





## two : Methods

### 2.1 Research question

**The research question for this priority-setting study was:**

*“What are the most effective, cost-effective, affordable and implementable policy options to prevent obesity across a range of settings?”*

This study aimed to inform decision-making at various levels about the package of obesity prevention interventions offering the greatest ‘value-for-money’ by conducting high quality, collaborative research.

### 2.2 The ACE approach

Although there is no ‘gold standard’ for priority-setting methodology, it is generally agreed that the process should be systematic, explicit, fair and evidence-based (30). The ACE approach to priority-setting is characterised by the use of consistent, rigorous methods for the technical cost-effectiveness analysis that provides decision-makers with quantitative data on the costs and outcomes of interest. In addition to technical cost-effectiveness analyses, effective priority-setting methods require a process that addresses the broader concerns of decision-makers and the range of issues that impinge on policy decisions (22). The ACE approach features a second stage in the analysis where important policy considerations (referred to as ‘implementation considerations’ hereafter) are analysed qualitatively and presented alongside the cost-effectiveness results.

Another key feature of the ACE approach is the consideration of ‘due process’, where legitimacy is achieved through discussion and debate at each stage of the process (21).

**The key features of the ACE-Obesity Policy study were:**

- The application of economic concepts of ‘opportunity cost’ (i.e., benefit versus benefit forgone, and all resources valued based on the alternative use of resources), ‘marginal analysis’ (incremental analysis of interventions compared to a common comparator and relationship between intervention design and resource use) and a clear ‘concept of benefit’ (to underlie ‘value-for-money’ considerations).
- Clearly specified rationale for intervention selection to underscore the opportunity cost principle. Intervention selection was undertaken initially by the ACE-Obesity Policy team and then presented and discussed with the Project Steering Committee (PSC) (see Section 2.3 and Figure 2).
- Standardised evaluation methods. Regular ACE-Obesity Policy team meetings ensured consistency in the application of methods and input values. Methodological decisions were documented and saved in a repository accessible by all members across institutions.

- A common setting, decision context (implementation across Australia) and comparator (i.e., current practice) across all evaluations.
- The use of Australia-specific data wherever possible, adjusted to reflect 2010 values.
- The use of the best available evidence in all analyses.
- Extensive uncertainty incorporated into parameter inputs, to ensure key outcomes reflected potential uncertainty in the costs, epidemiological assumptions, and process/effectiveness estimates.
- The cost-effectiveness results were placed within a broader decision-making framework where qualitative information on the 'strength of evidence', 'acceptability of the intervention to multiple stakeholders', 'feasibility of implementation', 'sustainability of implementation' and other relevant considerations were documented and assessed as 'high', 'medium' or 'low' (see Section 2.6).
- The development and application of a framework to ensure consistency in the assessment of the strength of evidence for interventions (see Figure 3).
- Technical cost-effectiveness results by SEP were presented for two interventions. The remaining interventions considered equity impacts qualitatively.
- Previous ACE studies involved a PSC consisting of stakeholders including experts, clinicians, community representatives and policy makers. For this study, the PSC consisted of the chief investigators and associate investigators of the CRE. This group included national and international experts with a breadth of knowledge, skills and expertise in economic and epidemiological modelling; policy making in prevention; obesity advocacy; and obesity and nutrition research. The PSC convened annually over the five years of the project, and provided guidance on the selection of interventions and the framework for the assessment of strength of evidence. The PSC also provided guidance on the logic pathway and the application of the implementation considerations for a selection of interventions.
- The ACE-Obesity Policy research team, consisting of epidemiologists, health economists, modellers and obesity experts, discussed all logic pathways and reviewed the application of the implementation considerations to ensure consistency across the interventions evaluated. For individual interventions, additional relevant policy makers and content area experts were engaged to ensure policy relevance, and use of the best available evidence for intervention evaluation.

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## 2.3 Intervention selection process

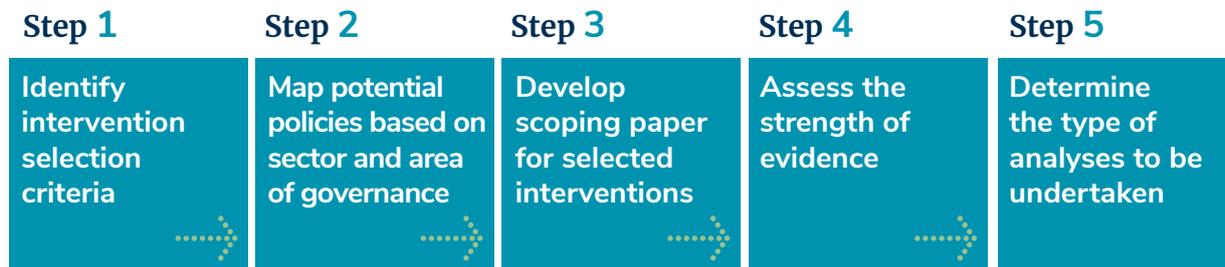
An important step in a priority-setting study involves the systematic selection of interventions for evaluation – the options for change. When addressing a single disease area within the healthcare sector, there is usually a limited choice of alternative interventions. However, when the aim is to inform priority-setting of obesity prevention interventions across a range of sectors, there are a large number of heterogeneous policy/intervention options that could be considered.

**The following overarching principles were applied for the selection of interventions for evaluation:**

- Include interventions aimed at primary prevention rather than treatment;
- Focus on population-wide interventions;
- Focus on options of a policy nature, with program-based interventions limited to those that could be rolled out to the target population across Australia; and
- Include options for change across a range of sectors.

A five-step process (Figure 2) was used to select the interventions for evaluation. The final step also considered the type of analysis (full economic evaluation, threshold analyses, or ‘what if’ scenario analyses)<sup>3</sup>, that would be suitable for application to the intervention and associated evidence base.

**Figure 2** *Intervention selection process*



### Step 1 Identify intervention selection criteria

**The ACE-Obesity Policy team and the PSC agreed on the following three intervention selection criteria:**

- 1 Potential impact on addressing the problem of obesity in Australia.
- 2 Relevance to current policy decision-making for national, state and/or local governments, and/or relevant private sector organisations (e.g., private health insurers). Interventions were required to be transferable to a range of settings and, therefore, interventions that were highly context specific and difficult to scale-up were excluded.
- 3 Availability of evidence of efficacy/effectiveness to support the analyses, using a broad definition of evidence.

<sup>3</sup> Threshold analyses show the threshold value for a key variable where the analysis tips from being cost-effective to no longer cost-effective. ‘What if’ analyses are based on plausible assumptions of the effect size.

## Step 2 Map potential policies based on sector and area of governance

The ACE–Obesity Policy study aimed to consider a range of interventions across different sectors that impacted different levels of government and non-government decision-makers. Potential policies were identified by reviewing key policy documents by the WHO (9, 10), the Australian National Preventive Health Agency (31) and the Institute of Medicine (32). Potential interventions were mapped to a matrix based on the ‘Obesity Policy Action’ framework (11). The matrix classified interventions according to whether policy adoption was the responsibility of local governments, state governments, the federal government or the private/non-government sector.

The matrix also classified potential interventions based on the following policy areas:

- Policies targeting food environments
  - Food production; food composition; food promotion; food labelling; food prices; food provision; and food retail
- Policies targeting physical activity environments
  - Transport; Infrastructure and Planning; Education; Employment; and Sports and Recreation
- Policies in sectors not routinely involved in obesity prevention
  - Finance; Commerce and Trade; Social Services; Environment; and Transport
- Settings-based policies
  - Early childcare; education; workplaces; and local communities
- Supporting infrastructure for obesity prevention
  - Leadership and governance; monitoring; platforms for interaction; workforce development

The matrix was presented to the PSC annually, and additional relevant interventions based on emerging evidence, policy activity globally, and expert views were added throughout the course of the project. The matrix is available at [www.aceobesitypolicy.com.au](http://www.aceobesitypolicy.com.au)

## Step 3 Develop scoping paper for selected interventions

In conjunction with the PSC, a range of interventions were selected for preliminary evaluation. For each of these interventions, a scoping paper was completed outlining:

- the intended impact of the intervention;
- the policy status of the intervention both in Australia and internationally;
- the relevant stakeholders;
- the evidence of effectiveness for the intervention; and
- the potential issues related to the modelling of the intervention.

Scoping papers were informed by systematic-like searches of the literature (grey and academic). Evidence from the literature related to the effectiveness of the intervention was assessed for quality using appropriate tools based on the study design (33, 34).

#### Step 4 Assess the strength of evidence

Unlike medical interventions for the treatment of disease, in the context of obesity prevention there are many cases where the evidence of effectiveness of preventive measures may only be seen indirectly (e.g., through changes in the food environment) or gradually (through small incremental changes in population behaviour or health) (35). Furthermore, there are a range of relevant outcomes for studies that investigate intervention effectiveness in the area of obesity prevention. The most proximal evidence comes from interventions reporting changes in weight or BMI. Some studies focus on less proximal outcomes, such as those related to change in diet and physical activity outcomes. In these cases, sustained changes without compensation are required to result in longer term changes to BMI.

Given that the obesity epidemic calls for immediate action, decision-makers are required to make decisions based on the best available evidence rather than waiting for the best possible evidence. The traditional hierarchy of evidence used in evidence-based medicine, where randomised

controlled trials (RCTs) with clinical outcomes provide the highest quality of evidence, is likely to be too narrow a framework to assess the quality of the evidence base for obesity prevention interventions. It has therefore been recommended that a broader perspective be taken on the admissible evidence considered for obesity prevention strategies (35, 36).

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The strength of evidence assessment developed for this study (Figure 3) considered the balance of evidence, and was based on the study type, the consistency of findings and the quality of studies. After deliberation by the ACE-Obesity Policy team, each intervention was classified as

having 'high', 'medium' or 'low' certainty of effect on BMI outcomes and on dietary/physical activity outcomes. This assessment fed into the implementation considerations.

#### Step 5 Determine the type of analyses to be undertaken

The final step in the intervention selection process was to determine the type of analysis suitable for the policy intervention. Full economic evaluations were undertaken for interventions determined to have high or medium certainty of effect. For interventions with low strength of evidence, but where the necessary data inputs were available, full cost-effectiveness analyses were undertaken incorporating appropriately large uncertainty in the inputs. For interventions determined to have a low certainty of effect and a lack of available input data, 'what if' and threshold analyses were considered. Interventions were prioritised for these analyses based on the likely importance of the intervention as part of a comprehensive obesity prevention strategy, and the likelihood of generating better evidence in the future, particularly considering the characteristics of the intervention.

Figure 3 Criteria for classifying the degree of certainty of effectiveness of each intervention

Body Mass Index (BMI) / weight outcomes	Diet / physical activity outcomes
<p><b>HIGH certainty of effect</b></p> <p>The balance of evidence was judged to provide high certainty of effect based on:</p> <ul style="list-style-type: none"> <li>• One or more Level I or Level II studies,<sup>#</sup> with accurately measured outcomes,<sup>%</sup> that show results consistent with other studies (where they exist) AND/OR</li> <li>• Multiple Level III studies,<sup>#</sup> with accurately measured outcomes,<sup>%</sup> that show consistent results</li> </ul>	<p><b>HIGH certainty of effect</b></p>
<p><b>MEDIUM certainty of effect</b></p> <p>The balance of evidence was judged to provide medium certainty of effect based on:</p> <ul style="list-style-type: none"> <li>• Multiple studies (including Level III, Level IV, relevant indirect / parallel / modelled evidence)<sup>#</sup> that show consistent results</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• The intervention effect is based on a single Level II study,<sup>#</sup> specified in the same way and conducted in the same context as the selected intervention. The single study needed to be assessed as superior to other studies if results were not consistent with previous studies.</li> </ul>	<p><b>MEDIUM certainty of effect</b></p>
<p><b>LOW certainty of effect</b></p> <p>The balance of evidence was judged to be inconclusive regarding effectiveness based on:</p> <ul style="list-style-type: none"> <li>• Level I, II, III or IV studies<sup>#</sup> and/or relevant indirect / parallel / modelled evidence that show inconsistent results</li> </ul> <p>AND/OR</p> <ul style="list-style-type: none"> <li>• No clear evidence of effect, but strong program logic coupled with evidence of effect on relevant distal outcomes</li> </ul>	<p><b>LOW certainty of effect</b></p>

**Notes:**

<sup>#</sup> Level I study: a systematic review of Level II studies; Level II study: a randomised controlled trial; Level III study: a comparative study with controls; Level IV: a cross sectional study or case series. Classification based on NHMRC Evidence Hierarchy (37).

<sup>%</sup> As an example, measured BMI is considered more accurate than self-reported BMI.

## 2.4 Key features of the economic analyses

Key methods of the economic evaluations, as recommended for reporting by the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement (38), are detailed in Table 1.

**Table 1** Key reporting items for methods utilised in the ACE–Obesity Policy economic evaluations

<b>Target population and subgroups</b>	Australian 2010 population aged 2-100 years (39). Subgroups of this population based on age, sex and BMI profile were used for targeted interventions. Subgroup analyses by SEP were undertaken for a limited number of evaluations.
<b>Setting and location</b>	Interventions requiring implementation by local, state, federal governments and private organisations across a range of settings (e.g., communities, schools, workplaces) were included. All analyses reflected implementation across Australia.
<b>Study perspective</b>	Limited societal. All evaluations attempted to collect the opportunity costs and benefits to individuals, governments and the private sector <sup>4</sup> . Productivity impacts were not included.
<b>Comparator</b>	Australian 2010 population aged 2-100 years, not exposed to the intervention.
<b>Time horizon</b>	Time horizon for the modelled implementation of an intervention varied according to the intervention's application in real life. The costs, cost-offsets and health impacts were tracked over the lifetime of the target population or 100 years.
<b>Discount rate</b>	3% was applied uniformly to costs and benefits to remain consistent with previous ACE studies related to obesity (22, 23).
<b>Choice of health outcomes</b>	Short term health outcomes were reported as change in BMI, weight (in kg), physical activity (in metabolic equivalent task (MET) minutes per week) and fruit and vegetable intake (in grams per day). The primary long term health outcome resulting from the change in the short term outcomes was reported in Health Adjusted Life Years (HALYs).
<b>Measurement of effectiveness</b>	Intervention effect assessed using strength of evidence framework (see Figure 3).
<b>Measurement and valuation of preference-based health outcomes</b>	Health related quality of life (HRQoL) impacts related to BMI status during childhood were included using published data (40).

<sup>4</sup> When using a societal perspective, the costs and benefits to all members of society should be captured. All interventions are likely to have spill-over effects on members of society not primarily targeted for an intervention. In order to ensure the evaluation was tractable and due to the availability of data, the capturing of downstream spill-over effects was beyond the scope of the evaluations. For example, a school-based intervention encouraging fruit and vegetable consumption may also increase the consumption of fruits and vegetables of other family members and may also have an impact on the family food budget. Our evaluation was limited to include the cost of the school-based intervention and the benefits to the school children. The spill-over effects on the whole family were excluded. The potential downstream spill-over effects are reported qualitatively for relevant interventions (see Section 5).

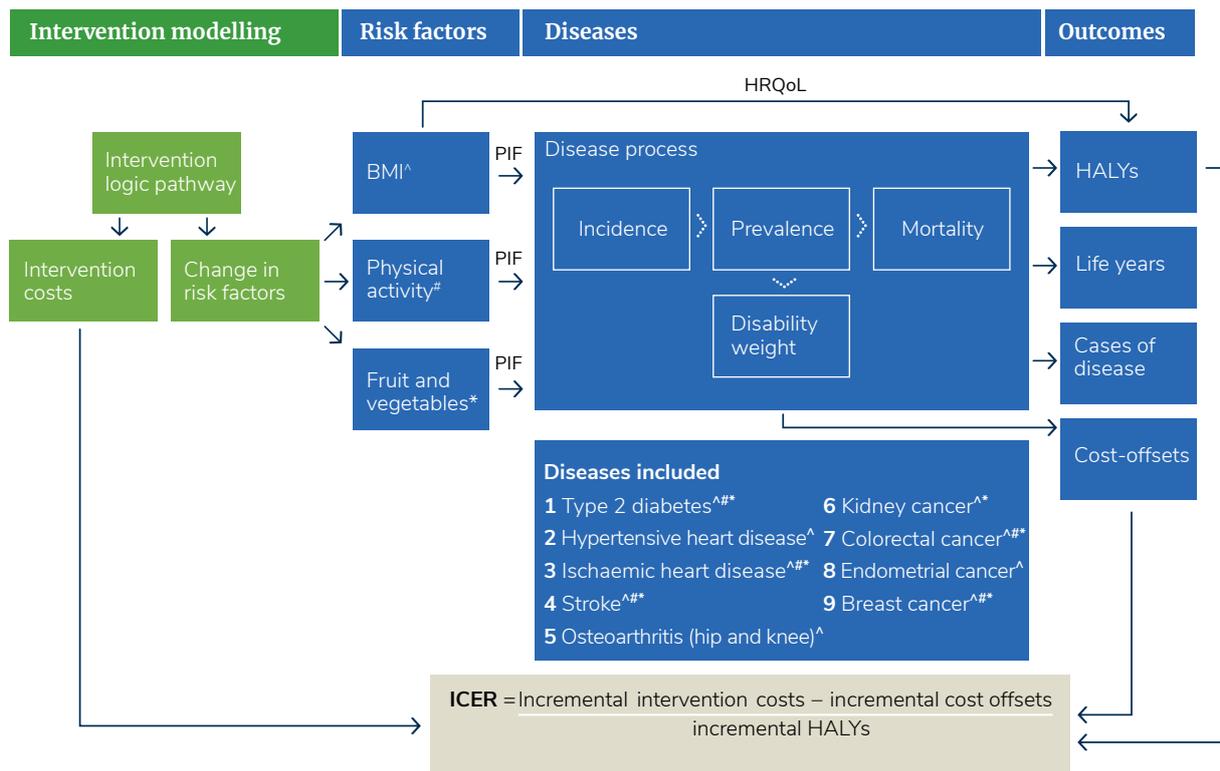
<b>Estimating resources and costs</b>	Event pathways for the implementation of the intervention were used to identify costs at each step in the process. The opportunity cost principle (41) was used to identify cost categories. Resource use was collected using primary and secondary data sources. Valuation was based largely on administrative databases using real prices for the reference year 2010. Details of the costing methodology are provided in Section 2.5.1.1.
<b>Currency, price date, and conversion</b>	2010 Australian dollars. When costs were not available for the 2010 reference year, the Australian Institute of Health and Welfare price indexes were used to adjust prices to 2010 values (42). For health related costs, the total health price index was used, whilst for non-health related costs, the gross domestic product index was used. International costs were not used in the evaluations.
<b>Choice of model</b>	A proportional, multi-state, life table Markov model simulating the BMI, physical activity and fruit and vegetable consumption profile of the 2010 Australian population (hereafter referred to as the ACE-Obesity Policy model). The impact of changing the BMI, physical activity and/or fruit and vegetable consumption profile of the population as a result of the intervention was captured in the reduced rates of obesity-related diseases. Details of the methods and key sources are provided in Section 2.5.
<b>Assumptions</b>	An outline of the structural assumptions is provided in Section 2.5. Key assumptions related to individual interventions are provided in the intervention reports section (Section 5) and details can be found in the individual intervention publication list available in Appendix 4
<b>Analytic methods</b>	An outline of the analytical methods used for the ACE-Obesity Policy model is presented in Section 2.5. The key methods used for individual interventions are provided in the intervention reports section (Section 5) and details can be found in the individual intervention publications (publication list available in Appendix 4).
<b>Notes:</b> ACE: Assessing Cost-Effectiveness; BMI: body mass index; HALYs: health adjusted life years; HRQoL: health related quality of life; kg: kilogram; MET: metabolic equivalent task; SEP: socio-economic position	

## 2.5 Modelling the cost-effectiveness of obesity prevention interventions

The modelling process consisted of three steps. The first involved modelling the intervention costs and impact on each of the risk factors of interest: BMI, physical activity, and fruit and vegetable intake. The second step involved modelling the short term changes in risk factor profile to long term changes in health and health related cost-savings using the ACE-Obesity Policy model. The final stage involved aggregating the incremental costs and the incremental health outcomes of the intervention compared to the comparator to calculate the incremental cost-effectiveness ratio (ICER) (Figure 4).

An intervention was considered cost-effective if the ICER was less than or equal to \$50,000 per health adjusted life year (HALY) gained. This willingness-to-pay threshold was used in previous ACE studies (22, 23), and is the commonly used threshold in Australia (43). ICER thresholds tend to be related to national income, and countries similar to Australia have similar thresholds (e.g., UK and Canada). A common rule-of-thumb is for the ICER threshold to be 1.5-2 times the Gross Domestic Product (GDP) per capita, with thresholds moving up or down based on factors such as capacity to spend, size of the disease burden and the severity of conditions addressed.

**Figure 4 Schematic of the ACE–Obesity Policy model**



**Notes:** BMI: body mass index; HALYs: health adjusted life years; HRQoL: health related quality of life; ICER: incremental cost-effectiveness ratio; PIF: population impact fraction.

## 2.5.1 Intervention modelling

### 2.5.1.1 Measurement of intervention costs

Using a limited societal perspective, the intervention costs accruing to a range of government sectors (as relevant to intervention implementation), private companies and individuals were included. Relevant intervention costs and outcomes were ascertained by using logic pathways to identify the steps required for the intervention to achieve a change in risk factors. The cost components varied by intervention type; however, the main cost elements included:

- recruitment for targeted interventions;
- the cost of legislation for mandatory policies; and
- key aspects of intervention delivery, implementation, administration, compliance and maintenance over the lifetime of the intervention.

The impact of an intervention on industry revenue was included in sensitivity analyses where appropriate data was available to support the analysis. In the primary analyses, the deadweight losses associated with taxation (decreased economic wellbeing as a result of the tax), and potential welfare losses to individuals were not included.

Individual out-of-pocket costs related to engagement with the intervention were included. Time and travel costs were included as part of this. Time costs for children, however, were not included. Productivity costs, costs associated with research and development, and intervention evaluation were also excluded.

### 2.5.1.2 Valuation of costs

Unit cost data were collected largely from administrative databases for the 2010 reference year. Wages included salary oncosts (i.e., superannuation, payroll tax, workers compensation, fringe benefits tax) and a 17.5% loading for four weeks of annual leave. Time costs were valued at the hourly average gender free wage rate (44). Volunteer time was valued at 33% of the average wage rate (45). Given that many of the policies would require legislative changes, a detailed costing study was undertaken to estimate the cost of passing legislation in the federal parliament (46).

### 2.5.1.3 Measurement of changes in risk factors

For interventions resulting in a change in food consumption, relevant food composition data were obtained from either the Food Standards Australia New Zealand NUTTAB 2010 database (47) or The George Institute Food Composition database, and used to estimate the difference in kilojoules (kJ) resulting from an intervention. Kilojoule change as a result of an intervention was converted into a corresponding change in weight in kilograms (kg) using validated energy balance equations for adults and children (48, 49), and then converted to a change in BMI using average height, by age and sex (50). Intervention effects in children measured in BMI z-score were converted to a change in BMI using WHO standardised growth charts for age and sex (51).

Changes in physical activity as a result of an intervention were assumed to have an impact on physical activity as well as a resultant change in BMI. Changes were modelled as the difference in metabolic equivalent task (MET) minutes per week using published values from the literature (52, 53). Changes in MET minutes per week were an input to the physical activity risk factor component of the model. MET minutes were also converted to change in kJ using the validated equation (52), and then to change in BMI. Changes in fruit and vegetable intake (in grams per day) resulting for an intervention were an input to the fruit and vegetable risk factor component of the model. Substitution and compensatory effects of an intervention (on diet and/or physical activity) were not included in the analyses unless there was evidence of such effects.

For comparability, it was assumed that the impact of regulatory interventions was maintained over the lifetime of the modelled population. However, when this assumption was deemed unreasonable, intervention scenarios were tested using plausible variations to the maintenance of effect. For program-based interventions, the duration of effect varied according to the characteristics of each intervention.

## 2.5.2 ACE-Obesity Policy model

Health economic models are analytical tools that help inform decision-making under uncertainty (54). These techniques are particularly important in the context of obesity prevention where longitudinal data on the impact of prevention initiatives are often not available. The ACE-Obesity Policy model uses mathematical relationships between the characteristics of the population, risk factors, and diseases to predict the longer term outcomes of obesity prevention initiatives. The structure of the ACE-Obesity Policy model is based on the previous ACE-Prevention model (55), with some important improvements and additional features. These included the ability to quantify costs and health impacts by SEP, an expanded analytic scope of health outcomes to include children and health-related quality of life (HRQoL) outcomes attributable to BMI status, and the inclusion of physical activity and fruit and vegetable intake as risk factors for disease.

The ACE-Obesity Policy model is a proportional, multi-state life table Markov model. A schematic of the model is shown in Figure 4. The model consists of three key components, namely risk factors, disease processes, and outcomes.

The model simulates the effects of intervention-related changes to the distribution of one or more risk factors (i.e., BMI, physical activity, and/or fruit and vegetable intake) in the population of interest (2010 Australian population aged 2 to 100 years (39)) on the incidence of diseases related to that risk factor. Reduced incidence of diseases results in reductions in prevalence and disease-related mortality and morbidity. This, in turn, results in improved long term health outcomes and healthcare cost-savings.

### 2.5.2.1 Risk factors

Population impact fractions (PIFs) were used to measure the proportional change in disease incidence as a result of changes in the population profile of the three risk factors of interest. Relative risks (RR) from the Global Burden of Disease 2010 study (56) were used to calculate the PIF for diseases related to BMI and physical activity. Various sources reporting the RR of diseases related to fruit and vegetable intake (57-62) were used to calculate the relevant PIFs. PIFs were calculated using the distribution shift method for BMI and fruit and vegetable intake (63) and the relative risk shift method for physical activity (64).

When interventions impacted both BMI and physical activity, the RRs and the PIFs for the diseases impacted by both risk factors were adjusted using a multiplicative function (65) to account for the joint effect of the two risk factors. It was assumed that fruit and vegetable intake had an independent effect on diseases, and no adjustment for joint effects was made.

BMI was modelled for individuals aged 18 to 100 years stratified by sex and 5-year age groups. Individuals aged 2 to 17 years were modelled by gender and 1-year age increments. The BMI distribution was modelled using data from the Australian Health Survey 2011-12 (50), assuming a lognormal distribution.

Physical activity was modelled for individuals aged 2 to 100 years by gender and 1-year age increments. Physical activity levels were classified using weekly energy expenditure measured in mean MET minutes per week (52). These were grouped into four categories according to risk, namely 'inactive', 'low active', 'moderately active', and 'highly active' (66).

Interventions that resulted in changes in sedentary behaviour were modelled based on the change in METs. The benefits of decreasing sedentary behaviour, independent of physical activity and BMI, were not included in the modelling. Fruit and vegetable intake distribution was modelled for individuals aged 2 to 100 years by gender and 5-year age groups. A lognormal distribution was modelled using mean intake of fruits and vegetables (in grams per day) from the Australian Health Survey 2011-12 (50).

### 2.5.2.2 Disease process

Nine diseases causally related to BMI (i.e., type 2 diabetes, hypertensive heart disease, ischaemic heart disease, stroke, osteoarthritis of the hip and knee, kidney cancer, colorectal cancer, endometrial cancer and breast cancer) were modelled. Of these, five diseases were also related to physical activity (i.e., type 2 diabetes, ischaemic heart disease, stroke, colorectal cancer and breast cancer) and six diseases were related to fruit and vegetable intake (i.e., type 2 diabetes, ischaemic heart disease, stroke, kidney cancer, colorectal cancer and breast cancer).

Disease-specific life tables were used to calculate the epidemiologic impact of a reduction in the average incidence of risk factor-related diseases. Incidence rates were used to calculate prevalence and mortality rates for each disease using DisMod2 software (67). These rates were used to simulate transitions between four health states (i.e., 'healthy', 'diseased', 'dead due to the disease' and 'dead due to other causes') for each disease (55). Morbidity impacts were quantified using prevalent years lived with disability (pYLDs), multiplied by disease-specific disability weights from the Global Burden of Disease 2010 study (68)<sup>5</sup>. As with previous ACE studies related to obesity, disability weights from the Global Burden of Disease were used rather than utility weights from the literature in order to use a uniform source with consistent methods for disease state disability/utility weighting across all the diseases included in the model.

<sup>5</sup> Although the disability weights used are from the Global Burden of Disease study (68), the calculation of Global Burden of Disease DALYs varies from the calculation of HALYs in this study. The ACE-Obesity Policy study follows similar methods to previous ACE studies. See the ACE-Prevention report (23) for further details.

### 2.5.2.3 Outcomes

The primary long term health outcome in the ACE-Obesity Policy model was the incremental Health Adjusted Life Years (HALYs) saved as a result of the intervention. HALYs were calculated by aggregating the population level changes to overall mortality and morbidity for each disease (using Global Burden of Disease disability weights and the negative HRQoL impacts attributable to BMI in childhood (40)). Given that the average age of onset of diseases associated with the risk factors of interest is generally mid-life, the addition of HRQoL impacts allowed the quantification of short-term impacts of obesity interventions in children and adolescents.

Other health outcomes included total life years saved (LYs) as a result of the intervention, calculated from mortality effects of the intervention, and the number of cases of disease averted, calculated from the changes in the incidence of disease.

Total healthcare cost-savings (the treatment costs that are averted due to reductions in disease prevalence as a result of an intervention, also referred to as cost-offsets) were used to calculate the net costs of an intervention. Data on healthcare costs for incident cases (all cancers in the model) or prevalent cases (other diseases in the model) were taken from the Australian Institute of Health and Welfare (AIHW) (69). The 2001 costs available from AIHW were inflated to 2010 prices using the Health Price Index (42).

### 2.5.3 Adaptation of the model for interventions targeted at children

At ages less than 20 years, the RR of obesity-related diseases associated with elevated BMI is not significant and the intervention impact as estimated by the ACE-Obesity Policy population model is limited to the HRQoL benefits of lower BMI in childhood. Model adaptations (the child matrix model) were made to allow interventions targeted at children to accrue benefits in adult years by simulating the impacts on obesity-related diseases as the targeted population ages over time. Note that there is a significant time delay before childhood interventions show significant impacts on obesity-related diseases and therefore HALYs.

### 2.5.4 Socio-economic position model

The ACE-Obesity Policy SEP model was developed to estimate the differential costs, benefits and cost-effectiveness of interventions across different SEP groups measured using the Socio-Economic Indexes for Areas (SEIFA). SEIFA Index of Relative Socio-Economic Disadvantage (IRSD) quintile specific data for key parameters such as disease incidence, mortality rate, BMI distribution and population numbers were used to populate quintile specific sub models (46).

The differential effectiveness of obesity prevention interventions across SEP groups was modelled for two interventions (i.e., the 'Sugar sweetened beverage tax (20%)' and 'Restricting television advertising of unhealthy foods'), allowing for the quantification of their equity impacts.

### 2.5.5 Uncertainty and sensitivity analyses

All modelling was undertaken using Microsoft Excel 2013 software. Extensive parameter uncertainty analyses were undertaken using Monte Carlo simulation using the Excel add-in software, Ersatz (version 1.35) (70). Two thousand iterations of the model with varying parameter values defined by the most likely distribution of each variable were used to present all results with 95% uncertainty intervals (95% UI).

Key assumptions related to specific interventions were tested in univariate sensitivity analyses. Where there was large uncertainty related to specific values, threshold analyses were undertaken to present the threshold value for the intervention effect variable that resulted in a mean ICER that would be considered cost-effective. This was designed to enable readers to make informed judgements on the economic credentials of interventions.

## 2.6 Implementation considerations

As part of the ACE approach, results from cost-effectiveness analyses were placed within a broader framework that seeks to incorporate other factors (implementation considerations) that are important to decision-makers but difficult to quantify (21, 22). The implementation considerations used as part of this study were adapted by the ACE-Obesity Policy team from those used in previous ACE studies (23, 24), and were reviewed by the PSC.

**The implementation considerations included for all modelled interventions were:**

- **Equity** qualitatively considers whether the intervention is likely to have a positive, neutral or negative effect on equity, and is defined as 'the impact of the intervention on inequity in the distribution of disease and health status, and access to, or utilisation of, specific intervention(s)' (23). In assessing these equity impacts, consideration was also given to out-of-pocket costs relative to income that may occur as a result of the intervention. This definition of equity is a 'composite' definition in the sense that it included both process and outcome dimensions of equity. This approach was suitable for a qualitative approach to equity assessment that sought to flag key issues to inform intervention design and policy judgements. The qualitative analysis was informed by the literature and expert judgement. The two quantitative assessments of equity undertaken in this study used a definition based on SEP. Socio-economic position as an indicator of equity has relevance to both process and outcome dimensions, but is not comprehensive in its coverage, nor does it weight these individual components.
- **Strength of evidence** incorporates an analysis of the strength of evidence of effect for the intervention based on the framework presented in Section 2.3. Strength of evidence was categorised into:
  - Strength of evidence for BMI or body weight effects (high, medium and low certainty of effect);
  - Strength of evidence for dietary-related effects (high, medium and low certainty of effect);
  - Strength of evidence for physical activity effects (high, medium and low certainty of effect).
- **Acceptability** considers the likely acceptability of an intervention to various stakeholders, informed by the literature and based on program logic, 'real-world' experience, expert input and/or parallel evidence. Acceptability was categorised into:
  - Acceptability to government (high, medium, and low);
  - Acceptability to industry (high, medium, and low); and
  - Acceptability to the general public (high, medium, and low).
- **Feasibility** considers the likely feasibility of implementation for an intervention, based on local/national/international experience and/or parallel evidence (high, medium, low).
- **Sustainability** considers likely sustainability based on:
  - The mechanism of intervention (e.g., mandatory regulations, voluntary regulations/guidelines, national roll-out of programs);
  - The level of ongoing funding required; and

The likelihood that the intervention will result in sustained behaviour change. By their very nature, legislative interventions were typically classified as highly sustainable, with voluntary and program-based interventions assessed based on the merits of each intervention (high, medium, and low).

- **Other considerations** summarises important considerations specific to each intervention, such as the potential for “spill-over” or side effects (positive or negative) resulting from the intervention but not included in the modelling.

Implementation considerations for each intervention were critically examined by the ACE-Obesity Policy team against the criteria for assessment, and relative to other interventions included as part of the study<sup>6</sup>.

## 2.7 Presentation of results

In this report, we aimed to provide policy-relevant high-level results, with supporting evidence to allow decision-makers to assess the relevance and reliability of the findings. Detailed results for individual interventions are available in individual publications (see publications list in Appendix 4).

### 2.7.1 League table and implementation considerations

Results from the cost-effectiveness analyses are presented in a league table (Section 3.3, Table 5), ranked by their ICERs in order from the most cost-effective to the least cost-effective intervention. For dominant interventions (interventions that result in both health gains and net cost-savings), the interventions have been ranked by total health gains (HALYs). Table 5 also includes a description of the type of intervention and the target population. The estimated intervention costs over the first three years of the intervention are provided as an indication of the short term budget impact (‘affordability’) of each intervention. In addition to the key cost-effectiveness results, Table 5 also includes the assessment of the strength of evidence, as it is a key consideration when interpreting the quantitative results.

Although the league table is a concise way of displaying the results of this study, caution is recommended against simplistic interpretation of the league table (e.g., ordering of interventions from best to worst), as there is a risk of inappropriate comparisons due to the different size and nature of the target populations, risk factor targeted, and nature of each intervention.

Implementation considerations are presented in Table 6 (Section 3.4) for all the interventions evaluated. This provides a succinct overview of the other factors likely to be important to decision-makers. The table is ordered firstly on strength of evidence for BMI, then strength of evidence on dietary and physical activity outcomes, followed by equity, and finally by the number of ‘positive’ or ‘high’ ratings for the remaining categories. Table 2 shows the traffic light colour coding for the classification for each of the implementation considerations.

**Table 2 Implementation considerations and categories for classification**

Implementation consideration	Categories for classification		
<b>Equity</b>	Positive	Neutral	Negative
<b>Strength of evidence (BMI)</b>	High	Medium	Low
<b>Strength of evidence (physical activity/diet)</b>			
<b>Acceptability to government</b>			
<b>Acceptability to industry</b>			
<b>Acceptability to the public</b>			
<b>Feasibility</b>			
<b>Sustainability</b>			

<sup>6</sup> Given the qualitative nature of implementation considerations, the assessment of ‘high’, ‘medium’ and ‘low’ were based on judgement. The ACE-Obesity Policy team made the assessments for this report to ensure consistency between interventions, however these may differ to the assessments made by authors of the publications of specific interventions.

## 2.7.2 Intervention reports

The results from each intervention are also presented in four-page summary reports (Section 5). These reports are designed to provide an overview of each intervention. Details of the publication citation or publication status are provided to guide readers to more detailed information on specific interventions. The first table in each intervention report describes:

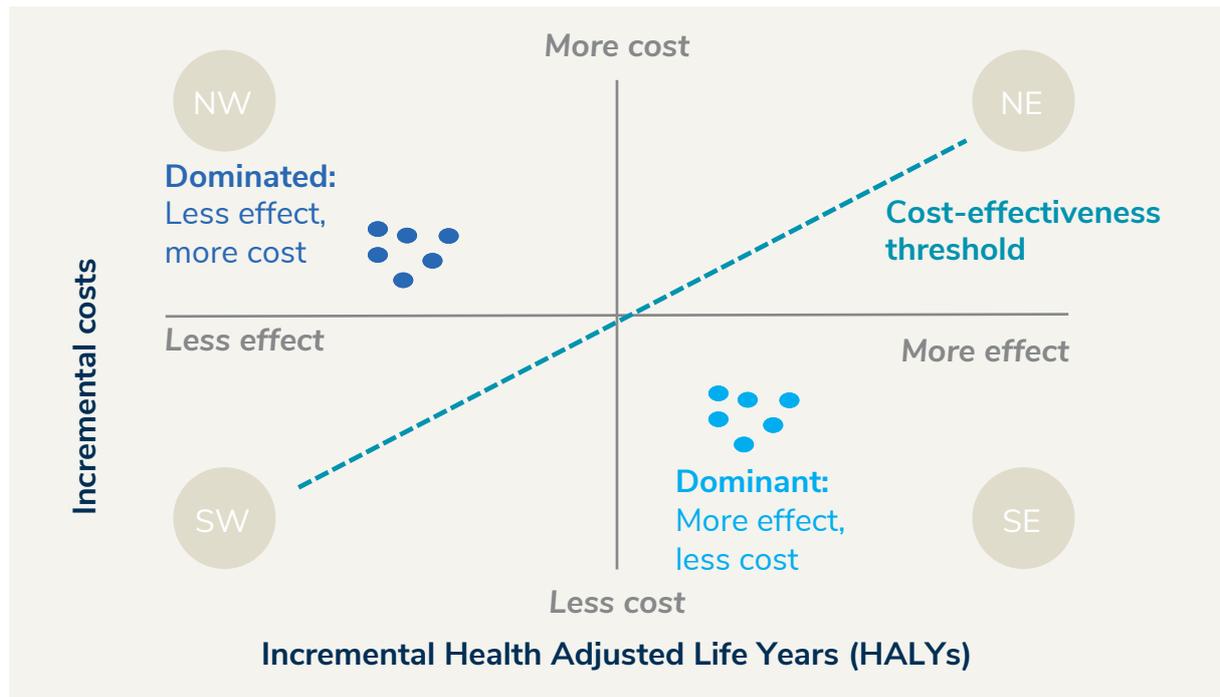
- the key intervention scenarios modelled, including the risk factors modelled;
- the type of model used in the evaluation (population model or the child matrix model);
- the population targeted;
- the weighted average change in body weight and BMI;
- assumptions related to the decay of intervention effect; and
- the categories of costs included in the analyses.

Results are also presented on a cost-effectiveness plane that plots the 2000 iterations of the incremental costs and health benefits (HALYs) of the intervention versus the comparator (i.e., no intervention) (Figure 5). This provides a visual representation of the range of cost-effectiveness results for the scenarios modelled. Iterations of the intervention falling in the north east (NE, Figure 5) quadrant represent runs of the model where the intervention produces more health benefits, but is more costly than the comparator. Iterations falling in the south east (SE, Figure 5) quadrant are 'dominant', as they result in more health benefits and less cost compared to the comparator. Interventions with the majority of interventions in the SE quadrant represent excellent opportunities for resource allocation. Iterations falling in the south west (SW, Figure 5) quadrant represent runs of the model that result in less health benefits but less cost compared to the comparator. Iterations falling in the north west (NW, Figure 5) quadrant are 'dominated' – representing runs of the model where the intervention results in less health benefits and more cost compared to the comparator. Interventions with the majority of interventions in the NW quadrant do not represent good value-for-money.

Results in the NE and SW quadrants are expressed as ICERs. For these quadrants, the 'cost-effectiveness' decision threshold line representing \$50,000 per HALY gained is shown in Figure 5. All iterations below this threshold in the NE quadrant and above the threshold in the SW quadrant represent runs of the model that are considered value-for-money. The probability of the intervention being cost-effective was calculated as the proportion of these iterations out of the total number of iterations.

*The results from each intervention are presented in four-page summary reports (Section 5). These reports are designed to provide an overview of each intervention.*

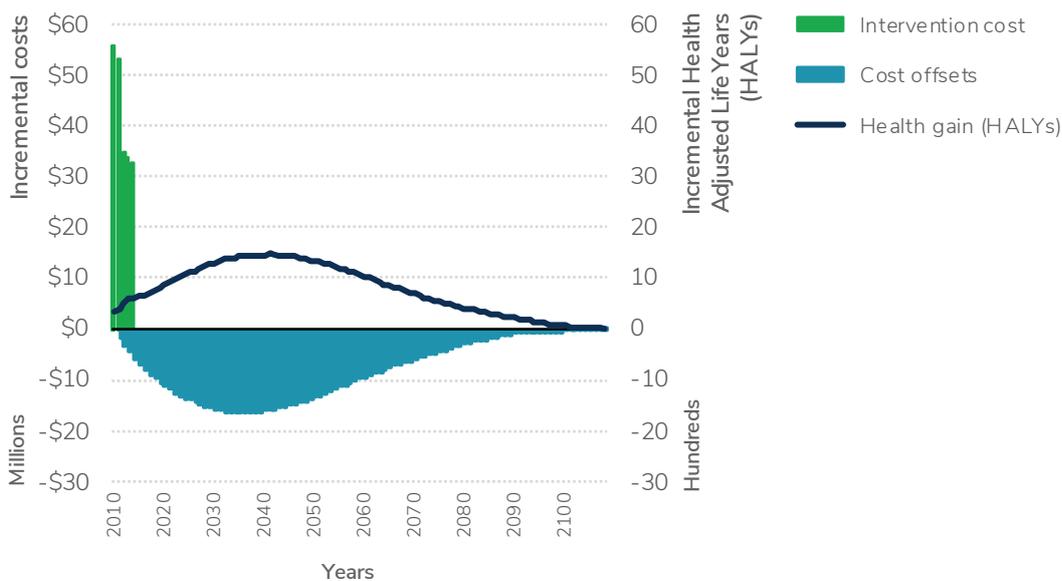
**Figure 5** *The cost-effectiveness plane*



**Notes:** HALYs: health adjusted life years; NE: north east; NW: north west; SE: south east; SW: south west

The second figure in the intervention reports represents the accrual of costs, healthcare cost-savings and health gains (HALYs) over the model time horizon (example shown in Figure 6). This provides important information to decision-makers, visually summarising the initial and ongoing investment needed to implement an intervention (green bars), and the time horizon over which the modelled health benefits (dark blue line) and healthcare cost-savings (light blue bars) are likely to accrue.

**Figure 6** *Costs, cost offsets and health gains over time*



**Notes:** Results are presented over time to demonstrate the timing of investment (green bars) relative to the timing of the cost-savings (blue bars) and health gains (dark blue line). Incremental costs are expressed in 2010 Australian dollars. HALYs: health adjusted life years.

The final section of the intervention reports provides a qualitative assessment and overall rating for the implementation considerations (see Section 2.6).