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Modelling the potential impact of a reduction in salt consumption on hypertension, coronary heart disease and stroke in the population of the United Kingdom from 2021 to 2035

HEALTH LUMEN

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Executive summary

8.4g

The average daily salt intake of working-age adults in England, nearly 70% higher than the World Health Organization target of 5g per day

1.4m

Under our salt reduction scenario, over 1.4 million fewer people will be living with hypertension in 2035 compared with the baseline scenario

Background

Poor diet is a factor contributing to the high prevalence of hypertension, obesity and non-communicable diseases (NCDs), such as cardiovascular diseases, cancers and diabetes, in Europe.[1,2,3,4] In particular, high levels of salt consumption are harmful to the cardiovascular system. Therefore, a comprehensive strategy to improve diet, including reducing the levels of salt consumption is widely recognised as a strategy to improve health at a population level.[5]

In 2003, the Scientific Advisory Committee on Nutrition (SACN) report, *Salt and Health*, recommended that the UK Government take action to reduce the population average intake of salt to 6g per day.[6] In 2004, the Food Standards Agency initiated a salt reduction programme, which saw good progress in reducing average salt intake from 9.5g to 8.1g by 2011. However, further salt reduction efforts in recent years have seen mixed results. The average daily salt intake of working-age adults in England of 8.4g exceeds the UK-recommended 6g per day by 2.4g (40%) and is 3.4g (68%) higher than the World Health Organization (WHO) target of 5g per day.[7]

Aims

The key aims of this project are to quantify the health and economic impact from 2021 to 2035 if the United Kingdom could achieve reduced salt consumption to meet national and international guidelines across the population by 2030.

Methods

Using a well-validated computer simulation model,[8,9,10,11,12] we built a virtual population of 20 million individuals that are representative of the UK population. This virtual population was modelled from 2021 to 2035. Cases of hypertension, CHD and stroke are recorded annually in the model. Each individual in the microsimulation who has prevalent hypertension, CHD, or stroke incurs a direct healthcare cost, and those who have CHD or stroke have an additional indirect cost associated with their condition.

We ran two scenarios in the microsimulation model:

1. **Baseline scenario**: current salt consumption remains stable for each age and sex group from 2021 to 2035 using a static trend from 2018.
2. **Intervention scenario**: salt consumption is reduced to a maximum of 6g per day in 2024, and then 5g in 2030, with the maximum 5g daily salt consumption holding to 2035.

Results

Results show that a reduction in salt consumption could attenuate the health and economic burden of hypertension, CHD and stroke. Under the intervention (salt reduction) scenario, we project that 1.4 million fewer people will be living with hypertension in 2035 compared to the baseline scenario. We project that 134,789 cumulative incidences of CHD and 48,540 cumulative incidences of stroke could be avoided by 2035. We project that these reductions will incur direct cost savings of £6.70 billion and indirect cost savings of £4.70 billion between 2021 and 2035. We also project that, under the intervention scenario, over 450,000 QALYs could be gained between 2021 and 2035.

Definitions & Abbreviations

Terms	Meaning
Baseline scenario	Where current salt consumption continues, assuming no change in salt consumption within age and sex group from 2018
CHD	Coronary heart disease, also known as Ischaemic heart disease (IHD)
Cumulative incidence	Successive additions of annual cases of a disease. For example, the cumulative incidence between 2021 and 2025 would be the sum of the all-new disease cases in each of those years
Direct cost	The expenditure that is directly attributable to the utilisation of healthcare resources
Hypertension	Defined in the microsimulation model as systolic blood pressure over 140mmHg
Incidence	The occurrence of new cases of a disease over a given time period
Indirect cost	Costs of a disease that are not related to healthcare, such as cost to business in terms of lost productivity and unpaid care such as that provided by family members
Intervention scenario	Where salt consumption is limited across the population to 6g per day by 2024, then 5g per day by 2030
Microsimulation	A computer model that replicates real life as closely as possible using national population and disease statistics. It can test the long-term impact of a range of different scenarios on future outcomes. The HealthLumen microsimulation is referred to as 'the microsimulation'
NCD	Non-communicable disease
NDNS	National Diet and Nutrition Survey
Prevalence	The total number of cases of a disease in a particular population over a given time period
QALY	Quality-adjusted life year: a unit used in the prediction of both quality and duration of life, where one QALY is equal to one year of perfect health
Regression	A statistical technique for estimating the relationships between variables
Risk factor results	Prevalence of different salt consumption categories and systolic blood pressure categories in the UK population by age and sex
SBP	Systolic blood pressure
Static	Where the probability of an individual belonging to a certain age and sex being in a certain consumption risk group remains constant throughout the duration of the microsimulation

Introduction

Hypertension is one of the leading risk factors for stroke and coronary heart disease (CHD), contributing significantly to the health and economic burden of non-communicable diseases (NCDs) in the UK.[13] Salt consumption is widely accepted as one of the most significant modifiable drivers of hypertension, with the National Institute for Health and Care Excellence (NICE)[14] recommending a reduction in salt intake to decrease the risk of hypertension and lessen the burden of cardiovascular disease.[1-3,5] Reducing salt consumption in the UK, therefore, represents an important means by which the prevalence of hypertension and incidence of stroke and CHD could be reduced in future.

68%

The average daily salt intake in England is 68% higher than the World Health Organization's target of 5g per day

The UK has a successful track record in reducing national salt consumption. Initially, this was achieved through the Food Standards Agency's (FSA's) salt reduction programme, which commenced in 2006 and consistently challenged the food industry to reduce the salt content of their products, while encouraging adults to reduce dietary salt consumption.[3] The programme's success contributed to a reduction in salt intake between 2000 and 2011, from an average of 9.5g to 8.1g per day,[15] with the most significant step change between 2005/6 and 2008/9,[7] illustrating the potential of population-level policy interventions to drive change. Later programmes, namely the 2011-2015 Public Health Responsibility Deal and Public Health England's voluntary programme,[16] saw mixed results. Analysis of progress against 2017 targets showed variability across the food industry, with just over half (52%) of average salt reduction targets for foods consumed in the home being met, and greater progress needed in the out-of-home sector.[17] The latest voluntary salt reduction targets for 2024 were set in 2020 by PHE (now the Office for Health Improvement and Disparities, OHID), with interim reporting expected to take place in 2022.[3]

More broadly, progress on salt intake has stalled in recent years, with England failing to meet the NICE recommended salt intake target of 6g per day by 2015. Most recent data available shows that the average daily salt intake of 8.4g in working-age adults in England exceeds the recommended 6g per day by 40% and is 68% higher than the WHO target of 5g per day.[18]

In this report, we applied the HealthLumen microsimulation model to quantify the significant health and economic benefits that could be achieved by 2035 if UK adult salt consumption was reduced to 6g per day, as per current recommendations, by 2024 and 5g per day by 2030, in line with the WHO target.

Methods

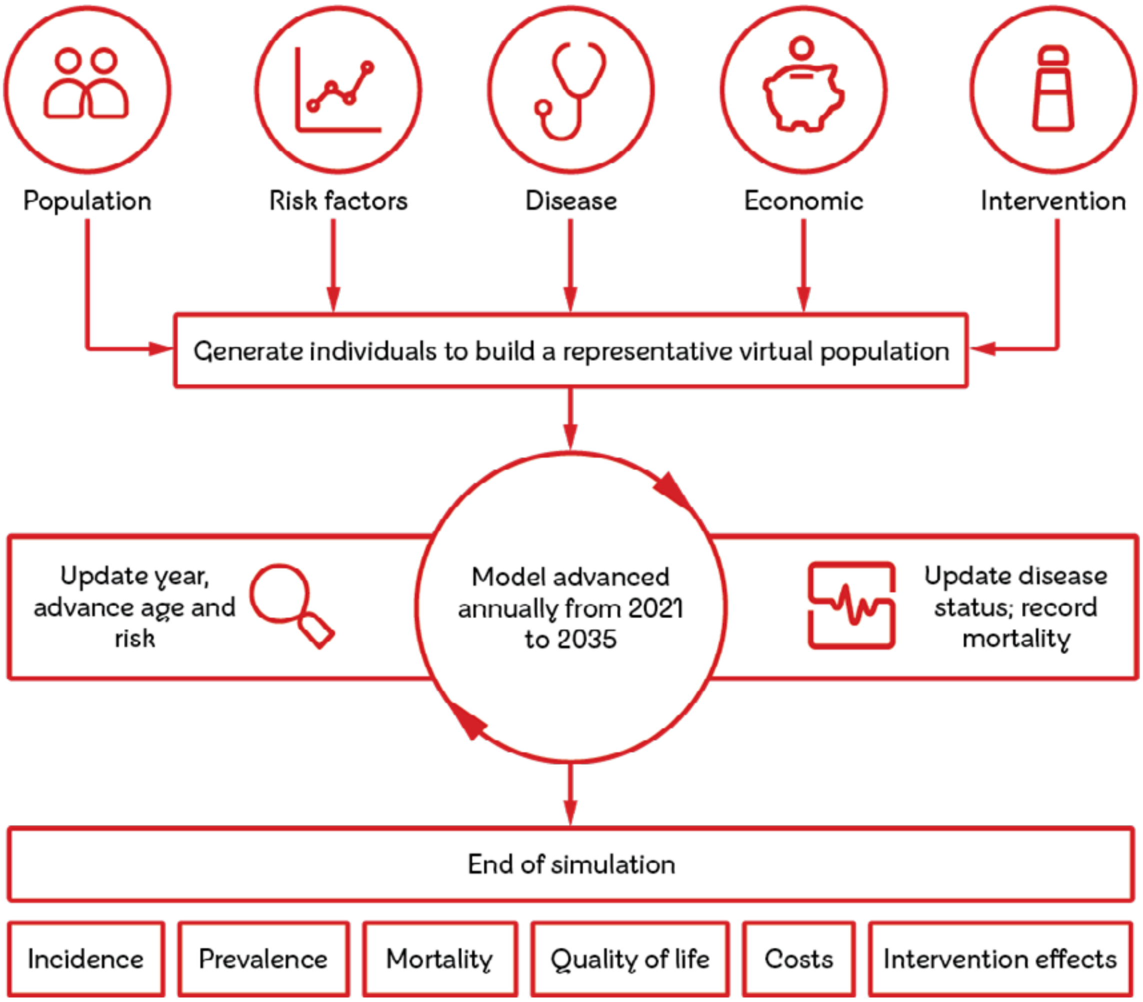
Overview of the microsimulation model

In this study, HealthLumen employed a dynamic, robust, flexible and well-validated microsimulation model to project the burden of salt-consumption related diseases (CHD and stroke) in the future.[4,8,9,12,19] The microsimulation method is an advanced method for modelling NCDs because of its capacity to simulate entire populations at an individual level over time.

The inputs of the microsimulation comprise five modules: 1) population, 2) risk factors, 3) disease epidemiology, 4) economic, and 5) intervention. The model inputs can be viewed in more detail in Appendix 1. Details of the microsimulation model engine are available in Appendix 2. An overview of the microsimulation model is illustrated in Figure 1.

Each individual in the model has an age, sex and exposure value for salt consumption and blood pressure. This exposure value in turn pertains to a particular risk of developing, dying from or surviving CHD and stroke (Appendix 2), in conjunction with the individuals' non-modifiable risk factors, such as age and sex.

FIGURE 1
Microsimulation model schematic



Module 1
Population

The model simulates a virtual population of individuals that are representative of the population of the UK. The Office for National Statistics (ONS) was used to source age-sex population statistics, population projections, birth rates by mother's age and death rates for the UK.[20] 20 million individuals were simulated in the model.

Module 2
Risk factor

This simulation utilises data on salt consumption by age and sex from the National Diet and Nutrition Survey (NDNS).[21] According to the NDNS, "trend analysis between 2005/06 and 2018/19 indicated no statistically significant linear change in estimated daily salt intake over time" at a population level[22], despite significant step changes between 2005/6 and 2008/9, due to subsequent increases in average salt intake.[7] A static model was therefore employed to predict salt consumption from 2021 to 2035 under the baseline model. Blood pressure data by age and sex was extracted from the Health Survey for England (HSE) 2018.[23] Individual-level measured data was extracted from the HSE study sample to determine the probability of each individual, by age and sex, belonging to one of three systolic blood pressure (SBP) categories. By extracting the data in this way, someone who has treated and controlled hypertension (with an SBP less than 140) would not be considered hypertensive in the model.

The categories for SBP are less than 120, 120-140, and more than 140 mmHg, with normal (normotensive) SBP defined as 90-120 mmHg, high blood pressure (hypertensive) as more than 140 mmHg, and pre-hypertensive as 120-140 mmHg.[22] The categories for salt consumption are less than 6g (the recommended UK maximum daily intake), 6-12g, and more than 12g per day per individual in the model.[22]

A change to individual salt consumption in the model is associated with an SBP change. For example, a 4.4g per day reduction in salt intake results in a 5.39 mmHg reduction in SBP in those who are hypertensive. For normotensive individuals, the same reduction in salt would result in a 2.42 mmHg reduction in SBP. In addition, we assume that if there are no changes in salt consumption this will incur no changes to the blood pressure.[24]

More details are available in Appendix 2.

Module 3
Disease

CHD and stroke are the two NCDs modelled in this study. Hypertension is included as a risk factor and a disease, with prevalence in the model determined by the number of individuals with an SBP more than 140 mmHg. The definition of stroke included ischaemic stroke, intracerebral haemorrhage and subarachnoid haemorrhage. Coronary heart disease included angina pectoris, unstable angina, acute myocardial infarction and associated complications, ischaemic heart disease, coronary artery aneurysm and dissection, and ischaemic cardiomyopathy.

The incidence, prevalence and mortality by age and sex for CHD and stroke were extracted from the Institute of Health Metrics and Evaluation's Global Burden of Disease (GBD) database[24] (Appendix 1), provided by BHF. Mortality rates are derived from those who have died with CHD or stroke recorded as a cause of death.

Module 4
Health economics

The direct and indirect healthcare costs for salt-related diseases were included (CHD, stroke and hypertension). Costs are reported as cost per prevalent case and per year in Table 1. The utility weights used are presented in Table 2. Utility weight data (on a 0 to 1 scale) used in the model were dependent on the salt-related disease events experienced. EQ-5D-based utilities for each salt-related disease were obtained from the literature following NICE recommendations.[25] It was assumed that individuals with no disease events had a utility of 1, and those who died had a utility of 0.

The direct cost estimates for stroke include costs associated with haemorrhagic or ischaemic stroke. These include any stroke-related personal social services and NHS costs 12 months after diagnosis of the first stroke. Indirect costs for stroke cover the same period and include informal care and lost productivity.

For CHD, the direct costs covered primary care, inpatient, outpatient, rehabilitation and social care costs for all CHD patients. Indirect costs include productivity loss and informal care.

Table 1: Per-patient costs used in the microsimulation model

Parameter	Cost original (year)	Inflated cost[a]	Reference
	STROKE[b]		
Direct healthcare cost	7,759 (2019)	8,770.51	Patel et al [26]
Lost productivity cost	1,666 (2019)	1,883.19	
Unpaid care cost	15,345 (2019)	17,345.47	
	CHD[c]		
Direct healthcare cost	643.68 (1999)	1,034.12	Liu et al [27]
Lost productivity cost	865.01 (1999)	1,329.54	
Unpaid care cost	946.91 (1999)	1,455.43	
	HYPERTENSION (managed)		
Direct healthcare cost	75 (2016)[d] + 57.20 (2009)[e]	324.66	Constanti et al [28] Lovibond et al [29]

a) All costs have been inflated to 2021 using the CCEMG-EPPI cost converted
b) Year 2 costs onwards (prevalent stroke)
c) Prevalent cost rather than acute (male and female averaged)
d) The annual cost of monitoring hypertension from the year after treatment
e) Average annual cost of hypertension treatment; lower estimate

Table 2: Utility weights used in the microsimulation model

Disease	Utility weight	Measure	Reference
CHD	0.7591	EQ-5D	Stevanovic et al [30]
Stroke	0.5260	EQ-5D-5L	Golicki et al [31]

In this model, utility summarises the overall impact on a person's health from their condition and assigns it a number between 0 and 1. Individuals with no salt-related disease events are assigned a utility of 1 and those who died are assigned a utility of 0. The lower utility of stroke indicates a worse state of health for people who have had a stroke, compared to those with CHD.

Module 5
Baseline and intervention scenarios

Baseline scenario

The baseline scenario refers to a situation whereby salt consumption patterns remain at 2018 levels until 2035 (for exact daily salt intake figures by age and sex in 2021, see Results, 'Risk factor results: daily intake and SBP, 2021').

Intervention scenario

The intervention scenario refers to a situation whereby the UK population that consumes more than 6g per day of salt reduce their consumption so that no-one exceeds 6g per day by 2024 and 5g per day by 2030 until 2035, in line with recommendations put forward by BHF. Figure 1 illustrates the design of the salt reduction scenario, which is detailed below:

1. Between 2021 and 2024, those who consume more than 6g salt per day reduce their salt consumption at even intervals annually to reach 6g salt per day. Individuals in the model may consume less than 6g salt per day in any given year based on the probability inferred from NDNS 2018 data.

2. From 2025 onwards, salt consumption reduces at even intervals to reach 5g salt per day in 2030. Individuals in the model may consume less than 5g salt per day in any given year based on the probability incurred from NDNS 2018 data.

3. Salt consumption remains at 5g or less per day between 2030 and 2035.

4. A minimum salt consumption value of 1.44g is set in the model throughout the microsimulation. This is equivalent to the 575mg of sodium per day noted in the 1991 Dietary Reference Values guide from the Department of Health.[32]

FIGURE 2
Microsimulation model schematic

Model outputs

Risk factor outputs

Salt consumption under baseline, 2021
The percentage of the population of the UK who consume less than 6g, 6-12g, and more than 12g salt per day in 2021.

Prevalence of hypertension and prehypertension, 2021-2035
The percentage of the population of the UK who are hypertensive, prehypertensive and normotensive in 2021 and 2035 under the baseline scenario and intervention scenario by age and sex.

Disease burden outputs

Prevalence of hypertension avoided
The number of people who do not have hypertension under the intervention scenario, who would have hypertension under the baseline scenario, by sex, annually from 2021 to 2035.

Cumulative incidence of CHD and stroke
The number of cumulative incidences of CHD and stroke in the UK under the baseline and intervention scenarios from 2021 to 2035.

Cumulative incidence of CHD, stroke and hypertension avoided
The total number of incident cases of disease avoided under the intervention scenario compared to the baseline scenario from 2021 to 2035. A positive value represents the number of cases avoided.

Cumulative mortality avoided
The projected number of deaths avoided under the intervention scenario compared to the baseline scenario from 2021 to 2035.

Economic outputs

All economic outputs are presented in 2021 GBP (£).

Total direct healthcare costs avoided
The total direct healthcare costs avoided in each year for hypertension, CHD, and stroke between 2021 and 2035 under the intervention scenario compared to the baseline scenario.

Total indirect costs avoided
The total indirect costs avoided in each year for CHD and stroke between 2021 and 2035 under the intervention scenario compared to the baseline scenario.

Cumulative QALYs gained
The number of QALYs gained between 2021 and 2035 in men and women under the intervention scenario compared to the baseline scenario.

Results

Risk factor results

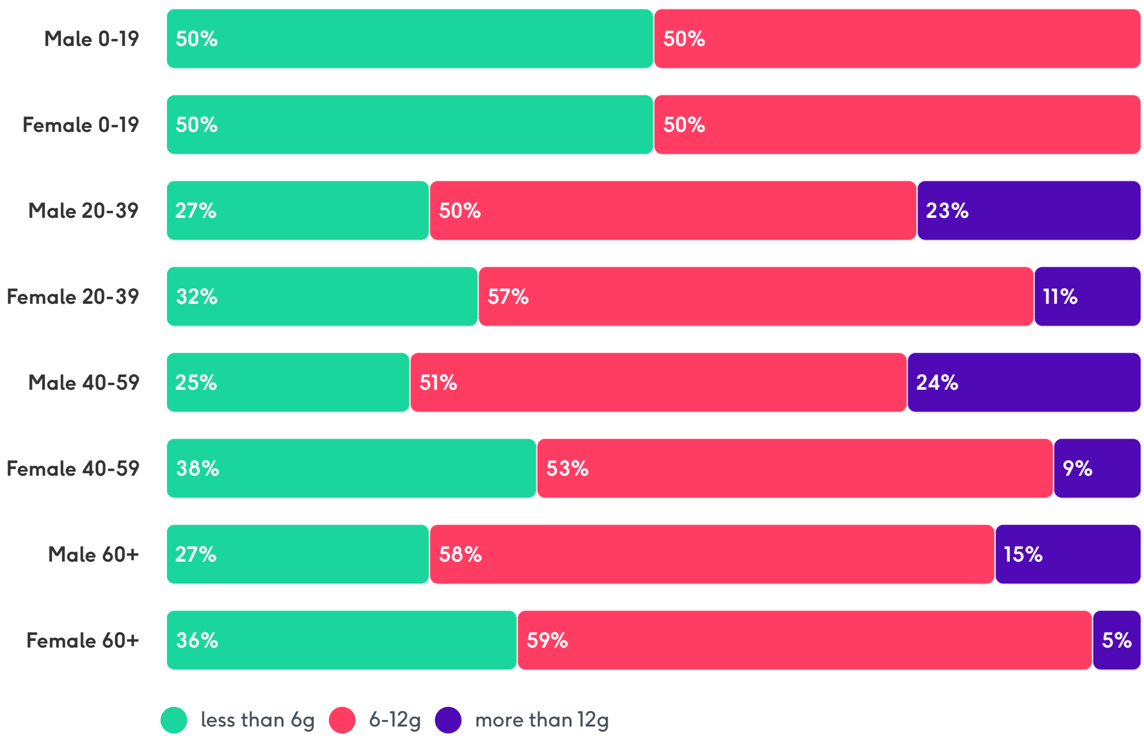
Daily salt intake

In 2021, over half of the modelled population of the UK consumed more than the maximum UK-recommended daily allowance of salt, with more males than females exceeding 6g of salt per day (Figure 3).

Salt consumption in 2021 also varied by age group. The proportion of men and women who consumed more than 12g of salt per day was lower in the 60+ age group (15% and 5%, respectively) than men and women in the 40-59 (24% and 9%, respectively) and 20-39 (23% and 11%, respectively) age groups.

Under the intervention scenario, the proportion of the population that consume less than 6g of salt per day is projected to increase to 100%, as per the design of the scenario.

FIGURE 3
The proportion (%) of the UK population that consumes less than 6g, 6-12g, or more than 12g of salt per day, by age and sex, 2021, in the modelled population



Risk factor results
Systolic blood pressure

Hypertension is common in adults and its prevalence increases with age.

Our estimates for 2021 suggest that 41% of individuals aged 20-39 had SBP more than 120 mmHg, a figure which rose to 77% in those aged 60+ (Figure 4). Less than 1% of individuals aged 0-19 had an SBP more than 120 mmHg.

The proportion of men and women living with high SBP differed in adults aged 20-59. In those aged 20-39, 34% more men than women had an SBP more than 120 mmHg and 4% more had an SBP more than 140 mmHg. In the 40-59 age group, 24% more males than females had an SBP more than 120 mmHg and 8% more had an SBP more than 140 mmHg.

In those aged 60+, the proportions of men and women that displayed an SBP less than 120 mmHg was comparable, with 22% of males and 25% of females having an SBP less than 120 mmHg, and only 1% more men having an SBP more than 140 mmHg.

Under the intervention scenario, in the 60+ age group, the percentage of men and women with hypertension decreases to 26% and 27% respectively by 2035, and a larger proportion of men than women have an SBP less than 120 mmHg (38% and 34%, respectively) (Figure 5). The prevalence of pre-hypertension decreases in all age groups under the intervention scenario.

FIGURE 4
The proportion (%) of the UK population with normal (less than 120 mmHg), increasing risk (120-140 mmHg), or high risk (more than 140 mmHg) SBP, by age and sex, 2021, in the modelled population

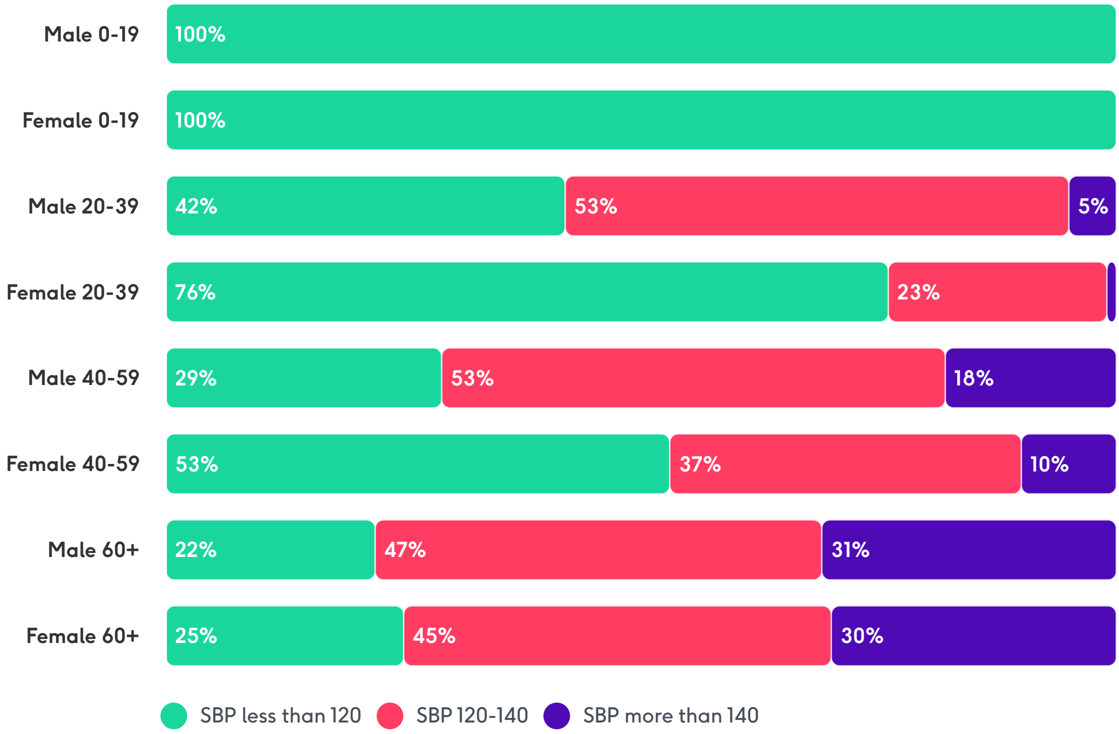
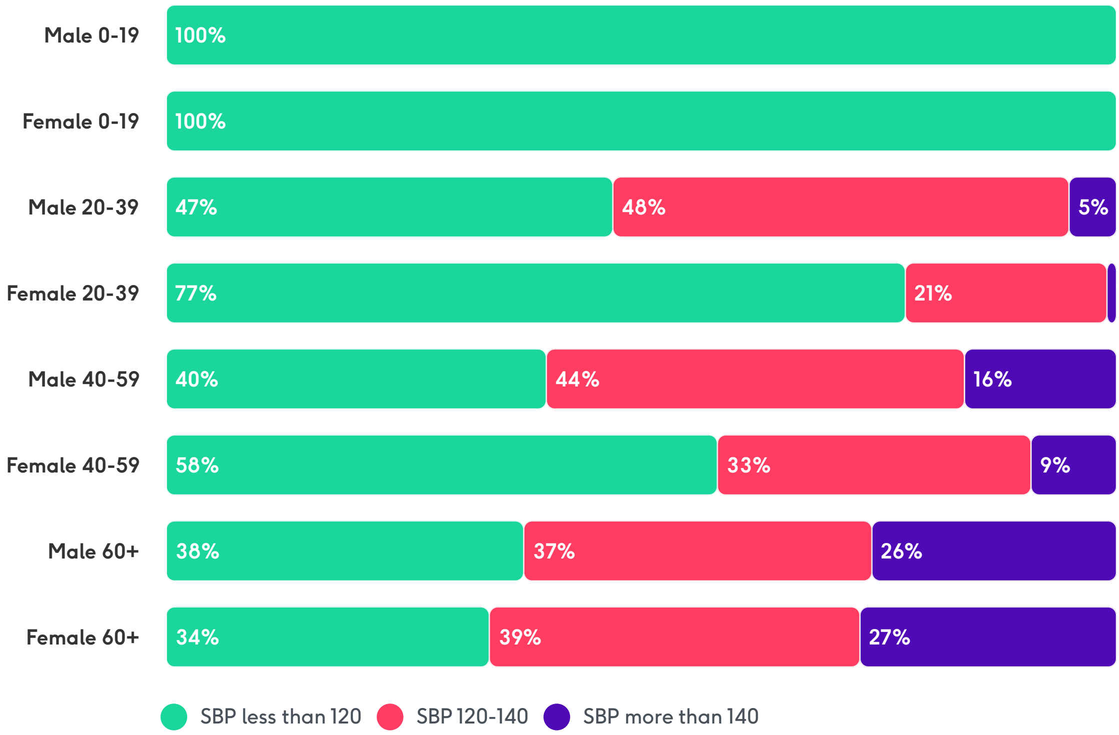


FIGURE 5
The proportion (%) of the UK population with normal (less than 120 mmHg), increasing risk (120-140 mmHg), or high risk (more than 140 mmHg) SBP, by age and sex, 2035, under the intervention scenario

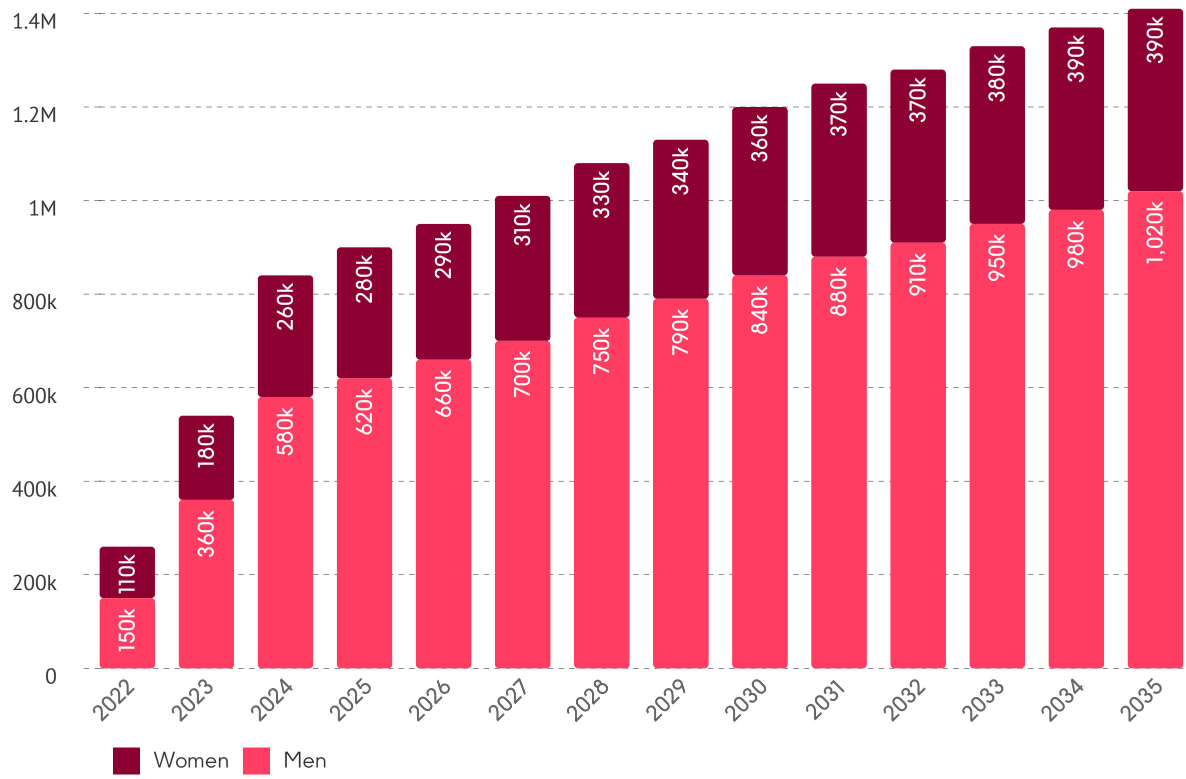


Disease burden results
Hypertension

A reduction in salt intake under the intervention scenario is projected to result in fewer prevalent hypertension cases by 2035.

Compared to the baseline scenario, in 2035, 1.02 million fewer men, and 0.39 million fewer women, will be living with hypertension (Figure 6). This output reflects the difference in the number of men and women with an SBP more than 140mmHg between the baseline and intervention scenarios.

FIGURE 6
Prevalent hypertension cases avoided amongst the UK population by sex under the intervention scenario, 2021-2035, relative to the baseline scenario. (2021 excluded for clarity)



Disease burden results
Coronary heart disease (CHD)

A reduction in the UK's daily salt consumption will lead to fewer incident cases of CHD between 2021 and 2035 (Figure 7).

Under the baseline scenario, the annual incidence of CHD is expected to grow from 203,134 in 2021 to 241,717 in 2035 at a mean annual growth rate of 1.25%. This equates to 3.34 million new cases of CHD by 2035.

Under the intervention scenario, the annual incidence of CHD is expected to grow to 231,788 in 2035 at a mean annual growth rate of 0.94%. This equates to 3.21 million new cases of CHD by 2035.

Compared to the baseline scenario, we project that 134,789 incident cases of CHD will be avoided under the intervention scenario between 2021 and 2035 (Figure 8).

FIGURE 7
Cumulative incidence of CHD under the baseline and intervention scenarios between 2021 and 2035

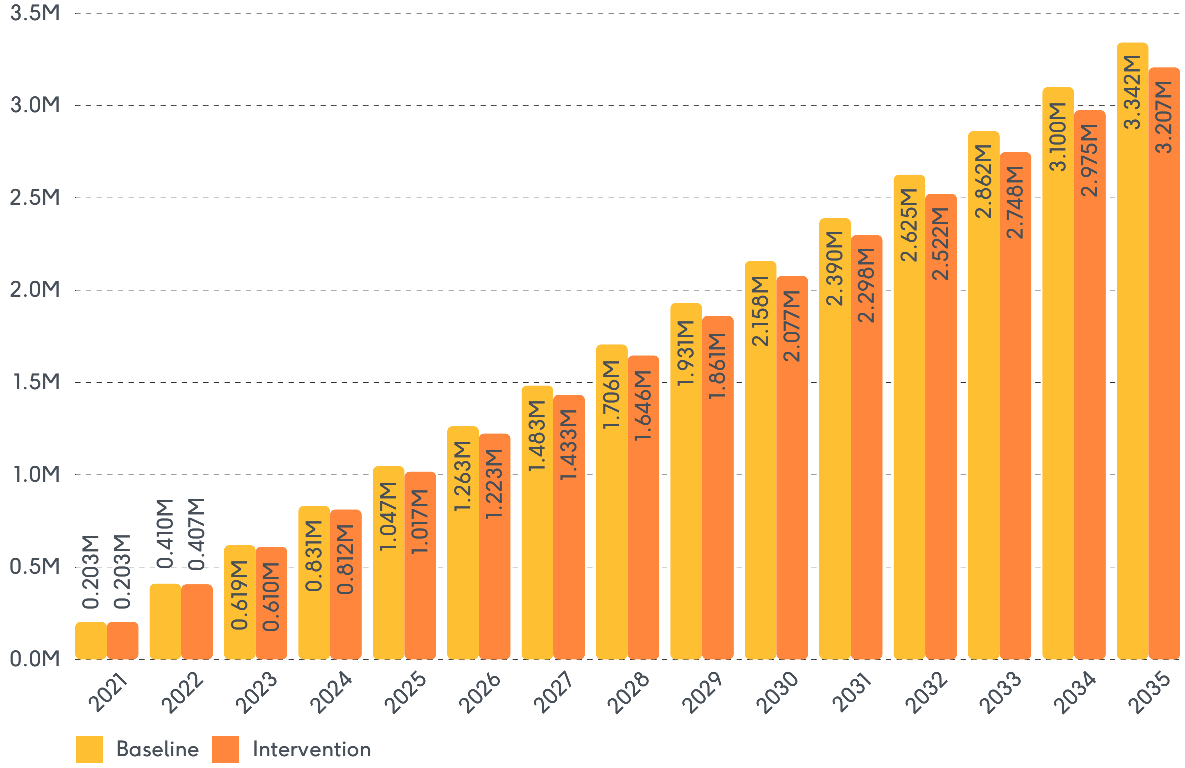
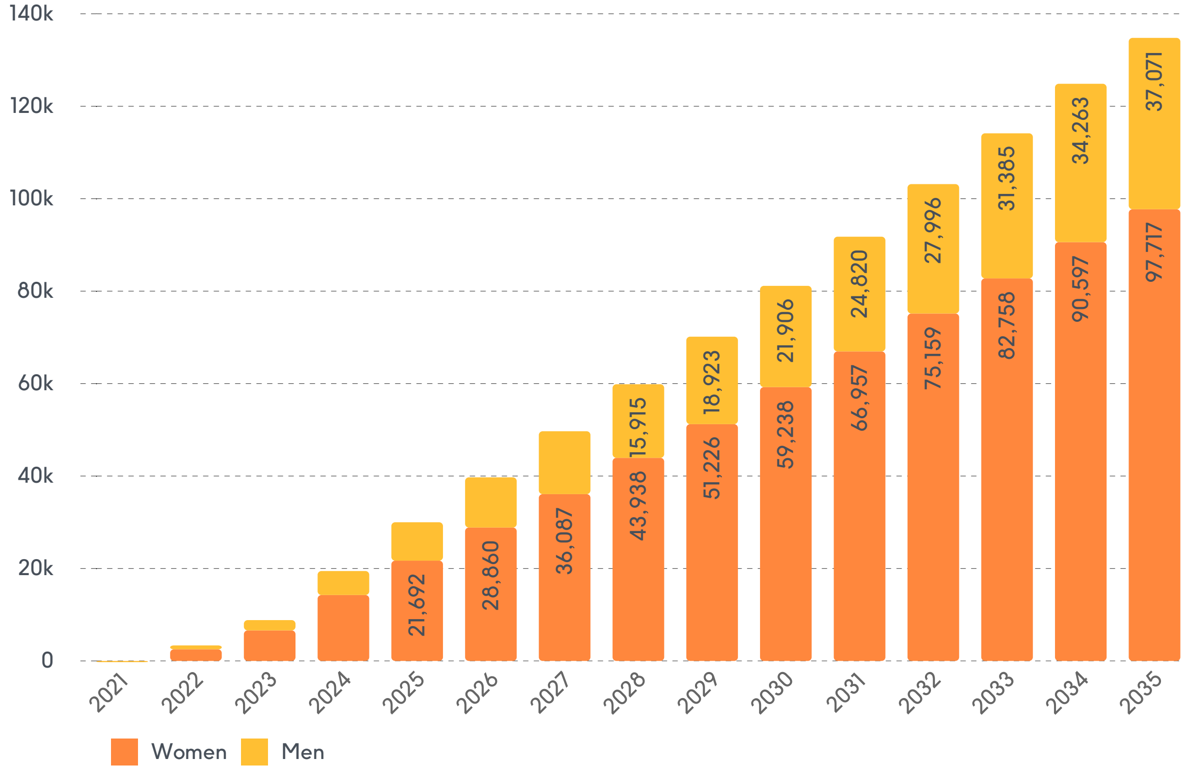


FIGURE 8
Cumulative incidence of CHD avoided in the UK population by sex under the intervention scenario, 2021-2035, relative to the baseline scenario



Disease burden results

Stroke

A reduction in the daily salt intake of the UK general public will lead to fewer cases of stroke developing between 2021 and 2035 (Figure 9).

Under the baseline scenario, the annual incidence of stroke is expected to grow from 75,135 in 2021 to 90,917 in 2035 at a mean annual growth rate of 1.38%. This equates to 1.24 million new cases of stroke between 2021 and 2035.

Under the intervention scenario, the annual incidence of stroke is expected to grow to 86,322 in 2035 at a mean annual growth rate of 0.99%. This equates to 1.19 million new cases of stroke between 2021 and 2035 (Figure 10).

Compared to the baseline scenario, 48,540 incident cases of stroke will be avoided under the intervention scenario by 2035.

FIGURE 9
Cumulative incidence of stroke under the baseline and intervention scenarios between 2021 and 2035, relative to the baseline scenario

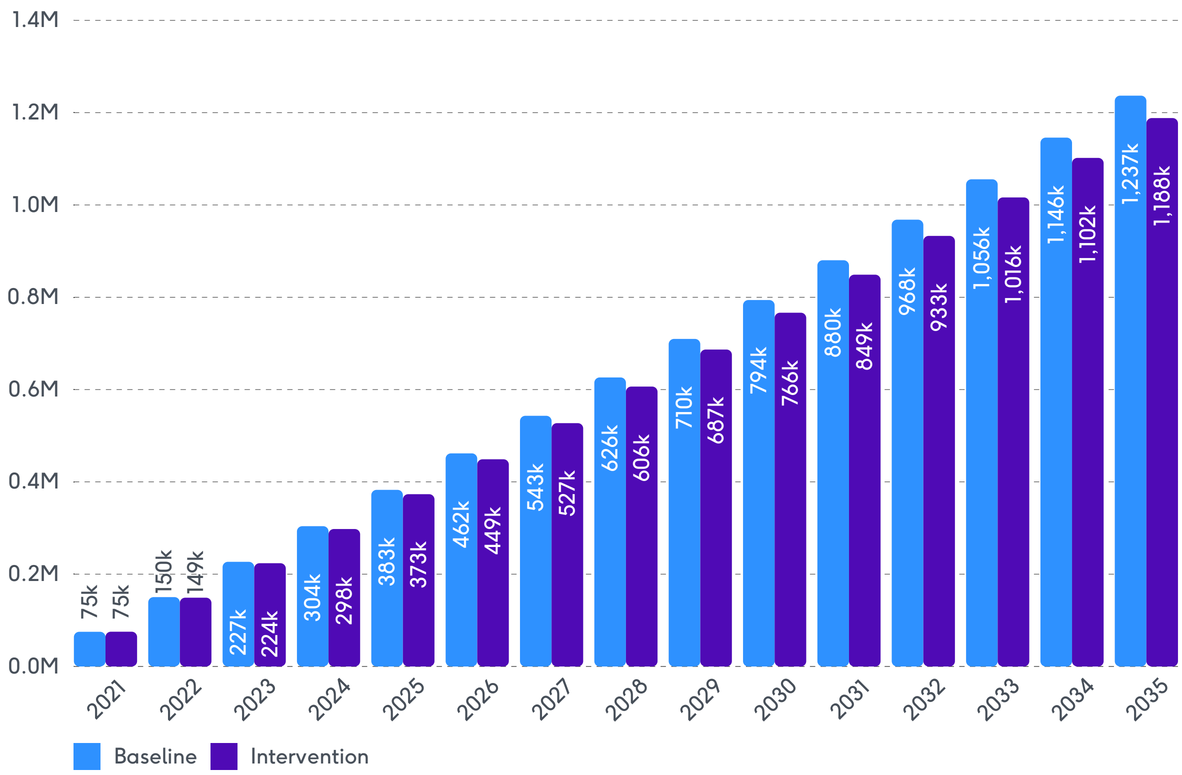
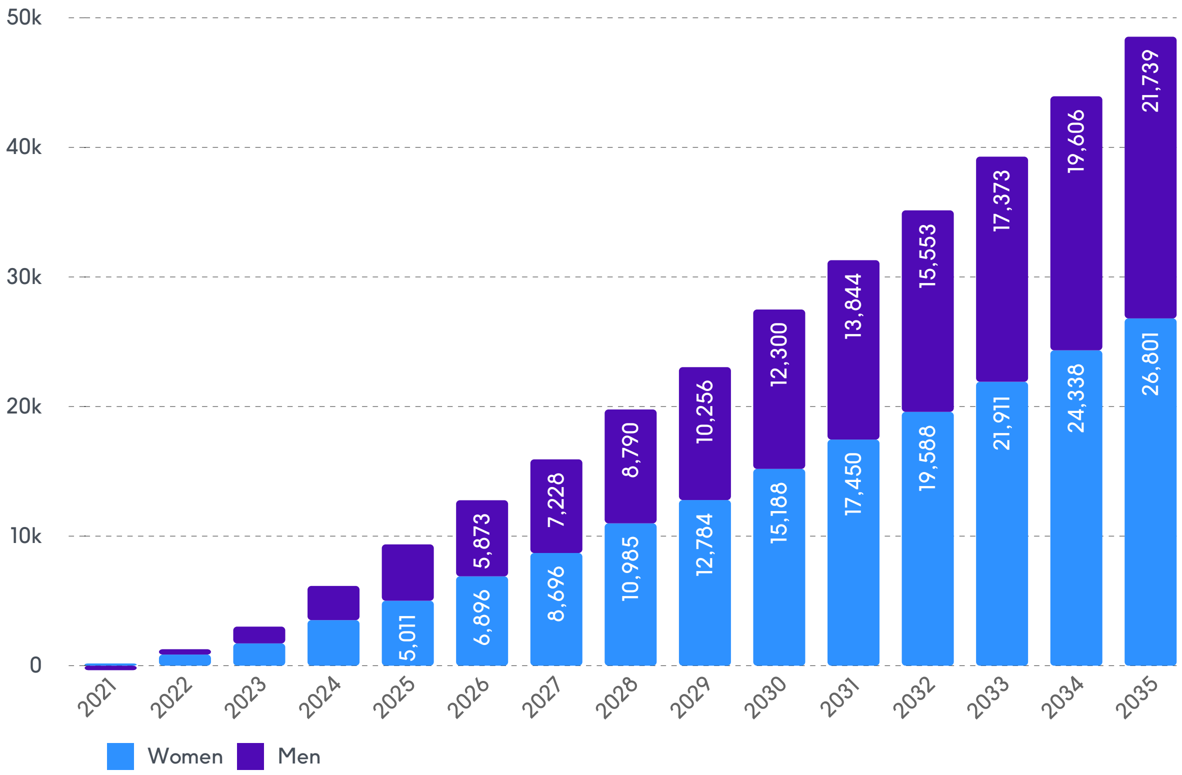


FIGURE 10
Cumulative incidence of stroke avoided amongst the UK population by sex under the intervention scenario, 2021-2035, relative to the baseline scenario

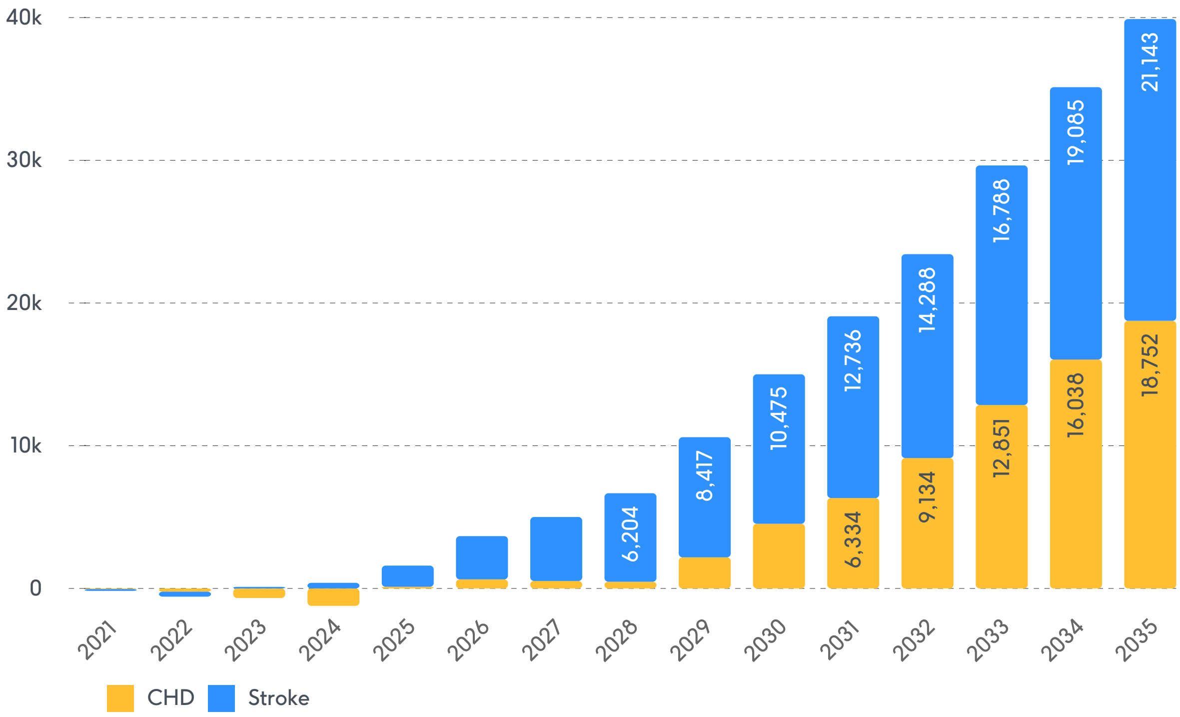


Disease burden results
Mortality

Reducing the UK's daily salt intake from 2021 to 2035 will contribute to reduced all-cause mortality within the sub-population of the UK that have CHD or stroke by 2035.

We project that 39,895 deaths could be avoided between 2021 and 2035 under the salt reduction scenario (Figure 11).

FIGURE 11
All-cause cumulative mortality avoided in people who have had CHD or stroke under the intervention scenario, 2021-2035, relative to the baseline scenario



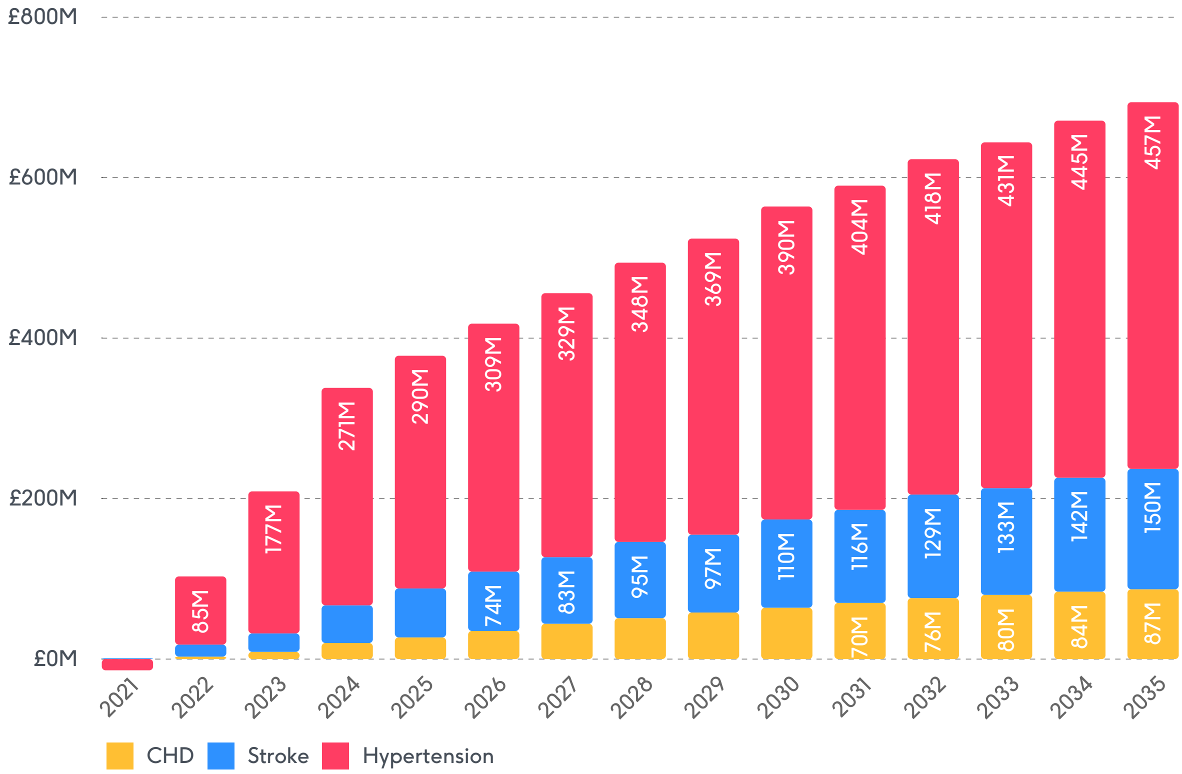
Economic results
Direct costs

The intervention (salt reduction) scenario is projected to result in significant direct and indirect healthcare cost savings between 2021 and 2035.

Direct Costs

Between 2021 and 2035, under the intervention scenario, it is predicted that a sum total of £1.28 billion could be saved in direct costs related to stroke, £0.71 billion related to CHD, and £4.71 billion related to hypertension. This equates to total direct cost savings of £6.70 billion between 2021 and 2035 (Figure 12) (19.1% stroke-related savings, 10.6% CHD-related savings, and 70.3% hypertension-related savings).

FIGURE 12
Direct healthcare costs related to CHD, stroke and hypertension avoided each year under the intervention scenario, 2021-2035, relative to the baseline scenario



Economic results
Indirect costs

Due to a decrease in CHD prevalence under the intervention scenario, it is predicted that a sum total of £1.00 billion could be saved in unpaid care and £0.91 billion in lost productivity between 2021 and 2035.

This equates to CHD-related indirect cost savings of £1.91 billion between 2021 and 2035 (Figures 13-17).

Due to a decrease in stroke prevalence under the intervention scenario, it is predicted that a sum total £2.52 billion could be saved in unpaid care and £274 million in avoiding lost productivity between 2021 and 2035. This equates to stroke-related indirect cost savings of £2.79 billion by 2035 under the intervention scenario.

In total, given a reduction in salt consumption in the UK, £4.70 billion could be saved in indirect costs due to reduced stroke and CHD prevalence between 2021 and 2035.

FIGURE 13
Indirect costs related to stroke and CHD avoided each year under the intervention scenario, 2021-2035, relative to the baseline scenario

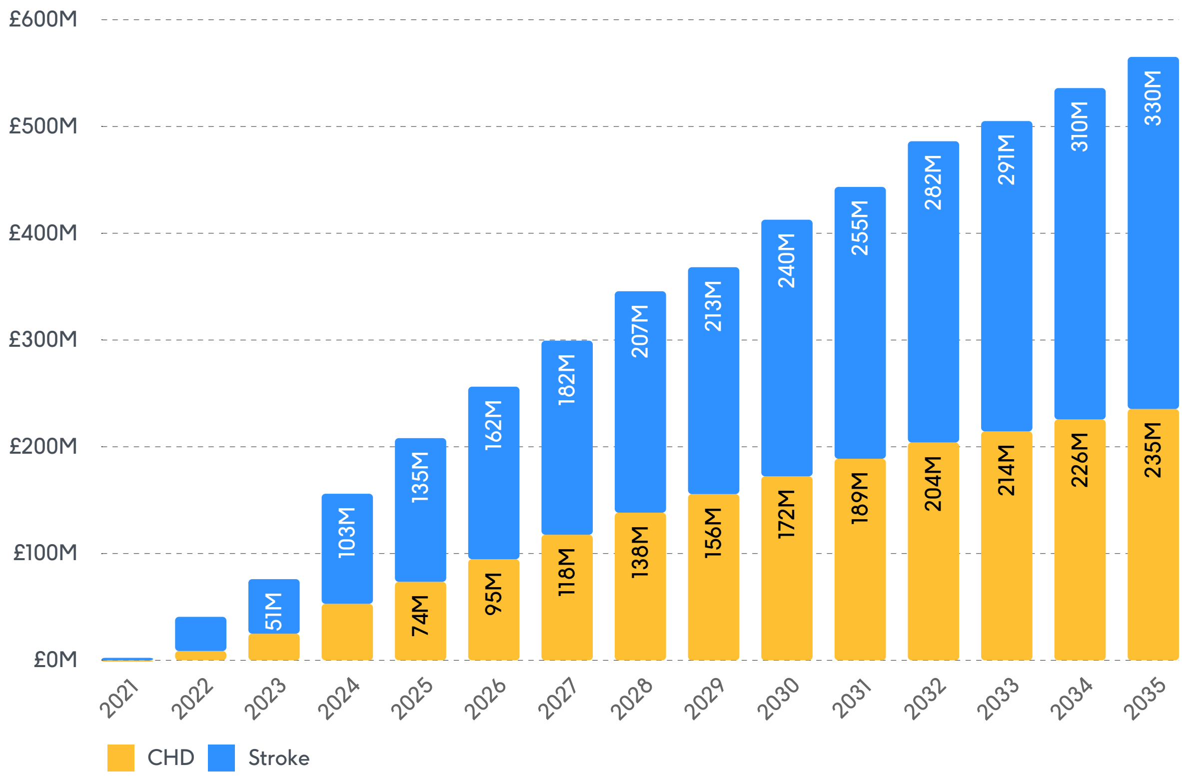


FIGURE 14
Stroke unpaid care costs avoided each year under the intervention scenario, 2021-2035, relative to the baseline scenario

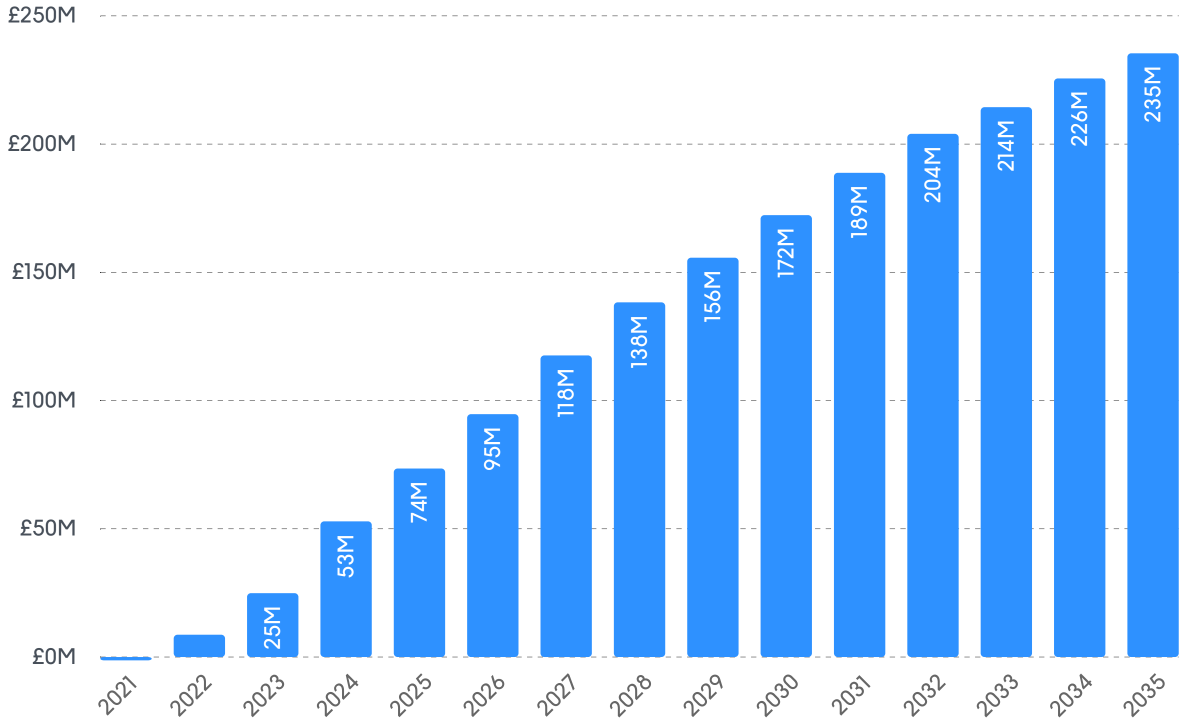


FIGURE 15
Stroke lost productivity costs avoided each year under the intervention scenario, 2021-2035, relative to the baseline scenario

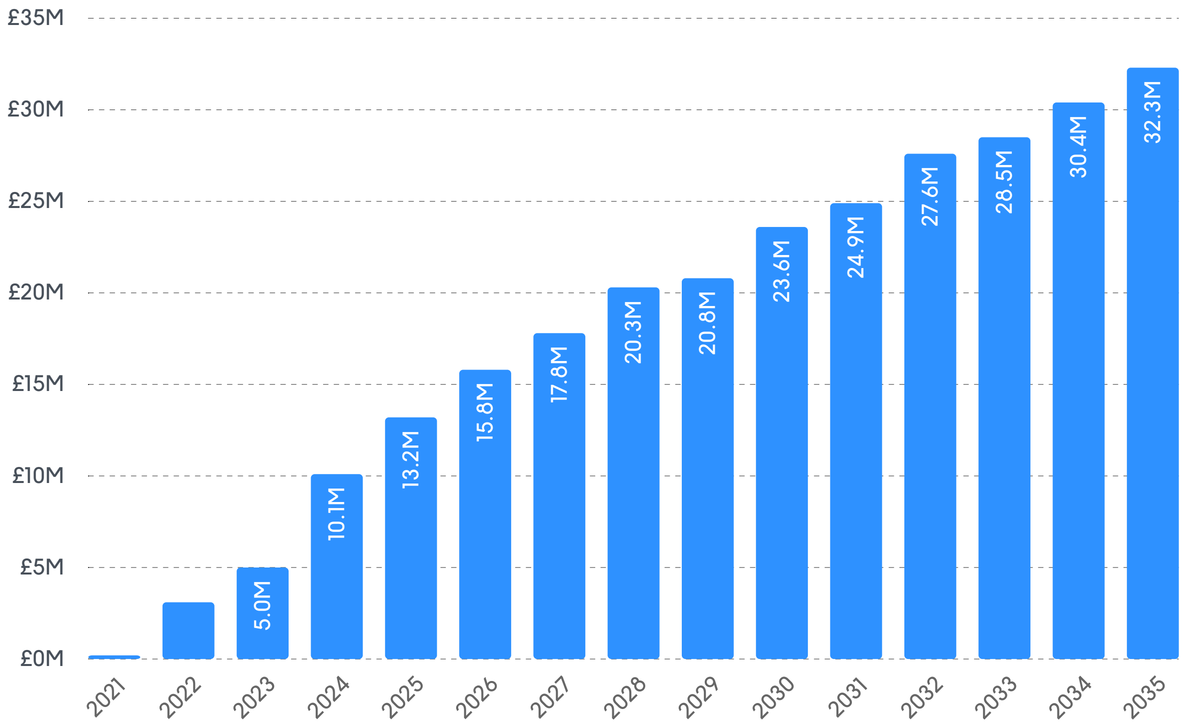


FIGURE 16
CHD unpaid care costs avoided each year under the intervention scenario, 2021-2035, relative to the baseline scenario

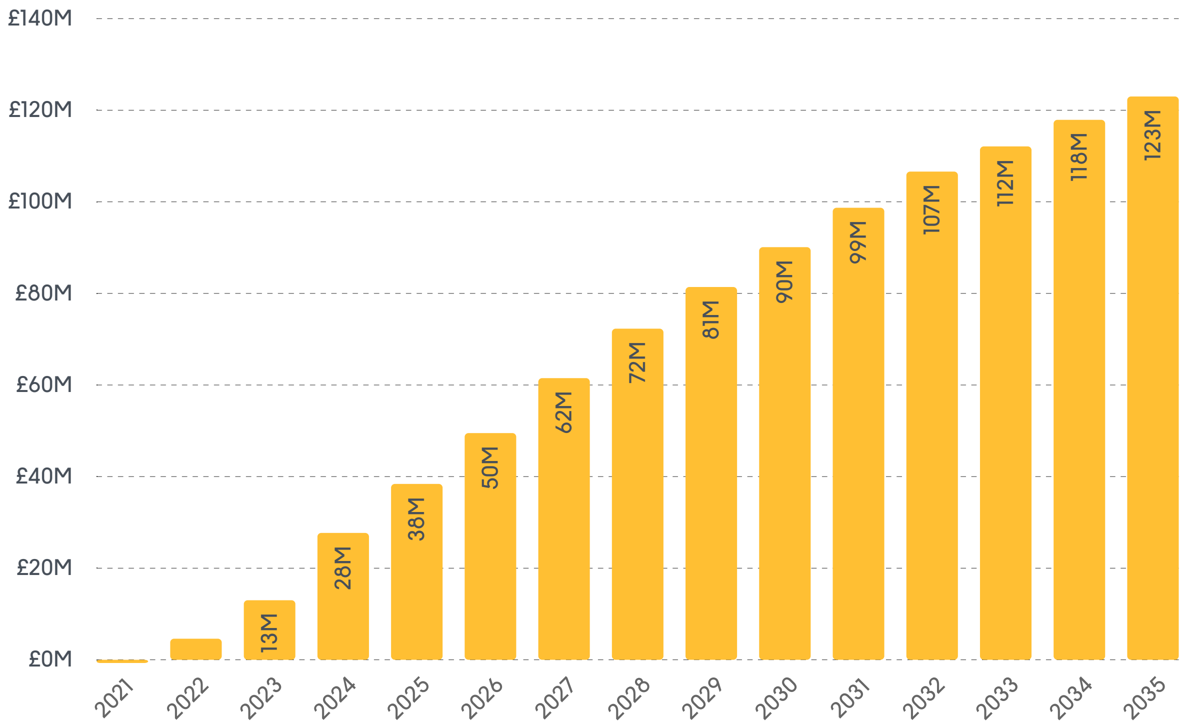
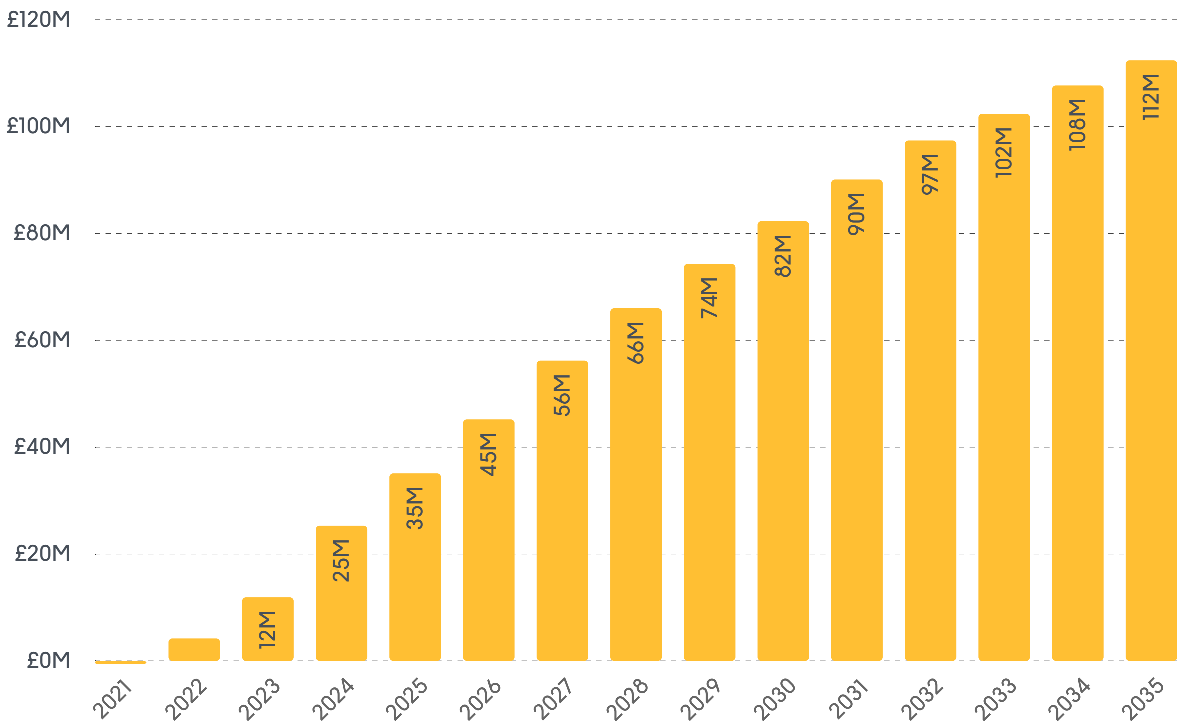


FIGURE 17
CHD lost productivity costs avoided each year under the intervention scenario, 2021-2035, relative to the baseline scenario

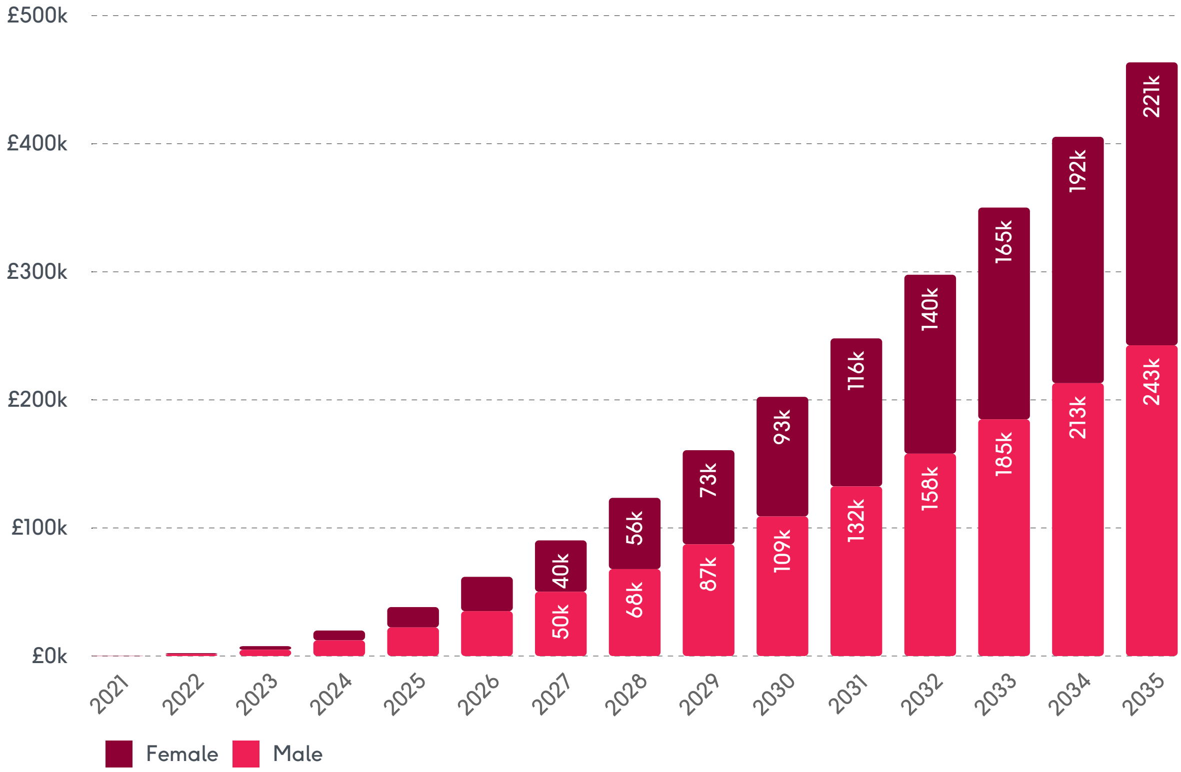


Economic results
Quality of life

Decreasing salt consumption in the UK is predicted to lead to a significant gain in quality-adjusted life years (QALYs).

Between 2021 and 2035, 242,624 QALYs will be gained amongst the male population, and 220,922 amongst females, totalling 463,546 QALYs gained through a reduction in CHD and stroke incidence as a result of the intervention scenario (Figure 18).

FIGURE 18
Cumulative quality-adjusted life years gained under the intervention scenario by sex, 2021-2035, relative to the baseline scenario



Discussion

What does this report show?

This report uses a microsimulation-based computer modelling methodology to quantify the impact that a reduction in national salt consumption to a maximum of 6g per day in 2024, and then 5g per day in 2030 has on health and economic outcomes. It found that this scenario would result in 183,328 fewer cases of CHD and stroke developing by 2035.

In turn, these health benefits are projected to produce 463,546 additional QALYs and generate savings of around £11.4 billion in direct and indirect costs resulting from reduced NHS service utilisation and increased patient/informal carer productivity, respectively.

Furthermore, the salt reduction policy outlined in this report is estimated to prevent 39,895 deaths in those with CHD or stroke by the year 2035.

Given the health and economic benefits that would be generated by a reduction in daily salt consumption, UK Government action that seeks to enforce the national salt reduction policy outlined in this report would contribute significantly to the 2019 NHS target of preventing "up to 150,000 heart attacks, strokes and dementia cases over the next 10 years".[33]

How does this report complement existing research?

In 2021, Alonso et al.[34] published the results of a multistate life table modelling study that utilised nationally representative 2000-2018 NDNS data. This projected the effects of two daily salt intake reduction scenarios on premature cardiovascular disease cases, quality-adjusted survival, and health and social care costs in England from 2018 to 2050. Under a scenario where national daily salt consumption is reduced at a constant rate from 9.19g per day in men and 7.58g per day in women in 2018 to 5.00g per day by 2030 within the model, the authors report that 87,870 premature cases of CHD and 126,010 cases of stroke could be avoided by 2050. This would deliver 343,260 additional QALYs and direct cost savings of £5.33 billion. The present study projects, in contrast, that more incident cases of CHD will be avoided compared to stroke.

The economic findings of Alonso et al. largely align with those presented in this report. Alonso et al. estimate mean annual cost savings from reduced health and social care costs related to CHD and stroke to be £166.56 million. In comparison, this study reports mean annual direct cost savings resulting from these conditions to be £132 million. The discrepancy between these values may be due to Alonso et al. including "informal care provided by family and friends, as well as other direct payments and indirect costs, such as domestic work" (Supplementary materials and methods) under social care costs. Such costs were considered indirect in this report.

In terms of disease burden, the findings of Alonso et al. are also comparable to those reported here. Alonso et al. project that, on average 2,835 CHD and 4,065 stroke cases will be avoided annually between 2018 and 2050, while this report projects that, on average 8,986 CHD and 3,236 stroke cases will be avoided annually between 2021 and 2035. Differences in estimates of CHD cases avoided may be related to Alonso et al. underestimating CHD incidence, as it is defined as "first admitted to hospital acute myocardial infarction", thereby reducing the number of CHD cases avoided due to a reduction in daily salt intake, as we model a broader range of conditions that fall within the definition of CHD.

Overall, the results reported in this study support the findings of Alonso et al., whilst concurrently building on their work by demonstrating the benefits of a more immediate decrease in national salt consumption to meet the 6g per day target in 2024.

Strengths & limitations

This study benefits from a well-validated microsimulation modelling approach that projects the impact of salt intake on health and economic outcomes in millions of individuals over time (rather than groups/cohorts using weighted averages, as in many studies). This allows for differences in disease burden and cost savings to be identified between sexes and age groups. As such, the results outlined here provide highly detailed and robust projections for UK salt intake over the next 14 years.

Several limitations should also be acknowledged. Firstly, although the NDNS risk factor data utilised in this report is representative across England, the sample size of the survey is limited to around 1,000 individuals per year, generating some uncertainty with regards to projected baseline trends in salt consumption between 2021 and 2035. Secondly, we did not conduct analysis by socioeconomic status (SES) in this study, because of the limited evidence to link SES to salt consumption with statistical significance through the NDNS in the UK.[35] Thirdly, the cost data available for the model may not represent all potential costs of CHD, stroke and hypertension and the projected savings from events avoided may therefore be an underestimation. Additionally, the analysis has not taken into account any potential future changes in circumstances, such as fluctuations in food prices, lifestyle changes following COVID-19, and changes in healthcare. Finally, in studying only hypertension, CHD, and stroke, this study likely underestimates the impact of a coordinated salt reduction policy on the health and economic burden of disease in the UK. For example, increased salt consumption has also been linked to increased risk of gastric cancer.[36]

What further research should be conducted?

This study serves as a timely and important first step in quantifying the future health and economic burden of salt-related diseases, thereby highlighting the need for governmental action via effective policy-making to reduce national salt consumption levels. Future research may build on the findings described in this report, by cost-effectiveness analyses,[37] and by modelling the impact of specific food reformulation policies, such as regulation around the salt content of processed food, on salt-related diseases.[37]

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