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Economic Evaluation

Distributional Cost-Effectiveness Analysis of Antenatal Lifestyle Interventions to Reduce the Incidence of Gestational Diabetes and Type-2 Diabetes

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ABSTRACT

Objectives: To evaluate the population net health benefit and distributional health impact across socioeconomic subgroups when considering alternative target populations for implementing antenatal lifestyle interventions in Australia.

Methods: Differences in the distributions of health within population subgroups defined by Socioeconomic Index for Areas quintiles were compared for standard care (no routine antenatal lifestyle intervention) versus subsidized provision to (1) all pregnant women, (2) women with body mass index (BMI) ≥ 25, (3) women aged ≥ 30 years, or (4) women giving birth within the public health system. Distributional cost-effectiveness analysis of the alternative implementation strategies was conducted to model the impact on disease incidence (gestational and type-2 diabetes), direct healthcare costs, opportunity costs, mortality and quality-adjusted life-years for socioeconomic subgroups. Data were obtained from national statistics, registries and the literature. Value judgements regarding aversion to social inequality in health were captured using the Atkinson index. Extensive sensitivity analyses were conducted.

Results: At an opportunity-cost threshold of AU$31 157 (2024 prices), all implementation strategies improved overall population health and reduced health inequality compared with current standard care. Provision to women with a BMI ≥ 25 generated the highest population net health benefit, whereas provision only within the public health system generated the greatest reduction in health inequality. Sensitivity analyses did not materially change these findings.

Conclusions: Among the targeted strategies evaluated, limiting implementation to women with BMI ≥ 25 is likely to result in the greatest incremental population net health gains and is the preferred strategy when trade-offs between efficiency and health equity are considered.

Keywords: distributional cost-effectiveness analysis, gestational diabetes, lifestyle intervention, pregnancy.

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Highlights

- Distributional cost-effectiveness analysis extends traditional cost-effectiveness analyses to facilitate insights into how interventions, when implemented at the population level, influence the overall lifetime health in different equity-relevant subgroups.
- Prioritizing implementation of antenatal lifestyle interventions for women with a prepregnancy body mass index ≥ 25 is estimated to generate the greatest population net health benefit, whereas implementation within the public health sector will have the greatest impact on reducing health inequality. Body mass index ≥ 25 is the preferred implementation strategy when both efficiency and equity are considered together.
- This study shows that, although antenatal lifestyle interventions are cost-effective, different clinical risk-targeted implementation strategies can influence both total incremental health gain and the distribution of health within equity-relevant subgroups of the population.

Introduction

Antenatal lifestyle interventions are both effective and cost-effective in reducing the adverse outcomes of gestational weight gain.[1-3] Advocates recommend making publicly funded interventions available to all pregnant women.[3] However, this approach is projected to cost health funders in Australia over $50 million annually,[4] potentially displacing other beneficial healthcare programs in an environment of limited healthcare resources.

Although traditional cost-effectiveness analysis (CEA) evaluates incremental costs and health effects of alternative interventions, it does not consider the distributional impacts of implementation on health equity within a population.[5,6] Ideally, large scale public health interventions would be evaluated using "Distributional Cost-Effectiveness Analysis" (DCEA) before implementation.[7,8] DCEA extends traditional CEA to account for underlying health inequalities, which allows equity-focused decision makers to determine whether cost-effective interventions exacerbate or reduce health disparities in a population.[5,6,9]

Socioeconomically disadvantaged groups are disproportionately affected by excess gestational weight gain, its short-term consequences, such as gestational diabetes, and associated long-term adverse health outcomes, such as the development of type 2 diabetes.[10-12] It is therefore plausible that antenatal lifestyle interventions to reduce gestational weight gain will reduce health inequalities in the population. What remains unclear is whether the net health benefit for the population and health equity gain, when adjusted for the baseline distribution of health in different socioeconomic groups, is greater when the intervention is provided to all women or targeted specifically at high-risk groups.

This study aims to evaluate the incremental cost-effectiveness, population net health benefit, and distributional impact on total population health when considering 4 alternative approaches for implementing antenatal lifestyle interventions into routine clinical practice in Australia. Current standard care (no routine antenatal lifestyle intervention) was compared with (1) fully subsidized universal provision to all pregnant women, (2) fully subsidized provision only to women with a body mass index (BMI) ≥ 25, (3) fully subsidized provision only to women aged ≥ 30 years, or (4) fully subsidized provision only to women giving birth within the public health system.

Methods

Intervention Design and Choice of Implementation Strategies

Antenatal lifestyle interventions incorporate structured dietary or physical activity components, delivered separately or together, with behavioral change coaching.[4] As in previous economic evaluations, we allowed flexible implementation of these interventions across different settings, populations, and health systems, provided that core elements—such as delivery by supplementary trained health professionals—are retained.[4,13] Current standard care in Australia (the comparator) does not incorporate structured lifestyle coaching into routine antenatal service provision, except in a small number of health services in which programs are being piloted.[1,14,15]

Current standard care was compared with 4 alternative strategies for implementing the antenatal lifestyle intervention into routine clinical practice at scale. The first strategy was fully inclusive and included subsidized universal provision to all pregnant women in Australia. Two strategies were based on targeting groups at higher risk of gestational diabetes: provision to women with prepregnancy BMI ≥ 25, and those aged ≥ 30 years at conception. The final strategy provided fully subsidized intervention only to women receiving antenatal care within state-funded public hospitals (Appendix Fig. 1).

Modeling Approach

Distributional cost-effectiveness analysis (DCEA) extends traditional cost-effectiveness or cost-utility analyses to facilitate insights into how alternative interventions, when implemented at the population level, influence the overall lifetime health in different equity-relevant subgroups. To provide decision makers with comprehensive information to inform policy decisions, this DCEA explored the costs and outcomes of the alternative implementation strategies through multiple lenses: incremental costs and benefits, incremental cost-effectiveness ratios (ICER), population net health benefit (NHB), and impact on health inequalities. The modeling approach followed established methodologies,[6] and is outlined in detail in the Supplementary Methods Protocol, with steps described briefly here.

The analysis was conducted from the public payer perspective. For all analyses, costs are presented in AU$ at 2024 prices, with 3% discounting applied to both costs and benefits consistent with other health equity-focused modeling for Australia that has taken a lifetime horizon.[16,17]

Distribution of Baseline Health

We utilized the distribution of lifetime health to compare between equity-relevant subgroups, defined by socioeconomic disadvantage, classified using the Socio-Economic Indexes for Areas (SEIFA) 2021 Index of Relative Socioeconomic Disadvantage.[18] Individuals were distributed across 5 population-based quintiles by the Index of Relative Socioeconomic Disadvantage, in which the lowest quintile (SEIFA1) represents those with greatest socioeconomic disadvantage, and the highest quintile (SEIFA5) those least disadvantaged.[19] The baseline distribution of lifetime health was measured by quality-adjusted life expectancy (QALE) at birth, stratified by SEIFA quintiles, taken from published Australian normative data.[19]

Incremental Costs and Benefits of Alternative Implementation Strategies

This study utilized and expanded upon a previously published cost-utility analysis (CUA) exploring the economic impact of implementing a structured lifestyle intervention to reduce excessive gestational weight gain and the associated incidence of gestational diabetes mellitus (GDM) and type-2 diabetes (see Methods Protocol, Appendix Fig. 2).[13] For this study, the previously published model was used to derive the incremental cost-utility (cost per quality-adjusted life-years [QALY] gained, expressed as an ICER) of each of the 4 implementation strategies compared with current standard care (no intervention). Cost and outcome parameters were updated with contemporaneous information where available, as outlined in the Data Sources section below.

The CUA model was stratified by SEIFA subgroups to capture differences in the number of women giving birth at different ages, baseline disease incidence (for both GDM and type-2 diabetes), baseline mortality, baseline health utility, and opportunity costs between these subgroups. The subgroup differences in parameter inputs are described in detail in the Methods Protocol, alongside data sources and justifications for assumptions.

Health Opportunity Cost and Net Health Benefit

Health opportunity cost refers to the health benefits that could have been achieved if the resources spent on a particular intervention were instead allocated to the next-best alternative intervention.[6] The opportunity-cost threshold is analogous to the decision threshold commonly applied in cost-utility analysis, which reflects how much the social decision maker is willing to pay for a QALY gain at the margin.[6] NHB measures the difference between health benefits from a novel intervention (eg, incremental QALYs gained), and the health opportunity costs (converted to QALYs lost using the opportunity cost threshold).[6] It therefore represents the incremental efficiency gain from the intervention. In the base case, we applied an opportunity-cost threshold of AU$31 157 (taken from a published study[20] and inflated to 2024 prices) per QALY foregone due to resources displaced to fund the lifestyle intervention.

The total NHB was stratified by SEIFA subgroups to estimate the aggregate incremental NHB per quintile,[9] recognizing that the proportion of total opportunity costs borne by each quintile is not necessarily equal:

$$\Delta NHB_j = \Delta QALYs * n_j - \frac{\Delta costs * N}{k} d_j$$

In which ΔNHB_j is the aggregated incremental net health benefit in SEIFA quintile j (the total NHB for all women receiving the intervention in that SEIFA quintile), $\Delta QALY$ is the per-patient incremental health gain, n_j is the number of women receiving in the intervention in quintile j, N is the total number of women receiving the intervention, $\Delta costs$ are the per-patient incremental costs, k is the opportunity-cost threshold, and d_j is the proportion of opportunity costs accrued in quintile j.

The proportion of health opportunity costs borne by each SEIFA quintile has not been evaluated previously for Australia. We therefore used the distribution of health opportunity costs by relative socioeconomic advantage estimated from a United Kingdom study[21] (Appendix Table 1) and tested this assumption in scenario analyses, including a flat opportunity-cost gradient (described below).

The incremental average health gain/loss per person stratified by SEIFA quintile was derived by dividing the change in NHB for each quintile by the total Australian population (both treated and untreated) in that quintile. This enables us to see whether an average person in each quintile is expected to gain or lose health after implementation of the new intervention. For this study, the incremental NHB by SEIFA quintile and sex was also calculated, given that the intervention is delivered only to females, but males bear a proportion of the opportunity cost.

Measuring Population-Level Equity Impact

A simple absolute QALY gap was calculated to provide an unweighted measure of the change in health equity after implementation compared with baseline. The absolute QALY gap is the difference between total lifetime QALYs for the most-advantaged population quintile minus total lifetime QALYs in the least-advantaged quintile. If the change in absolute QALY gap is negative after intervention, this implies that the gap in health between the most-advantaged and least-advantaged quintiles has reduced.

Inequality within both the baseline distribution and post-intervention distribution of health was then weighted to account for the degree of inequality aversion of the decision maker. In this study, inequality was measured using the Atkinson level-dependent social welfare function, with an Atkinson Inequality Aversion Parameter (IAP) for income of $\varepsilon = 6.98$ applied in the base case. This value for ε was derived from the Atkinson implied weight reported in an Australian study of aversion to health inequality (see Methods Protocol).[22]

Weighting an unequal health distribution enables derivation of equally distributed equivalent health (EDEH), which measures the average level of health in a perfectly equal health distribution (all SEIFA categories have the same total health) that the relevant decision maker considers to be comparable to the current unequal health distribution.[6] In other words, an inequity averse decision maker may be willing to accept a lower level of overall health in the population if the distribution of health is more equitable. The difference between mean health and the EDEH can be interpreted as the amount of QALE society would be willing to sacrifice to eliminate inequality. If health is distributed equally, EDEH equals the mean of health in the population.[6]

For each implementation strategy, the $\Delta NHBj$ for SEIFA quintile j is added to the baseline total health for that quintile to obtain the total postimplementation population health (in QALYs). Postimplementation EDEH is then calculated as for baseline EDEH. Finally, the population equity impact of each implementation strategy is derived by subtracting the incremental population NHB from the incremental EDEH (post-decision EDEH minus baseline EDEH). This equity impact reflects how far the NHB provided by the intervention is from what it should be based on the social welfare function/given the specified level of societal concern for equity (as determined by the selected social welfare function, in this study the Atkinson index).

Data Inputs

Population eligible to receive intervention

Accounting for 1.5% of multiple births,[23] there were a projected 302 016 pregnant women in Australia in 2024.[24] The proportion of pregnant women assigned to age group and SEIFA subgroup categories was taken from the Maternity2000 Dataset (Appendix Table 2). Maternity2000 utilized routinely collected administrative data from the state Perinatal Data Collection, which contains records of all live births, and stillbirths of babies of at least 400 grams birth weight or 20 weeks' gestation between January 01, 2015 and June 30, 2020 in New South Wales and between January 01, 2016 and December 31, 2019 in Queensland. These states account for nearly 50% of births in Australia annually and capture a broadly representative sample of women from urban, rural and socioeconomically diverse communities. Maternity2000 contains information on maternal demographics and clinical characteristics of mothers. Women were included in either the public or private patient analysis based on their admission status at birth.

The proportion of pregnant women receiving the antenatal lifestyle intervention was varied according to implementation strategy, with the Maternity2000 dataset further stratified by BMI index ($<$25 and $\geq$ 25), age, and charge status (public/private) (Appendix Tables 2-4). Consistent with previous economic evaluations of this intervention in the Australian setting, we assumed that 80% of eligible pregnant women would take-up the intervention if it is offered as a component of routine antenatal care.[4,13,14,25] The acceptability of interventions to reduce gestational weight gain has been found to be very high among pregnant women in Australia across broadly representative cohorts.[26] We therefore assumed that there was no differences in uptake across the SEIFA quintiles or implementation groups (BMI, age or hospital sector).

Incidence of diabetes and mortality under current standard care

The age and SEIFA-specific incidence of GDM was obtained from Maternity2000. The data were further stratified by BMI subgrouping and public/private charge status (Appendix Table 5).

The baseline (control group) age and sex-specific incidence of type-2 diabetes was taken from a previous study, stratified by SEIFA subgroup.[12] This study obtained data from the National Diabetes Services Scheme, which effectively serves as the Australian diabetes registry, and includes 80% to 90% of people with diagnosed diabetes in Australia.

For the analysis limited to women with BMI$>$25, in the base case, we took a conservative approach and assumed that the baseline age and SEIFA-specific risk of type-2 diabetes was equal to the population average risk because risk stratified by BMI was not available from the National Diabetes Services Scheme. For the analysis limited to women giving birth in the public health sector only, we assumed that public/private charge status had no independent association with incidence of type-2 diabetes, given that the relative socioeconomic advantage has already been adjusted for via stratification by SEIFA subgroup.

The age- and sex-specific mortality for Australia, for those with and without type-2 diabetes, was obtained from the aforementioned study.[12] Mortality was adjusted across the 5 SEIFA subgroups using data from the Australian Institute of Health and Welfare Mortality Over Regions and Time books.[27] For the analyses including only women with BMI > 25, no adjustment was made to baseline mortality given the absence of a linear relationship between obesity and increased risk of mortality in type-2 diabetes.[28] We also assumed that public/private charge status was not associated with risk of death, independent of the effect of socioeconomic advantage which has already been adjusted for via stratification of mortality by SEIFA subgroup.

Intervention clinical effects

Antenatal lifestyle interventions are supported by level 1 evidence from a meta-analysis of >100 clinical trials,[2] and diet and/or physical activity interventions significantly reduce the incidence of GDM (pooled analysis of relative risk [RR] vs standard care 0.67, 95% CI: 0.58-0.77). Previous meta-analyses have explored whether participant characteristics modify the effect of the lifestyle intervention on GDM outcomes, finding no evidence that effect size is different in women with overweight or obesity, compared with those who are normal/underweight.[3,29] Similarly, there is no evidence that the efficacy of intervention is impacted by socioeconomic status, although data are limited.[3] We therefore apply the same treatment effect size for risk of GDM in all implementation strategies and across all SEIFA sub-groups. Although there is no evidence that key clinical and demographic factors (such as age or BMI) modify the effect of treatment in clinical trials, large differences in baseline incidence of GDM in these subgroups result in a greater absolute reduction in total events if high-risk groups are targeted.[4]

We applied an elevated risk of developing type-2 diabetes after GDM (RR = 5.25 compared with women without GDM) for the 20 years after pregnancy, with these assumptions explained in the Methods Protocol (see Appendix Fig. 3). There is no evidence that the elevated risk of type-2 diabetes after GDM is modified by age or prepregnancy BMI; therefore, the same RR was applied for all implementation strategies in this study.[30]

Quality-adjusted life-years gained

This study measured the quantity of health, both at baseline and in terms of incremental gains, in QALYs, for which the years of life lived are adjusted by a health utility weight. Individuals in the “no type 2 diabetes” health state were assigned age-specific health utility weights for each SEIFA subgroup derived from the aforementioned Australian cross-sectional study of approximately 14 000 individuals representative of the general population.[19] Individuals in the “type 2 diabetes” health state were assigned a utility weight of 0.785, as reported in a published systematic review,[31] adjusted multiplicatively using age-specific population norms. We also assumed that the health utility decrement associated with type 2 diabetes was not modified by socioeconomic status.

As a decrease in health utility for women with GDM compared with those without has not been demonstrated in clinical trials,[32] women with GDM were assigned the age-specific population normative value for health utility.

Costs

All costs are reported in AU$ and were inflated to 2024 prices using the long-term trend in the Australian health price index (Appendix Table 6).[33] Assumptions underpinning the cost parameters are discussed in detail in the Methods Protocol.

The cost of the intervention was taken from the most recent Australian budget impact analysis,[34] (2022 base price year inflated to 2024 prices), and was $361 per woman (see Methods Protocol). Unit costs for mode of birth, antenatal care for GDM, and annual costs for management of type 2 diabetes are listed in Appendix Table 7.

Model Validation

The internal validation of the CUA was assessed using a checklist provided in Appendix 1 and by ensuring that the model outputs behaved as expected through a series of scenario analyses described below. A series of checks for the parameters introduced in the DCEA (IAP, opportunity-cost threshold, and distribution of opportunity costs) were also executed and are included in the Appendix.

Sensitivity Analyses

Decision makers can compare each of the above analyses to explore the trade-off between incremental cost-effectiveness, incremental healthcare costs (budget impact), change in total population health, and population health equality impact offered by alternative intervention strategies. Social value judgements will need to be applied regarding the extent to which unequal health distributions based on socioeconomic disadvantage are fair or unfair and whether the Australian general public’s view on inequality aversion is consistent with that of the decision maker.[22] A series of scenario analyses was conducted to explore the impact of varying inputs and assumptions for the equity-relevant distributions. First, equal distribution of opportunity costs applied to all was conducted to explore this assumption. A range of opportunity-cost thresholds ($20 000, $40 000, and $50 000) were explored to account for variation in the health opportunity costs adopted by different decision makers. A broad range of values for the Atkinson IAP (ε = 0-20) were explored to account for differences in the degree of inequality aversion of different decision makers. Finally, scenarios with no discounting, and with discounting of 5% (applied to both the baseline distribution of health (Appendix Table 8), and the incremental NHB of alternative treatment strategies) were performed.

Results

Base Case

Both incremental QALYs and costs were highest for the implementation strategy that included all women (Table 1). The incremental cost was AU$39 448 228 if the intervention was provided to all women, whereas this was reduced to AU$9 222 510 if only provided to women with BMI ≥ 25. The BMI ≥ 25 implementation strategy was also the most cost-effective (ICER = AU$6363/QALY) and resulted in the highest incremental population NHB (1153 QALYs), although all strategies were cost-effective at the base-case opportunity-cost threshold and therefore generated a positive NHB.

Similarly, all implementation strategies had a positive impact on net health equity, with the greatest benefits accrued by the most disadvantaged sub-group and the smallest benefit by least disadvantaged (Fig. 1, Table 1). Because this was a sex-specific intervention, all benefit was accrued by females, whereas both males and females bore a proportion of the opportunity cost. NHB to females exceeded net health loss to males. The incremental NHB accrued according to sex and SEIFA quintile is presented in Appendix Figure 4. The absolute gap in population QALE between the most-advantaged and -disadvantaged quintiles was reduced most by the public health system implementation strategy (−382 QALYs) (Table 1). At the

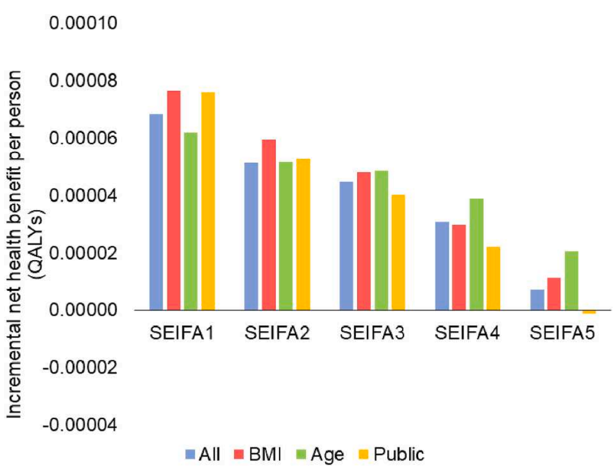
Table 1. Results of base-case analysis according to implementation strategy.

Outcome	All women	BMI ≥ 25 only	Age ≥ 30 years only	Public system only
Number of women receiving intervention	240 712	103 639 (43.1%)	148 100 (61.5%)	177 995 (73.9%)
Incremental costs vs standard care (net budget impact) ($)	39 448 228	9 222 510	19 845 764	26 446 772
Incremental QALYs vs standard care	2307	1449	1780	1821
ICER ($/QALY)	17 094	6363	11 148	14 520
Incremental Population NHB (QALYs)	1041	1153	1143	973
Change in absolute QALY gap* after implementation	−302	−320	−202	−382
Incremental Population EDEH† (QALYs)	1242	1384	1278	1237
Net equity impact (QALYs)	201	231	135	265

BMI indicates body mass index; EDEH, equally distributed equivalent health; ICER, incremental cost-effectiveness ratio; NHB, net health benefit; QALY, quality-adjusted life-years; SEIFA, Socio-Economic Index for Areas.
*The absolute QALY gap is the difference between total lifetime QALYs for the most advantaged population quintile minus total lifetime QALYs in the least advantaged quintile. If the change in absolute QALY gap is negative after intervention, this implies that the gap in health between the most advantaged and least advantaged quintiles has reduced.
†Population EDEH is a measurement of social welfare (in QALYs) that if equally distributed across the population would be considered (by the decision maker) to be as good as the current unequal distribution. When Incremental EDEH exceeds Incremental Population NHB, this implies that the intervention reduces health inequality.

base-case Atkinson IAP of ε = 6.98, the BMI ≥ 25 implementation strategy generated the highest incremental population EDEH (1384 QALYs), although the public health system implementation strategy had the largest net equity impact (265 QALYs). The trade-off between equity and efficiency is presented in the equity-efficiency plane (Fig. 2), illustrating that, although implementing the lifestyle intervention in high-risk groups (BMI ≥ 25 and age ≥ 30 years) offers the greatest efficiency, implementation in the public system has the greatest impact on health equity. However, at the accepted level of health aversion reported by the Australian population, the gain in efficiency associated with the BMI ≥ 25 implementation strategy more than offsets the gain in equity associated with implementation in the public system.

Figure 1. Incremental net health benefit per person according to implementation strategy and socioeconomic advantage quintile (base case). SEIFA1 is the most-disadvantaged and SEIFA5 is the most-advantaged quintile.



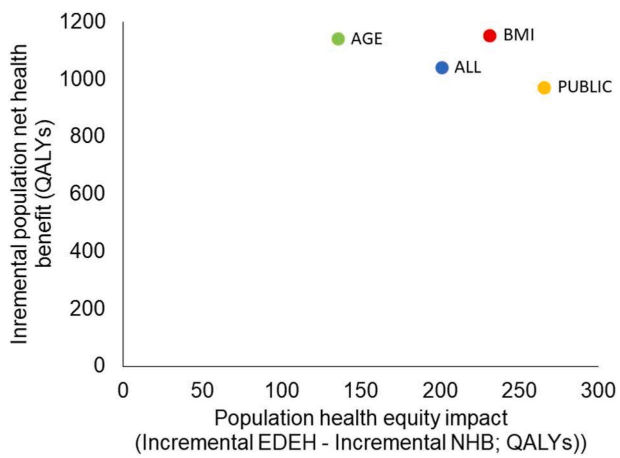
BMI indicates body mass index; QALY, quality-adjusted life-years; SEIFA, Socio-Economic Index for Areas.

Scenario Analysis

The first scenario analysis assumed that the distribution of opportunity costs was equal between sexes and SEIFA quintiles, finding that, under this assumption, all implementation strategies improved health equity to a greater extent than in the base case (Appendix Fig. 5). The strategy that included all women was most sensitive to the distribution of opportunity costs; however, the public sector implementation strategy continued to have the biggest overall improvement in health equity regardless of opportunity-cost distribution (Appendix Table 9), with the equity impact increasing from 265 QALYs to 344 QALYs.

The incremental population EDEH remained positive for each implementation strategy at all opportunity-cost thresholds

Figure 2. Equity-efficiency plane for base case. Colored dots represent the position of the four implementation strategies (all women; age ≥ 30 years; BMI ≥ 25; public health system only) relative to standard care (the comparator) on the equity-efficiency plane.



BMI indicates body mass index; EDEH, equally distributed equivalent health; NHB, net health benefit; QALY, quality-adjusted life-years.

examined (AU$20 000-50 000) across the range of Atkinson IAPs (ε = 0 to 20) (Appendix Fig. 6). This means that even for a decision maker with no aversion to health inequality and a low opportunity-cost threshold, all implementation strategies are expected to have a positive impact on incremental population health and reduce inequality. Varying the opportunity-cost threshold had the greatest impact on the implementation strategy that included all women; at the base-case IAP (ε = 6.98) and an opportunity-cost threshold of AU$20 000, the EDEH was 462 QALYs, whereas at AU$50 000, it was 1768 QALYs (difference 1306 QALYs).

Across the range explored for the Atkinson IAP (ε = 0 to 20), the incremental population EDEH was highest for the BMI ≥ 25 implementation strategy (Fig. 3). The age ≥ 30 years strategy was most sensitive to value judgements regarding equity; for a decision maker with no aversion to health inequality (ε = 0) implementation based on age increases population health by a similar amount as the BMI ≥ 25 strategy. However, for an inequality averse decision maker with an $\varepsilon > 10$, the age ≥ 30 years strategy had the lowest EDEH.

When modeling was repeated with no discounting, the incremental EDEH increased significantly for the implementation strategy including all women (4330 QALY gain), and this strategy had the highest EDEH (5572 QALYs) (Appendix Fig. 7, Table 10). Conversely, the implementation strategy including all women resulted in the smallest incremental EDEH gain (19 QALYs) when 5% discounting was applied. The BMI ≥ 25 and age ≥ 30 years strategies were least sensitive to variation in the discounting rate. Implementation in the public sector had the greatest impact on health equity for all discounting rates explored.

Discussion

This is one of the first DCEAs to be conducted for the Australian setting and provides unique insights into the impact of preventive health interventions on the distribution of health across socioeconomic subgroups of the population. It is also the first comprehensive DCEA globally, to our knowledge, to evaluate the overall population health equity impact of an intervention targeting only women. By comparing clinically relevant approaches to implementation (ie, based on risk stratification), which are related to the structure of the Australian health system, we have identified both efficient and equitable strategies. The comprehensive accompanying scenario analysis can be used by policy makers to balance efficiency against equity and apply their own value judgements with regard to the level of inequity aversion that should be applied.

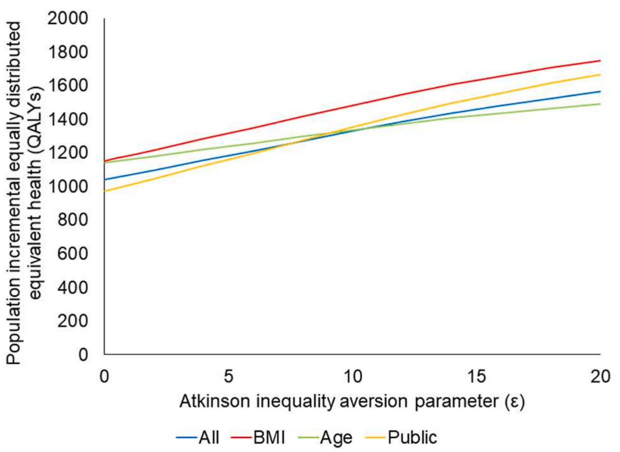
The BMI ≥ 25 implementation strategy resulted in the greatest incremental population health gains, and the public health system strategy resulted in the largest health equity gain. At the estimated level of aversion to inequality due to socioeconomic disadvantage in Australia,[22] BMI ≥ 25 is the preferred implementation strategy when both health gains and equity gains are considered simultaneously. Overweight and obesity have a well-established association with increased risk of adverse maternal and neonatal outcomes.[35] BMI is also a routinely collected clinical measure at antenatal screening visits in Australia and is already used to identify women at risk of pregnancy complications.[15] Here, we illustrate that this risk prediction measure is also useful in supporting the allocation of public funding to improve the health of women who are socioeconomically disadvantaged. Although BMI norms as a clinical indicator have been debated because of concerns about weight stigma,[36] this metric remains highly feasible, whereas alternatives such as waist circumference are inappropriate in pregnancy. It is also important to note that the key goal of antenatal lifestyle interventions is not to reduce BMI, as has been found to often be ineffective with lifestyle interventions alone,[37] but rather to prevent gestational weight gain.[2] This distinction is vital and can help explain the efficacy of the intervention in both normal weight and overweight groups.[3]

Although the cost-effective ICER (AU$17 094/QALY) supports implementation of publicly subsidized antenatal lifestyle interventions for all women, the total healthcare budget commitment for this strategy (~AU$50 million per year) is significant.[4] This strategy was also most sensitive to variation in the opportunity-cost threshold, IAP, and discounting rate, and the combined budget impact and degree of uncertainty around health benefits may concern risk-averse health program managers. This was due to the much larger number of women receiving the intervention under this strategy, greatly increasing costs in the first model cycle when the intervention is delivered, whereas health benefits were largely accrued well into the future. Estimated future health gains are therefore reduced by high discount rates and NHB is reduced by low opportunity-cost thresholds.

Despite unrestricted access to care in Australia's public hospitals, the public sector implementation strategy was found to be most equitable. This reflects the preference of many socioeconomically advantaged women choosing to access antenatal healthcare in the private sector, meaning that subsidizing the antenatal lifestyle intervention delivered exclusively within the public sector will reach a larger proportion of socioeconomically disadvantaged women.[38] The association between socioeconomic disadvantage and lifestyle risk factors also results in the public sector implementation strategy targeting those with higher clinical need, although risk stratification by public/private charge status was not as predictive of clinical need as the BMI ≥ 25 implementation strategy.

Implementation targeting older women was also efficient in terms of incremental NHB. However, this strategy illustrates an interesting paradox in maternity care whereby older women face greater clinical risk but are also more likely to be financially secure when entering pregnancy. Provision of subsidized antenatal lifestyle interventions to women aged over 30 is therefore more cost-effective than implementation only in the public sector but offers less gains in terms of health equity.

Figure 3. Impact of varying the degree of inequality aversion on population incremental equally distributed health. Incremental EDEH is compared with standard care (no intervention) for all implementation strategies. BMI indicates body mass index;



QALY, quality-adjusted life-years.

The strengths of this study were the use of population-level administrative and registry data to define baseline incidence of disease and mortality, and recently defined population normative data for the baseline distribution of health (QALE) obtained from a highly representative longitudinal study.[19] Treatment effect was obtained from a recent systematic review of over 100 randomized clinical trials of antenatal lifestyle interventions.[2] The potential for interaction between socioeconomic subgroups and input parameters was considered at all stages of the modeling. Our finding that cost-effectiveness was greatest in the most socioeconomically disadvantaged quintile was consistent with a previous evaluation of hypothetical interventions to target diabetes prevention at disadvantaged groups in Australia.[12]

Limitations include the unavailability of data relating to the distribution of opportunity costs in Australia, and the association of charge status and incidence of type 2 diabetes or mortality among women giving birth in Australia. The unavailability of long-term outcomes data from clinical trials evaluating antenatal lifestyle interventions was also a key limitation of both this and the preceding CUA,[13] which we addressed by adopting a conservative magnitude and time horizon of intervention effect. Consistent with recently published recommendations, and given the complexity of the distributional and social welfare function analyses, we did not conduct probabilistic evaluation of uncertainty in the model.[39] Similarly, we did not reevaluate uncertainty in the parameters informing the underlying cost-utility analysis because these have been comprehensively investigated previously, with the model demonstrated to be robust to sensitivity and scenario analyses.[13] The parameter inputs applied in this DCEA were deliberately conservative in terms of efficiency outcomes. Although this study drew from a recently published evaluation of inequity aversion in Australia,[22] there has been limited research on this topic to date, which informed our decision to model a wide range of inequity aversion parameters. Selection of predictors of clinical risk was based largely on availability of data. Evaluation of the distribution of targeted implementation based on more sensitive predictors of risk is an important objective for future research.

Distributional cost-effectiveness analysis is a growing field internationally, but it is yet to find its way into health technology assessment policy or practice in Australia. This study illustrates how alternative implementation strategies for interventions can impact efficiency and equity differently, and this information is crucial for equity-focused decision makers. A recent review by the Australian Government on health technology assessment methods and policy for medicines recommended that more equitable access be prioritized for First Nations and pediatric populations.[40] However, the role of DCEA in achieving this recommendation was not discussed. There are significant barriers to uptake including analytical complexity and the requirement for data stratified by equity-relevant subgroups to inform modeling.[41] If these barriers can be overcome, DCEA offers a methodology which can systematically and explicitly incorporate health equity impacts into economic evaluation. This study attempts to illustrate the additional information that can be generated from DCEA, when compared with traditional CEA, which can enable decision makers to balance equity and efficiency in a rigorous way.

Conclusions

Publicly subsidized implementation of antenatal lifestyle interventions to reduce the incidence of gestational and type-2 diabetes is likely to improve both total health and health equity within the Australian population. Among targeted strategies, limiting implementation to women with BMI $\geq$ 25 is likely to result in the greatest incremental population net health gains and is the preferred strategy when trade-offs between efficiency and health equity are considered.

Author Disclosures

Author disclosure forms can be accessed below in the Supplemental Material section.

Supplemental Material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.jval.2026.03.005.

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