCLI intervention in the start year of the intervention was also modelled – this was found not to be cost-effective even when the weight loss was maintained (results available in Appendix E1). This again shows that MCLIs need to be offered on a continuous basis to ensure individuals have the opportunity to take part when they are ready to make a behaviour change.

Impact of SSB tax on chronic disease burden

The literature shows that only a small proportion of individuals offered a weight loss programme take it up (10.44%); such non-mandatary interventions have a smaller reach than population-level interventions. As a result, the opportunity for making the large scale gains in disease avoidance necessary to abate the current chronic disease epidemic is unlikely to be fulfilled purely through individual level interventions. Therefore, we also tested the impact of a 20% tax on sugar-sweetened beverages – a policy intervention that is designed to target the whole population.

The impact of a 20% SSB tax on BMI was small, ranging between 0.00 (Lithuania) and 0.05 (UK) in BMI point reductions. An SSB tax was considered not to affect BMI levels in Lithuania, since the consumption of SSBs was found to be extremely small in this country. To note, individual level data on the consumption of SSBs was only available for the UK, so further work with more precise consumption data will improve the estimates. Despite small changes in BMI, important gains were made in terms of disease cases avoided across each of the countries (with the exception of Lithuania). The largest number of incidence cases avoidable were for diabetes, with between 7 (Finland) and 59 (UK) cases per 100,000, followed by pre-diabetes with between 14 (Finland) and 87 cases (UK) per 100,000. There was huge variability between countries, largely due to differences in input data. The greatest number of incidence cases avoided was found for the UK, since the BMI reduction as a result of an SSB tax was largest in this country. Regardless, across each country the results show that even small changes can have important effects on at least some disease outcomes.

In line with the literature (59), we modelled an exponential reduction in BMI by between 0.01-0.05kg/m^2 following implementation of the tax in year 1 of the simulation period (2015). While there is evidence for a reduction in SSB consumption following a levy (106), there is as yet a lack of observed data on the long term impact of SSB tax on BMI (107, 108). Despite this, the principle of removing calories from the diet and encouraging shifts in social norms is fundamental if behaviour change is to be initiated and maintained. Further, the EConDA model only included adults. Evidence shows that reducing intake and SSBs reduces weight gain in children, particularly those who are already overweight (109, 110). Since children and adolescents consume a large proportion of sugar-sweetened beverages future work should explore the impact of a tax on this group. The difficulty, however, lies in understanding how price effects this group and to our knowledge no price elasticity exists for the effect of SSB price increases on children and adolescents.

It should be noted that the results for the impact of SSB tax are likely to be conservative since the impact of SSB tax on disease outcome was quantified by its impact on BMI only. The model did not take account of non-BMI related diseases that would be affected with a reduction in sugary drinks such as dental caries or possible direct effects on diabetes via its impact on sugar reduction. Further, there is increasing evidence that a high intake of added sugars is independently associated with some non-communicable diseases.

Impact of SSB tax on costs

When an SSB tax is introduced, the extent to which direct healthcare costs can be avoided increases markedly over time. Across all the European nations in the model, SSBs are expected to have the largest impact on either stroke, CHD or T2DM in terms of avoidances in direct healthcare costs. Stroke featured in 4 of the EConDA countries as the disease with the largest avoidances in direct healthcare costs, whereas CHD featured as the top disease in 2 of the EConDA countries (Table 242). The patterns described are similar to what was observed in the MCLI interventions. However, the magnitude of the cost avoidances through an SSB tax is markedly smaller than through an MCLI intervention. Evidence shows that MCLIs tend to result in greater losses in weight compared to an SSB tax of 20% since MCLIs are applied to the obese group as opposed to the population at large.

In 3 of the EConDA countries, MCLIs are expected to have the largest impact on CHD in terms of avoidances in indirect costs (Table 242). Again, the magnitude of the cost avoidances stemming from SSB taxes is far smaller than that stemming from MCLIs that are implemented annually.

Table 242 Diseases associated with the highest amount of cost that can be avoided in 2050 following introduction of an SSB tax

Country	Diseases associated with the highest amount of cost that can be avoided in 2050	
	Direct healthcare costs	**Indirect costs**
Bulgaria	1 CHD 2 Stroke	1 CHD 2 Stroke
Finland	1 Stroke 2 T2DM	1 Stroke 2 T2DM
Greece	1 Stroke 2 CHD	1 CHD 2 Stroke
Lithuania	Not modelled	Not modelled
Netherlands	1 T2DM 2 Stroke	1 CHD 2 Stroke
Poland	1 Stroke 2 CHD	1 T2DM 2 Stroke
Portugal	1 Stroke 2 CHD	1 Stroke 2 T2DM
UK	1 T2DM 2 CHD	1 T2DM 2 CHD

1: Disease with the most amount of costs that can be avoided in 2050; 2: Disease with the second most amount of costs that can be avoided in 2050

Impact of SSB tax on QALYs

The introduction of an SSB tax is expected to result in gains in QALYs across every European nation within the model. Interestingly, unlike that of MCLIs, the gains in QALYs from SSB taxes are expected to remain steady over time. The exact reason for this remains unclear, but one can speculate that the discounting of health outcomes embedded into the model may partly be responsible for the apparent curbing of gains in QALYs over time. Additionally, the magnitudes of the gains in QALYs from an SSB tax are significantly smaller than those from an MCLI, indicating that the modelled level of taxation may be insufficient to impact health outcomes to the same level as that of annual MCLIs.

Cost effectiveness of SSB tax

Our results reveal that, across all the 8 EConDA countries, the SSB taxes results in negative ICER values, which, by definition, mean that the intervention is “dominant” over the comparator (which in this case is the baseline scenario). SSB tax was found to be cost-effective, and more cost-effective than MCLI. This can be inferred, despite not undertaking a direct comparison of the two interventions, because a baseline scenario was used as the comparator for both interventions, effectively acting as a common denominator. Taxes, by default, are cost-effective since they generate revenue, and are not associated with large implementation costs. To note, this model did not take account of potential losses of revenue to the government through value added tax as a result of reduction in consumption of SSBs.

Concluding remarks from the obesity model

Together, these results show that small but important gains can be attained from high-level policy and prevention interventions. However, given the surge in levels of obesity over recent decades a single intervention is not enough. Much work over recent years has concluded that a ‘whole systems approach’ is needed to tackle overweight and obesity, although this recommendation has largely been ignored (111). Future work should explore the impact of a range of combined interventions for tackling obesity. The EConDA model is developed in such a way to be able to do just that.

This set of results provide further evidence that fiscal policies provide a wider reach than community level interventions, and show that even small changes in BMI can have important effects on future disease incidence and related costs. However, the small impacts in costs and epidemiological measures means tax rates greater than 20% may be needed to bring about the level of changes expected from a preventative intervention.

Smoking model results

Prevalence of smoking

Unlike that of obesity, the prevalence of smoking has fallen in many parts of Europe, and this is largely due to the enforcement of a wide-range of tobacco control measures over the past couple of decades (112, 113).

With the exception of the UK, Finland and The Netherlands, data for smoking prevalence were less rich than those for BMI. Often, there was too little information to make accurate estimates of the future prevalence of smoking. For example, only two data points were available for Portugal and Greece, and only 3 points for Poland and Bulgaria –thus, interpretation of these estimates should be made with caution. Table 240 presents a brief scoring of the availability of smoking data by country.

Smoking prevalence was predicted to decrease in all countries with the exception of Bulgaria, Portugal, and Poland where increases were predicted. More data are required from these countries to determine if this is a real increase or an artefact of the limited data.

Table 243. Quantifying the quality of smoking data, by country

Country	Data Points	No. of National datasets	Sample Size data available?	Total
Bulgaria	3	3	3	**9**
Finland	13	13	13	**39**
Greece	2	2	2	**6**
Lithuania	5	5	5	**15**
Netherlands	13	13	0	**26**
Poland	3	3	3	**9**
Portugal	2	2	2	**6**
England (UK)	12	12	12	**36**

In those countries with more than 3 data points, smoking prevalence is predicted to fall. The lowest smoking prevalence is predicted in the UK (falling from 17% in 2015 to 7% by 2050) closely followed by Finland (falling from 23% in 2015 to 13% in 2050). Progressive policies that are known to be effective in reducing initiation of smoking, as well as those that are effective in promoting smoking cessation, have likely been important in this downward trend in these countries. Packaging is a key factor in consumer choice and the EU tobacco products directive has been introduced in different countries to regulate what is put onto cigarette packs. Countries vary in how they have implemented the current directive (112) and, interestingly, both Finland and UK (where smoking prevalence is predicted to be lowest) have implemented the most stringent rules relative to the other EConDA countries. In the UK, pictorial warnings have been in place since 2008 and standardised packaging[7] is set to come into force in 2016 (114). In Finland, 39% of the front and back of cigarette packs are mandated to be covered with specific health warnings. Standardised packaging is currently under formal consideration in this country as well (115).

When exploring trends by age and sex, decreasing smoking prevalence is observed in males among every EConDA country; however, this type of pattern is less clear cut for females. In Portugal, Poland, Bulgaria and Greece, increases in smoking are predicted particularly in females above 50 years old. However, again the wide confidence interventions due to data limitations limit the interpretation here so further monitoring of these possible trends is necessary to make more accurate estimates.

Data on smoking prevalence by education level were available for Finland, Lithuania, the Netherlands, and the UK only. Prevalence of smoking was projected to decrease across both education groups. However, across all of these countries there was a clear social gradient such that smoking prevalence was higher amongst the less educated group compared with the more educated group. Relative inequalities between groups tended to increase over time, whereas absolute inequalities tended to decrease by 2050. These findings are in line with existing literature showing a strong link between education level and smoking prevalence across Europe such that the less educated smoke more (116, 117). The present findings extend this work by projecting inequalities forward into to 2050 identifying the need for policies that prevent initiation of smoking amongst the less educated, such as fiscal policies, school-based programmes, and smoking cessation services.

A multi-stage COPD model was built to test the progression of COPD through GOLD stages. Longitudinal data were necessary to calculate transitions between stages. However, such data were only available for the UK and Finland. Therefore for other countries a 'single stage' COPD model was run to determine total incidence and prevalence of COPD. These results are interpreted first.

Impact of SCS on chronic disease burden

Smoking cessation services (SCS) were observed to have an important impact on disease incidence and prevalence cases avoided over time in each of the countries. Across each of the countries SCS had the largest effect on reducing cumulative incidence cases of stroke. For example between 381 per 100,000 (Finland) and 3,137 per 100,000 of stroke were predicted to be avoided by 2050 as a result of the SCS. Interestingly, where smoking prevalence is already low and decreasing across each age group (e.g.

[7] Standard packaging is defined as 'putting tobacco products into drab, purposefully unattractive packaging devoid of branding (other than name) or promotional information' (p10. Chantler et al, 2013). It refers to packaging that requires the removal of all branding (colours, imagery, corporate logos and trademarks). Manufactures must print only the brand name in a specified size, font and place on the pack in addition to health warnings and any other legally mandated information such as toxins. They include covert anti-counterfeiting markings as with existing packs.

Finland) SCS had a smaller impact than in countries where smoking rates are higher and/or increasing (e.g. Portugal, Bulgaria).

Interestingly, in the countries where smoking rates were predicted to fall, incidence and prevalence of some diseases were often predicted to increase over time. For example, in Finland incidence cases increase for CHD and stroke by 2050. This may seem counter-intuitive since we would expect the incidence of all diseases to fall as a result of falling smoking prevalence. Exploring the outputs by age help to explain this result, since improving life expectancy by reducing smoking prevalence leads to individuals living longer. Therefore CHD in the early ages is replaced with CHD in the later years by virtue of the fact that individuals are living longer. The model is run to 2050 so surviving individuals continue to have a probability of getting a disease. Appendix E9 shows the population growth in the 60+ age group by 2050 in Finland, Lithuania, the Netherlands and the UK. This shows that taking a life-course approach is necessary to fully understand the full effects and costs of population ageing. Other diseases such as lung cancer were not predicted to increase in Finland however, and this is likely due to the lower incidence rate of lung cancer relative to cardiovascular diseases. Similar results were shown for the UK, Lithuania and the Netherlands. CVD has a number of other behavioural risk factors associated with it (obesity, salt consumption, physical inactivity) so these too are likely to contribute to increasing rates of CHD in the later years. Diseases in older ages are inevitable; however behavioural risk factors such as smoking increase the likelihood of premature morbidity and mortality resulting in a great pressure on the health system and wider society. Further work should explore the impact of the ageing population and elderly diseases such as dementia within the model.

Impact of SCS on costs

When an SCS intervention is introduced, the extent to which direct healthcare costs can be avoided increases markedly over time. Across all the 8 European nations in the model, SCSs are expected to have the largest impact on stroke in terms of avoidances in direct healthcare costs. Stroke featured in all 8 of the EConDA countries as the disease whereby the largest avoidances in direct healthcare costs can be achieved. It remains unclear why a similar level of cost avoidance is not achieved in COPD, despite the fact that the relative risk of acquiring COPD from smoking is substantially higher than that of stroke. One plausible reason for the higher levels of cost avoidance observed for stroke is that stroke is more expensive to treat, and additionally, the relative risk decay rate following cessation of smoking is faster for stroke than it is for COPD, based on the DYNAMO-HIA model i.e. smoking cessation has a more immediate impact on the likelihood of acquiring stroke than on acquiring COPD.

In all 8 of the EConDA countries, SCSs are expected to have the largest impact on stroke in terms of avoidances in indirect costs (Table 240). The reason for this is the same as was described for the direct healthcare costs.

Table 244. Diseases associated with the highest amount of cost that can be avoided in 2050 following introduction of an SCS intervention

Country	Diseases associated with the highest amount of cost that can be avoided in 2050	
	Direct healthcare costs	**Indirect costs**
Bulgaria	1 Stroke 2 COPD	1 Stroke 2 COPD
Finland	1 Stroke 2 -	1 Stroke 2 COPD
Greece	1 Stroke 2 COPD	1 Stroke 2 COPD
Lithuania	1 Stroke 2 COPD	1 Stroke 2 COPD
Netherlands	1 Stroke 2 COPD	1 Stroke 2 COPD
Poland	1 Stroke 2 -	1 Stroke 2 -
Portugal	1 Stroke 2 COPD	1 Stroke 2 COPD
UK	1 Stroke 2 COPD	1 Stroke 2 COPD

1: Disease with the most amount of costs that can be avoided in 2050; 2: Disease with the second most amount of costs that can be avoided in 2050

Impact of SCS on QALYs

The introduction of an SCS is expected to result in gains in QALYs across every European nation in the model. Like that of MCLIs, the gains in QALYs from SCSs are expected to increase markedly over time. The most likely reason for this is the same as what was described in the MCLI section. The gains in QALYs noticeably plateau in some countries towards the end of the 35-year time horizon – a finding similar to what was observed in the MCLI interventions. It reiterates the need that a basket of approaches are necessary to curb the rising obesity epidemic if we are to achieve anything like what has been achieved in reducing tobacco consumption.

Cost effectiveness of SCS

Across all the 8 EConDA countries, the introduction of an SCS results in negative ICER values, which, by definition, means that the intervention is “dominant” over the comparator (which in this case was the baseline scenario) i.e. SCSs were found to be cost-effective.

During 2015 and 2020, the ICERs of SCS for every EConDA country (except Bulgaria and Finland) were positive in value, meaning that it was not possible to discern whether or not the intervention is cost effective during the first few years following its introduction – CE thresholds are required to determine whether or not ICERs that are positive in value are indeed cost effective.

Impact of a hypothetical COPD treatment on COPD burden

The multi-stage COPD model was developed for the UK and Finland – a model which enabled the testing of a treatment intervention based on the drug Roflumilast. Roflumilast is known to promote remission of COPD from stage 3+ to stage 2, reduce the risk of individuals from moving to stage 3+, and reduce the risk of acute exacerbation. The former two characteristics of Roflumilast were modelled for EConDA. To note, the baseline model assumes forward transitions only i.e. only individuals in the COPD treatment scenario can transition backwards from COPD stage 3+ to 2. Results reveal that the treatment is expected to increase the number of cumulative incidence cases of COPD stages 3+ *and* 2 by 2050 when compared to the baseline scenario, leading to the suggestion that the treatment may be counter-productive. However, this is not the case, but simply an artefact of the model's nature: when individuals in stage 3+ COPD are treated and consequently move back to stage 2, they still have the possibility of progressing back to stage 3+. This increases the incidence, since individuals who progress to stage 3+ COPD for a second time are counted twice under the incidence column. Looking at the prevalence gains is therefore important. Results show that the prevalence of stage 3+ COPD is indeed lower than that of the baseline scenario – indicating that the treatment is effective in reducing the prevalence of COPD stage 3+. As a consequence, an increase in the prevalence of COPD stage 2 is observed compared to the baseline scenario. The prevalence gains for Finland were much smaller than that of the UK. This is most likely explained by the fact that the Finnish model had access to prevalence datasets that involved diagnosis using post-bronchodilator spirometry values, whereas the UK model compromised on the use of prevalence data that only involved pre-bronchodilator spirometry values (i.e. higher false positives in the UK dataset).

For Finland and the UK, it is possible to compare the impact of SCS with that of the hypothetical COPD treatment. For example, in the UK, SCS resulted in the avoidance of 151, 12 and 26 prevalence cases (per 100,000 population) for stages 1, 2 and 3+ of COPD, respectively, in 2050. Conversely, the hypothetical COPD treatment resulted in the avoidance of 0 and 195 prevalence cases (per 100,000 population) for stages 1 and 3+ of COPD, respectively, in 2050, but a gain of 247 prevalence cases (per 100,000 population) for stage 2 of COPD in 2050. The implication is that while the SCS has impact across all stages of COPD (more so towards the less severe stages), the hypothetical COPD treatment only reduces the prevalence of the severe stages of COPD. The target is narrower, but may be just as important as COPD stage 3+ is more expensive to treat than the less severe stages. It is important to note that whereas the hypothetical COPD treatment only affects the prevalence of stage 3+ COPD, the SCS has wide reaching effects, improving the prevalence not just across all COPD severity stages but also across other chronic diseases, most notably stroke and lung cancer. This is of particular importance given the increases in multi-morbidities, especially in deprived communities where smoking prevalence is highest (118).

One interesting observation to take note is that, despite managing to reduce the prevalence of stage 3+ COPD, the hypothetical COPD treatment had no long-term impact on the prevalence of CHD and stroke, which can occur as a consequence of COPD. The reason for this remains unclear.

Impact of a hypothetical COPD treatment on costs

Results reveal that, for both Finland and the UK, the hypothetical COPD treatment positively impacts the direct healthcare and indirect costs of stage 3+ COPD only. Stage 2 COPD is slightly worse off because the treatment increases the prevalence of stage 2 COPD as a result of individuals shifting from stage 3+ COPD. This is in contrast to the SCS results, whereby, for the UK at least, the intervention positively impacts across most of the other chronic diseases modelled.

Impact of a hypothetical COPD treatment on QALYs

Due to the EConDA model structure, it was not possible to produce QALY outputs broken down by disease type. Thus, it was not possible to single out, and see how much of an impact the hypothetical COPD treatment had on the QALY of COPD patients. In effect, the hypothetical COPD treatment does not appear to impact the QALY of a population because its target is very much focused on a specific sub-population – those with COPD. In contrast, the SCS positively impacts the QALY of the Finnish and UK population. These findings, again, demonstrate the importance of public health preventative interventions since their impact on QALY on the general population is far greater than what is achievable from a medical intervention that only impacts the QALY of a specific and small sub-population.

Cost effectiveness of a hypothetical COPD treatment

It was not possible to demonstrate the cost effectiveness of the hypothetical COPD treatment because the QALY figures in the model are produced to the nearest integer. Thus, the QALY gains were zero in value on a number of occasions across the years (since the impact of the treatment on QALY was negligible), leading to ICER figures that were unquantifiable.

CKD model results

The impact of screening for albuminuria on the progression of CKD, CHD and stroke was tested in the UK only due to data limitations. Progression of CKD was based on changes in albumin and eGFR by age over time. Screening for albuminuria was implemented to demonstrate the ability of the model to quantify the impact of screening interventions. As expected, the screening intervention was effective in reducing the progression of CKD through each stage. Given that the costs of ESRD are substantial (£67,000 per patient per year) preventing the progression to ESRD is key. CKD is also an independent risk factor for CHD and interacts with diabetes and hypertension.

Multi-morbidities push up costs and reduce quality of life, providing further evidence for the need for prevention to reduce disease onset and progression. However, taking the NICE cost-effectiveness threshold of £30,000/QALY in the UK this intervention is not cost-effective.

A downloadable tool

As well as the development of a sophisticated microsimulation model the EConDA project has also delivered an online tool. This tool is a 'deterministic' version of the microsimulation model. This means that it processes cohorts of individuals (e.g. a group of overweight 20-39 year old males) rather than a whole population of a variety of individuals. The user can specify the cohort of individuals in the tool. For example, they can determine the future burden of CHD in a group of obese individuals aged 20-39 years old. The tool also enables a single individual of a given age and risk factor status to be run. The utility of the tool is that researchers, policy makers and commissioners can test the epidemiological and cost impact of a range of hypothetical or real interventions on disease burden. Further details about the tool can be found in Appendices D1-5. The tool can be downloaded here: www.econdaproject.eu/tools.php.

General comments

Strengths

There are a number of strengths of Work Packages (WP) 5 and 6. A key strength is the use of the microsimulation method to simulate the future burden of disease as a result of dynamic changes in risk factors. The use of a microsimulation method has been cited as the most vigorous method for risk factor and chronic disease modelling (119). As opposed to modelling cohorts of people with the same characteristics, the microsimulation can recreate the characteristics of individuals – such as age, sex and disease state – within a population and these characteristics can evolve over time. Importantly, the microsimulation takes history into account. This is vital since an individual's history of a given risk factor is an important determinant of chronic disease, survival or death. In contrast, Markov models are memoryless such that the subsequent state is dependent upon the current state and not the sequence of events that preceded it. The microsimulation is therefore the right approach for chronic disease modelling since it remembers an individual's history and takes it into account to influence their future life course.

The computing power required to run a microsimulation is often cited as a limitation of the method; however, the UKHF model has been built in a modular way such that computation of many millions of individuals on a desktop computer takes only hours. This project ran between 50-100 million individuals which took approximately 2-8 hours per scenario.

WP 5 has enabled significantly technical development of the models. They have been built in a way that they are structurally 'general' in that given enough data they can easily support new multi-stage diseases such as cancers, dementia and liver disease.

WP 6 built on the epidemiological disease models from WP 5 to include a cost-effectiveness module. The EConDA project has enabled a substantial development of the economic module to include: discounted direct and indirect costs of disease, direct and indirect costs by disease stage, and measures of cost-effectiveness of interventions relative to baseline.

A downloadable tool was also created as part of WP6 (appendix D1-5) and has been disseminated in 5 of the EConDA countries at workshops. While the estimates are less accurate than the microsimulation, the tool provides a useful check to the microsimulation as well as useful way to compare the outcomes of different interventions over time. This will be demonstrated further in WP 7, 'validation of the model'. Feedback was largely positive about the tool and upgrades to the tool made based on user feedback.

Challenges and ways forward

There are a number of limitations of the present project. A major challenge of any predictive model is that it does not take account of future developments such as new drugs or technologies. The effects of these possibilities can be tested through a rigorous sensitivity and uncertainty analysis. However, this was not possible within the time constraints of this project. With access to super computers, future work will carry out these analyses.

Data limitations

The microsimulation requires a large amount of data input and no country had a full set of data. In particular, data on risk factors by socio-economic status group were not always available. Risk factor data by education group was most frequently available. The UK was the only country where data by income, area level deprivation and social class were freely available; however, to maintain consistency across each country, education level was chosen to show the utility of the model to determine future trends in risk factors by social group. Projecting risk factors by a specified group is important if interventions are to be targeted at those most in need. However, larger datasets are required if projections by age group and sex are to be forecast with any degree of accuracy. While mean differences between high and low education groups provided an indication of a social gradient in the prevalence of obesity and smoking, for many countries, the errors around the estimates did not permit accurate estimates of the significance of this effect.

Disease incidence data were often difficult to find especially for coronary heart disease so myocardial infarction data were often used as a proxy for CHD where available. Therefore, estimates are likely to be underestimates of CHD incidence. Where no incidence data were available, these were calculated from prevalence and mortality using DISMOD equations (3).

Incidence, prevalence, mortality, survival and cost data by disease stage were required; however, this was difficult to obtain. The UK Health Forum developed a range of algorithms to calculate incidence by stage for T2DM and incidence, mortality and survival for COPD (appendices B1-4). Moreover, methods from the literature were adapted and implemented to estimate annual relative risks for the different stages of T2DM from a longitudinal study. Due to the lack of available data, the multi-stage COPD disease model was only run for the UK and Finland, and the multi-stage CKD model was only run for the UK. Despite this, the models that have been developed are general in structure so they can easily be updated when data become available to provide estimates of the burden of these diseases by stage. More longitudinal datasets are necessary to calculate relative risks, transition probabilities and incidence by stage.

Relative risks for smoking were taken from the dynamo project and assumed to be the same across each country. It is assumed that the effect of quitting smoking on risk of disease will be the same across the EU countries included in the project. Similarly, relative risks for BMI were taken from the IOTF and assumed to be the same across all countries. This was deemed a reasonable assumption especially given the scarcity of country specific relative risk data.

We did not include time lags between risk factor and disease because the relative risks included are averaged over time. However, further work should take account of varying risks depending on time of a given weight loss/smoking cessation period.

Model limitations

In order to take account of age and sex differences in risk factors, data were categorised into five year age groups by sex. This often resulted in a small sample size in each group and therefore large errors around the estimates. Therefore, the data available did not always provide enough information to make certain estimates about the future burden of overweight or smoking. Unfortunately, given the many thousands of calculations within the microsimulation it was not possible within the time constraints of the project to run a full error analysis to include these errors within the model. With access to super computers this exercise can be carried out over the next few years.

BMI is modelled as a continuous variable and BMI change is based on percentile mapping. Albumin and eGFR are also modelled as continuous risk factors and any change in these levels are based on percentile mapping. However, the distributions of albumin and eGFR in the simulated population are assumed to be constant and do not change with time. This assumption was due to the limited amount of data available. This model assumes that in the baseline case (no intervention), an individual's albumin and eGFR will only change as a result of ageing. In contrast, smoking is modelled as a categorical variable. Individuals will stochastically transition between smoking states based on the current trends. This means that once someone smokes they will be confined to either a smoking state or an ex-smoker state. A limitation of the smoking model is that it does not take account of the length of time smoked nor cessation time when calculating the chance of an individual changing their smoking status. Further work should develop the smoking model to take account of these variables. Appendix D4 provides more details of the dynamics of each risk factor model.

In a similar vein, the disease models were developed based on categorical variables such that individuals move from one categorical disease stage to the next (Appendix D1-3). The transitions between disease stages were not confined to just forward transitions. Backwards transitions were modelled for certain diseases if it was known to be possible. Further work could extend the disease module to enable the use of continuous data (e.g. FEV1%, impaired fasting glucose level) to model a disease by stage. If data were available this disease structure would allow us to use much finer relative risk data in the model. In WP 7 qualitative comparisons were made between the multi-stage diabetes model and another model that includes a continuous measure of fasting glucose (120).

Project sustainability and future work

The EConDA project has enabled the development of a microsimulation model that can test the effectiveness and cost-effectiveness of interventions to prevent, screen and treat chronic diseases within the same model. The models developed were demonstration models such that they illustrate the utility of this method in public health.

Further work will evolve from this project. The model has been developed in such a way that it can easily be updated when new data become available and accommodate additions of new data and (multi-stage) diseases. The results presented here highlight the need to take a lifecourse approach. We showed that reducing smoking is necessary to reduce premature morbidity. However, the increasingly ageing population mean that these diseases are delayed until later life. Critically, chronic diseases are intertwined with diseases co-existing; and one causing another. By 2020 it is expected that a quarter of Europeans will be over 60 years old and multi-morbidity[8] will be the norm (121). The EConDA project has enabled the UKHF microsimulation model to develop into a much more sophisticated model. Further work will refine the model to include multiple risk factors, which include diseases as risk factors for CHD as well as accounting for elderly diseases such as dementia to include a quantification of multi-morbidity. New diseases might also include a range of cancers and liver disease, while a range of additional risk factors might include alcohol, physical inactivity, diet, cholesterol, and salt consumption. The EConDA project observed the independent effects of each risk factor on diseases over time. Future work will accurately account for combined risks on the progression of disease.

SSB tax was generally found to be more cost effective than MCLI in each country, while SCS were found to be more cost-effective than treatment. Further work is necessary to test additional interventions as well as interventions in combination since we know that one intervention alone is not enough (122). Population level changes such as fiscal measures in combination with individual level approaches and societal approaches are necessary to provide a whole systems approach for tackling overweight and obesity.

For obesity in particular it is clear that more needs to be done to curb rising trends in prevalence. Further work should explore the impact of an SSB tax with varying parameters such as the impact on health of 100% reduction in SSBs, or a SSB tax escalator to account for shifts in inflation. In addition, we might test a range of combined interventions since there is no silver bullet to tackling obesity, but a basket of approaches is necessary. For example, the impact of increased controls on junk food marketing to children, buy-one-get-one free offers and sugar sweetened drinks tax combined.

[8] Multi-morbidity is defined as the co-occurrence of two or more chronic medical conditions in one person.

For smoking, it will be important for the model to be updated to include additional variables such as length of time smoked and time since quitting. In addition, passive smoking and other forms of tobacco such as chewing tobacco and hand rolled tobacco could be included to take better account of the effects of smoking on health. Exploring the role of e-cigarettes on health would also be a useful progression of the model. A Cochrane review on e-cigarettes reported that participants using e-cigarettes were ore likely to have abstained from smoking for at least 6 months compared to participants on placebo (123). However, we are yet to fully understand the long term health (if any) and wider social impacts of e-cigarettes. Continues monitoring of these trends in uptake and use of e-cigarettes alongside cigarettes will be necessary.

Conclusion

The EConDA model illustrates the extent to which disease burden and related costs can be avoided with specified interventions. The results provide evidence for the importance of disease prevention showing the impact of low cost interventions on the future burden of ill-health. Instead of treating a single disease, interventions that reduce a common risk factor can in turn have an important impact on a range of chronic diseases concurrently. Given that 97% of health spending is on treatment, and only 3% on prevention (124) with prevention bearing the brunt of austerity (125), our results show that investment in health to reduce disease onset and progression is cost-effective in the long-term.

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