The Health and Cost Impacts of Sodium Reduction Interventions in Australia

Scalable Health Intervention Evaluation (SHINE)
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ABBREVIATIONS

AUD	Australian dollar
BAU	Business as usual
BMI	Body mass index
BP	Blood pressure
CASH	Consensus Action on Salt and Health
CDC	Centre for Disease Control
CKD	Chronic kidney disease
CRA	Comparative risk assessment
CVD	Cardiovascular disease
DALY	Disability-adjusted life year
DH	Department of Health
FOP	Front-of-package
FSA	Food Standards Agency
GBD	Global Burden of Disease
HALY	Health-adjusted life year
HFP	Healthy Food Partnership
KCl	Potassium chloride
NaCl	Sodium chloride
NCDs	Non-communicable diseases
NPHS	National Preventative Health Strategy
NZ	New Zealand
NZD	New Zealand dollar
PMSLT	Proportional multistate lifetable
QALY	Quality-adjusted life year
SBP	Systolic blood pressure
SDT	Suggested Dietary Target
SEIFA	Socio-Economic Indexes for Areas
SHINE	Scalable Health Intervention Evaluation
UK	United Kingdom
UI	Uncertainty interval
WHO	World Health Organisation

EXECUTIVE SUMMARY

Diet plays a major role in our health and wellbeing, especially those high in sodium (or salt). High sodium intake is a key dietary risk factor that directly influences stomach cancer rates, and increases blood pressure leading to higher disease rates such as coronary heart disease, stroke, and hypertensive heart disease.

Like many other countries, Australia's sodium intake persists at higher levels than necessary, meaning opportunities for a healthier population are foregone. However, Australians can only do so much to reduce their sodium intake, as sodium is 'hard-baked' into many food products. Therefore, reducing sodium consumption is an example where the organised efforts of society are required if action is to be taken.

This Report estimates the health gains and costs of various sodium reduction policies, including their impact on morbidity and health inequalities (in addition to average health gains), and teasing out the economic impacts – an important consideration given the need to sustainably fund an aging population.

INTERVENTIONS MODELLED

We model three types of sodium interventions:

1. Achieving Australian and UK food reformulation targets, and WHO sodium benchmarks that, respectively, achieve 3%, 7% and 11% reductions (varies by sex and age) in population sodium intake.
2. Substitution of 10% of sodium chloride (NaCl) with potassium chloride (KCl) across all foods, and a 30% substitution just for discretionary salt (mainly salt we add when baking and cooking).
3. The UK salt reduction program (a combination of voluntary food reformulation targets and a mass media campaign) that achieved a 2% reduction in sodium intake, and the UK's mass media campaign that achieved a 0.6% reduction in sodium intake (that we assume returns to zero after the campaign stops).

METHODS

To simulate these interventions in Australia, we use the Scalable Health Intervention Evaluation (SHINE) modelling platform, which extends the methods used by the Assessing Cost Effectiveness (ACE) and Burden of Disease Epidemiology, Equity and Cost Effectiveness program (BODE[3]) in Australia and New Zealand (NZ). SHINE uses Global Burden of Disease data to specify 32 diet-related diseases in a proportional multistate lifetable, with future disease rates forecasted under 'business-as-usual' until 2034 – then held constant. Differences in these disease rates are stratified by sex, age and Socio-Economic Indexes for Areas (SEIFA) quintiles to allow estimates of intervention impacts on inequalities. SHINE also uses Australasian data on disease-related health expenditure and income loss, allowing us to estimate intervention-generated changes in future health expenditure, population income and income tax. Combined with the inclusion of government and industry costs for implementing sodium reduction interventions (undertaken by the Grattan Institute), this allows us to estimate net costs for varying perspectives, namely health, government and societal. Our modelling also incorporates the latest evidence on the association of sodium with blood pressure, which we've used to calculate variations by age and initial blood pressure.

RESULTS

Our results show sodium reduction interventions vary markedly in their health impact on the Australian population alive in 2023. The UK's mass media campaign had the lowest health impact with 1220 health-adjusted life years (HALYs) gained over the next 20 years (95% uncertainty interval (UI) 595 to 2,260; 3% annual discount rate). The mandatory implementation of WHO sodium benchmarks had the largest health impact with 43,200 (95% UI 29,400 to 61,900) HALYs gained over the next 20 years, and 255,000 (95% UI 171,000 to 370,000) HALYs gained over the population's remaining lifetime– equivalent to 1.7 and 10.2 healthy life years gained per 1000 people alive in 2023.

Relative to the HALYs gained in the next 20 years from the mandatory implementation of WHO sodium benchmarks:

- the Australian and UK reformulation targets achieve 28% and 63% of these HALY gains, respectively
- KCl substitution for 10% of sodium across the whole food system and 30% of discretionary salt achieve 39% and 33%, respectively
- and the UK's salt reduction program achieves 17% of these HALY gains.

The interventions gain 1.65 to 2.02 more HALYs per capita for the most socio-economically disadvantaged quintile compared to the least socio-economically disadvantaged quintile. However, the impact on the overall 'gap' in all-cause mortality rates between the most disadvantaged and least disadvantaged quintiles is modest. For example, mandatory implementation of the WHO sodium benchmarks was estimated to reduce the age-standardised gap in all-cause mortality rates in 2044 between the most and least disadvantaged by 0.303% (95% UI 0.182% to 0.590%). It is not surprising that one preventive intervention alone is not a panacea for reducing health inequalities – it takes many interventions together to substantively reduce health inequalities.

In the first 20 years after implementing an intervention, all interventions lead to reduced health system expenditure due to lower disease rates. For example, mandatory implementation of the WHO sodium benchmarks was estimated to save the health system Aus$974 million (95% UI 542 to 1,470 million; 3% annual discount rate; 2023 dollars). These health system savings greatly exceed the combined costs to government and industry for implementing the reformulation program. If we include the income gains from more people being alive with less morbidity then the net economic position is even better.

INTERPRETATION

Assessing the impact of sodium reduction interventions is challenging. However, even when allowing for uncertainty propagated through 1000s of model runs, all sodium reduction interventions (except for the mass media campaign) resulted in both health and economic gains in the first 20 years of their implementation.

Our health expenditure estimates are based on robust Australian disease-related estimates, but we assume that diseased-related expenditure in the future will be the same in 2023 dollars as it is now. Estimates of the upfront and direct intervention costs to government and industry are also uncertain.

Changes in population income are based on innovative NZ analyses of linked health and tax data that allow us to estimate by how much income changes in someone's first year of being diagnosed with a disease, their last year of life (if dying of that disease), and otherwise living with the disease. However, the absence of similar Australian data means we must purchase power parity these estimates into Australian dollars before inputting them into our model. Of note, our income change estimates due to preventive interventions only capture changes in income among the Australian population less than 65 years old. Sensitivity analyses in this report suggest the income gains would be substantially greater if we also included the income gains among those aged 65 and over working a bit longer due to being healthier. Finally, our societal costing does not extend include intervention impacts on government pension payments, which will increase due to sodium reduction interventions increasing longevity.

GRATTAN INSTITUTE RECOMMENDATIONS BASED ON THIS REPORT

A parallel report by the Grattan Institute examines the policy implications more deeply, using the results of this SHINE Report as one input. That Grattan Report recommends that Australia first makes its own sodium reformulation targets mandatory by 2027, then extends to the UK targets being mandatory by 2030 (unless they have been achieved on a voluntary basis). The SHINE modelling in this Report estimated that this 'Australian then UK mandatory sodium standards' intervention will:

- gain 22,500 HALYs (95% UI 15,400 to 33,100) in the Australian population over the next 20 years, and gain 152,000 discounted HALYs (101,000 to 229,000) over the remainder of the lifespan of the Australian population alive in 2023
- cost the government $55.6 million (95% UI 37.6 to 82.3) in regulatory and monitoring costs in the next 20 years
- cost the industry $214 million (95% UI 104 to 441) under what we assessed as most likely cost structures, or $318 million (95% UI 154 to 654) under conservative costing assumptions.
- save the health system $501 million (95% UI 257 to 763 million) over the next 20 years
- increase <65-year-olds gross incomes by $442 million (95% UI 311 to 623 million) in the next 20 years, with about 23% of this being increased income tax revenue to government.

If we reorganise the economic impacts of adopting the 'Australian then UK mandatory targets' intervention by perspectives, then:

- From a health perspective that also includes just the government intervention costs (the usual perspective used in preventive cost-effectiveness analyses), the net saving in the next 20 years is about $445 million (3% annual discount rate)
- Extending this perspective out to a full government perspective, to also include changes in income tax revenue, the net saving increases further to about $547 million in the next 20 years.
- Extending out further to a societal perspective, the post-tax gains in income to the population aged less than 65 years of age more than offset the costs to industry (that we assume will be passed on to consumers), meaning the net economic gain to society is about $673 million over the next 20 years.

Whilst not modelled in this Report, also implementing a 10% substitution of KCl for NaCl across the food system as well as the 'Australian then UK mandatory targets' intervention will likely achieve a nearly two-fold increase in both the health and economic benefits.

INTRODUCTION

Non-communicable diseases (NCDs) are the leading cause of disease burden in Australia, responsible for 5.5 million disability adjusted life years (DALYs) of all health loss in Australia in 2022.[1] Cancers and cardiovascular disease (CVD) contributed 17% and 5.5%, respectively, of this burden.[1] Many NCDs share common modifiable risk factors, such as poor diet and high blood pressure, which if prevented or treated could significantly reduce illness and death within the Australian population, especially for those living in the lowest socio-economic areas who experience higher rates of NCDs and their associated risk factors.[2]

Reducing sodium consumption is one of the most cost-effective strategies at reducing the health burden caused by NCDs.[3] This is due to excess sodium having a strong association with elevated blood pressure, which is linked to CVDs such as coronary heart disease, stroke, and hypertensive heart disease.[4] Studies have also shown that diets high in sodium increase the risk of stomach cancer and kidney disease.[5-8] In 2013, the WHO established a goal of reducing population mean sodium intake to less than 2g a day (equivalent to less than 5g salt) by 2025 – a commitment shared by its 194 member states.[9] To achieve this goal, the WHO recommended its member states adopt their “best buys” strategies – a set of affordable, feasible, impact-driven, and cost-effective sodium reduction policies and measures.[3] These include reformulating foods to reduce sodium content, limiting access to sodium-rich foods in public institutions such as schools and hospitals, adding nutrition labels on food packaging to help consumers choose low sodium products, and using media campaigns to raise consumer awareness of the health implications of excess sodium consumption.[3]

Unfortunately, little progress has been made towards this goal over the past ten years. A recent WHO report showed most member states (including Australia) had only implemented voluntary measures or had their governments express a commitment to reducing sodium intake.[10] Coupled with Australia’s average salt consumption estimated at almost double the WHO recommended intake – 9.6g per day (10.1g per day for men and 7.3g per day for women) [11], Australia needs to quickly implement sodium reduction policies to achieve the WHO target.

Of note, Australian citizens can only do so much to reduce their sodium intake, as sodium is ‘hard-baked’ into many food products. Therefore, reducing sodium consumption is an example where the organised efforts of society are required if action is to be taken. Reformulation of foods is one such population-wide strategy.

OBJECTIVES OF THIS REPORT

For society and governments to prioritise preventive interventions, of which salt or sodium reduction is just one policy option, it helps to understand what the health gains might be from such a policy – compared to health gains from other policy options, such as screening programs, tobacco reduction, and taxing sugary drinks. Therefore, this report aims to quantify the health gains from different sodium reduction interventions using a metric that is comparable across other interventions, namely the health-adjusted life year (HALY). HALY gains have been determined for many preventive interventions in Australia and are collated in the Australia New Zealand Health Information League Table (ANZ-HILT; described (12) and available at [A]).

Prioritisation of preventive interventions should – in addition to impacts on average health status – also compare interventions in terms of their impact on health inequalities, health system expenditure and societal impacts such as income productivity. In this report, therefore, we also estimate the impact of sodium interventions on:

- Socioeconomic inequalities in health, by estimating HALY gains by quintile of the SEIFA index and changes in future mortality and morbidity rates by SEIFA compared to forecast health inequalities under business-as-usual (BAU, i.e. no sodium intervention). We also estimate the impact on age-standardized all-cause mortality rate (ACMR) inequalities in 2040, comparing the most socio-economically disadvantaged quintile compared to the least socio-economically disadvantaged quintile according to the SEIFA index.
- Health system expenditure, using Australian Institute of Health and Welfare (AIHW) estimates of expenditure by disease (13), disaggregated by disease phase (incidence year, prevalent, last year of life if dying of the disease) using NZ data (14). We then also estimate, for the actual interventions, the upfront intervention costs. Adding these costs to the (usually) averted future health system expenditure generate the net health system cost, which can then be used in cost effectiveness analyses to determine the 'best bang for buck' interventions from a health perspective.
- Income productivity. As populations become older, with increasing longevity, it is essential that preventive interventions are compared not only in terms of their impact in the health sector, but also more widely. One such measure is income productivity, on the premise that if prevention it to keep adding (heathy) years to life we also need to add workforce productivity to support an increasingly aging population. In this report, we use NZ income loss estimates by disease (15), purchase power parity adjusted to Australia, to quantify income productivity impacts. (Comparable estimates of income loss by disease using Australian data do not exist.) In this Report, we use these income productivity impacts to estimate a net societal cost of interventions (combined with the costs to industry of the interventions that – we assume – will be passed on to consumers). We also assume 23% of the change in income will be changes in government income tax revenue, to round out a health plus government costing perspective.
- Morbidity at age 65 years. The HALY blends mortality and morbidity. To help assess the impact of sodium interventions on social sustainability (to support an increasingly aging population), we additionally report by how many days the morbidity rate experienced at 65 years of age in BAU is shifted out by the intervention. For example, the morbidity rate (prevalent years of life lived in disability as estimated by the global burden of disease (GBD), divided by population size) at age 65 under BAU might be 0.15 – roughly a 15% loss of quality of life compared to 'perfect health'. Under an intervention, this morbidity rate at age 65 might

[A] https://populationinterventions.science.unimelb.edu.au/research/australia-new-zealand-health-intervention-league-table/

reduce to 0.1485 (a 1% decrease), and the morbidity rate of 0.15 is now experienced (on expectation) by someone aged 65 years and 20 days. This shift of morbidity is not only a health and quality of life gain, but also a potential productivity gain as society and people may 'convert' this health gain to extended workforce participation. This metric has been occasionally used by us before (e.g. [(16, 17)]); the use in this report is an experiment to assess its utility with end-users.

This Report is far from the first attempt to evaluate health impacts of sodium reduction interventions in Australia (see next section for a summary of previous research). This current Report updates these previous estimates in several ways. First, we use prospective modelling on the health impacts – that allows for competing mortality and morbidity risk, time lags and such like that are not included in a simpler comparative risk assessment (CRA) analysis (e.g.[(18)]).[B] Second, we have included a refined model of the causal association of sodium change to systolic blood pressure (SBP) change that allows for little (if any) impact of sodium change among younger people and those with lower starting SBP – using research by Huang et al (2020).[(19)] Third, we have applied contemporary sodium reduction targets for Australia, the UK and WHO.

LITERATURE REVIEW OF SODIUM REFORMULATION AND MASS MEDIA EVALUATIONS IN AUSTRALASIA

A literature review was conducted to identify peer-reviewed and grey literature modelling the health and cost impacts of food reformulation and mass media campaign interventions in Australia and New Zealand (NZ) (see *Appendix A* for a description of the literature search strategy).

FOOD REFORMULATION

Most modelling studies that have focused on food reformulation examined voluntary and mandatory sodium limits of packaged foods, apart from one study that also looked at salt substitution. Cobiac et al (2010) used a proportional multistate lifetable (PMSLT) model to simulate the CVD outcomes and cost impacts of reducing sodium consumption over the lifetime of the 2003 Australian adult population.[(20)] Results showed 610,000 HALYs (3% per annum discount rate) could be gained in the population alive in

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[B] Comparative risk assessment (CRA) is embedded in burden of disease study methodology. A CRA determines the DALYs estimated in a given calendar year (all deaths in that year with resultant years of life lost (YLL) into the future, and all morbidity in that year in years of life lived with disability (YLDs)) attributable to a risk factor (e.g. sodium). No time lags or competing mortality are allowed, and no discounting of future YLLs are included. That is, a CRA approximates the counterfactual "had sodium levels been [some counterfactual to current BAU] forever in the past, DALYs now would be X less".

CRA methodology varies from that used in Australian Cost-Effectiveness of Prevention (ACE-Prevention), the NZ Burden of Disease Epidemiology, Equity and Cost-Effectiveness program (BODE[3]; https://www.otago.ac.nz/bode3) and the University of Melbourne Scalable Health Intervention Evaluation (SHINE) program; https://mspgh.unimelb.edu.au/shine). These three programs use a prospective simulation modelling approach, for the population alive in a given base year, simulated over the remainder of their lifespans using proportional multistate lifetable (PMSLT) methods. This PMSLT approach includes forecasts of future disease incidence and case fatality, and all-cause mortality and morbidity rates, and 'builds in' time lags from change in risk factors to change in disease incidence rates and then time lags to changes in morbidity and mortality rates. It also allows for competing mortality, and often includes a cost effectiveness component. It usually has future health gains (variably labelled as HALYs gained, DALYs averted and sometimes QALYs gained – they are conceptually the same, and we use HALYs as the default) discounted at 3% per annum, meaning a HALY gained in 10-, 20- and 40-years time is equivalent to 0.74, 0.54 and 0.30 HALYs today. Accordingly, care must be taken comparing DALYs attributable to a risk factor in a CRA to HALYs gained in a prospective PMSLT approach. But generally speaking, the DALYs attributed to sodium in a CRA will be greater than the HALYs gained in a PMSLT study.

2003 over the remainder of their lifespans if they reduced their sodium intake to 2.5g or less per day – the recommended population mean sodium intake at that time. Programs encouraging the food industry to reduce the sodium content in their packaged foods improved population health and were cost effective to the Australian health sector (as determined by an Aus$50,000 per HALY willingness to pay threshold) compared to interventions aimed at changing individual behaviour, like dietary advice.[(20)] Setting mandatory sodium limits for all food manufacturers was expected to gain 18% of the total potential health gain that could be averted by a 'magic wand' intervention that achieved the 2.5g per day target. The authors argued that for population health gains to be significant, current sodium limits needed to cover more than just breads, margarines and cereals.[(20)]

Cobiac et al (2012) expanded on this body of work using Markov modelling to simulate CVD outcomes and cost impacts of different public health intervention packages over the lifetime of the 2008 Australian adult population.[(21)] Their results showed that the optimal package of interventions would need to include mandated sodium limits as it generated the largest population health gains and was the most cost-effective intervention (against the Aus$50,000 per HALY threshold) for preventing CVD compared to other interventions, which included pharmaceutical drugs, dietary advice, and voluntary sodium reformulation targets for packaged food.[(21)]

More recently, Aminde et al (2023) used a PMSLT model to estimate chronic kidney disease outcomes and costs of achieving the Australian Suggested Dietary Target (SDT) and the National Preventative Health Strategy (NPHS) 2021-2030 targets.[(22)] Results showed that if the SDT and NPHS targets were reached by 2030, an estimated 59,200 and 49,900 new CKD cases could be prevented by 2030 (5.3% and 4.4% of BAU expected cases), respectively, and 568 and 511 CKD deaths postponed.[(22)] Over the lifetime of the 2019 Australian adults modelled in this study, this generated 199,488 HALYs and $Aus644 million in health savings for the SDT, and 170,425 HALYs and $Aus514 million in health savings for the NPHS.[(22)] The authors concluded that more comprehensive sodium reformulation targets were needed to generate larger health gains and that future studies modelling the long-term impacts of sodium reduction would also need to consider a broader range of health conditions and the impact of health inequity on sodium reduction strategies.

Trieu et al (2021) and Trieu et al (2023) used a CRA approach to model a broader range of disease outcomes when estimating the population health gains of various sodium reformulation targets on packaged foods in Australia, which included the Australian government's 2020 targets, the UK government's 2017 targets, and the WHO's global sodium benchmarks.[(23, 24)] Results from these comparative modelling studies showed that mandating Australia's targets could lower the population mean daily sodium intake by more than 3%, preventing 510 deaths, 1,920 new cases, and 7,240 DALYs each year from CVD, chronic kidney disease (CKD), and stomach cancer.[(18)] [C] Complying with the UK's targets could lower the population mean daily sodium intake by nearly 6.5%, preventing an additional 660 deaths, 2,341 new cases and 8,748 DALYs each year to these same diseases compared to the Australia's targets.[(18)] Full compliance with the WHO's benchmarks could lower the population mean daily sodium intake by 12%, preventing 1,770 deaths, 6,900 new cases, and 25,700 disability-adjusted life years (DALYs) each year from the same set of diseases.

[C] Note that estimates of deaths and disease cases averted – whilst useful for simple advocacy – are challenging to conceptualise. In a CRA study it is relatively easy to generate such estimates. But what they mean in reality is another matter, as public health prevention delay deaths – be that for death from the disease in question, or some competing cause of death. This become evident in prospective PMSTL simulation modelling, where one instead estimates HALYs that intrinsically capture the additional health years lived.

Neither of the three reformulation scenarios independently met the required 40% daily reduction in the population mean sodium intake required for Australia to achieve the WHO sodium target.[25] Therefore, the authors concluded that additional sodium reduction strategies were needed to target other aspects of the food industry that contribute to the population's sodium consumption, such as restaurants and take-away businesses.[23, 24] They also recommended a national salt reduction strategy that included a suite of interventions, like mass media campaigns that promoted healthier, minimally processed foods to consumers.[24]

While Trieu et al (2021) and Trieu et al (2023) did not investigate the impacts of their findings on health inequity, some of these authors were involved in another modelling study that estimated the potential impact of the Australian government's voluntary reformulation program on household sodium purchases by income level.[26] Coyle et al (2021) showed that low-income households had a 15% greater reduction in per capita sodium purchases across different food categories compared to high-income households (or a mean difference of 7mg of sodium per day).[26]

Nghiem et al (2016) simulated the population health gains and health expenditure impacts of salt substitution across the lifetime of the 2011 NZ adult population.[27] The largest health gains and cost savings were from mandating the substitution of 59% of sodium chloride (NaCl) in processed foods with a mix of potassium (K) and magnesium (Mg) salts, which saw a gain of 294,000 quality-adjusted life years (QALYs) across the lifetime of the population and health savings of NZ$1.5 billion over the remainder of the population's lifespan (3% per annum discount rate).[27] Mandating the substitution of 25% of NaCl in processed foods with a mix of K and Mg salts also produced a health gain of 121,000 QALYs and health savings of NZ$600 million across the lifetime of the population.[27] The Indigenous Māori population were estimated to have larger per capita QALY gains compared with non- Māori, demonstrating the potential impact that salt substitutions have on reducing health inequalities.[27]

MASS MEDIA CAMPAIGNS

Nghiem et al (2015) was the only Australasian modelling study we found that assessed the impact of sodium reduction mass media campaigns on population health gains and health savings.[28] The authors included the initial phase of the UK's sodium reduction program (a combination of mass media campaign, voluntary food reformulation, and front-of-package (FOP) labelling changes) that ran from 2003-2009, as well as just the mass media campaign component of that program in their Markov model. Drawing on evidence that the campaign was ineffective in the long-term, and that industry reformulation was occurring at the same time as the media campaign was running, the authors estimated the intervention's contribution at 30% of the total UK program's effect size – an approximation that was also confirmed by experts that had studied the campaign. Nghiem et al's baseline model assumed that consumers would get used to the reduced sodium content in foods over time (i.e. the reformulation component), therefore the campaign's effects would remain over the lifetime of the modelled population.

Nghiem et al estimated that across the remaining lifetime of the 2011 NZ adult population the UK program gained 85,100 QALYs and generated NZ$440 million in health savings (3% discount rate), while the UK mass media campaign gained 25,200 QALYs and generated NZ$120 million in health savings.[28] Both interventions had greater per capita health benefits among the Indigenous Māori population. In a scenario analysis where intervention effectiveness attrited over time the interventions were still found to be worthwhile.

SPECIFICATIONS OF SODIUM REDUCTION INTERVENTIONS MODELLED IN THIS REPORT

A summary of the sodium reduction intervention scenarios is shown in *Table 1 below.* The following sections give more context about the interventions.

The interventions include:

- Australian government's sodium reformulation targets for 2024
- UK government's reformulation targets for 2017
- WHO's global sodium benchmarks
- Substituting 30% of NaCl across the Australian food industry for KCl – considered technically feasible, but probably not policy feasible in the short term. However, we include it in this Report as a 'magic wand' intervention to give a likely technically feasible maximum impact of sodium reduction
- Substituting 10% of NaCl across the Australian food industry for KCl – considered more policy feasible, and costed as an intervention for full cost effectiveness analysis
- Reformulating table salt by substituting 30% of NaCl with KCl
- The UK's salt reduction program (combination of voluntary industry reformulation and mass media campaign)
- The UK's mass media campaign.

AUSTRALIAN GOVERNMENT'S SODIUM REFORMULATION TARGETS

In 2015, the Australian government established the Healthy Food Partnership (HFP) – a voluntary collaborative forum between the government, food industry, and public health sector to improve the health of the Australian population.[29] One of its key initiatives was reducing sodium consumption, which led to voluntary sodium reformulation targets being implemented for foods with the highest levels of sodium in the Australian diet. [29] The first wave of targets commenced in July 2020 for 12 food categories and 27 subcategories, followed by a second wave of targets in July 2021 for 5 additional food subcategories: plain puffed or flaked or extruded breakfast cereals, all other ready-to-eat cereals, plain cereal biscuits, ready meals, and popcorn.[29] All targets have an implementation period of four years (either 2024 or 2025 timeframe) except for breakfast cereals, which have a five-year implementation period (2026 timeframe).[29]

Our modelling did not include the second wave of targets as our effect size for this intervention scenario was based on findings from Trieu et al (2021) – the only study we identified that modelled the health impacts of mandating Australia's sodium reformulation targets, which was accepted for publication prior to the second wave of targets being implemented.[18] Trieu et al (2021) had calculated the percentage of total sodium (from non-discretionary sources) by sex and age group that could be reduced from mandating the reformulation targets for 2024.[18] We expanded these estimates to include total sodium reduction across non-discretionary and discretionary sources and incorporated them into our model.

Table 1: Intervention descriptions and intervention effect sizes and costs

Intervention	Description	Sources of effect size	Epi spec	Intervention cost
Reformulation				
Mandatory-Australia (100% compliance): mandating Australia's sodium reformulation targets for 2024.	Based on the voluntary sodium reformulation targets established in 2020 as part of the Australian government's Partnership Reformulation Program[29]. Targets were set for 12 food categories and 27 subcategories (see *Supplementary Table 1, page 72)* for the list of food categories and subcategories).	For the effect size, we used the percentage reduction of total sodium from non-discretionary sources generated by Trieu et al (2021) and converted these estimates to a proportionate reduction of total sodium from all sources (non-discretionary and discretionary) by sex and age group. [18]	Below is the mean proportionate reduction in sodium in 2027 and beyond, compared to BAU, for 100% compliance. (The effect size steps up in 2025 (25% of below proportionate reductions) and 2026 (50%).) **Age** **Male** **Female** 0-24 0 0 25-29 0.026 0.030 30-34 0.031 0.033 35-39 0.033 0.028 40-44 0.030 0.029 45-49 0.030 0.034 50-54 0.026 0.026 55-59 0.036 0.027 60-64 0.038 0.033 65-69 0.034 0.034 70-74 0.036 0.034 75-79 0.041 0.030 80+ 0.037 0.034 *Uncertainty beta distribution with 10% of mean as SD. Uncertainty in each draw 100% correlated across sex and age.*	**Our expected costings:** $3.77 million (2023 Aus$) government costs in 2024 and every year henceforth for monitoring and compliance costs. $47.2 million Industry costs per year in 2024, 2025 and 2026 to achieve reformulation, then no further industry costs. **Conservative costings (from Industry):** government costs as per 'expected' above. $70.0 million Industry costs per year in 2024, 2025 and 2026 to achieve reformulation, then no further industry costs. *Uncertainty +/-20% SD for government costs, and 37% for Industry costs, on ln-normal (i.e. 0.2 and 0.37, respectively, on absolute unit on ln scale). Government and Industry costs' uncertainty independent.*
Australia (90% compliance)			90% of "Mandatory – 100% compliance" Correlated with Australia Mandatory 100%.	Government same as for 100% compliance, Industry costs scale by 90%.
Australia (70% compliance)			70% of "Mandatory – 100% compliance" Correlated with Australia Mandatory 100%.	Government same as for 100% compliance, Industry costs scale by 70%.
Australia (50% compliance)			50% of "Mandatory – 100% compliance" Correlated with Australia Mandatory 100%.	Government same as for 100% compliance, Industry costs scale by 50%.
Mandatory-UK: mandating the UK's sodium	Based on voluntary sodium reformulation targets established in	As per the Mandatory-Australia intervention, we converted Trieu et al	Below is the mean proportionate reduction in sodium in 2027 and beyond, compared to BAU, for 100% compliance.	**Our expected costings:** $3.77 million (2023 Aus$) government costs in 2024 and every year henceforth for monitoring and

Intervention	Description	Sources of effect size	Epi spec	Intervention cost
reformulation targets for 2017.	2014 by the UK government[30]. Targets were set for 28 food categories and 76 subcategories (see *Supplementary Table 2 page* 73 for the list of food categories and subcategories).	(2021) results to a percentage reduction of total sodium from all sources (non-discretionary and discretionary) by sex and age group.[18]	(The effect size steps up in 2025 (25% of below proportionate reductions) and 2026 (50%).) **Age** **Male** **Female** 0-24 0 0 25-29 0.048 0.057 30-34 0.059 0.061 35-39 0.060 0.057 40-44 0.059 0.057 45-49 0.064 0.060 50-54 0.059 0.063 55-59 0.088 0.056 60-64 0.078 0.072 65-69 0.076 0.066 70-74 0.085 0.081 75-79 0.080 0.077 80+ 0.086 0.088 *Uncertainty beta distribution with 10% of mean as SD. Uncertainty in each draw 100% correlated across sex and age.*	compliance costs. $78.7 million Industry costs per year in 2024, 2025 and 2026 to achieve reformulation, then no further industry costs. **Conservative costings (from Industry):** Government costs as per 'expected' above. $116.6 million Industry costs per year in 2024, 2025 and 2026 to achieve reformulation, then no further industry costs. *Uncertainty +/-20% SD for government costs, and 37% for Industry costs, on ln-normal (i.e. 0.2 and 0.37, respectively, on absolute unit on ln scale). Government and Industry costs' uncertainty independent.*
UK (90% compliance)			90% of "Mandatory – 100% compliance" Correlated with UK Mandatory 100%	government same as for 100% compliance, Industry costs scale by 90%.
UK (70% compliance)			70% of "Mandatory – 100% compliance" Correlated with UK Mandatory 100%	government same as for 100% compliance, Industry costs scale by 70%.
UK (50% compliance)			50% of "Mandatory – 100% compliance" Correlated with UK Mandatory 100%	government same as for 100% compliance, Industry costs scale by 50%.
Mandatory-Australia, followed by additional reformulation to also achieve Mandatory-UK	A secondary objective added by the authors of this Report.	As above.	25%, 50%, 100%, 75%, 50% of the Australia Mandatory sodium reduction in 2025 to 2029, with the addition of 25% and 50% of the UK Mandatory sodium reduction in 2028 and 2029 respectively. Sodium reduction as per UK Mandatory in 2030 onwards. *Uncertainty draw of each element of the sum matches underlying interventions.*	As per Australia Mandatory, with an additional $31.5 million Industry cost in years 2027, 2028 and 2029. This is the extra cost of UK Mandatory, so that the total Industry cost matches UK Mandatory, just delayed by three years. **Conservative costings (from Industry):** As per Australia Mandatory, with an additional $46.6 million Industry cost in years 2027, 2028 and 2029.

Intervention	Description	Sources of effect size	Epi spec	Intervention cost
Mandatory-WHO: mandating the WHO global sodium benchmarks.	Based on the WHO's global sodium benchmarks established in 2021[31]. These targets were set for 18 food categories and 64 subcategories (see Supplementary Table 3 , page 76, the list of food categories and subcategories).	For the effect size, we used the percentage reduction of total sodium from non-discretionary sources generated by Trieu et al (2023) and converted these estimates to a percentage reduction of total sodium from all sources (non-discretionary and discretionary) by sex and age group. [24]	Below is the mean proportionate reduction in sodium in 2027 and beyond, compared to BAU, for 100% compliance. (The effect size steps up in 2025 (25% of below proportionate reductions) and 2026 (50%).) **Age / Male / Female** 0-24 / 0 / 0 25-29 / 0.099 / 0.109 30-34 / 0.121 / 0.111 35-39 / 0.117 / 0.125 40-44 / 0.110 / 0.113 45-49 / 0.117 / 0.119 50-54 / 0.112 / 0.113 55-59 / 0.130 / 0.100 60-64 / 0.135 / 0.136 65-69 / 0.126 / 0.126 70-74 / 0.127 / 0.135 75-79 / 0.143 / 0.119 80+ / 0.133 / 0.124 *Uncertainty beta distribution with 10% of mean as SD. Uncertainty in each draw 100% correlated across sex and age.*	**Our expected costings:** $3.77 million (2023 Aus$) government costs in 2024 and every year henceforth for monitoring and compliance costs. $132.6 million Industry costs per year in 2024, 2025 and 2026 to achieve reformulation, then no further industry costs. **Conservative costings (from Industry):** Government costs as per 'expected' above. $196.4 million Industry costs per year in 2024, 2025 and 2026 to achieve reformulation, then no further industry costs. *Uncertainty +/-20% SD for government costs, and 37% for Industry costs, on ln-normal (i.e. 0.2 and 0.37, respectively, on absolute unit on ln scale). Government and Industry costs' uncertainty independent.*
Substitution of NaCl with KCl				
KCl Substitution-30% all foods: using a potassium-enriched salt substitute across the Australian food industry.	Substituting 30% of sodium chloride (NaCl) for potassium chloride (KCl) across the Australian food industry.	The effect size was based on consumer acceptability of potassium-enriched salt substitutes in processed foods from previous studies [32, 33].	28.5% reduction in sodium, all in 2024 *Uncertainty beta distribution with 10% of mean as SD. Uncertainty in each draw 100% correlated across sex and age.*	NA
KCl Substitution-30% discretionary: enriching discretionary salt (i.e. salt added during cooking or at the table) with KCl.	Reformulating discretionary salt to a 70% NaCl and 30% KCl mix.	As per the Salt Substitution-All intervention, the effect size was based on consumer acceptability of potassium-enriched salt substitutes shown	4.5% reduction in sodium in 2027 onwards (4.5% = 15% of dietary sodium being discretionary, multiplied by 30% 'taste tolerance'; 100% of full effect in 2027 – then hold).	Government costs $3 million per year from 2027 onwards, for monitoring. Industry costs starting at $3.5 million in 2027, falling linearly to $2.4 million in 2037, then linearly increasing to $2.7 million by 2050, then held indefinitely.

Intervention	Description	Sources of effect size	Epi spec	Intervention cost
		in previous studies[32, 33].	*Uncertainty beta distribution with 10% of mean as SD. Uncertainty in each draw 100% correlated across sex and age.*	*Uncertainty +/-40% SD for government costs, and 40% for Industry costs, on ln-normal (i.e. 0.4 and 0.4, respectively, on absolute unit on ln scale). Government and Industry costs' uncertainty independent.*
KCl Substitution – 10% all foods	Substituting 10% of NaCl over 10 years.	Subsidiary to above.	9.5% reduction of sodium achieved over ten years. Effect is linearly interpolated from 0% reduction in 2026 to 9.5% reduction in 2036, which is then held forever. *Uncertainty beta distribution with 10% of mean as SD. Correlated across sex and age.*	Government costs $3 million per year from 2027 to 2050, for monitoring. Industry costs increase from $0.8 million in 2027 to $5.5 million in 2036, then increase linearly from $5.2 million in 2037 to $6 million in 2050, then held indefinitely. Given it is a 'real' cost to the Industry of KCl being more expensive than NaCl salt, we assume the 'expected' and 'conservative' costs are the same. *Uncertainty +/-40% SD for government costs, and 40% for Industry costs, on ln-normal (i.e. 0.4 and 0.4, respectively, on absolute unit on ln scale). Government and Industry costs' uncertainty independent.*
Programs				
UK salt reduction program: rolling out the UK program that used a mix of mass media campaign, <u>*voluntary*</u> food reformulation, and FOP labelling.	The voluntary UK salt reduction program was developed by Consensus Action on Salt and Health (CASH), and the quasi-government organisation, Food Standards Agency (FSA), in collaboration with the UK food industry in 2003.[34]	For the effect size, we used the estimate calculated by Nghiem et al (2015)[28].	Below is the proportionate reduction in sodium in 2024 to 2030 compared to BAU, then hold indefinitely. 2024 0.003 2025 0.006 2026 0.009 2027 0.012 2028 0.015 2029 0.018 2030 0.021 *Uncertainty beta distribution with 10% of mean as SD. Uncertainty in each draw 100% correlated across sex and age, and year.*	Sum of **Mandatory-UK** (reformulation; above; 100% compliance; expected and conservative costing options) and **UK Mass Media Campaign** *Uncertainty draw of each element of the sum matches underlying interventions.*
UK Mass Media Campaign: running just the mass media campaign used in the UK's salt reduction program.	Based on the mass media campaign that ran in the initial phase of the UK's voluntary salt reduction program (2003-2009). [4] This	For the effect size, we used the estimate calculated by Nghiem et al (2015), which was informed by expert opinion (i.e.	Percentage reduction in sodium increases linearly from 0% in 2023 to a peak of 0.6% in 2030, then reduces linearly to 0% in 2037.	government: Aus $7.27 million in each of 2024 and 2025, then $3.63 million in each of 2026, 27, 28 and 29. (A total of $29.1 million.) *Uncertainty: SD = 20% of central estimate, ln-normal distribution.*

Intervention	Description	Sources of effect size	Epi spec	Intervention cost
	program was developed by the non-governmental organisation, Consensus Action on Salt and Health (CASH), and the quasi-government organisation, Food Standards Agency (FSA), in collaboration with the food industry.[4]	researchers, He and MacGregor, who studied the UK campaign)[28].	*Uncertainty beta distribution with 30% of mean as SD. Uncertainty in each draw 100% correlated across sex and age, and year.*	

UK GOVERNMENT'S SODIUM REFORMULATION TARGETS

In 2011, the UK government established the Public Health Responsibility Deal, which was a partnership aimed at bringing together government, and health organisations and businesses to improve population health.[30] By 2014, the UK government's Department of Health had published their fourth set of voluntary salt reduction targets for 28 food categories and 76 subcategories – to be achieved by 2017. [30] A fifth set of targets was published in 2020, however we did not identify any studies that had worked up what these targets would translate to as sodium changes in the diet for Australia. [30]

Our intervention effect size for this UK reformulation target scenario was based on findings from Trieu et al (2021) [18]– the only study we identified that modelled the health impacts of mandating the UK's sodium reformulation targets in Australia. Trieu et al (2021) had calculated the percentage of total sodium (from non-discretionary sources) by sex and age group that could be reduced from mandating the reformulation targets for 2017.[18] We expanded these estimates to include total sodium reduction across non-discretionary and discretionary sources and incorporated them into our model.

WHO GLOBAL SODIUM BENCHMARKS

In 2020, the WHO developed global sodium benchmarks for different food categories to support its member states in setting national policies and strategies that aim to reduce population sodium consumption to less than 2g a day by 2025. [31] A new set of global benchmarks were released in 2021 for 18 food categories and 97 subcategories. [31] These benchmarks are in the form of maximum sodium targets, which are based on the lowest maximum values from existing country targets. [31]

Our intervention effect size for this scenario was based on findings from Trieu et al (2023) [35] – the only study we identified that modelled the health impact of mandating the WHO's global sodium benchmarks in Australia. Upon our request, the authors provided us with percentage estimates of total sodium (from non-discretionary sources) reduction by sex and age group from mandating the reformulation targets for 2017. We expanded these estimates to include total sodium reduction across non-discretionary and discretionary sources and incorporated them into our model.

SUBSTITUTION OF NaCl WITH KCl

There was no Australian study we found that modelled salt substitution, but NZ findings from Nghiem et al (2016) [27] demonstrated the health gains and cost savings that could be achieved by mandating salt substitution in processed foods. Therefore, we chose to model two salt substitution scenarios across the Australian population: (1) substituting 30% of NaCl across the Australian food industry for KCl, (2) substituting 10% of NaCl across the Australian food industry for KCl ,and (3) reformulating table salt by substituting 30% of NaCl with KCl.

The substitution effect size across the two scenarios was based on consumer acceptability of potassium-enriched salt substitutes in processed foods that was observed in previous studies.[32, 33] We did not incorporate any possible beneficial effects of adding potassium salts, just the beneficial of removing sodium.

UK'S SALT REDUCTION PROGRAM

The UK's salt reduction program was the only national program we chose to model in our study. In 2003, the UK's Consensus Action on Salt and Health (CASH) and Food Standards Agency (FSA) engaged with the food industry to launch a national salt reduction program – one of the first countries to do so.[34] This voluntary program consisted of food reformulation, mass media campaigns, and FOP labelling, all of which contributed to consistent reductions in the population's sodium intake.[34] However, in 2010, the FSA nutrition team transferred to the Department of Health (DH) ahead of the 2011 announcement that salt reduction was one of the public health goals included in the newly established Public Health Responsibility Deal.[34]

While the Responsibility Deal adopted the FSA's salt targets for 2012, DH failed to commit to FSA's new set of targets (to be met in 2014). It was early 2013 before DH committed to new targets, resulting in three years of progress lost. The decrease in population sodium intake was found to be larger between 2003 to 2010 than 2011 onwards (the program is still active today). [4, 36]

We found two studies that we could use to parameterize this UK national program intervention. Nghiem et al (2015) [28]had estimated the program's effect during the 2003-2010 period, while Gressier et al (2021)[36] focused on its effect during the 2011-2017 period. We chose to use the effect size from Nghiem et al (2015) as the study had also modelled the mass media component of the program as a standalone intervention (below) in a format we could readily use in our own model, unlike Gressier et al (2021) whose standalone effect size was difficult to tease apart from the program's overall effect size.

UK'S MASS MEDIA CAMPAIGN

The mass media component of the UK's salt reduction program was chosen to demonstrate the impact consumer awareness could have on population sodium intake if it were implemented as a standalone intervention. CASH regularly used media coverage, such as television, radio, press, and internet, as well as organising the annual National Salt Awareness Week to educate consumers on the health risks associated with diets high in sodium.[4]

From 2004 to 2007, the FSA launched a three-stage media campaign: raising consumer awareness to health risks associated with excess sodium; promoting the 2.4g of sodium (or 6g of salt) per day health target; and getting consumers into the habit of checking food labels.[4] Surveys conducted to evaluate the campaign's impact showed participants had reduced their sodium intake, were aware of the daily sodium consumption target, and checked food labels. However, market research showed the campaign was expensive to run and its overall effects were transitory.[4]

We based our intervention effect size on the estimate calculated by Nghiem et al (2015) [28] for the mass media component of the UK salt reduction program during the 2003-2010 period, which was informed by expert opinion (i.e. researchers, He and MacGregor, who studied the UK campaign).

METHODS

Modelling the health and cost impacts of different sodium reduction interventions involved a series of steps.

1. Conceptualising the interventions and their business-as-usual (BAU) comparator.
2. Specifying the model structure.
3. Specifying the model's input parameters, including demographics, disease epidemiology, health expenditure, income, intervention effect sizes, and intervention costs.
4. Conducting analyses.

These steps are described in more detail in the following sections.

CONCEPTUALISATION OF BUSINESS-AS-USUAL

The base-year in the model was 2023. The net present values of costs and health adjusted life years for each intervention was calculated for 2023 using a 3% discount rate (0% discount rate results given in supplementary results). Two time horizons were used: the next 20 years, and the remaining lifetime of the cohort alive in 2023.

The BAU comparator was conceptualised as 'the recent past's force of change continuing into the future'. For epidemiological disease-specific inputs of incidence, remission, and case fatality rates this was achieved using Global Burden of Disease data (GBD; source https://ghdx.healthdata.org) from 1990 to 2019 to estimate sex by age cohort rates and annual percentage changes for each sex by age cohort. Briefly, we used a series of algorithms that solved the best fitting trends in the past for incidence rate, case fatality rate (mortality rate divided by prevalence) and remission rate (solved using sequential year estimates of prevalence to determine – given the incidence and case fatality rates, and assuming disease independence – the annual remission rate). Calculations were iterative, using the PMSLT specified with the last iteration of incidence, case fatality and remission rates to generate past and future disease prevalence and mortality rates, and calibrating these against 'stand-alone' projections of future prevalence and mortality rates (these calibration targets being based on relatively simple regression forecasts just using the last 30 years of trends in GBD prevalence and mortality). The final set of disease rates was then forecast forward to 2034; disease rates beyond 2035 were set to those for 2034. Likewise, we forecast all-cause mortality rates out to 2034, then hold constant. (Note this implies that the COVID-19 'health shock' will pass, with epidemiological trends returning to the underlying pre-COVID-19 trend – consistent with what has happened after past health shocks.[37])

Disability rates are fixed by disease (equivalent to assuming no change in severity distribution into the future), and all-cause morbidity (used to specify the main lifetable) is also assumed unchanging into the future (consistent with GBD studies showing little if any change in age-specific all-cause morbidity rates over time [38]).

The sex by age cohorts were then disaggregated by socioeconomic strata, namely quintiles of the SEIFA index. For the epidemiological components of BAU, this was achieved using SHINE's heterogeneity module [39] that uses relative differences by socioeconomic strata (e.g. incidence rate ratios) to break the population apart, and ensure that in future years the sum of life years and people across the five socioeconomic strata equals that in the disaggregated 'working truth' sex by age strata. We assumed that health systems expenditure by person with disease did not vary by socioeconomic strata. For this Report we also set income loss by disease to be uniform by socioeconomic strata; thus we do not report income loss by socioeconomic strata.

Disease-related health expenditure by sex and age was sourced from the Australian Institute of Health and Welfare [13, 40], and further stratified by disease-phase (first year of diagnosis, last year of life if dying of that disease, and otherwise prevalent) using New Zealand estimates of relative variation by phase.[14] Disease-related income loss by sex, age and disease phase was sourced from New Zealand.[15]

At the risk factor level, sodium and systolic blood pressure distributions (mean and standard deviation) were estimated by sex, age and socio-economic strata, and assumed to be unchanging under BAU into the future. However, for the actual sex by age by socioeconomic cohorts in the modelling, they do 'jump' from one age group's mean and standard deviation as they age.

Our approach to conceptualising the interventions that were 'laid over' BAU is detailed in the previous conceptualisation section.

MODEL STRUCTURE

We used the Scalable Health Intervention Evaluation (SHINE) proportional multistate lifetable (PMSLT) platform [41] at the University of Melbourne for simulating long-term impacts of sodium reduction interventions across the Australian population. The core model structure flow is a three-step process, starting with the effect of changes in sodium on systolic blood pressure (SBP), followed by the effect of changes in SBP on disease incidence, finishing with the effect of changes in disease morbidity and mortality on health-adjusted life years (HALY), health expenditure and income.

MODEL INPUT PARAMETERS

The sections below describe in more detail the more important or specific input parameters for this Report on sodium interventions.

DEMOGRAPHICS

The baseline population counts by sex, age and SEIFA quintile were sourced from Australian Bureau of Statistics data for 2019. Moderate scenario fertility projections from the Australian Bureau of Statistics were used to introduce new cohorts born in 2019, 2020, 2021 and 2022, effectively creating a closed cohort from 2023 onwards.

DISEASE EPIDEMIOLOGY

There were 32 diseases in our model (shown in bold in Table 2). We selected them using GBD data as follows. First, for Australia we ranked the level 3 GBD level causes by their contribution to the total health loss from sodium as a risk factor and selected those diseases that cumulatively contributed >95% of the sodium-related health loss. Those diseases were: ischemic heart disease, stroke, hypertensive heart disease, atrial fibrillation and flutter, other cardiovascular and circulatory disease, cardiomyopathy and myocarditis, stomach cancer, non-rheumatic valvular heart disease, and chronic kidney disease. However, at the level of parametrisation, differences in epidemiological characteristics by sub-category mean that the GBD (and by extension SHINE) gives epidemiological parameters for stroke, non-rheumatic heart disease and chronic kidney disease for their disaggregated level 4 sub-categories. Thus, there are 16 diseases included in our model that are 'purely' sodium-related (i.e. the first 16 bold entries in *Table 2*).

Second, we wished to build a model that was future-proofed for interventions more directly targeting systolic blood pressure (SBP) and overweight and obesity. Using the same 'top 95% of disease contribution to the risk factor' criteria as described above for sodium, this extended the number of diseases to 32. The 16 additional diseases are made up of four SBP-related diseases and 12 BMI-related diseases. In the modelling in this Report, a modest contribution to health gain and costs will be through the four additional SBP-related diseases (as our modelling changes sodium which then goes on to change SBP). The additional 12 diseases are essentially silent in this Report.[D]

Table 2: Diseases included in the proportional that contribute cumulatively to 95% of the burden of disease attributable to diets high in sodium, high SBP, high BMI, and diets low in fibre.

Disease	GBD cause level	Is the disease included in the top 95% of diseases contributing to each risk factor's burden?		
		Diet high in sodium	High SBP	High BMI
1. Ischemic heart disease	3	✓	✓	✓
Stroke	3	✓	✓	✓
2. Ischaemic stroke	4			
3. Intracerebral haemorrhage	4			
4. Subarachnoid haemorrhage	4			
5. Hypertensive heart disease	3	✓	✓	✓
6. Atrial fibrillation and flutter	3	✓	✓	✓
7. Other cardiovascular and circulatory diseases	3	✓		
8. Cardiomyopathy and myocarditis	3	✓	✓	
9. Stomach cancer	3	✓		
Non-rheumatic valvular heart disease	3	✓	✓	
10. Non-rheumatic calcific aortic valvular heart disease	4			
11. Other cardiomyopathy	4			
Chronic kidney disease	3	✓	✓	✓
12. Chronic kidney disease due to diabetes mellitus type 1	4			
13. Chronic kidney disease due to diabetes mellitus type 2	4			
14. Chronic kidney disease due to hypertension	4			
15. Chronic kidney disease due to glomerulonephritis	4			

[D] The additional 12 BMI-related diseases are not completely silent as they impact model structure which as interventions change future disease rates can alter in a very minor way the HALY and cost impacts compared to a model that did not have these 12 diseases parameterised separately. But such an impact is negligible, and much smaller than other sources of uncertainty in the modelling.

Disease	GBD cause level	Is the disease included in the top 95% of diseases contributing to each risk factor's burden?		
		Diet high in sodium	High SBP	High BMI
16. Chronic kidney disease due to other and unspecified causes	4			
17. Rheumatic heart disease	3		✓	
18. Aortic aneurysm	3		✓	
19. Endocarditis	3		✓	
20. Peripheral artery disease	3		✓	
21. Diabetes mellitus	3			✓
22. Low back pain	3			✓
23. Esophageal cancer	3			✓
24. Asthma	3			✓
25. Alzheimer's disease and other dementias	3			✓
26. Osteoarthritis	3			✓
27. Colon and rectum cancer	3			✓
28. Liver cancer	3			✓
29. Kidney cancer	3			✓
30. Pancreatic cancer	3			✓
31. Gallbladder and biliary diseases	3			✓
32. Gout	3			✓

SHINE modelling includes time lags from change in risk factors to change in diseases. We do that by using the average population impact fraction (PIF) for a window of time in the past. (The PIF is the percentage reduction in disease incidence rate, determined by the difference in risk factor distribution between each intervention and the BAU, mathematically combined with the GBD incidence rate ratios for each risk factor – see elsewhere for more detail on how the PMSLT pivots about PIFs.[41]) Cardiovascular disease and diabetes tend to have reasonably short time lags, i.e. the impact of a change in sodium and/or SBP onto changes in disease incidence rates only takes a few years to be fully felt. Accordingly, for CVD and diabetes the model was specified to use the average PIF for the last zero to three years. Cancers on the other hand take time for a change in risk factor to manifest as a change in disease incidence rate (e.g. [42]), which we model by using the average PIF in the last 2 to 20 years. The non-zero limits of these windows (i.e. the upper three year limit for CVD and diabetes, and 2 and 20 years for cancers) are modelled with +/- 20% standard deviation uncertainty (e.g. each run of the Monte Carlo simulation draws a value for the upper limit for cancer from a normal distribution with mean 20 and SD 4 years).

SODIUM

The sex by age sodium distribution (mean and standard deviation) was taken from Trieu et al (2021).[18] We further disaggregated this by SEIFA quintile by assuming the income differences in sodium [26] by cumulative socioeconomic rank of the population could be extrapolated to rankings of the population by SEIFA quintile.

BLOOD PRESSURE

The mean and standard deviation of systolic blood pressure (SBP) were estimate for every sex by five-year age group by SEIFA quintile, using 2017/18 Health Survey data. We used two regression equations, one for the mean and one for the SD of the BMI distribution, using Health Survey data in categories of sex by age group by SEIFA. The predicted mean and SD for each sex by age by SEIFA category was then used to allocate the proportionate distribution of SBP across bins with 10 mm Hg cut-points. We assumed no future trends in blood pressure change under BAU, consistent with no change was found from 2014-15 to 2017-18.[43]

ASSOCIAITON OF CHANGE IN SODIUM WITH CHANGE IN SYSTOLIC BLOOD PRESSURE

Huang et al (2020) estimated the reduction in systolic blood pressure for changes in sodium intake, using meta- regression of randomized trials of sodium reduction with follow-up for blood pressure change.[19] They found that the strength of association varied by age and initial SBP, but did not provide equations to predict the change in SBP by all of change in sodium intake, age and starting SBP were not provided.

Therefore, we conducted our own meta-regression on the 48 studies in Supplementary File 2 of Huang et al that had a change of sodium of <= 100 mmol per day, for a duration of > 14 days. For the two studies with missing average age, we assigned them the average age across the 46 studies with non-missing age. For the 17 studies with missing proportion non-White, the average proportion non-White from studies in the same country among the remaining 31 studies were used, or assigned as 0% non-White (Belgium, Australia, Italy, New Zealand, Spain, Bosnia and Herzegovina).

We fitted a linear regression model across the 48 observations, weighted by the inverse of the variance of the change in SBP for each study/observation, with change in SBP as the dependent variable, no intercept (as theoretically no change in sodium results in no change in SBP), and a main effect for the change in sodium (in grams of sodium). Interaction terms were included for change in sodium with: average age (centred on 50, and divided by 10 to give a unit change per 10 years of age); average starting SBP (centred on 140, and divided by 10 to give a unit change per 10 mmHg); and proportion non-White. (A further three-way interaction term of change in sodium, by average age, by starting SBP, was also included in an extended model, but the term had a non-statistically significant p-vale and the extended model did not have better fits by either a deviance or AIC test – so this three-way interaction term was not included in the final model.)

The specification of the model meant that the main effect for change in sodium (in grams) was that for the reference person: White, age 50, starting SBP of 140. The coefficients, their standard error and 95% CI, are shown in *Table 3:* Accordingly, for the reference person, a 1 gram decrease in sodium intake per day (equivalent to 43.5 mmol, equivalent to 2.54 grams of sodium chloride salt) the central or median estimate of their reduction in SBP it 2.026 mmHg. Variation in this effect size by age, starting blood pressure and 'non-White race' can be calculated using the remaining coefficients. In our simulation modelling, we additionally used the standard errors and covariance matrix in *Table 4* when drawing values of the SBP change in each iteration of the Monte Carlo simulation. As per Trie et al (2021 and 2023) [18, 35], we set the theoretical minimum exposure risk level to 2 grams of sodium per day (i.e. sodium only had an association with SBP above 2 grams per day intake),

Table 3: Coefficients of change in SBP by change in sodium from a meta-regression model of 48 randomised trials with a change of sodium of <= 100 mmol per day, for a duration of > 14 days (sourced from Huang et al 2020)

Change in mmHg of SBP for	Coefficient	s.e.	95% CI
Change in sodium (grams) [ΔNa]	2.026	0.212	1.610 to 2.442
Change in sodium (grams), interacted with average age in study (centred 50, divided by 10) [ΔNa-by-age]	0.502	0.134	0.239 to 0.765
Change in sodium (grams), interacted with average starting SBP in study (centred 140, divided by 10) [ΔNa-by-SBP]	0.659	0.195	0.277 to 1.041
Change in sodium (grams), interacted with proportion non-White in study [ΔNa-by-race]	2.353	0.547	1.281 to 3.425

Table 4: Covariance matrix for regression model shown in Table 3

	ΔNa	ΔNa-by-SBP	ΔNa-by-age	ΔNa-by-race
ΔNa	0.0448	0.0034	0.0177	0.0677
ΔNa-by-SBP	0.0034	0.0180	0.0078	0.0133
ΔNa-by-age	0.0177	0.0078	0.0381	0.0322
ΔNa-by-race	0.0677	0.0133	0.0322	0.2993

LINKING CHANGE IN SODIUM TO CHANGE IN STOMACH CNACER INCIDENCE RATES

Incidence rate ratios from the GBD [44] were used to calculate the population impact fractions (PIFs).

LINKING CHANGE IN SYSTOLIC BLOOD PRESSURE TO CHANGE IN DISEASE INCIDENCE RATES

Incidence rate ratios from the GBD [44] were used to calculate the population impact fractions (PIFs).

ANALYSES

The PMSLT is described in detail elsewhere.[41] It was run on the University of Melbourne high performance cloud computer, using Monte Carlo estimations across 2000 iterations and sampling from uncertainty intervals about each input parameter in each iteration.

RESULTS

HEALTH ADJUSTED LIFE YEARS

Figure 1 shows the HALYs gained for both the next 20 years and remaining lifetime of the population alive in 2023, discounted at 3% per annum to base year 2023. *Table 5* and *Table 6* give the same data (medians and 95% uncertainty intervals for all interventions), and also give the HALYs disaggregated by socioeconomic quintile.

HALYs gained, combined over sex, age and socioeconomic strata, are greatest for the 30% immediate substitution of KCl for NaCl across the whole food system; 112,000 (95% UI 76,700 to 154,000) HALYs gained over the first 20 years, and five times greater at 554,000 (375,000 to 780,000) HALYs over the lifetime. The 10% KCl substitution across the whole food system had approximately a third of the HALY gains over a lifetime perspective compared to the 30% substitution – unsurprisingly. However the HALY gains over a 20-year time horizon for the 10% substitution intervention were only about 15% of the 30% KCl substitution intervention, due to the 10% substitution intervention having its roll-out occur incrementally over ten years (compared to overnight for the 30% substitution intervention). The 30% substitution of KCl for NaCl in discretionary salt (i.e. table salt and salt added to food and cooking in the home) had similar HALY gains over 20 years to the 10% substitution across all foods intervention.

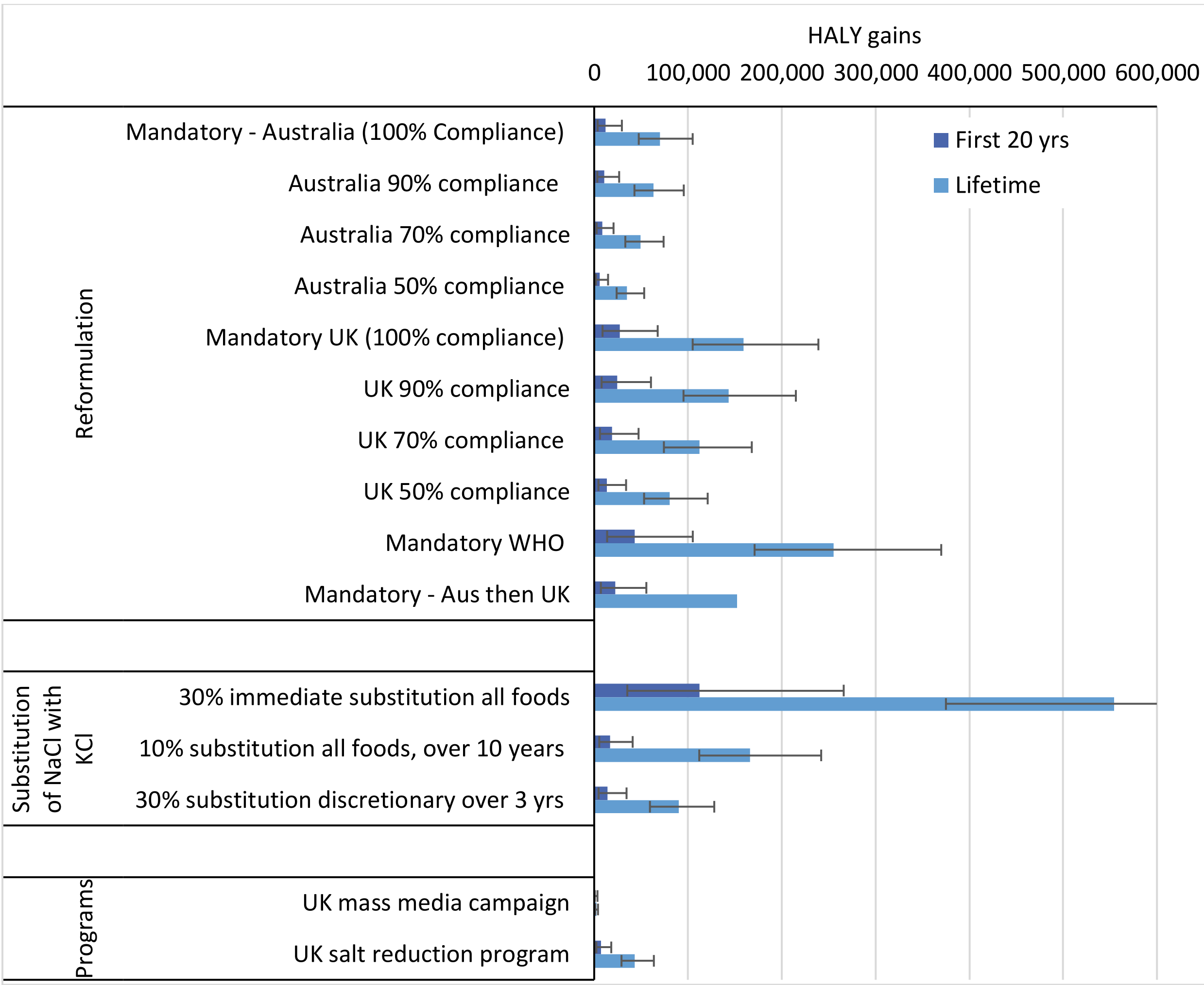
The least HALY gains arose from replicating the media only component of the UK package, with median HALY gains of 1,220 in the first 20 years and 2,190 over the lifetime. The two-fold ratio of HALYs gained over the lifetime compared to the first 20 years is less that the approximately five-fold ratio for the other interventions, as the education-only intervention has an assumed attrition of effect once education stops (whereas other interventions have enduring effects forever into the future – a common limitation of education campaigns if they cannot exact a permanent behaviour change).

Reformulation health gains for the mandatory programs were greatest for the WHO reformulation intervention (median values of HALY gains 43,200 over 20 years, and 255,000 HALYs over the lifetime of the Australian population), approximately two thirds of that for the mandatory UK reformulation, and approximately one third for the Australian mandatory reformulation program. Less than mandatory, namely 50% to 90% compliance, had the expected pro-rata reductions.

The one 'package' reformulation intervention, namely the Australian mandatory reformulation program (completed by 2027), followed by 'topping up' to the UK mandatory reformulation (completed by 2030), had somewhat less than the going straight to completing the UK reformulation program by 2027. This is simply a function of the slower phasing in of the combined Australian and UK package compared to the UK package alone. For example, over a 20-year time horizon the median HALYs gained for the mandatory Australia then UK package was 22,500 compared to 27,100 for mandatory UK reformulation achieved by 2027.

Table 5 and *Table 6* also show HALY gains by socioeconomic quintile, and the age-standardised ratio of per capita HALY gains comparing the most and least deprived over a 20-year time horizon in *Table 5*. (Age-standardised HALYs over a lifetime perspective become difficult to interpret, as cohort aging means there are increasingly fewer younger people to contribute to the analysis.) HALY gains over a 20-year time horizon range from 1.65 (95% UI 1.58 to 1.76) to 2.02 (1.76 to 2.39) times greater for the most deprived, for the 10% KCl substitution and 30% substitution of KCl for NaCl across all foods interventions respectively. That is, these population-wide sodium reduction interventions generate more health gain for lower SES groups due to the higher incidence and prevalence rates of diseases in lower socioeconomic groups that are modifiable by sodium reduction (and despite only modest differences in sodium and systolic blood pressure by socioeconomic status).[E]

Figure 1: Health adjusted life years (HALYs) gained in the first 20 years (2024-2043) and over the remainder of the lifetime of the Australian population alive in 2023 (discounted 3% per annum to base-year of 2023)



x-axis truncated to 600,000 HALYs, meaning 95% upper UL for “30% immediate substation KCl all foods” of 780,000 not shown.

[E] Note that we do not model differential uptake of the UK education program; if this was differential by SES (as many education programs are), then our estimated ratio of 1.72 will be biased.

Table 5: Health adjusted life years (HALYs) gained over 20 years (2024 to 2043 inclusive) for the overall population, 3% discount rate, and by quintile of SEIFA index)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	Ratio SES 1 c.f. 5 †
HALYs 2024 to 2043							
Reformulation							
Mandatory - Australia (100% Compliance)	11,900	3,010	2,660	2,360	2,020	1,840	1.67
	(8,280 to 17,600)	(2,100 to 4,450)	(1,850 to 3,940)	(1,640 to 3,500)	(1,400 to 2,960)	(1,270 to 2,710)	(1.61 to 1.75)
Australia 90% compliance	10,700	2,710	2,390	2,130	1,810	1,650	1.67
	(7,400 to 15,900)	(1,880 to 4,050)	(1,650 to 3,570)	(1,470 to 3,160)	(1,260 to 2,690)	(1,150 to 2,440)	(1.61 to 1.75)
Australia 70% compliance	8,310	2,100	1,860	1,650	1,410	1,280	1.67
	(5,730 to 12,300)	(1,460 to 3,120)	(1,280 to 2,760)	(1,140 to 2,440)	(972 to 2,070)	(885 to 1,890)	(1.61 to 1.75)
Australia 50% compliance	5,950	1,510	1,330	1,180	1,010	917	1.67
	(4,130 to 8,840)	(1,050 to 2,230)	(922 to 1,980)	(821 to 1,760)	(702 to 1,490)	(642 to 1,360)	(1.61 to 1.74)
Mandatory UK (100% compliance)	27,100	6,870	6,080	5,410	4,600	4,150	1.67
	(18,200 to 40,600)	(4,620 to 10,200)	(4,070 to 9,100)	(3,620 to 8,060)	(3,080 to 6,850)	(2,790 to 6,230)	(1.60 to 1.79)
UK 90% compliance	24,400	6,180	5,460	4,850	4,130	3,740	1.67
	(16,500 to 36,100)	(4,180 to 9,130)	(3,690 to 8,100)	(3,280 to 7,210)	(2,800 to 6,110)	(2,530 to 5,550)	(1.60 to 1.78)
UK 70% compliance	18,900	4,800	4,250	3,770	3,210	2,920	1.66
	(12,800 to 28,400)	(3,260 to 7,170)	(2,860 to 6,360)	(2,540 to 5,650)	(2,180 to 4,800)	(1,970 to 4,370)	(1.60 to 1.76)
UK 50% compliance	13,700	3,460	3,060	2,720	2,320	2,110	1.66

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	Ratio SES 1 c.f. 5 †
	(9,220 to 20,300)	(2,350 to 5,160)	(2,070 to 4,550)	(1,830 to 4,050)	(1,560 to 3,450)	(1,410 to 3,130)	(1.60 to 1.74)
Mandatory WHO	43,200	11,000	9,730	8,640	7,320	6,490	1.70
	(29,400 to 61,900)	(7,540 to 15,700)	(6,610 to 13,900)	(5,860 to 12,400)	(4,970 to 10,400)	(4,390 to 9,390)	(1.62 to 1.90)
Mandatory Aus followed by UK (100% compliance)	22,500	5,670	5,020	4,490	3,830	3,470	1.65
	(15,400 to 33,100)	(3,910 to 8,350)	(3,440 to 7,430)	(3,070 to 6,600)	(2,630 to 5,600)	(2,380 to 5,080)	(1.58 to 1.77)
Substitution of NaCl with KCl							
30% immediate substitution of all foods	112,000	30,200	26,000	22,300	18,100	15,100	2.02
	(76,700 to 154,000)	(20,900 to 41,200)	(17,900 to 35,700)	(15,200 to 30,600)	(12,200 to 25,000)	(10,100 to 21,500)	(1.76 to 2.39)
10% substitution all foods, over 10 years	16,900	4,250	3,760	3,380	2,900	2,610	1.65
	(11,500 to 24,100)	(2,890 to 6,090)	(2,550 to 5,390)	(2,300 to 4,830)	(1,970 to 4,130)	(1,760 to 3,740)	(1.58 to 1.76)
30% substitution discretionary over 3 years	14,300	3,620	3,190	2,840	2,420	2,180	1.68
	(9,620 to 20,200)	(2,450 to 5,140)	(2,140 to 4,520)	(1,910 to 4,020)	(1,630 to 3,420)	(1,460 to 3,100)	(1.61 to 1.76)
Programs							
UK mass media campaign	1,220	314	274	241	203	184	1.72
	(595 to 2,260)	(154 to 583)	(134 to 511)	(118 to 448)	(99.5 to 379)	(90.2 to 343)	(1.65 to 1.80)
UK salt reduction program	7,390	1,890	1,660	1,470	1,250	1,130	1.70
	(5,090 to 10,800)	(1,300 to 2,760)	(1,140 to 2,420)	(1,000 to 2,130)	(855 to 1,800)	(771 to 1,630)	(1.63 to 1.77)

† Ratio of age-standardised HALYs gained per capita of the population alive in base year (2023) for SES 1 compared to SES 5. 0% discount rates are shown in *Supplementary Table 7.*

Table 6: Health adjusted life years (HALYs) gained over the remaining lifetime, 3% discount rate, and by quintile of socioeconomic status (SEIFA index)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5
HALYs Lifetime						
Reformulation						
Mandatory - Australia (100% Compliance)	70,100	16,500	14,600	14,300	13,100	11,600
	(47,500 to 105,000)	(11,300 to 24,700)	(9,920 to 21,900)	(9,610 to 21,400)	(8,900 to 19,600)	(7,780 to 17,300)
Australia 90% compliance	63,100	14,900	13,200	12,800	11,800	10,400
	(42,900 to 95,500)	(10,200 to 22,600)	(9,000 to 20,000)	(8,650 to 19,400)	(8,010 to 17,800)	(7,030 to 15,600)
Australia 70% compliance	49,100	11,600	10,300	9,990	9,200	8,090
	(33,200 to 74,000)	(7,910 to 17,400)	(6,960 to 15,500)	(6,730 to 15,100)	(6,180 to 13,900)	(5,460 to 12,200)
Australia 50% compliance	35,200	8,300	7,340	7,140	6,580	5,790
	(23,900 to 53,300)	(5,710 to 12,600)	(5,000 to 11,100)	(4,820 to 10,800)	(4,470 to 9,910)	(3,940 to 8,760)
Mandatory UK (100% compliance)	159,000	37,400	33,100	32,300	29,800	26,000
	(105,000 to 239,000)	(25,000 to 56,000)	(22,100 to 49,800)	(21,500 to 48,800)	(19,700 to 44,900)	(17,200 to 39,400)
UK 90% compliance	143,000	33,700	29,900	29,200	26,800	23,500
	(95,200 to 215,000)	(22,600 to 50,300)	(19,900 to 44,800)	(19,300 to 44,000)	(17,800 to 40,400)	(15,700 to 35,800)
UK 70% compliance	112,000	26,300	23,300	22,800	20,900	18,400
	(74,300 to 168,000)	(17,700 to 39,300)	(15,600 to 35,100)	(15,100 to 34,400)	(13,900 to 31,600)	(12,100 to 28,000)
UK 50% compliance	80,200	18,800	16,700	16,300	15,000	13,200
	(53,200 to 121,000)	(12,600 to 28,200)	(11,100 to 25,200)	(10,800 to 24,700)	(9,910 to 22,700)	(8,710 to 20,200)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5
Mandatory WHO	255,000	60,600	53,500	52,000	47,600	41,000
	(171,000 to 370,000)	(40,900 to 87,300)	(36,000 to 77,300)	(34,600 to 75,600)	(31,600 to 69,500)	(27,000 to 60,400)
Mandatory Aus followed by UK (100% compliance)	152,000	35,500	31,600	31,000	28,600	25,000
	(101,000 to 229,000)	(23,800 to 53,300)	(21,100 to 47,500)	(20,500 to 46,800)	(18,900 to 43,100)	(16,700 to 37,900)
Substitution of NaCl with KCl						
30% immediate substitution of all foods	554,000	140,000	121,000	113,000	99,100	80,900
	(375,000 to 780,000)	(95,500 to 197,000)	(82,100 to 170,000)	(76,600 to 160,000)	(66,100 to 140,000)	(52,900 to 117,000)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5
10% substitution all foods, over 10 years	166,000	38,900	34,400	33,900	31,300	27,100
	(112,000 to 242,000)	(26,400 to 56,900)	(23,200 to 50,200)	(22,700 to 49,700)	(21,100 to 45,900)	(18,100 to 39,700)
30% substitution discretionary over 3 years	89,900	21,400	18,800	18,300	16,800	14,700
	(59,400 to 128,000)	(14,200 to 30,600)	(12,400 to 26,800)	(12,000 to 26,100)	(11,100 to 23,900)	(9,690 to 21,100)
Programs						
UK mass media campaign	2,190	560	485	435	373	334
	(1,090 to 4,040)	(280 to 1,030)	(242 to 896)	(216 to 807)	(185 to 692)	(166 to 614)
UK salt reduction program	42,900	10,200	8,990	8,700	7,980	7,010
	(29,100 to 63,600)	(7,020 to 15,100)	(6,170 to 13,300)	(5,890 to 12,900)	(5,410 to 11,900)	(4,710 to 10,400)

† The ratio is the ratio of age-standardised HALYs gained per capita of the population alive in base year (2023) in SES 1 compared to SES 5 0% discount rates are shown in *Supplementary Table 8.*

IMPACT ON ALL-CAUSE MORTALITY INEQUALITIES

Above we estimate the ratio of HALY gains (age standardised per capita of the population in base-year) for the most deprived versus least deprived quintiles of SEIFA; this showed that the interventions generate more HALYs per capita among deprived populations. However, that analysis does not tell us what the impact of the interventions are on the difference in all-cause mortality rates (ACMR) between the most and least deprived quintiles – the purpose of this section.

It helps first to have a heuristic example. Imagine that the age standardised ACMR in 2044 under BAU was forecast to be 300 per 100,000 among the most deprived SEIFA quintile and 200 per 100,000 among the least deprived. We would describe this inequality as a rate ratio of 1.5 (300/200) or a rate difference of 100 per 100,000 (300 – 200). Now imagine an intervention reduces these two ACMRs in 2044 to 290 per 100,000 among the most deprived and to 195 per 100,000 among the least deprived. That is all SES groups benefit, but the most deprived benefit more in absolute terms such that the ACMR rate difference is now 95 per 100,000 – or a 5% reduction in the absolute gap.[F]

Table 7 shows the percentage reductions in the age standardised ACMR for the most and least deprived SEFIA quintiles for each intervention scenario compared to BAU, and the percentage reduction in the ACMR rate difference between the most and least deprived quintiles of SEIFA. The reductions are small. For example, the package of mandatory Australian reformulation followed by stepping up to the mandatory UK reformulation results in a 0.176% and 0.109% reduction in the ACMR for the most and least deprived quintiles in 2044 compared with those under BAU. Nevertheless, because the reduction is greater among the most deprived, there is a reduction in the 'gap' or ACMR difference of 0.336% (95% UI 0.221% to 0.508%).[G]

All interventions shown in *Table 7* lead to modest reductions in the ACMR rate difference, with 95% UI excluding the null of 0%.

[F] Note the magnitude of change in ACMR inequalities varies if one asks the question on a *relative* scale. In this heuristic example, the RR changes from 1.5 to 1.487 (i.e. 290/195) which is a 2.6% reduction in the relative inequality (i.e. 1 – (1.5-1)/(1.487-1)). For this Report, we focus on the changes in the absolute gap (or age-standardised ACMR difference).

[G] The age-standardisation used in these calculations is for all ages; had we presented, say, the age-standardised ACMRs and rate differences for 65+ year olds the percentage changes would have been somewhat greater given sodium related mortality is more common at older ages.

Table 7: Percentage reduction in age standardised all-cause mortality rate (ACMR) difference (gap) between SEIFA 1 and SEIFA 5 in 2044, for interventions each compared with BAU

Intervention	% reduction in ACMR c.f. BAU by SEFIA quintile		% reduction in ACMR difference between the most and least deprived SEIFA quintiles	
	SEFIA 1	SEIFA 5		
Reformulation				
Mandatory - Australia (100% Compliance)	0.0832%	0.0511%	0.158%	(0.105% to 0.241%)
Australia 90% compliance	0.0748%	0.0461%	0.143%	(0.0943% to 0.217%)
Australia 70% compliance	0.0579%	0.0357%	0.111%	(0.0738% to 0.168%)
Australia 50% compliance	0.0416%	0.0256%	0.0796%	(0.0529% to 0.122%)
Mandatory UK (100% compliance)	0.183%	0.113%	0.350%	(0.228% to 0.523%)
UK 90% compliance	0.165%	0.102%	0.315%	(0.206% to 0.474%)
UK 70% compliance	0.128%	0.0796%	0.245%	(0.160% to 0.367%)
UK 50% compliance	0.0921%	0.0572%	0.176%	(0.115% to 0.262%)
Mandatory WHO	0.303%	0.182%	0.590%	(0.393% to 0.867%)
Mandatory Aus followed by UK (100% compliance)	0.176%	0.109%	0.337%	(0.221% to 0.508%)
Substitution of NaCl with KCl				
30% immediate substitution of all foods	0.683%	0.366%	1.42%	(0.956% to 2.06%)
10% substitution all foods, over 10 years	0.196%	0.117%	0.381%	(0.254% to 0.566%)
30% substitution discretionary over 3 years	0.109%	0.0653%	0.211%	(0.140% to 0.308%)
Programs				
UK mass media campaign	0.00319%	0.00188%	0.00629%	(0.00301% to 0.0122%)
UK salt reduction program	0.0508%	0.0306%	0.0990%	(0.0663% to 0.147%)

MORBIDITY IMPACT

The HALY is a composite measure of mortality rate reduction (due to lower disease mortality rates) and impacts of morbidity rates (due to less prevalent disease). As societies age, the morbidity impacts take on more relevance. One way to look at morbidity rate impacts is to consider the morbidity rate of a 65-year-old under BAU and determine under the intervention how many days into the future this morbidity rate is deferred. We deliberately select this metric as it can be cross walked to how much preventive interventions can allow the retirement age (and/or age of eligibility for government pensions) to be deferred. We emphasise that society may which to reap the rewards of lower morbidity through a longer healthy retirement rather than a longer working life – the purpose of our metric is purely to allow "policy thinking" about the potential use of morbidity reduction dividends in societal domains other than health.

Table 8 shows the number of days beyond the age of 65 (in the year 2040) that the morbidity rate of a 65-year-old in BAU is experienced under each intervention. Putting aside the immediate 30% KCl substitution intervention, the impacts range from less than a day for the UK mass media intervention to nearly 11 days for the Mandatory WHO benchmark reformulation. There was little difference by quintile of socioeconomic strata in the 'day shifts' of morbidity.

It is useful to estimate by how much population wide income would increase if individuals and society chose to use these morbidity reductions to extend work lives. Our modelling embeds an average income per day for a 65-year-old female of $26,500 and $42,900 for males – or an average across sexes of $34,700. (These average incomes are across all 65-year-olds, be they in the workforce or not.) Using the Mandatory WHO intervention as an example, there were 292,000 person years lived under the WHO mandatory intervention by people aged 65 in 2040. Therefore, if society chose to fully 'cash in' the morbidity gain (10.97 day shift out of the morbidity a 65-year-old experiences under BAU) by pro-rata increasing the average citizens working-life, that equates to a benefit to society of Aus$304 million in 2040 (292,000 × [10.97/365.25] × $34,700 = $304 million; or $181 million in 2023 dollars, using a 3% per annum discount rate).[H]

[H] Whilst beyond the scope of this Report to estimate total 20-year and lifetime income gains from extending the working life of citizens beyond the age of 65 years due to morbidity reductions, their magnitude is likely at least as large as the <65 year olds increases in income we present in the Income Productivity Impacts section of this Report Income Productivity Impacts (page 49).

Table 8: Morbidity impacts of interventions, expressed as the number of days that the morbidity rate of a 65-year-old in BAU is shifted out beyond 65 years of age under each intervention – in 2040

	All	SES1	SES2	SES3	SES4	SES5
Reformulation						
Mandatory - Australia (100% Compliance)	2.94	3.10	2.89	2.94	2.94	2.88
Australia 90% compliance	2.64	2.80	2.61	2.66	2.65	2.60
Australia 70% compliance	2.06	2.18	2.03	2.07	2.06	2.02
Australia 50% compliance	1.47	1.56	1.45	1.48	1.47	1.44
Mandatory UK (100% compliance)	6.41	6.78	6.31	6.42	6.40	6.30
UK 90% compliance	5.77	6.11	5.69	5.80	5.78	5.69
UK 70% compliance	4.50	4.76	4.44	4.52	4.50	4.43
UK 50% compliance	3.22	3.41	3.18	3.23	3.22	3.17
Mandatory WHO	10.97	11.61	10.81	11.02	10.97	10.78
Mandatory Aus followed by UK (100% compliance)	6.06	6.38	5.96	6.08	6.07	5.97
Substitution of NaCl with KCl						
30% immediate substitution all foods	25.22	27.38	25.34	25.41	24.78	23.49
10% substitution all foods, over 10 years	6.19	6.52	6.07	6.23	6.21	6.08
30% substitution discretionary over 3 years	3.84	4.09	3.80	3.85	3.83	3.75
Programs						
UK mass media campaign	0.20	0.22	0.20	0.20	0.19	0.19
UK salt reduction program	1.83	1.95	1.81	1.83	1.82	1.78

EXPENDITURE: HEALTH, HEALTH + GOVERNMENT EXPENDITURE, HEALTH + GOVERNMENT + INDUSTRY

The expenditure impacts are more nuanced than the HALY gains. First, health expenditure is the change in future health expenditure due to changing disease incidence, and thence prevalence and mortality rates (as disease expenditure in first year of diagnosis, last year of life if dying of the disease, and otherwise prevalent) into the future and the changing population size. In the early years after an intervention, one usually sees reducing health expenditure as disease incidence rates decrease (with no change in case fatality and remission), meaning the prevalent pool decreases and therefore health expenditure decreases – a saving to the health system (or at least funding that can be allocated elsewhere). However, as time progresses the intervention also saves lives, seeing a slowly increasing population size and an aging population compared to BAU, both of which drive health expenditure up (due to the other competing diseases people get as they age). The expenditure we present here is cumulative over 20-years, and then cumulative over the lifetime of the population alive in 2019. The discount rate also matters: a 3% discount rate means that $1 spent in 10-, 20- and 40-years' time is valued at $0.74, $0.54 and $0.30; undiscounted results are shown as supplementary tables.

Turning to the results in *Table 9* below, the median health expenditure estimates for all interventions are negative (i.e. cost saving) with a 20-year time horizon, but then all flip to being a positive expenditure with a lifetime time horizon (except the UK mass media campaign intervention) – although 95% UI for a lifetime perspective straddle zero. (Note that the lifetime of those alive in 2023 perspective does not include people not alive in 2023 that – in the future when they are middle age – will have disease prevented saving health expenditure.)

The remaining columns sequentially add the 'intervention costs', namely the government costs (e.g. monitoring, regulatory frameworks) and then the industry costs (both the costs we *expect* the Industry to incur that allows for reducing costs over the long run as systems bed-in, and a more *conservative* (higher) industry-estimated cost). (The separate government and industry costs are shown in

Table 10, in addition to how they effect cumulative costings in *Table 9*). The net cost increases with sequential addition of government and industry intervention costs. For example, the sum of Health and government and Industry (expected not conservative) over the lifetime shown in the third to last column of *Table 9* has median net expenditure approximately double that of a health-only costing over a lifetime perspective – and with about half the 95% UI excluding zero, although uncertainty intervals are wide.

We interrogate these costs further below, alongside income productivity and income tax effects, and jointly with HALY gains as cost-effectiveness planes and incremental cost-effectiveness rations.

Table 9: Expenditure in Aus$ millions: Health, Health + government Expenditure, and Health + government + Industry (both expected and conservative); 3% discount rate; 20-year and lifetime perspectives

	Health - 20 Years	Health - Lifetime	Health + Govt - 20 years	Health + Govt - Lifetime	Health + Gov + Industry (expected) - 20 years	Health + Gov + Industry (expected) - Lifetime	Health + Gov + Industry (conservative) 20 years	Health + Gov + Industry (conservative) - Lifetime
Reformulation								
Mandatory - Australia (100% Compliance)	-265	242	-209	361	-67.8	501	-4.31	575
	(-401 to -141)	(-283 to 1,030)	(-347 to -82.2)	(-170 to 1,160)	(-223 to 116)	(-30.9 to 1,300)	(-180 to 236)	(34.5 to 1,370)
Australia 90% compliance	-238	221	-182	340	-55.8	473	2.56	534
	(-361 to -126)	(-260 to 939)	(-305 to -66.2)	(-150 to 1,060)	(-197 to 110)	(-22.0 to 1,180)	(-158 to 216)	(37.1 to 1,250)
Australia 70% compliance	-184	170	-129	288	-30.0	392	15.0	441
	(-280 to -99.8)	(-204 to 731)	(-228 to -42.3)	(-92.7 to 846)	(-139 to 96.3)	(13.6 to 948)	(-108 to 181)	(53.5 to 999)
Australia 50% compliance	-132	123	-75.7	242	-5.61	314	26.4	347
	(-202 to -70.3)	(-138 to 518)	(-149 to -10.8)	(-26.6 to 644)	(-83.2 to 87.2)	(45.8 to 725)	(-63.8 to 147)	(71.9 to 756)
Mandatory UK (100% compliance)	-558	697	-500	819	-271	1,050	-163	1,160
	(-861 to -277)	(-549 to 2,630)	(-807 to -214)	(-425 to 2,760)	(-613 to 88.1)	(-215 to 3,020)	(-528 to 261)	(-124 to 3,150)
UK 90% compliance	-502	639	-445	755	-240	960	-143	1,060
	(-774 to -249)	(-485 to 2,390)	(-723 to -191)	(-378 to 2,530)	(-546 to 83.0)	(-182 to 2,780)	(-469 to 243)	(-83.3 to 2,900)
UK 70% compliance	-392	495	-335	612	-175	769	-100	846
	(-605 to -193)	(-372 to 1,880)	(-553 to -139)	(-261 to 2,010)	(-408 to 75.1)	(-132 to 2,220)	(-352 to 196)	(-75.2 to 2,300)
UK 50% compliance	-280	357	-224	474	-110	591	-55.6	649
	(-435 to -138)	(-277 to 1,350)	(-380 to -79.7)	(-159 to 1,470)	(-283 to 71.5)	(-65.3 to 1,610)	(-241 to 159)	(-13.3 to 1,690)
Mandatory WHO	-974	809	-917	929	-515	1,330	-336	1,520

The health and cost impacts of sodium reduction interventions

	Health - 20 Years	Health - Lifetime	Health + Govt - 20 years	Health + Govt - Lifetime	Health + Gov + Industry (expected) - 20 years	Health + Gov + Industry (expected) - Lifetime	Health + Gov + Industry (conservative) 20 years	Health + Gov + Industry (conservative) - Lifetime
	(-1,470 to -542)	(-1,100 to 3,530)	(-1,410 to -484)	(-977 to 3,650)	(-1,070 to 35.0)	(-602 to 4,110)	(-959 to 379)	(-462 to 4,340)

	Health - 20 Years	Health - Lifetime	Health + Govt - 20 years	Health + Govt - Lifetime	Health + Gov + Industry (expected) - 20 years	Health + Gov + Industry (expected) - Lifetime	Health + Gov + Industry (conservative) 20 years	Health + Gov + Industry (conservative) - Lifetime
Mandatory Aus followed by UK (100% compliance)	-501 (-763 to -257)	703 (-518 to 2,580)	-445 (-708 to -201)	820 (-401 to 2,700)	-231 (-493 to 13.4)	1,030 (-186 to 2,910)	-127 (-390 to 117)	1,140 (-83.1 to 3,010)
Substitution of NaCl with KCl								
30% immediate substitution of all foods	-2,410 (-3,630 to -1,400)	1,290 (-2,860 to 6,750)	N/A	N/A	N/A	N/A	N/A	N/A
10% substitution all foods, over 10 years	-466 (-713 to -277)	682 (-608 to 2,570)	-428 (-672 to -223)	780 (-520 to 2,640)	-377 (-620 to -176)	942 (-351 to 2,820)	-377 (-620 to -176)	942 (-351 to 2,820)
30% substitution discretionary over 3 years	-329 (-499 to -182)	310 (-389 to 1,260)	-291 (-462 to -136)	407 (-304 to 1,350)	-254 (-428 to -97.0)	490 (-217 to 1,430)	-254 (-428 to -97.0)	490 (-217 to 1,430)
Programs								
UK mass media campaign	-21.2 (-43.6 to -8.61)	-3.37 (-20.5 to 13.3)	5.31 (-17.6 to 24.0)	23.4 (4.07 to 43.8)	5.31 (-17.6 to 24.0)	23.4 (4.07 to 43.8)	5.31 (-17.6 to 24.0)	23.4 (4.07 to 43.8)
UK salt reduction program	-156 (-240 to -83.5)	135 (-187 to 627)	-72.6 (-161 to 4.73)	282 (-51.7 to 759)	149 (-0.180 to 384)	519 (145 to 1,060)	255 (58.6 to 587)	633 (225 to 1,230)

†A 30% substitution of KCl across all foods is included more as a ‘magic wand’ intervention to assess maximal hypothetical sodium intervention impacts. For the purposes of this Report, it was not considered feasible to implement – and was not costed for its government and Industry costs.
0% discount rates are shown in *Supplementary Table 9*

Table 10: Government and industry costs of implementing the interventions , 20-year time horizon and 3% discount rate

	Government costs		Industry costs – expected		Industry costs - conservative	
	Median	**(95% UI)**	**Median**	**(95% UI)**	**Median**	**(95% UI)**
Reformulation						
Mandatory - Australia (100% Compliance)	55.6	(37.6 to 82.3)	133	(64.8 to 274)	198	(96.0 to 407)
Australia 90% compliance	55.6	(37.6 to 82.3)	120	(58.3 to 247)	178	(86.4 to 366)
Australia 70% compliance	55.6	(37.6 to 82.3)	93.3	(45.3 to 192)	138	(67.2 to 285)
Australia 50% compliance	55.6	(37.6 to 82.3)	66.7	(32.4 to 137)	98.8	(48.0 to 203)
Mandatory UK (100% compliance)	55.6	(37.6 to 82.3)	222	(108 to 457)	329	(160 to 678)
UK 90% compliance	55.6	(37.6 to 82.3)	200	(97.2 to 412)	296	(144 to 610)
UK 70% compliance	55.6	(37.6 to 82.3)	156	(75.6 to 320)	230	(112 to 474)
UK 50% compliance	55.6	(37.6 to 82.3)	111	(54.0 to 229)	165	(80.0 to 339)
Mandatory WHO	55.6	(37.6 to 82.3)	374	(182 to 770)	554	(269 to 1,140)
Mandatory Aus followed by UK (100% compliance)	55.6	(37.6 to 82.3)	214	(104 to 441)	318	(154 to 654)
Substitution of NaCl with KCl						
30% immediate substitution of all foods	N/A		N/A		N/A	
10% substitution all foods, over 10 years	35.8	(16.3 to 78.4)	48.3	(22.1 to 106)	48.3	(22.1 to 106)
30% substitution discretionary over 3 years	35.8	(16.3 to 78.4)	33.6	(15.3 to 73.5)	33.6	(15.3 to 73.5)
Programs						
UK mass media campaign	26.6	(17.9 to 39.3)	0.00	(0.0 to 0.0)	0.00	(0.0 to 0.0)
UK salt reduction program	82.2	(55.5 to 122)	222	(108 to 457)	329	(160 to 678)

INCOME PRODUCTIVITY IMPACTS

In a similar way to how differences in health expenditure between the interventions and the BAU comparator are tallied up in the simulation modelling, so too are income differences. Specifically, we use analyses of longitudinally linked health and tax data from NZ (such data does not yet exist for Australia) to determine the within individual differences in income earnings between people with and without disease, and further disaggregated by first year of diagnosis with a disease, last year of life and dying of that disease and otherwise prevalent with that disease. Such data is rare internationally. These NZ estimates of income loss by disease phase are then purchase power parity adjusted to Australia, and 'attached' to disease states in the model for the 25- to 64-year-old working-age population. Note that the force of increasing total population income under interventions is due to two drivers: people not having disease under the intervention (yet who would still have been alive under BAU, but with the disease); and simply due to more 25- to 64-year-olds alive and working under the intervention scenario.

Table 11 shows the estimated income gains in $Aus millions discounted at 3% per annum to 2023 real-dollars. The income gains are substantial, and (unlike net health expenditure) *increase* by two- to three-fold for a lifetime perspective compared to a 20-year time horizon. The largest income gains of $2.45 billion in the next 20 years (95% UI $1.72 to $3.46 billion) and $6.07 billion over the remainder of the population's lifespan (95% UI $4.2 to $8.63 billion) is for the 'magic wand' intervention of immediate substation of 30% of NaCl across the whole food system with KCl. These are discounted at 3% per annum; the median estimates undiscounted are $3.63 and $15 billion for a 20-year and lifetime perspective (*Supplementary Table 10, page 87*).

For the remaining interventions, the 3% discounted income gains in the first 20 years / lifetime range from $24.6 million / $29.2 million for the UK mass media campaign to $886 million / $2.45 billion for the WHO mandatory benchmarks (*Table 11*).

The income gains in *Table 11* are just those estimated among the <65-year-old population due to more people without disease. Above (page 41) we tentatively estimated that if individuals and society 'cashed in' the morbidity reductions about the age of 65 years due to Mandatory WHO reformulation, that the population income in 2040 might be $181 million greater (3% discount rate). This estimate is just for the year 2040, not cumulative over the first 20 years let alone lifetime. If we now compare this to the 20-year time horizon gain in income of $886 million among <65 year olds (*Table 11*), it is plausible to hypothesise that the income gains from citizens working longer beyond the age of 65 years may be considerably larger again.

Table 11: Income gains among 25- to 64-year-olds ($Aus millions, 3% discount rate) in next 20 years and over the lifetime for each intervention compared to BAU

	20-year time horizon		Lifetime horizon	
Reformulation	Median	(95% UI)	Median	(95% UI)
Mandatory - Australia (100% Compliance)	236	(165 to 336)	647	(448 to 925)
Australia 90% compliance	212	(147 to 303)	583	(402 to 835)
Australia 70% compliance	165	(114 to 235)	455	(310 to 644)
Australia 50% compliance	118	(82.4 to 167)	325	(224 to 465)
Mandatory UK (100% compliance)	516	(361 to 740)	1,410	(974 to 2,030)
UK 90% compliance	465	(324 to 664)	1,270	(879 to 1,820)
UK 70% compliance	362	(252 to 516)	989	(683 to 1,410)
UK 50% compliance	260	(181 to 372)	708	(489 to 1,020)
Mandatory WHO	886	(613 to 1,240)	2,450	(1,660 to 3,440)
Mandatory Aus followed by UK (100% compliance)	442	(311 to 623)	1,330	(927 to 1,890)
Substitution of NaCl with KCl				
30% immediate substitution of all foods	2,450	(1,720 to 3,460)	6,070	(4,200 to 8,630)
10% substitution all foods, over 10 years	387	(268 to 548)	1,590	(1,080 to 2,270)
30% substitution discretionary over 3 years	307	(214 to 429)	903	(617 to 1,260)
Programs				
UK mass media campaign	24.6	(12.3 to 44.9)	29.2	(14.3 to 53.6)
UK salt reduction program	155	(108 to 218)	436	(300 to 615)

0% discount rates are shown in *Supplementary Table 10.*

NET COSTS BY PERSPECTIVE: HEALTH + GOVERNMENT EXPENDITURE; HEALTH + GOVERNMENT; SOCIETAL

It is useful to consider the net cost of the interventions. This requires selecting perspectives; we present three:

1. *Health + government (Govt) Expenditure*. This is a health perspective (i.e. changes in future health system expenditure due to changing disease rates and population size), extended out to include the immediate and direct Govt costs of implementing the intervention (i.e. the cost of monitoring and enforcement).
2. *Health + Govt*. This perspective extends out further to include the revenue changes for government, which is the gain in income tax in the future from a healthier <65 year-old working age population. Note that we do not include any increase in income tax revenue from 65+ year olds working longer due to better health. Also note that we assume a 23% marginal income tax rate that when multiplied by the total income gains (*Table 11* above) gives the income tax gains.[l]
3. *Societal* (Health + Govt + Industry + Citizen). This perspective extends out to include the industry costs (expected, not conservative) and the post-tax income gains to citizens.

Figure 2 shows the net costs for these three perspectives, for a 20-year time horizon. The dollar values are treated as:

- negative if it is a:
  - decrease in expenditure
  - increase in revenue
- positive if it is a:
  - increase in expenditure
  - decrease in revenue.

Thus, the x-axis can be treated as net cost (i.e. further to left is better, further to right is worse).

The first panel of results in *Figure 2* is for the mandatory Australian reformulation targets. From a *Health + Govt Expenditure* perspective, there is negative health expenditure (i.e. savings to the health system due to reduced disease rates) and a positive government intervention expenditure (i.e. the cost to government of monitoring and implementing the targets as policy). The net of these two components is a $208 million lower expenditure. From a wider *Health + Govt* perspective, we include increases in revenue due to increased income tax (due to a healthier population earning more), leading to the government being better off again by $262 million compared to BAU. From a wide *Societal* perspective,

[l] This calculation is an approximation only. In future analyses (beyond the scope of this Report) the sex by age marginal income tax rates for Australia should be applied within the simulation modelling – and possibly extended to include sex by age by SEIFA income losses by disease, accompanied by sex by age by SEIFA marginal income tax rates. The 23% estimate was the average marginal tax rate of 55–59-year-old males and females in Australia, provided by the Grattan Institute (derived using Australian Bureau of Statistics census data 2021). We use this 23% value as the health impacts, and therefore income impacts, will be skewed more to the upper end of the working-age population (as their disease rates are higher). We note that the marginal income tax rate estimated by the Grattan Institute was approximately 25% for<55-year-olds, and 21% for 60-64 year olds.

we include the costs to industry and the post-tax income gains to citizens; society is $301 million better off with the mandatory Australian reformulation intervention compared to BAU, for a 20-year time horizon and the costs that we were able to include.

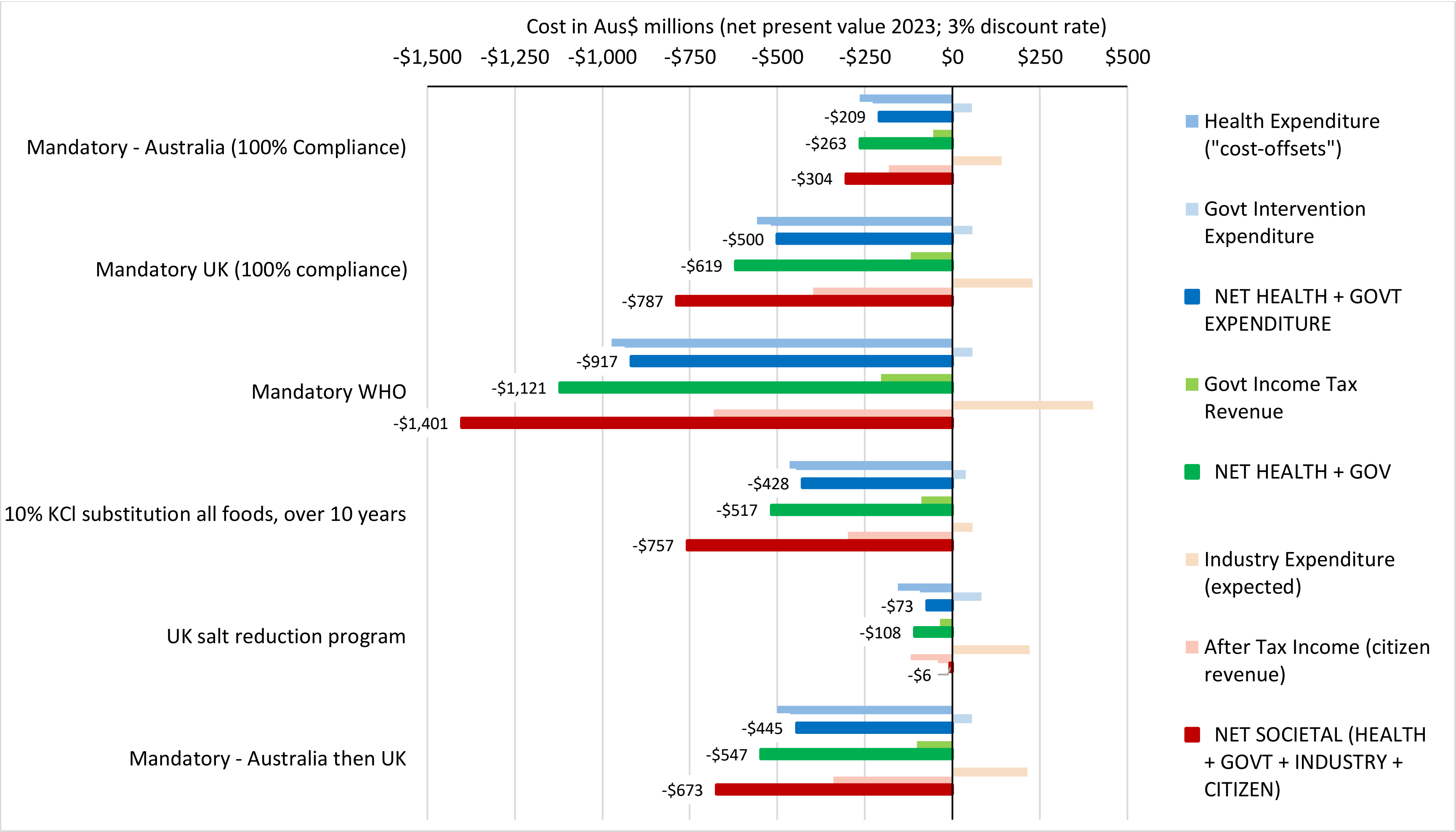
The next two panels (UK and WHO reformulation interventions) are similar in pattern to the Australian mandatory reformulation intervention, but with magnitudes of costs being approximately two and a half- and four-fold greater.

The 10% KCl substitution over all foods intervention is similar in pattern and magnitude to the UK Mandatory reformulation intervention. One notable exception is the lesser costs to industry, as our costings for KCl substation were estimated as considerably less than reformulating foods – at least over a 20-year time horizon.

The UK salt reduction programme is net cost saving from both *Health + Govt Expenditure* and *Health + Govt* perspectives, but from a *Societal* perspective is essentially a zero (actual estimate 3 million) net cost over a 20-year time horizon).

In sum, all interventions are favourable on net costs from all three perspectives (*Health + Govt Expenditure*, *Health + Govt*, and *Societal*) over a 20 year time horizon.

Figure 2: Net costs of selected interventions, for a 20-year time horizon (3% discount rate) and from varying perspectives



COST EFFECTIVENESS PLANES AND INCREMENTAL COST EFFECTIVENESS

An integrated analysis of health gains and costs can be achieved with cost-effectiveness planes (and incremental cost-effectiveness ratios presented in the next section). A cost-effectiveness plane is a scatter plot with the health gains on the x-axis, and the net-costs on the y-axis.

In public health research, the standard perspective to use is a health system perspective, with inclusion of government costs to implement the intervention, i.e. what we call *Health + Govt Expenditure*. *Figure 3* shows the cost effectiveness plane for this perspective, for a 20-year time horizon. Other than the UK mass media intervention, all interventions are in the southeast quadrant where health gains are accompanied by less expenditure, meaning the interventions are strongly favoured as (over a 20-year time horizon, at a 3% annual discount rate, and considering health and upfront government intervention expenditure) one is both gaining health and saving money.

Figure 3b layers over the 95% uncertainty intervals for both HALYs gained and net costs, reminding us that each 'dot' has uncertainty about its exact location on the cost effectiveness plane. Nevertheless, most interventions have error bars contained within the southeast quadrant of the plane.

Not conveyed in *Figure 3b* is uncertainty about the ranking of interventions. Whilst the error bars for many interventions overlap, the error bars are for each intervention compared to BAU (or the origin 0,0 on the cost effectiveness plane). It was beyond the scope of this Report to directly determine the uncertainty of each intervention compared with other interventions. However, because many of the uncertainties in each intervention are correlated (e.g. future disease rates in BAU), there will be less uncertainty in the ranking of interventions than that conveyed in *Figure 3b.*

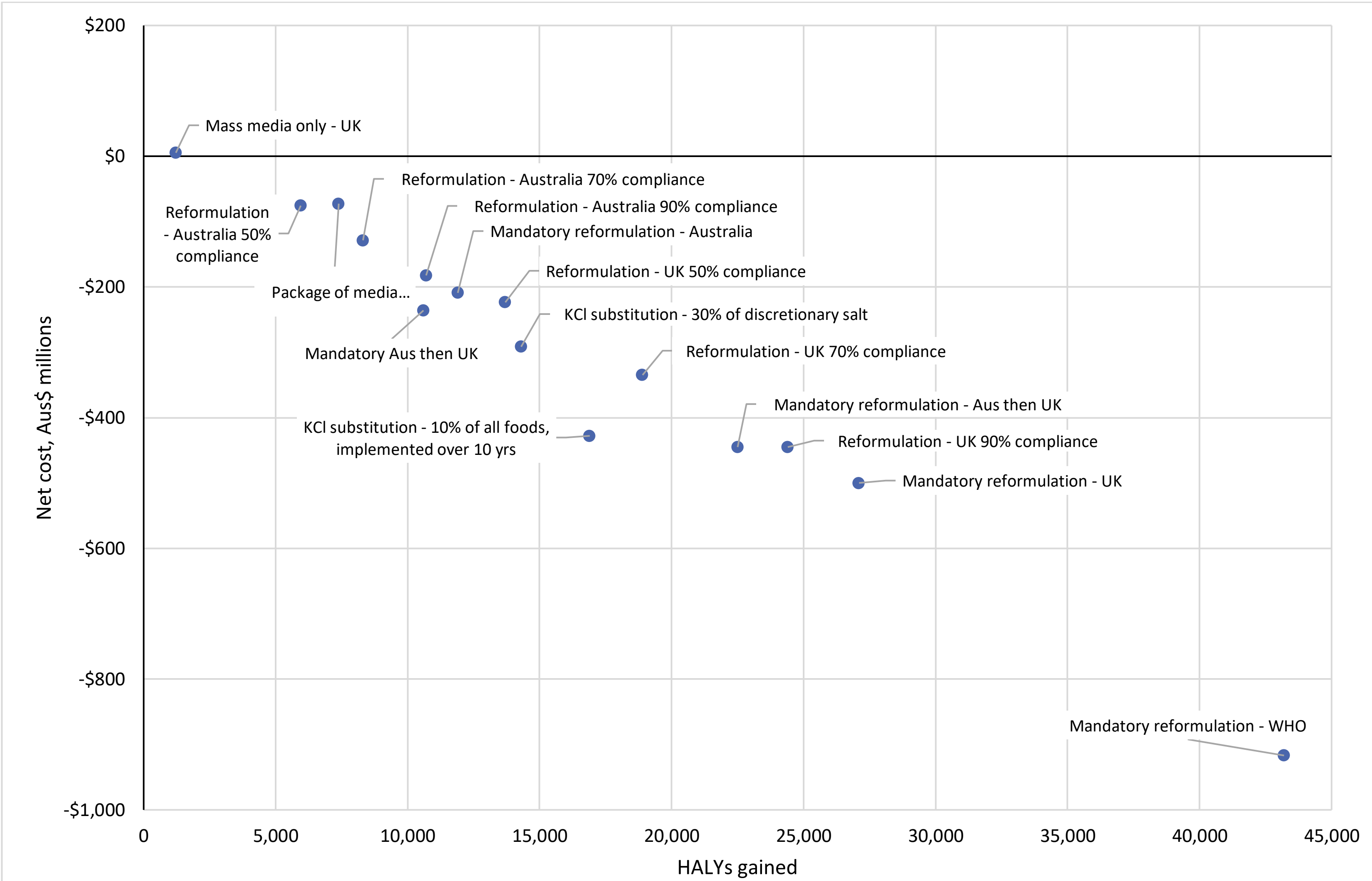
Figure 4 shows the cost effectiveness plane for a lifetime horizon, from the *Health + Govt Expenditure* perspective. The 'dots' now largely move to the northeast quadrant where one is incurring cost to gain health. A rule of thumb is that countries tend to spend up to their GDP per capita per HALY or QALY gained when funding pharmaceuticals and devices, or a threshold of about Aus$90,000 per HALY gained. *Figure 4* also shows willingness to pay radial lines for $5,000 per HALY gained (blue dotted line) and $1,000 per HALY gained (green dotted line). Most interventions are about $5,000 per HALY gained, well beneath the 'good buy' threshold of $90,000 per HALY gained.

Table 12 (*page 58)* presents the incremental cost effectiveness ratios (cost per HALY gained) for each intervention, from a *Health + Govt Expenditure* perspective, for both 20-year and lifetime (of the cohort alive in 2019) time horizons. Consistent with the cost effectiveness planes, all interventions other than just education are 'cost saving' for a 20-year time horizon, and for a lifetime horizon the uncertainty intervals span from cost saving to $14,900 per HALY gained.

All the incremental cost effectiveness ratios in *Table 12* are incremental to BAU. However, the Mandatory Australia then UK reformulation should be considered incremental to Mandatory Australia alone. Such an incremental analysis from a 20-year time horizon is still cost saving with health gains. From a lifetime perspective, the incremental HALY gain is 81,900, and the incremental cost is $459 million – an incremental cost effectiveness ratio of $5,600 per HALY gained.

Figure 3: Cost effectiveness plane: 20-year time horizon, 3% discount rate, Health + government Expenditure perspective

(a) With intervention name labels



The “30% immediate substation KCl all foods” is not shown as it was not considered feasible and therefore not costed.

(b) With uncertainty intervals as error bars

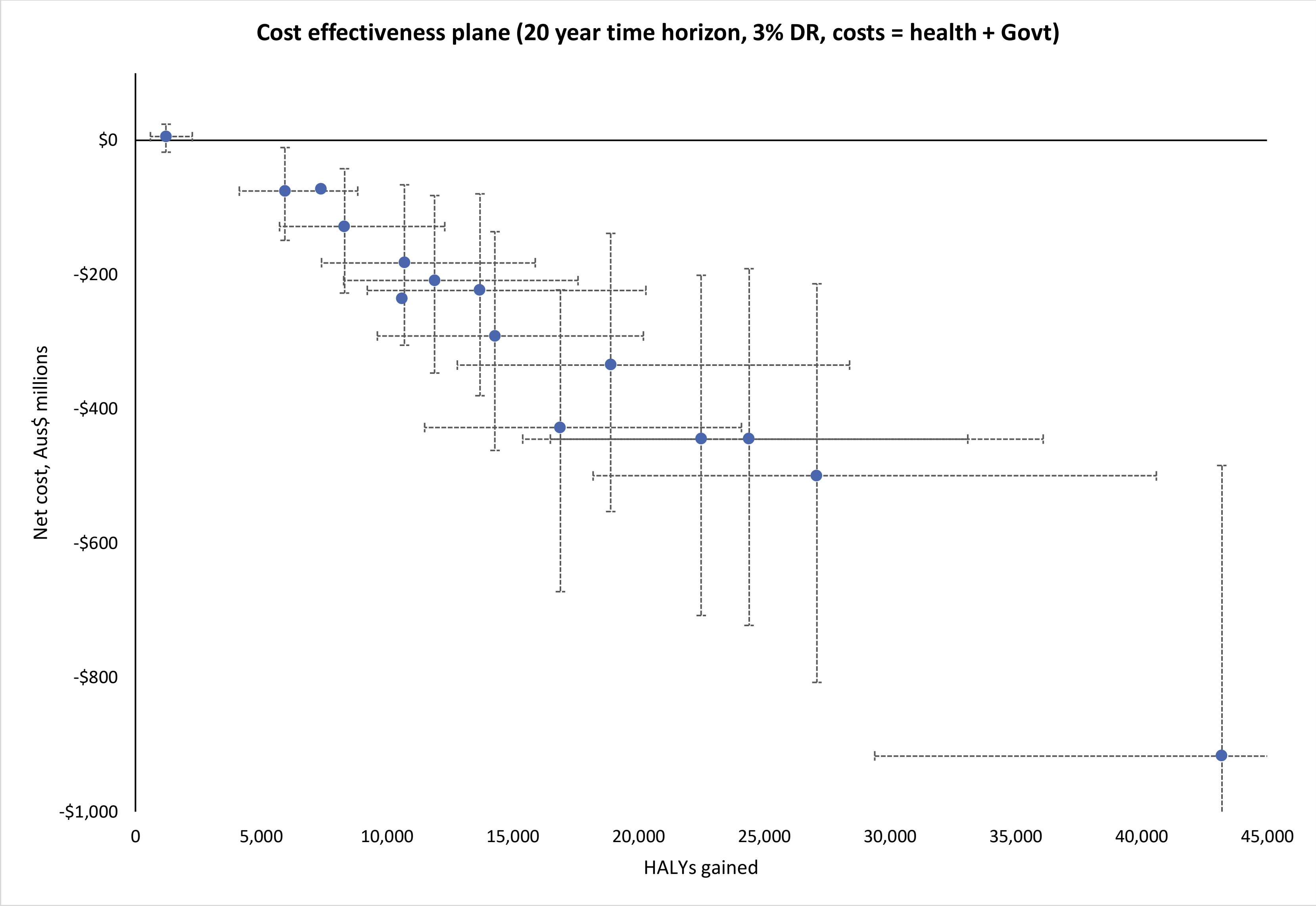
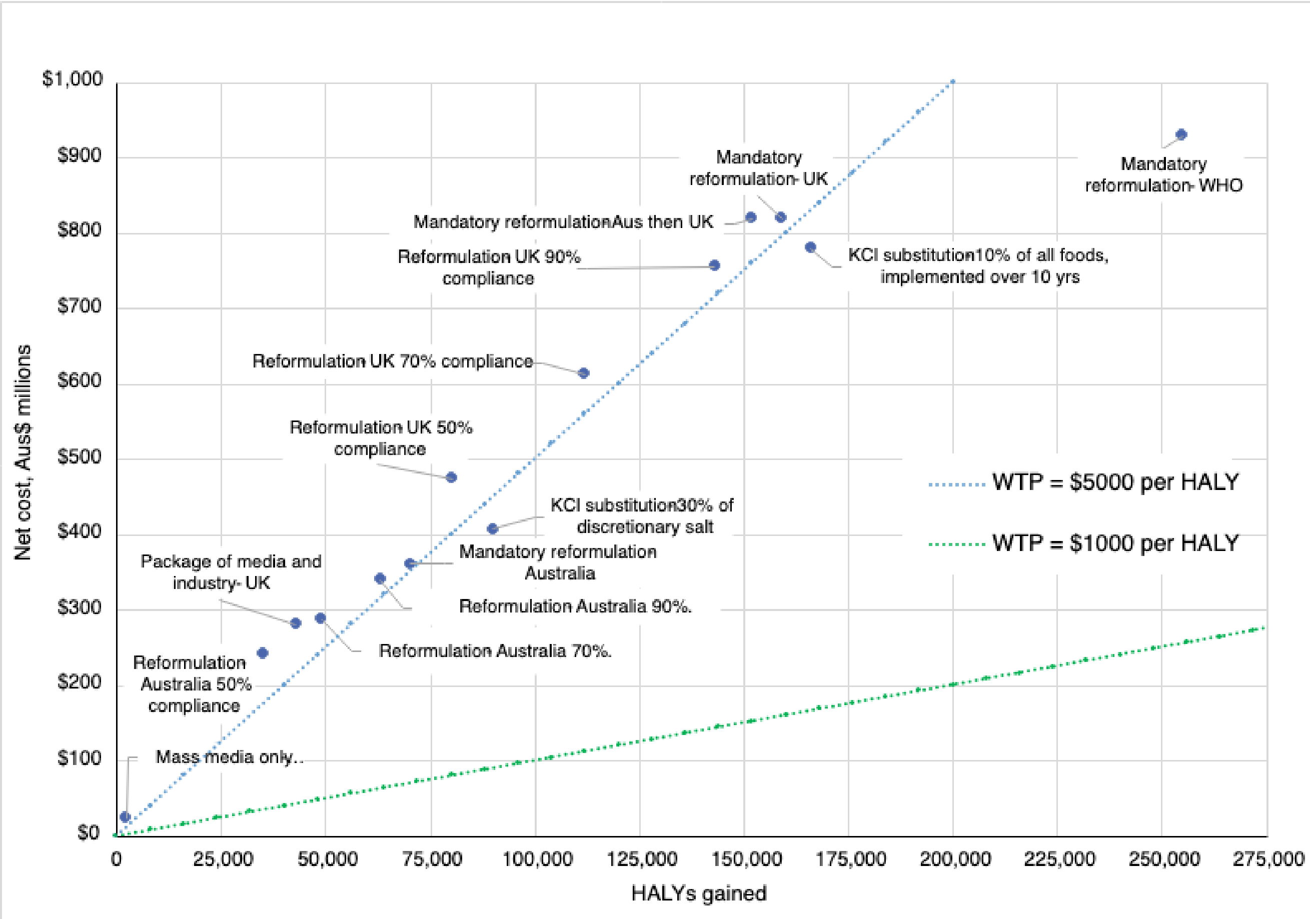


Figure 4: Cost effectiveness plane: lifetime time horizon, 3% discount rate, Health + government Expenditure perspective (WTP = willingness to pay per HALY radians)



The "30% immediate substation KCl all foods" is not shown as it was not considered feasible and therefore not costed.

Table 12: Incremental cost effectiveness ratio (each intervention c.f. BAU; Aus$ per HALY gained) from the *Health + Govt Expenditure* perspective, 3% discount rate: 20 year and lifetime horizons

Intervention	20 years	Lifetime
Reformulation		
Mandatory - Australia (100% Compliance)	Cost Saving	5,190
		(Cost Saving to 13,200)
Australia 90% compliance	Cost Saving	5,440
		(Cost Saving to 13,200)
Australia 70% compliance	Cost Saving	6,010
		(Cost Saving to 13,800)
Australia 50% compliance	Cost Saving	6,940
		(Cost Saving to 14,900)
Mandatory UK (100% compliance)	Cost Saving	5,170
		(Cost Saving to 13,200)
UK 90% compliance	Cost Saving	5,310
		(Cost Saving to 13,300)
UK 70% compliance	Cost Saving	5,560
		(Cost Saving to 13,500)
UK 50% compliance	Cost Saving	6,040
		(Cost Saving to 13,900)
Mandatory WHO	Cost Saving	3,730
		(Cost Saving to 11,500)
Mandatory Aus followed by UK (100% compliance)	Cost Saving	5,510
		(Cost Saving to 13,600)
Substitution of NaCl with KCl		
10% substitution all foods, over 10 years	Cost Saving	4,730
		(Cost Saving to 12,700)
30% substitution discretionary over 3 years	Cost Saving	4,520
		(Cost Saving to 12,400)
Programs		
UK mass media campaign	4,280	10,800
	(Cost Saving to 33,100)	(1,560 to 26,600)
UK salt reduction program	Cost Saving	6,640
	(Cost Saving to 767)	(Cost Saving to 14,400)

95% UI not given if median estimate 'cost saving'.

Figure 4 above uses the remaining lifetime of the population alive in 2023 as the time horizon. Whilst this is a common cohort-by-time-horizon approach to use in cost effectiveness analyses, it must be noted that (say) in 60 years' time only older people remain in the analysis for whom the intervention has extended their lives but they are now incurring costs to the health system; missing in the analysis are the new cohorts of people not yet born that will have lesser disease and health expenditure in their 40s and 50s due to the interventions. If these missing yet-to-be-born cohorts were included in the analysis, for something like a 60-year time horizon, all dots in *Figure 4* would move down (possibly into the highly favourable southeast quadrant). This highlights, again, that perspectives and time horizons matter in cost effectiveness analysis.

We have not presented cost effectiveness planes for all possible perspective and time horizons. However, we can make the following deductions of conclusions:

- For a 20-year time horizon, a wider Societal perspective will see all dots in the south east quadrant of being a 'good buy' as over 20 years one will both gain HALYs and be better off in terms of net costs.
- For a life-time horizon with conservative industry costings, all interventions except Australia reformulation with 50% compliance and the UK salt reduction program have a better net cost position under a *Societal* perspective – making them 'good buys'. (This net cost position can be generated by subtracting the lifetime incomes gains in *Table 11* from the lifetime Health + Govt + Industry (conservative) costs in the last column of *Table 9*.) For a lifetime horizon with expected industry costs, all interventions are in the southeast quadrant of both gaining health and being in a better net cost position.

DISCUSSION

KEY FINDINGS

This Report models the health and cost impacts of three reformulation interventions: the adoption of the Australian targets, the adoption of the UK targets applied to Australia, and the meeting of the WHO benchmark standards. These three target or benchmark reformulation interventions, if they are mandatory with 100% compliance, will achieve approximately 3%, 7% and 11% reductions in population sodium intake when applied to Australia (the actual reduction varies by sex and age; *Table 1*). This Report also models three KCl substitution interventions: a 'magic wand' immediate 30% substitution of KCl for NaCl across the whole food system [J], a 10% substitution of KCl for NaCl across the whole food system, implemented over 10 years; and a 30% substitution of KCl for NaCl in discretionary salt (i.e. salt added to food in the home). Finally, we modelled the UK sodium package intervention as implemented in the UK from 2003-2009, as well as just the mass media campaign, each applied to Australia now.

All interventions generate health gains in the first 20 years, ranging from 1,220 HALYs gained for the UK media-only intervention to nearly 100 times that for the 30% immediate KCl substitution for NaCl across the whole food system (112,000 HALYs gained; HALYs discounted at 3% per annum). Putting aside these media-only and 'magic wand' interventions, the range in HALYs gained was six-fold from 7,390 (95% UI 5,090 to 10,800) for the combined UK package to 43,200 (29,400 to 61,900) for the 100% or mandatory adoption of the WHO reformulation benchmark. The Australian reformulation targets achieved less than a third of the WHO benchmark, and the UK reformulation target was intermediary.

This Report also gives other health impacts of the sodium interventions. Briefly, HALY gains over a longer time horizon, namely the remainder of the lifetime of the population alive in 2019, where five- to six-fold greater than those in the first 20-years post intervention. The interventions generated 60% to 100% more HALYs per capita in the next 20 years for the most deprived quintile, compared to the least deprived quintile. However, the interventions only modestly (1% or less) reduced the forecast socioeconomic inequality or gap in all-cause mortality rates in 2040.

This Report includes economic analyses from three perspectives: (1) *Health + Govt Expenditure* that includes changes in future health expenditure due to decreasing disease rates, and the direct costs to government to implement the policies; (2) *Health + Govt* that extends the former perspective to a full government perspective to include increases in income tax revenue (due to a healthier and larger population earning more income); and (3) *Societal* that includes industry costs (that we assume will be passed on to consumers) and post-tax income gains to citizens. All interventions other than the media-only program were cost saving over the first 20 years post-intervention from all three perspective. Put another way, all but the media-only intervention achieved <u>both</u> health gains <u>and</u> a better economic position from these three perspectives in the first 20 years post-intervention.

[J] We call this intervention a 'magic wand intervention' as it allows no time for industry to incrementally implement, and we suspect may not be <u>policy</u> feasible in the short term. However, it is a useful intervention to model as it gives a <u>technically</u> feasible maximum impact sodium reformulation might have, given consumers find that beyond 30% substitution of KCl for NaCl the taste of food becomes too bitter. Put another way, it is an outer 'envelope' of the maximum potential health gains for sodium reformulation policies. Given it is a 'magic wand' intervention, we do not present its costs beyond just the changes in future health expenditure due to changing disease rates.

This Report focuses on the epidemiological and economic impacts of sodium interventions. A parallel Report by the Grattan Institute examines the policy implications more deeply, using the results of this current Report as one input. That Grattan Report recommends that Australia first makes its own sodium reformulation targets mandatory by 2027, then extends to the UK targets being mandatory by 2030 (unless they have been achieved on a voluntary basis). The SHINE modelling in this Report estimated that this 'Australian then UK mandatory sodium targets' intervention will:

- gain 22,500 HALYs (95% UI 15,400 to 33,100) in the Australian population over the next 20 years, and gain 152,000 discounted HALYs (101,000 to 229,000) over the remainder of the lifespan of the Australian population alive in 2023
- cost the government $55.6 million (95% UI 37.6 to 82.3) in regulatory and monitoring costs in the next 20 years
- cost the industry $214 million (95% UI 104 to 441) under what we assessed as most likely cost structures, or $318 million (95% UI 154 to 654) under conservative costing assumptions.
- save the health system $501 million (95% UI 257 to 763 million) over the next 20 years
- increase <65-year-olds gross incomes by $442 million (95% UI 311 to 623 million) in the next 20 years, with about 23% of this being increased income tax revenue to government.

If we reorganise the economic impacts of adopting the 'Australian then UK mandatory targets' intervention by perspectives, then:

- From a health perspective that also includes just the government intervention costs (the usual perspective used in preventive cost-effectiveness analyses), the net saving in the next 20 years is about $445 million (3% annual discount rate)
- Extending this perspective out to a full government perspective, to also include changes in income tax revenue, the net saving increases further to about $547 million in the next 20 years.
- Extending out further to a societal perspective, the post-tax gains in income to the population aged less than 65 years of age more than offset the costs to industry (that we assume will be passed on to consumers), meaning the net economic gain to society is about $673 million over the next 20 years.

Whilst not modelled in this Report, also implementing a 10% substitution of KCl for NaCl across the food system as well as the 'Australian then UK mandatory targets' intervention will likely achieve a nearly two-fold increase in both the health and economic benefits.

In sum, sodium interventions are triple win interventions: health gains are substantial; health inequalities will be somewhat reduced; and they are cost saving from health to societal perspectives. Reformulation of foods to have less sodium, are therefore a high public health priority.

COMPARISONS WITH PREVIOUS STUDIES

Many studies have demonstrated the health and cost effectiveness benefits of sodium reformulation interventions, e.g. [18, 20, 22, 27, 28, 45-48]. The closest previous study to this Report, being for Australia and using prospective simulation modelling (as opposed to a comparative risk assessment leveraging a burden of disease study) is Cobiac et al (2010).[20]They estimated that 610,000 HALYs would be gained over the remainder of the lifespan of the Australian population alive in 2003 if the Australian population reduced their sodium intake to 2.5 grams per day of sodium (or 6.35 grams per day of NaCl salt). Noting the average daily NaCl consumption of 9.6 grams per day [11], this equates to a 34% reduction in sodium – not too different from our 'magic wand' 30% substitution of KCl for NaCl in the food system (which results in a 28.5% reduction in daily sodium intake given 5% of sodium in the diet naturally occurs in foods). Our 30% KCl substitution intervention generated 554,000 HALYs gained. The population size in Australia in 2023 is about a third greater than the 2003 population size, but this is roughly cancelled out by the lower cardiovascular disease rates (that sodium interventions largely work through) in 2019 compared to 2003. Thus, the magnitude of our estimates is in keeping with Cobiac et al (2010).

How do the sodium interventions in this Report compare in magnitude of health gain to other - interventions? Recent comparable work, using similar modelling methodology, includes:

- A tobacco endgame strategy in Aotearoa New Zealand, for an intervention of very low nicotine cigarettes, 90% reduction in tobacco retail outlets and a tobacco-free generation where people born after 2006 are no longer legally able to purchase tobacco, resulting in tobacco smoking plummeting to near zero percent, resulted in 3% per annum discounted HALY gains of 57,000 in the first 20 year and 594,000 over the remaining lifespan of the NZ population.(49) Cross-walking that to the five times larger Australian population, that is approximately 300,000 and 3 million HALYs gained in 20 years and the remainder of the Australian population's lifespan, respectively – or about three and six times, respectively, the 112,000 and 554,000 HALY gains for the 30% KCl substitution across the whole food system intervention. Thus, unsurprisingly, a radical tobacco intervention has greater health gains than a somewhat radical sodium intervention.
- A NZ-based modelling study of a salt tax that resulted in a 12% reduction in population-wide sodium intake (and, due to cross-price elasticities and co-consumption, also resulted in 3% and 4% increases in fruit and vegetable intake, a 2.1% and 3.4% reduction in saturated and polyunsaturated fat intake, and a 1.9% reduction in BMI) generated 435,000 HALYs (3% discount rate) over the populations remaining lifespan.(50) Assuming similar diets and disease rates, and price elasticity responses to food price, in Australia as in NZ, this would translate to roughly 2.2 million HALYs – or nearly five times the HALY gains for the 30% KCl substitution intervention across all foods in this Report. At first glance, this discrepancy seems odd given the NZ intervention only reduced sodium intake by 12%. But a sodium tax also changes many other aspects of the diet and BMI (due to reduced energy intake due to salty foods costing more). Herein lies an important learning. Whilst sodium-only changes in the diet can have substantial health impacts, if wider changes in the diet can be achieved the health impacts can be much greater.
- An Australian-based study of eradicating cold housing (a 'magic wand' intervention that impacts health through changes in blood pressure and then cardiovascular disease, and directly changes respiratory and mental health) estimated 50,600 (95% UI 24,600 to 106,000) HALYs gained in the first 20 years, and 89,600 (47,700 to 177,000) HALYs gained over the remainder of the population's lifespan.(51) Two features of these findings are noteworthy: first, there was very wide uncertainty as (unlike sodium) the evidence of magnitude of effects is much more uncertain; and second, much of the health gain was in the first 20 years as much of the health gain is through mental health which is immediate and at younger ages. Thus, a 'magic wand' housing intervention has roughly the same health impact as 'actual' sodium reformulation interventions such as the Australian, UK and WHO targets and benchmarks. The housing study also estimated relative gains in HALYs by SEIFA quintile, finding them to be approximately six times greater per capita for the most compared to least deprived quintiles. That is, interventions to tackle cold housing have much greater relative benefits for deprived populations than population-wide sodium interventions – which is due to a large difference in the distribution of cold housing by the socio-economic position.
- An Australian-based 'magic wand' study of eradicating overweight and obesity (i.e. shifting everyone with a BMI of greater than 25 to 25) estimated 1.37 and 5.77 million 3% per annum discounted HALYs gained in the first 20 years and over the remaining lifespan of the Australian population.(52) This study also estimated that HALYs gained per capita in the first 20 years would be 2.5 times greater among the most compared to least deprived. The

magnitude of these health gains are far greater than the targeted sodium interventions in this Report. This is unsurprising given the high prevalence of overweight and obesity, and the many diseases association with BMI. That said, the overweight and obesity paper was a 'magic wand' modelling study that did not evaluate 'actual' interventions.

- The Australian Cost Effectiveness (ACE) Obesity Policy Study did evaluate many 'actual' interventions to tackle high body weight in Australia.[53] Lifetime HALY gains (3% per annum discount rate) included: 4,207 for a FOP intervention; 13,958 for a national mass media campaign related to sweetened sugary drinks; 63,492 for kilojoule labelling on fast food; and 175,300 for a 20% tax on sugar sweetened beverages. That is, for 'actual' interventions that policy partners working with the ACE-Obesity Policy Study considered feasible, the magnitude of health gain was similar to those we model in this Report for sodium interventions.

STRENGTHS

The strengths of the modelling in this Report include:

- The operationalization of the heterogeneity of the systolic blood pressure response to changing sodium, by age and initial blood pressure, as determined by Huang et al (2020).[19]
- The BAU epidemiological data by disease, and disease modelling, incorporating incidence, remission and case fatality rates derived from GBD data and forecast into the future.
- The stratification of the Australian population by socioeconomic strata.
- The inclusion of disease-related health expenditure by disease phase.[13, 14]
- The inclusion of disease related income loss [15], allowing a comparable and robust determination of income gains from interventions (and by extension estimation of changes in income tax)
- The comprehensive inclusion and simulation of uncertainty about all input parameters.

LIMITATIONS AND CAUTIONS

Simulating future health gains and cost impacts forces one to be explicit about the many input parameters and structural assumptions of what is related to what – which is a strength. But this structured thinking necessarily comes with assumptions and limitations that the reader must be aware of, including for this Report:

- Data on sodium intake is based on a meta-analysis of 32 Australian studies published from 1989 to 2015 [11] (as opposed to one large representative and recent 24 hour urinary sodium study), then disaggregated by us using relative differences by sex, age and socioeconomic position in selected Australian studies.[26] We believe sodium intake has not changed much in the last 10 years in Australia, but there is no direct empirical evidence on this.

- Disease incidence, case fatality and remission rates, and all-cause morbidity and mortality rates, are forecast based on trends from 1990 to 2019 out to 2034, then held constant. Such estimates are a scenario forecast – they may not actually be what occurs in the future. (No allowance is made for COVID-19 impacts on disease and mortality rates, which is equivalent to an assumption that future disease and mortality rates will revert to the underlying trends that existed pre-COVID-19.)

- The disease expenditure estimates are derived from an Australian Institute of Health and Welfare study [13], and disaggregated by disease phase (first year of diagnosis, last year of diagnosis if dying of that disease, and otherwise prevalent) using NZ data from the 2000s.[14] Future health expenditure by disease is likely to change due to technological innovations, patient demand and many other factors. The implicit assumption in the modelling in this Report is that those changes in the future – whatever they are – will still result in approximately the same disease-related expenditure once one sums across all disease states included in the modelling.

- Australia does not have the data necessary to estimate disease-related impacts on income, meaning we had to use NZ estimates [(15)] purchase power parity adjusted to Australia. Whilst NZ and Australian societies are similar, the assumption of similar losses in income due to disease is untested.

- The increases in income tax revenue to government were estimated as 23% of total income differences between the interventions and BAU. Future SHINE simulations will upgrade the modelling to make such estimates by sex, age and socioeconomic strata – but this was beyond the scope of this Report. Accordingly, the income tax estimates should be treated with caution. But given their contribution to an overall *Health + Govt* and *Societal* perspectives on net cost (*Figure 2*, *page* 52) was not overly influential, the costs are reliable.

- We did not extend the societal costings out to government pension payments (which will increased due to increased longevity).

- Estimating government and industry costs of implementing sodium reformulation and substation interventions is very uncertain. We incorporate wide uncertainty about these estimates, but also alert the reader and user to the assumptions and caveats outlined in our estimates of government and industry costs of interventions in *Appendix B:* Costing of interventions (undertaken by Grattan Institute) *(page* 91*).*

- It is standard practice in simulation and cost effectiveness studies of prevention in Australasia (e.g. ACE Prevention [(54)], BODE³ (www.otago.ac.nz/bode3) and Deakin's ACE-Obesity Policy Study [(53)]) to report the health and cost impacts of an intervention over the remainder of the lifetime of the population alive in a given 'base-year'. This may not be as useful as, say, reporting results for an open cohort (i.e. including new births, and possible migrants) over the next 20 year, 40 year and possibly longer time horizons, because following one cohort until the end of their lifetime means missing the contributions of younger adults (not yet born) in future years. Whilst beyond the scope of this Report, SHINE will in the future pivot to reporting open cohort findings. In this Report, though, we emphasise findings for the next 20-years rather than a lifetime time horizon for two reasons: first, the further one goes into the future the more uncertain the findings (although discounting somewhat lessens the influence of impacts many years into the future); second, any impact of 'missing' people is minimal by not including yet-to-be-born children and youth in the next 20 years for sodium reduction interventions that largely influence CVD in middle and older age groups.

POLICY RECOMMENDATIONS

All interventions evaluated in this Report are good 'value for money'. The education only intervention is limited in its magnitude of impact. Making the WHO benchmark levels of sodium in food has have the greatest impact (excluding the 'magic wand' 30% substitution by KCL for NaCl across the food system), followed by an application of the UK targets to Australia, and finally the Australian targets themselves. This suggests that the Australian targets are not ambitious enough.

This SHINE Report is published in parallel with a Grattan Institute Report that examines the policy implications of these findings in more depth[55]; we recommend readers use this Grattan Report for a deeper policy consideration.

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SUPPLEMENTARY TABLES

Supplementary Table 1: List of the food categories and their sodium reduction targets as part of the Australian government's Healthy Food Partnership's reformulation program

Food category	Sub-category	Target (mg/100g)
Bread	Leavened breads	380
	Flat breads	450
Cheese	Cheddar style cheeses	710
	Processed cheeses	1270
Crumbed and battered proteins	Meat and poultry	450
	Seafood	270
Gravies and sauces	Gravies and finishing sauces	450
	Pesto	720
	Asian style sauces	680
	Other savoury sauces	360
Pizza	Pizza	450
Processed meat	Ham	1005
	Bacon	1005
	Processed deli meat	720
	Frankfurts and saveloys	900
Sausages	Sausages	540
Savoury biscuits	Plain savoury crackers and biscuits	630
	Plain corn, rice and other cakes	270
	Flavoured biscuits, crackers and corn cakes	720
Savoury pastries	Dry pastries	500
	Wet pastries	400
Savoury snacks	Potato snacks	500
	Salt and vinegar snacks	810
	Extruded and pelleted snacks	720
	Vegetable, grain and other snacks	450
Soups	Soups	280
Sweet bakery	Cakes, muffins and slices	360

Supplementary Table 2: List of the food categories and their sodium reduction targets as part of the UK government's sodium reformulation program

Food category	Sub-category	Target (mg/100g)[1]
Meat products	Bacon	1150 (average)
	Ham/other cured meats	650 (average)
	Sausages (Fresh, chilled, frozen)	550
	Cooked sausages and sausage meat products	680
	Delicatessen, pork pies and sausage rolls	450
	Cornish and meat-based pasties	400
	Other meat-based pastry products	300
	Cooked uncured meat (Whole muscle)	270
	Cooked uncured meat (Reformed whole muscle)	360
	Cooked uncured meat (Comminuted or chopped reformed meat)	540
	Burgers and grill steaks	350
	Canned frankfurters, canned hotdogs and canned burgers	700
	Fresh chilled frankfurters	750
Bread	Bread and rolls	450
	Bread and rolls with additions	450
	Morning goods – yeast raised	350
	Morning goods – powder raised	500
Breakfast cereals	Breakfast cereals	400
Cheese	Cheddar and other similar 'hard pressed' cheeses	800
	Soft white cheese	270
	Cottage cheese – plain and flavoured	210
	Mozzarella	540 (average)
	Blue cheese	800 (average)
	Cheese spreads	720
	Other processed cheese	800
Butter	Salted butters and buttery spreads	670
	Lightly salted butter	450 (average)
Fat spreads	Margarines/other spreads	550
Baked beans	Baked beans in tomato sauce without accompaniments	225
	Baked beans and canned pasta with accompaniments	290
Ready meals and meal centres	Ready meals and meal centres	380

Food category	Sub-category	Target (mg/100g)[1]
Soups	Soups (as consumed)	250
Pizzas	All pizzas (as consumed)	500
Crisps and snacks	Standard potato crisps	580
	Extruded and sheeted snacks	800
	Pelleted snacks	1150
	Salt and vinegar products	1000
Cakes, pastries, fruit pies and other pastry-based desserts	Cakes	280
	Pastries	180
	Sweet pies and other shortcrust or choux pastry-based desserts	130
Bought sandwiches	Sandwiches with high salt fillings	600
	Sandwiches without high salt fillings	350
Table sauces	Tomato ketchup	680
	Brown sauce	480
	Salad cream	630
	Mayonnaise (not reduced fat/calorie)	500
	Mayonnaise (reduced fat/calorie only)	680
	Salad dressing	600
Cook-in and pasta sauces, thick sauces and pastes	Cook in and pasta sauces	370
	Pesto and other thick sauces	650
	Thick pastes	1500
Biscuits	Sweet biscuits	380
	Savoury biscuits	700
Pasta	Pasta and noodles, plain and flavoured	350
Rice	Rice (unflavoured), as consumed	70
	Flavoured rice, as consumed	230
Other cereals	Other cereals	250
Processed puddings	Dessert mixes, as consumed	180
	Cheesecake	140
	Sponge-based processed puddings	250
	All other processed puddings	110
Quiche	Quiches	270
Scotch eggs	Scotch eggs	310
Canned fish	Canned tuna	360 (average)
	Canned salmon	320 (average)

Food category	Sub-category	Target (mg/100g)[1]
	Other canned fish	600
Canned vegetables	Canned and bottled vegetables	50
	Canned processed, marrowfat and mushy peas	180
Meat alternatives	Plain meat alternatives	250
	Meat-free products	500
	Meat-free bacon	750
Other processed potatoes	Dehydrated instant mashed potato, as consumed	60
	Other processed potato products	275
Beverages	Dried beverages, as consumed	60
Stocks and gravies	Stocks, as consumed	380
	Gravy, as consumed	450

[1]The UK maximum salt target is displayed except for targets where no maximum target was set, in which case the average target as indicated by (average), was used as a maximum sodium target.

Supplementary Table 3: List of the food categories and their sodium reduction targets as part of the WHO's global sodium benchmarks

Main product category	Sub-categories	Benchmark
Cakes, sweet biscuits and pastries; other sweet bakery wares and dry-mixes for making such	Cookies/sweet biscuits	265
	Cakes and sponges	205
	Pies and pastries	120
	Baked and cooked desserts	100
	Pancakes, waffles and French toast	330
	Scones and soda bread	475
Savoury snacks	Crackers/savoury biscuits	600
	Nuts, seeds and kernels	280
	Potato, vegetable and grain chips	500
	Extruded snacks	520
	Pretzels	760
Breakfast cereals	Minimally processed breakfast cereals	100
	Highly processed breakfast cereals	280
Cheese	Fresh unripened cheese	190
	Soft to medium ripened cheese	520
	Semi-hard ripened cheese	625
	Mould ripened cheese, white and red	510
	Process cheese	720
Ready-made and convenience foods and composite dishes	Canned foods	225
	Pasta, noddles, and rice or grains with sauce or seasoned (prepared)	230
	Pasta, noddles, and rice or grains with sauce or seasoned (dry-mix, concentrated)	770
	Pizza and pizza snacks	450
	Sandwiches and wraps	430
	Prepared salads	390
	Ready-to-eat meals composed of a combination of carbohydrate and either vegetable or meat, or all three combined	250
	Soups (ready-to-serve, canned and refrigerated soups)	235
	Soups (dry soup only) (concentrated)	1,200
Butter and other fats and oils	Salted butter, butter blends, margarine and oil-based spreads	400
Bread, bread products and crisp breads	Sweet and raisin breads	310
	Leavened bread	330

Main product category	Sub-categories	Benchmark
	Flatbreads	320
Processed meat, poultry, game, fish and similar	Canned fish	360
	Processed fish and seafood products, raw	270
	Processed fish and seafood prdocts, not heat-treated	800
	Raw meat products and preparations	230
	Whole muscle meat products, heat treated (frozen and canned products)	270
	Whole muscle meat products, heat treated (refrigerated products)	600
	Whole muscle meat products, non-heat preservation	950
	Comminuted meat products, heat treated (cooked)	540
	Communited meat products, non-heat preservation	830
Processed fruit, vegetables and legumes	Canned vegetables and legumes	50
	Pickled vegetables	550
	Olives and sundried tomatoes	780
	Vegetable juice and cocktail	200
	Frozen vegetables and legumes	180
	Frozen potatoes and other potato products (ready-to-eat)	260
	Battered or breaded vegetables	510
Plant-based food/meat analogues	Tofu and tempeh	280
	Meat and analogues	250
Sauces, dips and dressings	Bouillon and soup stock (not concentrated)	350
	Bouillon and soup stock (concentrated)	15,000
	Cooking sauces including pasta sauces and tomato sauces (not concentrated)	330
	Dips and dipping sauces	360
	Emulsion-based dips, sauces and dressings	500
	Condiments	650
	Soy sauce and fish sauce	4,840
	Other Asian-style sauces	680
	Marinades and thick pastes	1,425

Supplementary Table 4: Ranking of diseases and their DALY burden attributable to a diet high in sodium, in Australia, using GBD 2019 data

Disease	DALYs (95% UI)	Per cent contribution to total burden	Per cent cumulative contribution to total burden
Ischemic heart disease	10,187 (834 to 38,155)	47.1	47.1
Stroke	4,476 (410 to 17,301)	20.7	67.8
Chronic kidney disease	1,758 (184 to 7,241)	8.1	75.9
Stomach cancer	1,461 (67 to 7,602)	6.8	82.7
Atrial fibrillation and flutter	1,191 (148 to 4,711)	5.5	88.2
Hypertensive heart disease	721 (37 to 3,247)	3.3	91.5
Other cardiovascular and circulatory diseases	496 (44 to 1,750)	2.3	93.8
Cardiomyopathy and myocarditis	356 (37 to 1,285)	1.6	95.4
Aortic aneurysm	334 (43 to 1,299)	1.5	97.0
Non-rheumatic valvular heart disease	262 (39 to 996)	1.2	98.2
Peripheral artery disease	158 (22 to 704)	0.7	98.9
Endocarditis	128 (11 to 479)	0.6	99.5
Rheumatic heart disease	105 (17 to 389)	0.5	100.0

Supplementary Table 5: Ranking of diseases and their DALY burden attributable to high SBP, in Australia, using GBD 2019 data

Disease	DALYs (95% UI)	Per cent contribution to total burden	Per cent cumulative contribution to total burden
Ischemic heart disease	188,648 (147,192 to 230,506)	46.4	46.4%
Stroke	89,673 (72,414 to 108,873)	22.1	68.5%
Chronic kidney disease	48,755 (40,433 to 57,650)	12.0	80.5
Atrial fibrillation and flutter	27,434 (19,934 to 37,592)	6.7	87.2
Hypertensive heart disease	17,007 (13,925 to 19,956)	4.2	91.4
Other cardiovascular and circulatory diseases	8,282 (6,447 to 10,565)	2.0	93.4
Aortic aneurysm	6,679 (5,083 to 8,359)	1.6	95.1
Cardiomyopathy and myocarditis	6,091 (4,407 to 8,677)	1.5	96.6
Non-rheumatic valvular heart disease	5,764 (3,984 to 8,014)	1.4	98.0
Peripheral artery disease	3,805 (1,887 to 7,272)	0.9	98.9

Endocarditis	2,262 (1,105 to 3,198)	0.6	99.5
Rheumatic heart disease	2,048 (1,286 to 3,483)	0.5	100.0

Supplementary Table 6: Ranking of diseases and their DALY burden attributable to high body mass index (BMI), in Australia, using GBD 2019 data

Disease	DALYs (95% UI)	Per cent contribution to total burden	Per cent cumulative contribution to total burden
Diabetes mellitus	105,848 (146,201 to 72,590)	20.2	20.2
Ischemic heart disease	101,852 (141,637 to 65,159)	19.4	39.6
Stroke	50,459 (66,656 to 35,018)	9.6	49.2
Chronic kidney disease	34,284 (48,842 to 21,315)	6.5	55.7
Low back pain	31,764 (50,185 to 17,669)	6.0	61.7
Alzheimer's disease and other dementias	29,568 (72,823 to 8,354)	5.6	67.4
Asthma	24,758 (38,755 to 15,038)	4.7	72.1
Atrial fibrillation and flutter	22,749 (35,850 to 12,797)	4.3	76.4
Osteoarthritis	22,352 (48,309 to 9,218)	4.3	80.7
Colon and rectum cancer	16,668 (24,290 to 9,857)	3.2	83.8
Esophageal cancer	11,135 (19,176 to 3,830)	2.1	86.0
Hypertensive heart disease	9,243 (13,660 to 5,121)	1.8	87.7
Gallbladder and biliary diseases	8,963 (13,303 to 5,679)	1.7	89.4
Liver cancer	8,221 (13,907 to 3,629)	1.6	91.0
Gout	7,704 (13,201 to 3,992)	1.5	92.5
Kidney cancer	7,579 (10,924 to 4,550)	1.4	93.9
Pancreatic cancer	5,925 (10,623 to 2,234)	1.1	95.0
Uterine cancer	5,846 (7,608 to 4,183)	1.1	96.1
Breast cancer	5,040 (10,603 to 702)	1.0	97.1
Leukemia	4,166 (6,580 to 2,197)	0.8	97.9
Non-Hodgkin lymphoma	3,297 (5,691 to 1,501)	0.6	98.5
Gallbladder and biliary tract cancer	2,532 (3,782 to 1,459)	0.5	99.0
Multiple myeloma	2,373 (4,181 to 1,085)	0.5	99.5
Ovarian cancer	1,108 (2,473 to -28)	0.2	99.7
Blindness and vision loss	908 (1,575 to 435)	0.2	99.8
Thyroid cancer	796 (1,273 to 423)	0.2	100.0

Supplementary Table 7: Health adjusted life years (HALYs) gained over 20 years (2024 to 2043 inclusive) for the overall population, 0% discount rate, and by quintile of socioeconomic status (SEIFA index)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	RR SES 1 c.f. 5
HALYs in next 20 yrs							
Reformulation							
Mandatory - Australia (100% Compliance)	18,700	4,730	4,170	3,720	3,170	2,890	1.66
	(13,000 to 27,600)	(3,290 to 6,970)	(2,900 to 6,180)	(2,580 to 5,510)	(2,210 to 4,660)	(2,000 to 4,270)	(1.60 to 1.74)
Australia 90% compliance	16,800	4,240	3,750	3,340	2,850	2,590	1.66
	(11,600 to 25,100)	(2,950 to 6,340)	(2,590 to 5,600)	(2,310 to 4,980)	(1,980 to 4,230)	(1,800 to 3,840)	(1.60 to 1.74)
Australia 70% compliance	13,000	3,300	2,910	2,590	2,220	2,020	1.66
	(8,970 to 19,300)	(2,290 to 4,900)	(2,010 to 4,330)	(1,780 to 3,840)	(1,530 to 3,260)	(1,390 to 2,980)	(1.60 to 1.74)
Australia 50% compliance	9,360	2,370	2,090	1,860	1,590	1,440	1.66
	(6,460 to 13,900)	(1,640 to 3,510)	(1,440 to 3,110)	(1,290 to 2,770)	(1,100 to 2,340)	(1,010 to 2,130)	(1.60 to 1.74)
Mandatory UK (100% compliance)	42,600	10,800	9,530	8,490	7,240	6,530	1.66
	(28,600 to 63,800)	(7,230 to 16,000)	(6,380 to 14,300)	(5,680 to 12,700)	(4,840 to 10,800)	(4,380 to 9,810)	(1.59 to 1.78)
UK 90% compliance	38,200	9,680	8,560	7,620	6,490	5,900	1.66
	(25,900 to 56,600)	(6,560 to 14,300)	(5,780 to 12,700)	(5,140 to 11,400)	(4,400 to 9,610)	(3,980 to 8,750)	(1.59 to 1.77)
UK 70% compliance	29,800	7,530	6,670	5,930	5,060	4,600	1.66
	(20,100 to 44,600)	(5,120 to 11,200)	(4,490 to 9,980)	(4,000 to 8,880)	(3,420 to 7,580)	(3,090 to 6,870)	(1.59 to 1.75)
UK 50% compliance	21,500	5,420	4,790	4,270	3,650	3,320	1.65
	(14,500 to 31,900)	(3,690 to 8,080)	(3,250 to 7,150)	(2,870 to 6,370)	(2,450 to 5,420)	(2,220 to 4,930)	(1.59 to 1.73)
Mandatory WHO	67,800	17,300	15,200	13,600	11,500	10,200	1.70
	(46,100 to 97,300)	(11,800 to 24,700)	(10,300 to 21,900)	(9,200 to 19,500)	(7,810 to 16,500)	(6,890 to 14,800)	(1.61 to 1.89)
Mandatory Aus followed by UK (100% compliance)	35,900	9,010	8,000	7,150	6,120	5,540	1.65
	(24,600 to 52,900)	(6,220 to 13,300)	(5,480 to 11,800)	(4,900 to 10,600)	(4,200 to 8,960)	(3,780 to 8,120)	(1.58 to 1.76)
Substitution of NaCl with KCl							
30% immediate substitution of all foods	171,000	46,200	39,900	34,200	27,800	23,300	2.00
	(118,000 to 236,000)	(31,900 to 63,300)	(27,400 to 54,800)	(23,400 to 47,100)	(18,800 to 38,600)	(15,500 to 33,100)	(1.75 to 2.38)
10% substitution all foods, over 10 years	27,700	6,960	6,150	5,530	4,750	4,280	1.64
	(18,800 to 39,600)	(4,730 to 9,950)	(4,160 to 8,830)	(3,760 to 7,920)	(3,220 to 6,790)	(2,870 to 6,130)	(1.57 to 1.75)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	RR SES 1 c.f. 5
30% substitution discretionary over 3 yrs	22,600	5,720	5,040	4,500	3,840	3,460	1.67
	(15,200 to 32,000)	(3,870 to 8,130)	(3,390 to 7,160)	(3,020 to 6,380)	(2,580 to 5,430)	(2,320 to 4,930)	(1.60 to 1.76)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	RR SES 1 c.f. 5
Programs							
UK mass media campaign	1,850	476	416	366	310	280	1.72
	(900 to 3,430)	(232 to 886)	(203 to 773)	(178 to 680)	(151 to 574)	(137 to 522)	(1.65 to 1.80)
UK salt reduction program	11,500	2,930	2,570	2,280	1,940	1,760	1.69
	(7,890 to 16,800)	(2,020 to 4,300)	(1,770 to 3,770)	(1,560 to 3,330)	(1,330 to 2,820)	(1,200 to 2,550)	(1.62 to 1.77)

3% discount rates are shown in *Table 5*

Supplementary Table 8: Health adjusted life years (HALYs) gained over a Lifetime for the overall population, 0% discount rate, and by quintile of socioeconomic status (SEIFA index)

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	RR SES 1 c.f. 5
HALYs Lifetime							
Reformulation							
Mandatory - Australia (100% Compliance)	295,000	68,100	60,100	60,400	56,900	49,100	1.39
	(197,000 to 447,000)	(45,900 to 104,000)	(40,500 to 91,400)	(40,300 to 91,900)	(37,800 to 86,700)	(32,600 to 74,400)	
Australia 90% compliance	266,000	61,400	54,200	54,500	51,300	44,000	1.39
	(179,000 to 407,000)	(41,300 to 94,200)	(36,500 to 83,000)	(36,600 to 83,800)	(34,200 to 78,600)	(29,400 to 67,400)	
Australia 70% compliance	207,000	47,900	42,200	42,400	39,900	34,400	1.39
	(138,000 to 315,000)	(32,100 to 72,900)	(28,200 to 64,200)	(28,100 to 65,000)	(26,400 to 61,000)	(22,800 to 52,500)	
Australia 50% compliance	148,000	34,200	30,200	30,400	28,600	24,600	1.39
	(99,600 to 228,000)	(23,200 to 52,700)	(20,500 to 46,500)	(20,300 to 46,800)	(19,100 to 44,000)	(16,400 to 37,600)	
Mandatory UK (100% compliance)	667,000	154,000	136,000	137,000	129,000	111,000	1.39
	(442,000 to 1,020,000)	(103,000 to 233,000)	(90,100 to 207,000)	(90,100 to 210,000)	(84,600 to 200,000)	(72,300 to 171,000)	
UK 90% compliance	603,000	139,000	123,000	124,000	117,000	100,000	1.39
	(398,000 to 923,000)	(92,300 to 211,000)	(81,500 to 187,000)	(81,300 to 190,000)	(76,300 to 179,000)	(65,500 to 155,000)	
	470,000	108,000	96,000	96,700	91,100	78,400	1.38

	Combined	SES 1	SES 2	SES 3	SES 4	SES 5	RR SES 1 c.f. 5
UK 70% compliance	(309,000 to 724,000)	(72,100 to 166,000)	(63,500 to 146,000)	(63,100 to 149,000)	(59,300 to 141,000)	(50,800 to 121,000)	
UK 50% compliance	337,000	77,600	68,700	69,200	65,300	56,200	1.38
	(221,000 to 519,000)	(51,600 to 119,000)	(45,400 to 105,000)	(45,200 to 107,000)	(42,300 to 101,000)	(36,200 to 87,900)	
Mandatory WHO	1,070,000	250,000	220,000	221,000	206,000	174,000	1.44
	(709,000 to 1,580,000)	(167,000 to 366,000)	(146,000 to 323,000)	(145,000 to 327,000)	(135,000 to 307,000)	(113,000 to 261,000)	
Mandatory Aus followed by UK (100% compliance)	655,000	151,000	133,000	135,000	127,000	109,000	1.38
	(430,000 to 1,010,000)	(99,900 to 230,000)	(88,000 to 205,000)	(87,800 to 209,000)	(82,800 to 197,000)	(71,200 to 168,000)	
Substitution of NaCl with KCl							
30% immediate substitution of all foods	2,240,000	557,000	480,000	464,000	415,000	332,000	1.68
	(1,490,000 to 3,210,000)	(372,000 to 795,000)	(319,000 to 684,000)	(306,000 to 666,000)	(272,000 to 599,000)	(214,000 to 489,000)	
10% substitution all foods, over 10 years	756,000	175,000	154,000	156,000	147,000	124,000	1.41
	(503,000 to 1,120,000)	(117,000 to 258,000)	(103,000 to 228,000)	(103,000 to 230,000)	(96,900 to 217,000)	(81,400 to 183,000)	
30% substitution discretionary over 3 yrs	383,000	89,000	78,300	78,300	73,600	63,100	1.41
	(250,000 to 553,000)	(58,900 to 128,000)	(51,300 to 113,000)	(50,900 to 114,000)	(47,800 to 107,000)	(40,800 to 91,500)	
Programs							
UK mass media campaign	4,420	1,130	974	881	764	676	1.67
	(2,240 to 8,180)	(569 to 2,080)	(491 to 1,800)	(445 to 1,630)	(384 to 1,410)	(337 to 1,240)	
UK salt reduction program	180,000	41,900	36,800	36,700	34,500	29,700	1.41
	(121,000 to 270,000)	(28,600 to 62,600)	(24,900 to 55,100)	(24,600 to 55,800)	(23,100 to 52,200)	(19,700 to 44,700)	

3% discount rates are shown in *Table 6*

Supplementary Table 9: Expenditure: Health, health + government, and health + government + Industry (both expected and conservative); 0% discount rate; 20-year and lifetime perspectives

	Health - 20 Years	Health - Lifetime	Health + Govt - 20 years	Health + Govt - Lifetime	Health + Gov + Industry - 20 years	Health + Gov + Industry - Lifetime	Health + Gov + Industry (conservative) 20 years	Health + Gov + Industry (conservative) - Lifetime
Reformulation								
Mandatory - Australia (100% Compliance)	-379	3,600	-304	4,010	-153	4,160	-82.0	4,240
	(-584 to -188)	(1,040 to 7,930)	(-512 to -112)	(1,470 to 8,360)	(-369 to 87.1)	(1,610 to 8,510)	(-319 to 202)	(1,680 to 8,560)
Australia 90% compliance	-342	3,230	-266	3,650	-131	3,790	-67.4	3,860
	(-526 to -170)	(934 to 7,150)	(-451 to -89.9)	(1,350 to 7,590)	(-321 to 85.5)	(1,490 to 7,710)	(-279 to 187)	(1,560 to 7,760)
Australia 70% compliance	-264	2,510	-189	2,930	-83.5	3,040	-34.0	3,090
	(-407 to -134)	(724 to 5,560)	(-336 to -54.1)	(1,130 to 5,960)	(-238 to 84.5)	(1,240 to 6,050)	(-197 to 163)	(1,280 to 6,090)
Australia 50% compliance	-190	1,800	-113	2,220	-38.7	2,300	-3.07	2,340
	(-292 to -96.1)	(537 to 4,010)	(-222 to -13.2)	(914 to 4,390)	(-149 to 86.8)	(1,000 to 4,440)	(-121 to 141)	(1,040 to 4,480)
Mandatory UK (100% compliance)	-794	8,730	-716	9,140	-469	9,370	-352	9,490
	(-1,250 to -364)	(2,640 to 18,900)	(-1,170 to -280)	(3,030 to 19,300)	(-953 to 16.1)	(3,270 to 19,600)	(-859 to 204)	(3,390 to 19,700)
UK 90% compliance	-714	7,860	-637	8,250	-415	8,460	-310	8,570
	(-1,120 to -330)	(2,440 to 17,100)	(-1,050 to -243)	(2,860 to 17,600)	(-854 to 36.2)	(3,010 to 17,800)	(-767 to 194)	(3,100 to 17,900)
UK 70% compliance	-558	6,120	-480	6,540	-307	6,690	-228	6,780
	(-878 to -254)	(1,890 to 13,400)	(-800 to -176)	(2,280 to 13,800)	(-645 to 37.8)	(2,490 to 14,000)	(-576 to 166)	(2,580 to 14,100)
UK 50% compliance	-399	4,390	-322	4,790	-198	4,920	-140	4,980
	(-626 to -181)	(1,360 to 9,600)	(-555 to -101)	(1,760 to 10,000)	(-445 to 49.0)	(1,890 to 10,100)	(-396 to 142)	(1,950 to 10,200)
Mandatory WHO	-1,400	12,800	-1,320	13,200	-891	13,600	-690	13,800

	Health - 20 Years	Health - Lifetime	Health + Govt - 20 years	Health + Govt - Lifetime	Health + Gov + Industry - 20 years	Health + Gov + Industry - Lifetime	Health + Gov + Industry (conservative) 20 years	Health + Gov + Industry (conservative) - Lifetime
	(-2,120 to -732)	(3,620 to 27,200)	(-2,050 to -663)	(4,050 to 27,600)	(-1,680 to -155)	(4,440 to 28,000)	(-1,530 to 160)	(4,620 to 28,200)
Mandatory Aus followed by UK (100% compliance)	-732	8,650	-657	9,050	-421	9,290	-307	9,400
	(-1,130 to -351)	(2,730 to 18,800)	(-1,050 to -275)	(3,140 to 19,200)	(-819 to -39.3)	(3,380 to 19,500)	(-705 to 74.4)	(3,490 to 19,600)
Substitution of NaCl with KCl								
30% immediate substitution of all foods	-3,310	26,000	N/A	N/A	N/A	N/A	N/A	N/A
	(-5,090 to -1,850)	(6,940 to 52,900)						
10% substitution all foods, over 10 years	-721	9,550	-668	9,900	-589	10,500	-589	10,500
	(-1,110 to -416)	(2,740 to 19,700)	(-1,050 to -341)	(3,070 to 20,000)	(-974 to -271)	(3,760 to 20,500)	(-974 to -271)	(3,760 to 20,500)
30% substitution discretionary over 3 years	-479	4,680	-424	5,010	-373	5,310	-373	5,310
	(-735 to -249)	(1,400 to 9,580)	(-682 to -187)	(1,750 to 10,000)	(-635 to -132)	(2,020 to 10,400)	(-635 to -132)	(2,020 to 10,400)
Programs								
UK mass media campaign	-26.9	25.9	2.12	55.9	2.12	55.9	2.12	55.9
	(-56.3 to -9.74)	(-1.15 to 73.6)	(-28.1 to 24.4)	(24.5 to 105)	(-28.1 to 24.4)	(24.5 to 105)	(-28.1 to 24.4)	(24.5 to 105)
UK salt reduction program	-223	2,140	-117	2,580	121	2,830	231	2,960
	(-350 to -113)	(633 to 4,720)	(-247 to -0.414)	(1,040 to 5,180)	(-67.2 to 386)	(1,280 to 5,440)	(3.18 to 598)	(1,380 to 5,540)

3% discount rates are shown in *Table 9*

Supplementary Table 10: Income gains among 25 to 64 year olds ($Aus millions, 0% discount rate) in next 20 years and over the lifetime for each intervention compared to BAU

	20-year time horizon		Lifetime horizon	
Reformulation	Median	(95% UI)	Median	(95% UI)
Mandatory - Australia (100% Compliance)	358	(250 to 509)	1,660	(1,140 to 2,370)
Australia 90% compliance	321	(222 to 460)	1,490	(1,030 to 2,140)
Australia 70% compliance	250	(172 to 357)	1,170	(798 to 1,650)
Australia 50% compliance	179	(125 to 255)	833	(576 to 1,190)
Mandatory UK (100% compliance)	782	(548 to 1,130)	3,600	(2,500 to 5,200)
UK 90% compliance	706	(492 to 1,010)	3,240	(2,250 to 4,660)
UK 70% compliance	550	(383 to 784)	2,530	(1,750 to 3,610)
UK 50% compliance	395	(274 to 564)	1,810	(1,250 to 2,610)
Mandatory WHO	1,350	(929 to 1,880)	6,280	(4,250 to 8,810)
Mandatory Aus followed by UK (100% compliance)	683	(482 to 963)	3,480	(2,410 to 4,990)
Substitution of NaCl with KCl				
30% immediate substitution of all foods	3,630	(2,540 to 5,130)	15,000	(10,400 to 21,400)
10% substitution all foods, over 10 years	621	(430 to 880)	4,460	(3,020 to 6,390)
30% substitution discretionary over 3 years	473	(330 to 659)	2,350	(1,600 to 3,300)
Programs				
UK mass media campaign	35.6	(17.6 to 65.0)	45.7	(22.3 to 84.0)
UK salt reduction program	234	(163 to 330)	1,110	(763 to 1,570)

3% discount rates are shown in *Table 11.*

APPENDIX A: LITERATURE SEARCH STRATEGY ON THE IMPACTS OF SODIUM REDUCTION INTERVENTIONS

SEARCH TERMS

A literature search was conducted on MEDLINE using the Ovid platform during January, 2023 to identify relevant studies limited to Australian and New Zealand populations that were published between 2000 and 2023, and reported in English.

The search strategy used was modified from the Santos et al systematic review of global salt reduction initiatives:

Supplementary Table 11: Papers by step of search strategy

Step number	Search terms	Results
1	sodium, dietary/ or sodium chloride, dietary/	17128
2	Sodium Chloride/	60801
3	Diet, Sodium-Restricted/	6475
4	((salt or sodium) adj10 (reduc* or target* or cutback* or decreas* or limit* or consumption)).tw.	58526
5	((diet* or nutrition* or food or intake) adj10 (salt or sodium)).tw.	32123
6	1 or 2 or 3 or 4 or 5	144550
7	potassium.tw.	149951
8	potassium, dietary/	1204
9	potassium chloride.tw.	6667
10	potassium chloride/	18084
11	potassium/	103785
12	7 or 8 or 9 or 10 or 11	224192
13	6 or 12	350128
14	Food, Formulated/	6181
15	Food-Processing Industry/	5132
16	food technology/ or food analysis/ or food preservation/	39211
17	Food Industry/	6114
18	14 or 15 or 16 or 17	55304
19	(adjust* or alter* or change or changing or control* or decreas* or limit* modify or modified or new or reduce or reducing or reduction* or reformulat* or redevelop* or restrict*).tw.	12771107
20	18 and 19	23697
21	((adjust* or alter* or change or changing or control* or decreas* or limit* or modify or modified or new or reduce or reducing or reduction* or reformulat* or redevelop* or restrict*) adj10 (recipe* or food or foods or formula* or ingredient*)).tw.	180524
22	13 or 20 or 21	543182

Step number	Search terms	Results
23	taxes/ or tax exemption/	8387
24	government Programs/	6317
25	financing, organi?ed/ or financing, government/	21346
26	Cost Sharing/	2713
27	(pricing or cost or costs or subsidi*).tw.	694337
28	(taxation or taxes or subsid*).tw.	34570
29	(financial adj3 (incentive* or disincentive*)).tw.	5816
30	23 or 24 or 25 or 26 or 27 or 28 or 29	749735
31	Nutrition Policy/	10604
32	((food* or menu or nutrition*) adj5 (buy* or procur* or purchas* or stock*) adj5 (guideline* or policy or policies or practice* or standard*)).tw.	196
33	31 or 32	10760
34	Food Labeling/ or Food Labelling/	4469
35	Food Packaging/lj, st [Legislation & Jurisprudence, Standards]	397
36	((food* or nutrition* or diet*) adj10 (facts or information or label* or symbol* or warning*)).tw.	33506
37	health check.tw.	4107
38	34 or 35 or 36 or 37	39950
39	nutrition surveys/ or diet surveys/	32206
40	(intervention* or model* or strateg* or initiativ* or evaluat* or simulat*).tw.	9112774
41	(systematic review or modeling study or modelling study or economic evaluation).ti.	210892
42	communications media/ or exp mass media/	49072
43	Social Marketing/	2515
44	health education/ or exp consumer health information/ or health fairs/	75942
45	exp Health Promotion/	84417
46	Information Dissemination/	19070
47	newspapers/ or periodicals as topic/	54776
48	computer communication networks/ or internet/ or blogging/ or social media/	107143
49	Electronic Mail/	2936
50	((communicat* adj2 campaign*) or (information adj2 campaign*) or mass media or newspaper* or television* or radio* or (public adj2 campaign*) or (national adj2 campaign*) or public information).tw.	1185229
51	(blog* or email* or facebook or internet or magazine* or mobile device* or PDA or SMS or smartphone* or social media or text messag* or twitter or web).tw.	310671
52	(health education or health information or health promotion).tw.	96434
53	39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52	10299008
54	("salt substitution" or "salt substitute" or "low-sodium salt substitute" or "salt replacing" or "salt replacement" or "salt replacer" or "salt reduction" or "salt	119640

Step number	Search terms	Results
	reducer" or "Low-So salt replacer" or "KcLean salt" or "Kalisel" or "Salt Trim" or "Lacto Optitaste" or "Pansalt" or "Sub4salt" or "LomaSalt" or "Saltwise" or "Myciscent" or "Salt reducer N100" or "Salt reducer N200" or "Dr Lohmann's Premix salt replacer" or "AlsoSalt" or "Nu-Tek's modified potassium chloride" or "Soda-Lo" or "Zalt" or "Maxorite delite" or "Maxarite Bsalt" or "Maxarite Dsalt" or "Maxarome select" or "Maxarome pure" or "KojiAji" or "Ajimate super RK" or "Ajinomoto" or "SaltAnswer" or "Super YE" or "Fonterra Savoury Powder" or "Flavour intensifier" or "Savoury Flavour enhancer" or "Flavour enhancer" or "SavourCrave" or "UnSal20" or "Seagreens Organic Mineral Salt" or "Sense Capture Salt" or "magnesium" or "MgCl").mp.	
55	20 or 30 or 33 or 38 or 53 or 54	10778714
56	13 and 55	109046
57	(food* or nutrition* or diet*).tw.	1315959
58	41 and 57	11366
59	56 or 58	120094
60	exp animals/ not humans.sh.	5084723
61	59 not 60	83214
62	(Australia or "New Zealand").tw.	163194
63	61 and 62	524
64	limit 63 to (english language and yr="2000 - 2023")	483

Additional articles were identified from the reference lists of extracted articles and experts in the field. A search of grey literature was also undertaken using Google, Open Grey, and medRxiv with the same search terms used on MEDLINE.

APPENDIX B: COSTING OF INTERVENTIONS (UNDERTAKEN BY GRATTAN INSTITUTE)

This Appendix and costing method was prepared by Lachie Fox, Grattan Institute.

This document explains how we costed the policies modelled in this Report. We costed mandatory salt limits, enriching the salt supply chain with potassium, consumer education campaigns, and population-wide monitoring of salt intake. Where relevant, we calculated both government and industry costs.

REFORMULATION INTERVENTIONS

We estimated the costs to Australia of four salt-limit scenarios:

1. Making Australia's existing voluntary limits mandatory, to be met by 2027.
2. Adopting the UK's 2014 limits, to be met by 2027.
3. Making Australia's existing voluntary limits mandatory, to be met by 2027, and expanding targets to include the UK's 2014 limits, to be met by 2030.
4. Adopting the World Health Organisation (WHO) benchmarks, to be met by 2027.

The costs are calculated relative to a business-as-usual scenario – that is, current policy settings.

COSTS TO GOVERNMENT

The costs incurred by government to implement salt limits instead of the present voluntary limits include policy development, a review of nutrition information labels, and monitoring and compliance costs. This could be supported by a population-wide salt monitoring program, which was included in the government cost of salt-limit scenarios.

Policy development costs

The government budget already allocates funding to the Partnership Reformulation Program, which broadly shares the same policy development functions as the salt limits proposed in this report.[K] It is unlikely significantly more funding would be required to develop a broader scheme, particular because we propose limits which have already been developed and implemented overseas.

While a mandatory scheme may require more sector involvement and risk management from government, we assume policy development costs could be managed within existing funding.

Costs of reviewing nutrition information labels

There is little data to suggest how much it would cost to develop a credible, robust, ongoing program to more closely monitor nutrition information labels on Australian foods to ensure they are accurate. In the absence of robust data, we assumed a monitoring program would cost $3 million a year for all salt limits scenarios (but with wide uncertainty; Aus$3 million a year would probably allow assessment of 1,000 to 1,500 products a year, according with US estimates for such work [https://www.nutridata.com/feeschedule.asp]).

[K] Treasury (2023). "Budget May 2023-24: Budget Paper 2". https://budget.gov.au/content/bp2/download/bp2_2023-24.pdf.

Monitoring and compliance costs

Salt limits require ongoing monitoring to determine food industry compliance. We assumed that existing and newly funded infrastructure, such as the ABS' current reporting mechanism for compliance with voluntary salt limits and the development of the Australian Branded Food Database, would be sufficient for this and that any additional investment required would be negligible.

Some of the monitoring and compliance costs required to implement a mandatory salt limit scheme are likely to be covered under existing programs. For example, the ABS already reports on compliance with current reformulation efforts.[L]

The 2023 Budget allocated additional funding to the Healthy Food Partnership Program (an additional $3.2 million over three years), in part to fund the new Australian Branded Food Database.[M] This database, while voluntary, will contain information from the nutrition information panels (therefore including sodium content).[N]

Participation in the database project may need to be made mandatory to enforce compliance with salt limits, but we assume that existing funds allocated to its development are sufficient.

COSTS TO THE FOOD INDUSTRY

Broader and tougher salt limits may create additional costs for the food industry because companies need to reformulate their products to meet the limits. We use two estimates of industry costs for each scenario: an 'expected' scenario, and a 'conservative' estimate. For both scenarios, we estimated the cost of reformulation, by multiplying the cost of reformulating a unique product line (for example, products with a unique bar code in the supermarket) by the number of unique product lines which are estimate to require reformulation to meet limits in each scenario. For reasons discussed in the following sections, this approach is likely to overestimate the costs of reformulation for industry. Under the 'expected' scenario, we make some assumptions to account for this overestimation of costs.

To estimate the costs of product reformulation to reduce sodium content, we extracted prior cost estimates from a systematic review of population-based sodium reduction interventions.[O] We recorded the methodology of each study where product reformulation was involved, and where a full cost-benefit or similar economic assessment was done (see table below).

[L] ABS (2023). Healthy Food Partnership Reformulation Program: Two-year progress. Australian Bureau of Statistics. https://www.abs.gov.au/articles/healthy-food-partnership-reformulation-program-two-year-progress (visited on 22/02/2023)

[M] Treasury (2023). "Budget May 2023-24: Budget Paper 2". https://budget.gov.au/content/bp2/download/bp2_2023-24.pdf.

[N] (FSANZ 2022). Australian Branded Food Database. https://www.foodstandards.gov.au/science/monitoringnutrients/Pages/Branded-food-database.aspx (visited on 07/09/2023).

[O] Hope et al (2017). Hope, S. F., Webster, J., Trieu, K., Pillay, A., Ieremia, M., Bell, C., Snowdon, W., Neal, B. and Moodie, M. "A systematic review of economic evaluations of population-based sodium reduction interventions". PLOS ONE 12.3. Publisher: Public Library of Science, e0173600. ISSN: 1932-6203. DOI: 10.1371/journal.pone.0173600. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0173600 (visited on 14/02/2023)

Supplementary Table 12: Methods used in other studies to estimate industry reformulation costs

Study(ies)	Methodology	Costs
British retail consortium estimates: Food Standards Agency (2009b)[P] (as used by Collins et al (2014)[Q] and Pearson-Stuttard et al (2017))[R]	Company reported average cost of reformulating a product. Prices have been adjusted for inflation and converted to Australian dollars.	Average cost of Aus$71,000 per product reformulated.
Costs reported by various industries to the regulatory impact analysis in the UK: Food Standards Agency (2009a)[S]	Company reported costs of product reformulation. Prices have been adjusted for inflation and converted to Australian dollars.	Per product cost estimates: Non-complex reformulation: Aus$7,000 High-complexity reformulation: Aus$1,263,000 We assume that 10% of products will require high complexity reformulation, giving an average cost of $133,000
United States FDA reformulation cost model: Muth et al (2015)[T] (as summarised and used by WHO (n.d.)[U])	Cost estimates from expert panel, developed into a 'reformulation model'. Average values for critical and non-critical reformulations used, from WHO (ibid)[V]. Cost estimates have been adjusted	Per product cost estimates: Non-critical reformulation: Aus$77,000. Critical reformulation: Aus $217,000 We assume that half of products will require critical reformulation (WHO

[P] Food Standards Agency (2009b). Annex - 1: British Retail Consortium. https://webarchive.nationalarchives.gov.uk/ukgwa/20131206183208/http://www.food.gov.uk/multimedia/pdfs/annex1parasreleasedmay09.pdf.

[Q] Collins et al (2014). Collins, M., Mason, H., O'Flaherty, M., Guzman-Castillo, M., Critchley, J. and Capewell, S. "An Economic Evaluation of Salt Reduction Policies to Reduce Coronary Heart Disease in England: A Policy Modeling Study". Value in Health 17.5, pp. 517–524. ISSN: 10983015. DOI: 10.1016/j.jval.2014.03.1722. https://linkinghub.elsevier.com/retrieve/pii/S1098301514018282 (visited on 13/02/2023)

[R] Pearson-Stuttard et al (2017). Pearson-Stuttard, J., Hooton, W., Critchley, J., Capewell, S., Collins, M., Mason, H., Guzman-Castillo, M. and O'Flaherty, M. "Cost-effectiveness analysis of eliminating industrial and all trans fats in England and Wales: modelling study". Journal of Public Health 39.3, pp. 574–582. ISSN: 1741-3842. DOI: 10.1093/pubmed/fdw095. https://doi.org/10.1093/pubmed/fdw095 (visited on 04/04/2023).

[S] Food Standards Agency (2009a). Summary: Intervention and Options. https://www.legislation.gov.uk/ukia/2009/86/pdfs/ukia_20090086_en.pdf.

[T] Muth et al (2015). Muth, M., Bradley, S., Brophy, J., Capogrossi, K., Coglaiti, M., Karns, S. and Viator, K. FDA Reformulation Cost model. RTI International. https://downloads.regulations.gov/FDA-2012-N-1210-0882/content.pdf.

[U] WHO (n.d.). Elements of economic analysis of removing industrially produced trans fat from the food supply. World Health Organisation. https://cdn.who.int/media/docs/default-source/replace/l-elements-of-economic-analysis.pdf?sfvrsn=be3a5f02_2.

[V] WHO (n.d.). Elements of economic analysis of removing industrially produced trans fat from the food supply. World Health Organisation. https://cdn.who.int/media/docs/default-source/replace/l-elements-of-economic-analysis.pdf?sfvrsn=be3a5f02_2.

Study(ies)	Methodology	Costs
	for inflation and converted to Australian dollars.	(ibid))[W], giving an average cost of Aus$147,00
Frito-Lay reported costs: Eckel et al (2007)[X]	Company reported costs of a novel and reasonably complex effort to reformulate 187 product lines for reduced trans-fatty acid content. cost estimates have been adjusted for inflation and converted to Australian dollars.	Average reported cost of Aus$242,000 per product line

We also included other relevant studies (for example those published after the systematic review [O], and studies that included the cost of reformulation to reduce trans-fatty acid content). Because most studies use identical data sources for cost estimates, only the underlying data source or method was recorded.

We transformed each of the costs into an estimate of how much it costs to reformulate an individual product line. All costs were converted to Australian dollars and adjusted for inflation. We excluded from our subsequent analysis the cost estimate reported in Eckel et al (2007)[Y], because it was specific to a highly novel, complex-to-reformulate product.

The average of the cost estimates was $92,000 per single unique product line reformulated. However, the cost estimates that informed this average are widely distributed. To account for the wide uncertainty, we used the costs to generate a distribution. We assumed that the average of the cost estimates was the mean of the distribution, and that the highest and lowest cost estimates were two standard deviations from the mean.

To determine the number of unique product line costs would apply, we assumed that:

[W] WHO (n.d.). Elements of economic analysis of removing industrially produced trans fat from the food supply. World Health Organisation. https://cdn.who.int/media/docs/default-source/replace/l-elements-of-economic-analysis.pdf?sfvrsn=be3a5f02_2.

[X] Note, these costs are not included in the final analysis. Eckel et al (2007). Eckel, R. H., Borra, S., Lichtenstein, A. H. and Yin-Piazza, S. Y. "Understanding the Complexity of Trans Fatty Acid Reduction in the American Diet". Circulation 115.16. Publisher: American Heart Association, pp. 2231–2246. DOI: 10.1161/CIRCULATIONAHA.106.181947. https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.106.181947 (visited on 06/04/2023)

[Y] Eckel et al (2007). Eckel, R. H., Borra, S., Lichtenstein, A. H. and Yin-Piazza, S. Y. "Understanding the Complexity of Trans Fatty Acid Reduction in the American Diet". Circulation 115.16. Publisher: American Heart Association, pp. 2231–2246. DOI: 10.1161/CIRCULATIONAHA.106.181947. https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.106.181947 (visited on 06/04/2023)

- The existing Australian food categories cover about 4,300 products.[Z] It is estimated that 47 per cent of eligible foods currently meet Australia's existing targets. Therefore, 53 per cent of eligible products (about 2,280 products) must be reformulated to comply with the limits.[AA]
- The 2014 UK categories cover about 10,000 Australian products.[BB] It is estimated that 62 per cent of eligible Australian foods currently meet the 2014 UK salt limits. Therefore, 38 per cent of eligible products in Australia (about 3,800 products) would require reformulation to comply with the 2014 UK limits.[CC]
- The WHO targets cover about 10,000 Australian products.[DD] It is estimated that 36 per cent of eligible Australian foods currently meet the WHO targets. Therefore, 64 per cent of eligible products in Australia (about 6,400 products) would require reformulation to comply with the WHO targets.[EE]

Under the 'conservative' cost scenario, we estimated the total cost of reformulation under each of the targets as the number of products requiring reformulation (see above dot points), multiplied by the average estimated cost of reformulating a single product ($92,000 per product, as previously explained).

Under the 'realistic' scenario, a series of further assumptions were made, as discussed below.

The 'unique product' counts estimated above consider a product to be 'unique' if it is distinct based on product information such as bar-codes. This approach counts similar products – such as products which comes in multiple different sized packets – as individual from one another. Assuming that all of these products incur the full cost of reformulation would overestimate the costs of salt limits. Data is lacking on how many of the products requiring reformulation are similar, or the same product in different sizes

[Z] D. Coyle et al (2021). Coyle, D. et al. "Estimating the potential impact of Australia's reformulation programme on households' sodium purchases". BMJ Nutrition, Prevention & Health 4.1. Publisher: BMJ Specialist Journals Section: Original research. ISSN: 2516-5542. DOI: 10.1136/bmjnph-2020-000173. https://nutrition.bmj.com/content/4/1/49 (visited on 24/04/2023)

[AA] D. Coyle et al (2021). Coyle, D. et al. "Estimating the potential impact of Australia's reformulation programme on households' sodium purchases". BMJ Nutrition, Prevention & Health 4.1. Publisher: BMJ Specialist Journals Section: Original research. ISSN: 2516-5542. DOI: 10.1136/bmjnph-2020-000173. https://nutrition.bmj.com/content/4/1/49 (visited on 24/04/2023)

[BB] D. Coyle et al (2021). Coyle, D. et al. "Estimating the potential impact of Australia's reformulation programme on households' sodium purchases". BMJ Nutrition, Prevention & Health 4.1. Publisher: BMJ Specialist Journals Section: Original research. ISSN: 2516-5542. DOI: 10.1136/bmjnph-2020-000173. https://nutrition.bmj.com/content/4/1/49 (visited on 24/04/2023)

[CC] D. Coyle et al (2021). Coyle, D. et al. "Estimating the potential impact of Australia's reformulation programme on households' sodium purchases". BMJ Nutrition, Prevention & Health 4.1. Publisher: BMJ Specialist Journals Section: Original research. ISSN: 2516-5542. DOI: 10.1136/bmjnph-2020-000173. https://nutrition.bmj.com/content/4/1/49 (visited on 24/04/2023)

[DD] Trieu et al (2021). Trieu, K., Coyle, D. H., Afshin, A., Neal, B., Marklund, M. and Wu, J. H. Y. "The estimated health impact of sodium reduction through food reformulation in Australia: A modeling study". PLOS Medicine 18.10. Publisher: Public Library of Science, e1003806. ISSN: 1549-1676. DOI: 10.1371/journal.pmed.1003806. https: //journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003806 (visited on 18/04/2023).

[EE] Trieu et al (2021). Trieu, K., Coyle, D. H., Afshin, A., Neal, B., Marklund, M. and Wu, J. H. Y. "The estimated health impact of sodium reduction through food reformulation in Australia: A modeling study". PLOS Medicine 18.10. Publisher: Public Library of Science, e1003806. ISSN: 1549-1676. DOI: 10.1371/journal.pmed.1003806. https: //journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003806 (visited on 18/04/2023).

or packaging. In the absence of robust data, we assume a low estimate, that one in ten products fits this category, and will not incur any reformulation costs.

Further, not all of the cost of reformulation will be an 'additional' cost caused by the introduction new salt limits. It is commonly reported that for many food companies, the natural product cycle of a product is around 3 or 4 years.[56, 57] Many products are reformulated within this natural cycle, regardless of whether salt limits are set. However, good data on the proportion of products reformulated within a given time-frame is lacking. Given that a natural product cycle is similar to the 3-year implementation time-frame we propose for meeting salt limits, we assume that only half of the products which require reformulation to meet salt limits are 'additional' to what would have otherwise been reformulated. These products are assumed to incur the full cost of reformulation.

For the remaining 50 per cent of products, we assume that some reformulation activity would have otherwise taken place in the absence of salt limits. For these products, we assume that the cost of adding salt reduction to the reformulation process (given salt reduction may not have been a focus in the absence of salt limits), is 50 per cent of the standard reformulation cost we estimated above. This is an assumption – there is little data to suggest how reformulation costs would change if sodium reduction is added as a goal.

The combined effect of these assumptions is to lower the de-facto assumed price of reformulation, to a value of $62,100 per unique product line reformulated.

With the exception of the phased Australian-UK target scenario, total cost estimates were divided over the implementation timeframe on a pro-rata basis (for both the 'expected' and 'conservative' cost estimates).

To estimate the cost of the 'phased' approach to meeting the UK's 2014 salt limits, we assume that all Australian limits are met by 2027 as required, but that there is no progress on the additional voluntary UK targets within this time-frame. We assume that the additional UK targets are met from 2027, and completely complied with by 2030. Within these phases, costs were divided over the timeframe on a pro-rata basis.

Why our estimates of industry costs may overstate costs

We use two estimates of industry costs for each scenario: an 'expected' scenario, and a 'conservative' estimate. As this section explains, our conservative estimates are likely to significantly overstate the costs to industry of reformulation.

Under the 'expected' scenario, we make further assumptions to correct for the overestimation of industry costs. However, due to data limitations, the 'expected' scenario may still overestimate costs, although to a lesser extent.

There are four reasons our methodology may overstate costs to industry.

First, both the expected and conservative cost scenarios rely on industry reported cost estimates of reformulating an individual product line (Supplementary Table 12) rely on industry reported costs of reformulating products. Industries tend to oppose mandatory reformulation targets, and so have an incentive to exaggerate the costs of reformulation. There is little that researchers or governments can do to validate industry-provided costs. Due to data limitations, we do not adjust for this potential source of overestimation in the 'expected scenario'.

Second, salt limits are not the only reason that companies reformulate products. It is commonly reported that most food products are reformulated at some point in a three- to four-yearly product cycle, and products can often be reformulated faster if there is a strong incentive to do so.[FF],[GG] If this is the case, the additional cost of reformulating products to reduce salt is likely to be lower than we estimate.

Under the 'conservative' cost estimates, we do not adjust for this effect.

For the 'expected' cost estimates, we make some adjustment for the natural reformulation cycle, by assuming that half of the products requiring reformulation incur a lower reformulation cost (see previous section).

Third, under more-stringent salt limits, manufacturers would need to reformulate many products. Many of these products are likely to be similar and could be reformulated together, reducing costs. This effect is not accounted for under the 'conservative' cost estimates.

For the 'expected' cost estimates, we account for this by assuming that one in ten products requiring reformulation incurs no additional reformulation cost. to account for this. If more products than this figure are similar and share reformulation costs, the expected costs may be higher than reality.

Fourth, the costs of reformulation in lagging countries such as Australia are likely to be significantly smaller than in leading countries. Many reformulation solutions are known and do not need to be tested. As there is little data to suggest how reformulation costs have changed over time, this effect is not accounted for under either the 'conservative' or 'expected' cost estimates.

A final limitation of our costing method is that we assume reformulation costs (per product) are the same in all reformulation scenarios. This assumption may understate the difference in cost between targets which are less stringent (such as Australia's) and more stringent (such as the WHO's), but this is highly uncertain.

SUBSTITUTING POTASSIUM CHLORIDE FOR SODIUM CHLORIDE

We estimated government and industry costs of mandatory enrichment of the salt supply chain with potassium chloride, a salt substitute.

COSTS TO GOVERNMENT

We assumed that the costs of developing a potassium-enrichment scheme for Australia's salt supply chain could be absorbed within existing departmental budgets.

[FF] European Commission (2020). Commission staff working document evaluation of the regulation (EC) No 1924/2006 on nutrition and health claims made on foods with regard to nutrient profiles and health claims made on plants and their preparations and of the general regulatory framework for their use in foods. **https://food.ec.europa.eu/system/files/2020-05/labelling_nutrition-claims_swd_2020-95_part-1.pdf**.

[GG] WHO (2020). Technical consultation on setting global sodium benchmarks for different food categories. https://apps.who.int/iris/bitstream/handle/10665/353331/9789240046467-eng.pdf?sequence=1&isAllowed=y.

But enrichment would require ongoing monitoring to determine compliance. There is little data to suggest how much it would cost to enforce a potassium enrichment scheme. We indicatively assumed a cost of $3 million a year, with a wide uncertainty.

COSTS TO INDUSTRY

We modelled the industry costs of mandatory potassium enrichment policies by estimating the additional cost of potassium salts and multiplying the additional cost by the amount of potassium salt required to meet the specific intervention.

To estimate the cost of potassium salts, we used data from Yin et al (2021a).[HH]

We adjusted data on the estimates price ratio of NaCl:KCl, and estimated the 25th percentile and median price ratios between the salts.

To calculate the absolute cost difference of substitution, we multiplied price ratios by the estimated wholesale cost of sodium chloride used in food manufacturing, to determine the cost of substituting 1 tonne of sodium chloride for potassium chloride.[II] The median cost of substituting a single tonne of NaC for KCl was estimated to be $845, and the 25th percentile cost was estimated at $513 per tonne.

We assumed that the median cost estimate apply from 2027 (at the beginning of the intervention periods), and linearly decrease to the 25th percentile cost by 2036, as the industry grows and potassium salts are sold at greater scale.

We assumed that the total amount of salt consumed grows in line with the Australian population (at 1.5 per cent per year), from a baseline intake of 9.6 grams per person per day. The total amount of KCl required under each scenario was calculated by multiplying the substitution rate by the total amount of salt consumed by Australians.

CONSUMER EDUCATION CAMPAIGNS

We assumed the scale of consumer education campaigns would be of the same magnitude as the scheme implemented in the UK between 2003 and 2009. The total cost of that program has been estimated at $1.13 per person, or about $30 million in total.[JJ] We assumed that 50 per cent of this cost is incurred in the first two years of the scheme, and the remaining 50 per cent is spread evenly over the remaining four years.

[HH] Yin et al (2021b). Yin, X. et al. "Barriers and Facilitators to Implementing Reduced-Sodium Salts as a Population-Level Intervention: A Qualitative Study". Nutrients 13.9. Number: 9 Publisher: Multidisciplinary Digital Publishing Institute, p. 3225. ISSN: 2072-6643. DOI: 10.3390/nu13093225. https://www.mdpi.com/2072-6643/13/9/3225 (visited on 07/06/2023)

[II] https://www.statista.com/statistics/916733/us-salt-prices-by-type

[JJ] Land et al (2018a). Land, M.-A., Neal, B. C., Johnson, C., Nowson, C. A., Margerison, C. and Petersen, K. S. "Salt consumption by Australian adults: a systematic review and meta-analysis". Medical Journal of Australia 208.2._eprint: https://onlinelibrary.wiley.com/doi/pdf/10.5694/mja17.00394, pp. 75–81. ISSN: 1326-5377. DOI: 10.5694/mja17.00394. https://onlinelibrary.wiley.com/doi/abs/10.5694/mja17.00394 (visited on 20/02/2023)

POPULATION-WIDE SALT MONITORING PROGRAM

We assumed Australia's population-wide salt monitoring program would be of a similar scale and cost to the program implemented in the UK. In 2014, the cost of that program was estimated to be about $770,000 a year.[KK] We assumed the cost in Australia to be the same.

We also recommend that the federal government invest in monitoring how the salt content of individual food products changes in response to salt limits. But this is likely to incur negligible additional cost, because Australia already monitors the salt content of foods through the ABS,[LL] and funding has already been allocated for the development of an Australian Branded Food database, which could be used for this purpose.[MM]

[KK] The figure has been converted from pounds and adjusted for inflation. Briggs et al (2019). Briggs, A. D. M., Wolstenholme, J. and Scarborough, P. "Estimating the cost-effectiveness of salt reformulation and increasing access to leisure centres in England, with PRIMEtime CE model validation using the AdViSHE tool". BMC Health Services Research 19, p. 489. ISSN: 1472-6963. DOI: 10.1186/s12913-019-4292-x. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6631881/ (visited on 10/05/2023)

[LL] ABS (2023). Healthy Food Partnership Reformulation Program: Two-year progress. Australian Bureau of Statistics. https://www.abs.gov.au/articles/healthy-food-partnership-reformulation-program-two-year-progress (visited on 22/02/2023

[MM] (FSANZ 2022). Australian Branded Food Database. https://www.foodstandards.gov.au/science/monitoringnutrients/Pages/Branded-food-database.aspx (visited on 07/09/2023).

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