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ORIGINAL ARTICLE

The cost-effectiveness of removing television advertising of high-fat and/or high-sugar food and beverages to Australian children

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Objective: To model the health benefits and cost-effectiveness of banning television (TV) advertisements in Australia for energy-dense, nutrient-poor food and beverages during children's peak viewing times.
Methods: Benefits were modelled as changes in body mass index (BMI) and disability-adjusted life years (DALYs) saved. Intervention costs (AUD$) were compared with future health-care cost offsets from reduced prevalence of obesity-related health conditions. Changes in BMI were assumed to be maintained through to adulthood. The comparator was current practice, the reference year was 2001, and the discount rate for costs and benefits was 3%. The impact of the withdrawal of non-core food and beverage advertisements on children's actual food consumption was drawn from the best available evidence (a randomized controlled trial of advertisement exposure and food consumption). Supporting evidence was found in ecological relationships between TV advertising and childhood obesity, and from the effects of marketing bans on other products. A Working Group of stakeholders provided input into decisions surrounding the modelling assumptions and second-stage filters of 'strength of evidence', 'equity', 'acceptability to stakeholders', 'feasibility of implementation', 'sustainability' and 'side-effects'.
Results: The intervention had a gross incremental cost-effectiveness ratio of AUD$ 3.70 (95% uncertainty interval (UI) $2.40, $7.70) per DALY. Total DALYs saved were 37 000 (95% UI 16 000, 59 000). When the present value of potential savings in future health-care costs was considered (AUD$ 300m (95% UI $130m, $480m), the intervention was 'dominant', because it resulted in both a health gain and a cost offset compared with current practice.
Conclusions: Although recognizing the limitations of the available evidence, restricting TV food advertising to children would be one of the most cost-effective population-based interventions available to governments today. Despite its economic credentials from a public health perspective, the initiative is strongly opposed by food and advertising industries and is under review by the current Australian government.
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Keywords: children; advertising; modelling health benefit; cost-effectiveness

Introduction

The prevalence of overweight and obesity as classified by the International Standard Definition[1] is rising among Australian children, increasing from 11% in 1985 to 21% in 1995[2] and to 26% in 2007.[3] The diet of children is also changing towards consumption of more energy. The energy intake of Australian children aged 10–15 years increased by 12% for girls and by 15% for boys between 1985 and 1995, and remained at these elevated levels in 2007.[4] This was because of increased consumption of confectionary, sugar products, cakes, biscuits and food from the take-away group (that is, energy-dense, nutrient-poor (EDNP) foods and beverages).[5]

Television (TV) advertising is the dominant form of food marketing to children.[6,7] The current regulation of TV advertising to children in Australia is a system of coregulation between the Australian Communications and Media Authority, the Children's Television Standards (both regulated

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by the Commonwealth Government) and the Commercial Television Industry Code of Practice (self-regulated). Despite these periodically reviewed regulations, Australian children are exposed to high levels of advertising for EDNP foods while watching 2–3 h of TV each day.[8,9]

At the same time, there is international concern with regard to increasing commercial exploitation of young children who are unable to understand the purpose of advertising, nor distinguish advertisements from programs, nor understand the relationship between food choices and future chronic nutritional diseases or dental caries.[10–13] These advertised food messages directed at children undermine the health messages promulgated by governments, nutrition experts, many parents and schools. This issue is now being actively considered by the Member States of the WHO (World Health Organization) and United Nations bodies,[14–16] and is the subject of the recently increased regulation in the United Kingdom.[17]

There seems to now be a body of evidence that demonstrates a logical pathway from advertising to unhealthy weight gain in children.[10,18] Indirect evidence linking marketing of EDNP foods and beverages to their increased consumption is very strong. The proprietary evidence that the food companies have showing cause and effect between marketing campaigns and sales leads them to continue to advertise very heavily to children.[6] Furthermore, a recent ecological study found a significant association between the proportion of overweight children and the number of advertisements per hour on children's TV, notably advertisements for energy-dense foods ($r=0.81$, $P<0.005$).[19]

We aim to shift the debate from the question of the contribution of marketing to the rise in childhood obesity, to the question of whether specific interventions that reduce food marketing to children are likely to provide an important cost-effective contribution to reduction in childhood obesity. The aim of this study was to present the best available evidence of the health benefits and cost-effectiveness of reduced TV advertising for EDNP food and beverages to inform the policy debate. This analysis was part of the Assessing Cost-Effectiveness in Obesity (ACE-Obesity) project, which evaluated 13 potential interventions to reduce child obesity in the 2001 Australian population.[20]

Materials and methods

Overview

All analyses undertaken in ACE-Obesity adhered to a detailed economic protocol specifically designed for the project (outlined in Supplementary Information). A brief summary of the main points is provided here. We calculated the additional cost and the associated health benefits of a public health intervention to calculate the intervention's incremental cost-effectiveness ratio (ICER), which can be expressed as the cost (AUD$) per body mass index (BMI) unit saved and also as the cost per disability-adjusted life year (DALY) saved. Because randomized controlled trial data of the direct effect of advertising on BMI and DALYs are not available, modelling is used to create a mathematical depiction of relationships between known data and likely associated future costs and health outcomes. The model uses the best available evidence from a variety of sources, and calculates the likely impact of the intervention on the population of Australian children in 2001. The incremental costs and benefits of the intervention were assessed against the level of regulation in place in 2001. In addition to the quantitative analysis that generates ICERs, the intervention was assessed qualitatively by a Working Group of stakeholders using a series of second-stage filter criteria (strength of evidence, equity, acceptability, feasibility, sustainability, potential for side effects) to incorporate important additional factors that affect resource allocation decisions in health.

The intervention

The intervention modelled was an extension of existing regulations within the Children's Television Standards to preclude advertising for EDNP foods, as well as for beverages and fast food outlets, during specified children's TV viewing hours and where a substantial proportion ($\geqslant$15%) of children aged 5–14 years were in the viewing audience. This would effectively remove food and beverage advertising from TV during peak child viewing times in the morning for 1 to 2 h, and in the afternoon/evening for 5 h (up to 2100 hours).[21]

Current practice

Current practice was specified according to the Children's Television Standards 16–23,[22] which limit advertisements to 5 min every 30 min for 5 h per week of designated children's timeslots and prohibit advertisements for $2\frac{1}{2}$ h per week of designated preschool children's timeslots, as well as place some limitations on the content of advertisements. The content limits include accuracy of claims, sensitivity to cultural diversity and disabled groups, a quantum of Australian content, as well as not be frightening to children, nor display unsafe situations.

Assessment of benefit

Benefits of intervention are calculated using a two-stage process. The first stage involves estimation of the health gain that could be attributed to the intervention measured in DALYs, an outcome measure combining premature years of life lost (YLL) and years lived with disability (YLD). The second stage involves a consideration of issues (filters) that either influence the degree of confidence that can be placed in the ICERs or broader issues that need to be taken into account in decision making with regard to resource allocation in health. The secondary filters considered qualitatively by the Working Group in this study include strength of evidence, equity, acceptability, feasibility, sustainability and side effects.

Evidence of the impact of reduced advertising on food and beverage consumption

Randomized controlled trial evidence of the effect of reducing TV advertising of EDNP foods to children on BMI does not exist. Instead, we used the best available evidence, which included a combination of limited randomized controlled trial evidence of food consumption (behaviour change), together with modelled behavioural change to BMI change, using a mix of cross-sectional and longitudinal evidence.[18,23,24] Parallel evidence of behavioural change measured with reductions in advertising of other products, such as toys, tobacco and alcohol, supported the conclusions reached in this analysis for EDNP foods.[25–28]

The most relevant study to assess the effectiveness of a reduction in advertising was a randomized controlled trial that compared the impact of exposure to different food advertisements on food and beverage selections in 288 5- to 8-year old children on holiday camp for a period of 2 weeks in Quebec in 1982.[23] The children were exposed to sweet commercials, no commercials, fruit commercials or nutritional public service announcements. Children who viewed sweet commercials chose (and ate) significantly more sweets over fruit as snacks compared with children in the other three groups (75 versus 67%, 64 and 65%, respectively). Children who viewed sweet commercials also consumed more sugar-sweetened KoolAid rather than orange juice, compared with children in the other three groups (75 versus 65%, 55 and 60%, respectively).

Gorn and Goldberg[23] controlled for age and tested all combinations simultaneously. From the reported summary data, we assumed that the reported statistical significance of food choice difference was maintained for all age groups and used the percentage of time sweet food was consumed in the sweet-commercials group, compared with the average of the other three groups, as the measure of intervention effect. We assumed that the intervention effect applied to children up to the age of 14 years. We converted the percentage of time sweet food choices were made in the exposed and unexposed groups to relative risks of making sweet food choices (RR 0.87; 95% CI 0.74, 0.99). We also used the percentage of time KoolAid was consumed in the sweet-commercials group compared with the other three groups in the same manner, to determine the relative risk of making sweetened beverage choices (RR 0.80; 95% CI 0.68, 0.95).

For food intake, the intervention was thus estimated to reduce consumption of EDNP foods by 13% (to 87% of current practice). The impact of this reduction on energy intake and energy balance was assessed using previously analysed dietary data from the 1995 National Nutrition Survey in Australia.[5,29] Bell *et al*. classified foods and beverages as noncore or core according to the food groups defined in the Australian Guide to Healthy Eating.[30] A classified listing of foods and beverages is detailed in Table 1. Bell *et al*. analysed them on the basis of their contribution to the total diet of Australian children with regard to energy (kJ per day) and weight (g per day) (Table 2). Noncore foods

Table 1 Core and non core foods and beverages

Foods	*Beverages*
Core	
Bread, cereals, rice, pasta, noodles	Water
Vegetables, legumes	Tea, coffee
Fruit	Fruit juice
Yoghurt, cheese, milk	
Meat, fish, poultry, eggs, nuts	
Non core	
All other foods not listed above	All other beverages
Fish if covered in batter	
Potatoes prepared as fries	

Sources: Australian Bureau of Statistics[5] and Bell *et al.*[29]. Non core foods and beverages are largely equivalent to the energy-dense, nutrient-poor (EDNP) classification, except that high-sugar breakfast cereals and fruit juice could also be considered to be EDNP.

Table 2 Core versus non core food consumption in Australian children

	Foods		*Beverages (excluding water)*	
	Core	*Non core*	*Core*	*Non core*
Energy density (kJ g^{-1})	6.5	13.8	0.5	2.2
% by weight	72	28	63	37
% by energy	56	44	25	75

Source: Australian Bureau of Statistics[5] and Bell *et al.*[29]

correspond to what is generally called EDNP foods based on individual food nutrient profile. However, it should be noted that by adopting Bell *et al.*'s classification of all breakfast cereals regardless of sugar content as core foods, and all fruit juices as core beverages, it is likely that the difference in energy density between EDNP and other foods was underestimated.[29] The 13% reduction in the consumption of EDNP foods from the intervention trial was applied to the currently consumed average food weight of 265 g per day,[5] yielding 35 g per day of EDNP foods swapped for equal weight of other foods, assuming no change in the total weight (g) of daily food consumed.[20] As other foods generated a lower energy density of 6.5 kJ g^{-1} compared with 13.8 kJ g^{-1} for EDNP foods, the substitution of other foods for EDNP foods resulted in a reduced average energy intake of 259 kJ per day (35 g per day $\times$ (13.8–6.5) or 7.3 kJ g^{-1}), which was 3% of the total daily energy intake of 8220 kJ.[5] We further assumed that no interactions occurred affecting beverages consumed or physical activity levels of Australian children. By reducing the EDNP to other food ratio in the diet, reductions in total energy intake occurred because of the different energy densities of EDNP and other foods (Table 2).

We then used the validated equation from Swinburn *et al.*[18] to assess the impact of a change in energy balance on the body weight. Every 1% change in energy intake led to a 0.45% (95% CI 0.38, 0.51) change in weight. The 3% change in energy intake led to a 1.4% ($0.45 \times 3\%$) change in weight. The average weight of male and female children in

Australia was reduced by 1.4%, yielding an average weight reduction of 0.54 kg per child. The weight reduction converted to a reduction of 0.26 BMI units (95% CI 0.07, 0.46) for the Australian population of 5–14-year olds. This BMI effect was assumed to occur within 12 months.

To model the impact of reduced sweetened beverages intake on BMI change, we used a prospective observational study.[24] Ludwig *et al.*[24] examined the association between change in consumption of sugar-sweetened beverages in 548 school children (mean age: 11.7 years, s.d.: 0.8) and difference in measures of obesity, over a period of 19 months between 1995 and 1997. They found that each additional serving of sugar-sweetened drink consumed (comprising 8–12 ounces) predicted a BMI increase after adjustment for confounders of 0.24 $kg\,m^{-2}$ (95% CI 0.10, 0.39; $P = 0.03$). We assumed that, in the absence of any other behavioural change, the same size and opposite effect on BMI would occur from a reduction in sugar-sweetened beverage servings per day. We used the average consumption of grams of sweetened beverages per day from the National Nutrition Survey 1995 as current practice in 2001,[5] and calculated the reduction in grams by applying the relative risks derived from the Gorn and Goldberg trial results ($(1–0.80) \times 496$ g). The change in grams (94 g per day) was converted into servings per day, assuming that a serve was between 8 and 12 ounces,[31] which is approximately 296 g (237–355 g). The reduced consumption of sweetened drinks observed in the trial converted to 0.33 fewer servings per day ($296 \div 94$ g) and generated a reduction of 0.08 BMI units (95% CI 0.03, 0.15) per child (0.33 serves $\times$ 0.24 $kg\,m^{-2}$). The BMI effect of reduced beverages was assumed to occur within 12 months.

In consideration of the likely continuation of most other nontelevised advertising in Australia, and even some compensatory increased advertising of other forms and at other televised times, we have adjusted the Gorn and Goldberg trial efficacy results downwards by an arbitrary factor of 40–60%. In this manner, we have adjusted downwards the reported trial efficacy of the potential intervention to a level of modelled effectiveness under more realistic Australian conditions.

The final effective reduction in BMI units due to the reduced EDNP food consumption modelled was 0.13 (95% uncertainty interval 0.03, 0.25) and 0.04 (95% uncertainty interval 0.01, 0.08) for reduced sweetened beverage consumption. The concept of uncertainty interval is detailed in the Supplemental Information.

Assessment of costs

In Australia, compliance with regulations, together with the cost of noncompliance, rests with individual commercial broadcasters. We assumed that broadcasters would comply with tightened regulations to minimize any cost associated with noncompliance and subsequent complaint handling. The incremental costs of stricter monitoring and the enforcement of tightened regulations were estimated to be quite minimal with two extra staff at the Australian Communications and Media Authority (salary plus on-costs), as a regulatory framework already existed.

Cost offsets were assessed as future health sector costs saved because of fewer occurrences of obesity-related conditions in the adult life of children exposed to the intervention. Cost offsets were deducted from the cost of intervention to determine the net cost of intervention.

Results

Quantitative results are presented in Table 3. Removing TV advertising for EDNP food and beverages when children

Table 3 Cost-effectiveness results with 95% uncertainty interval

Target population	All children aged 5–14 years in Australia in 2001
Number of children	2.4 million
Total BMI units saved	400 000 (170 000, 700 000)
Median BMI reduction per child	Males 0.17 (0.05, 0.32); females 0.17 (0.05, 0.33)
Total DALYs saved	37 000 (16 000, 59 000)
DALYs saved per person	0.014 (0.006, 0.022)
Total intervention cost (AUD$)	$130 000 ($120 000, $140 000)
Total intervention cost by sector (AUD$)	
C1: health sector	$0
C2: client/family	$0
C3: other sectors	$130,000 (100% of total cost) (government regulators)
Gross cost per BMI unit saved	$0.33 ($0.19, $0.80)
Gross cost per DALY saved	$3.70 ($2.40, $7.70)
Total cost offsets (million AUD$)	$300 ($130, $480)
Net cost per DALY saved (with cost offsets)	Dominant

Abbreviations: BMI, body mass index; DALY, disability-adjusted life year. Overview of economic evaluation: The intervention dominates current practice because it achieves health gain while saving money. Does not include any potential cost implications to manufacturers of EDNP food and beverages nor families, or potential loss of revenue to television broadcasters—but no data to support their inclusion. 100% of iterations fall well below the acceptability cut-off of AUD$50 000 per DALY.

Table 4 Incremental cost, benefits and ICERs under different assumptions

Parameter	Median (95% uncertainty interval)	
Scenario	30 staff monitoring compliance	Swinburn method used for both food and beverages
Total BMI units saved ('000)	410 (170, 720)	520 (250, 840)
Total DALYs saved ('000)	37 (16, 59)	44 (21, 69)
Gross cost per BMI unit saved (AUD$)	$5.00 (2.80, 12.00)	$0.26 (0.16, 0.54)
Gross cost per DALY saved (AUD$)	$55 (37, 120)	$3.00 (2.10, 6.00)
Total cost offsets millions (AUD$)	$300 (130, 480)	$360 (180, 570)
Net cost per DALY saved (with cost offsets)	Dominant	Dominant

Abbreviations: BMI, body mass index; DALY, disability-adjusted life year; ICER, incremental cost-effectiveness ratio.

make up a significant proportion of the audience had a gross ICER of AUD$3.70 (95% uncertainty interval $2.40, $7.70) per DALY. When the present value of potential savings in future health-care costs was considered (AUD$300 million), the intervention was 'dominant', because it resulted in both a health gain and a cost offset compared with current practice. The variables that most strongly correlated with the ICER were the relative risks of a reduced consumption of EDNP food ($r_s = 0.88$), followed by the effectiveness under Australian conditions assumption ($r_s = -0.28$) and the relative risk of reduced beverages consumption ($r_s = 0.19$). Neither of the scenarios evaluated in sensitivity testing altered the major conclusions of the analysis. The intervention remained dominant under both scenarios (Table 4). These results assumed full maintenance of BMI benefit through adulthood. Threshold analysis identified that BMI benefit could be almost completely eroded over time, and that this intervention would remain dominant because of its modelled very low cost. However, if lost advertising revenue or lost sales of EDNP foods were to reach approximately AUD$2 billion per year without any substitution of replacement revenue, the intervention would then return a gross ICER of AUD$50 000 per DALY.[32,33]

A complete consideration of the qualitative second-stage filters for this intervention is shown in Table 5. The limited evidence of the effectiveness of this intervention and lack of acceptability to some stakeholders of removing TV advertising were the key concerns of the Working Group with this analysis. Public health experts and industry representatives have very divergent views. The former Australian federal government was opposed to the increased regulation of the advertising industry in this form, preferring the self-regulation model, and the current government has it under review. Without political support, the intervention is neither feasible nor sustainable, despite its economic credentials.

Discussion

Restricting TV advertising of EDNP food and beverages seems to be extremely cost-effective in reducing unhealthy weight gain in children aged 5–14 years. Although the BMI change per child was small, the total health benefit was high because of the large number of children affected and the low cost. In fact, this intervention was the most cost-effective at a population level of 13 interventions analysed in the ACE-Obesity project.[20] However, an appropriate evaluation should accompany any implementation of the intervention, given the concerns with regard to the limited evidence base.

Economic analysis raises important issues as to what constitutes 'value-for-money', and it is not uncommon to use a threshold ICER as a guide for decision making. In the ACE-Obesity project, we used a threshold of AUD$50 000 per DALY saved and assumed that anything below this threshold was essentially a 'good buy'. The probability that the cost per DALY saved for this intervention would fall below this threshold was 100%, suggesting that this intervention is a 'very good buy'. In fact, 100% of the ICERs were less than AUD$10 per DALY.

Whether the reduction in BMI would be maintained over the lifetime of the child is unknown and difficult to predict. At a technical level, the maintenance assumption has the potential to distort the health benefit and cost-effectiveness results, but as there is a lack of available data for children, on which to base quantitative modelling, we applied threshold analysis, which indicated that even if most of the reduction in BMI was lost over time, the intervention would still be cost neutral, and probably save money, from a societal perspective. None of the scenarios examined in the sensitivity analysis altered the cost-effectiveness conclusions reached. Furthermore, it is possible that if policies are maintained over time, there could be a synergistic and multiplicative effect between obesity interventions, such that we would expect reductions in overall obesity rates.[20]

This brings us to address whether any possible revenue impacts on the advertising industry or on producers of EDNP foods should be included in the analysis. Apart from the empirical issue of how such effects could be estimated with any precision, there are theoretical issues of whether they are relevant from a public health perspective. In modelling this potential impact, it was not clear in the Australian context whether the food advertising previously directed at children might be replaced with advertising directed at adults, without influencing total TV station revenues, nor whether other forms of advertising to children would be increased to

Table 5 Second-stage filters and policy considerations

Strength of evidence	*Equity*	*Acceptability*	*Feasibility*	*Sustainability*	*Side-effects*
Single RCT assessing food choice after reduced advertising. Supportive parallel evidence in toys, smoking and alcohol advertising bans exists. Cross-sectional studies used for evidence of impact of food choice on BMI. Implementation of this intervention should be accompanied by an appropriate evaluation budget Maintenance of BMI benefit through time in children needs evaluation	Likely to benefit lower SES families under current cost and time assumptions	May not be acceptable to all levels of government Highly acceptable to public health sector experts Not acceptable to food, advertising and broadcasting industries Mixed parental support due to potential time and costs impact	Feasible but only with the support of the Australian government Implementation at a state level difficult in the environment of national broadcasting Assumption of full advertisement compliance may be unrealistic	Likely to be sustainable if implemented but requires ongoing political support	*Positive:* nil *Negative:* Advertisers and food producers may need to adjust the mix of products on the market
Decision point: Limited evidence of effectiveness	Not an issue	Not acceptable to all stakeholders	Some concerns	Sustainable if implemented	Some concerns determined

Policy considerations: The reduction of TV advertising to children intervention is extremely cost-effective under the current assumptions, in terms of its effect on obesity in children. However, the intervention does not currently have the necessary Federal political support. An appropriate evaluation should accompany the implementation of the intervention. Implementation in a rural setting could be an option to explore to make a more definitive assessment of the intervention's effectiveness in reducing BMI under Australian conditions.

compensate for the fall in TV advertising exposure. Both response options are possible in Australia today. Advertising in Australia today, compared with the period covered by Gorn and Goldberg, takes a multitude of forms in addition to TV advertising, providing greater opportunity for diversification of advertising revenues. These new forms include magazine ads, product placement on TV, product placement on DVD, web sites, webcasts, blogs, promotions, loyalty magazine programmes, brochures, in-store communication and mobile phone communication.

In addition, even if potential lost sales of EDNP foods to children were considered as a cost to industry, we estimated that AUD\$2 billion sales per year to children would need to be lost before this intervention would reach the AUD\$50 000 cost per DALY threshold that ACE studies have used as an arbitrary cutoff for cost-effectiveness evaluation.[34] We were unable to determine whether the potential lost sales would be replaced by diversification within the food industry into adult food products or into healthier foods for children, but both options would be available. These potentially lost sales have similarly been excluded from the base analysis, but their possible impact has been explored in threshold analysis.

The multiple-country ecological analysis by Lobstein and Dibb[19] supports these results. The relationship they described was the association between the national mean number of advertisements for sweet and fatty foods during children's TV and the national prevalence of overweight and obesity. Reducing the number of EDNP food advertisements from 10 per hour (about the rate in Australia) to 5 per hour (about the rate in Germany) could, assuming causality, reduce the prevalence of overweight and obesity by 0.05 percentage points.

Supportive evidence is also gained from the evaluation of other products (toys in children, tobacco products and alcohol in adults) for which reduced exposure to advertising has been evaluated. Robinson[26,35] found fewer demands for toys (OR = 0.29), Saffer found reduced demand for tobacco products (RR = 0.93),[27] and for alcohol (RR = 0.75).[28] We assumed that adjusted odds ratios were a good estimate of adjusted relative risks. Although acknowledging the fact that some of these products were evaluated in adults and are addictive (in the case of tobacco), the magnitude of the effects of reduced advertising for these products is parallel evidence supporting the reduced demand for EDNP foods that we model (RR = 0.87).

We have also assumed that not only was the cost of other food that was substituted for the EDNP food removed from the diet of equal dollar value, but the food preparation time component was also equivalent. If this were not the case, the intervention would become less acceptable to parents. Any cost differential would particularly affect lower socioeconomic families. A study conducted in the United States found that, in terms of cost per kJ, high-fat, high-sugar products were cheaper, but in terms of cost per gram, fruit and vegetables were the cheaper alternative.[36] Our substitutions were estimated using weight in grams; therefore, replacing fruit bars, for example, with an equal weight of fresh fruit, or soft drinks with an equal weight of water, is likely to be cost-saving for consumers.

The first and third most important parameters influencing the results were derived from the Gorn and Goldberg trial, conducted many years ago in Quebec, on children out of their home environment, at camp. The trial was conducted in 1982 and the level of exposure to advertisements during the trial (5 min within 30 min of TV) was less than under Australian conditions in 2001.[37] The impact of greater restrictions on televised advertising in Australia may thus be more or less than that found in the Gorn and Goldberg trial. To account for any possible overestimation of impact and to present a conservative approach, the reported efficacy of the trial was halved in the base model to reflect the different conditions in Australia. For these reasons, the intervention could be trialled and should be formally evaluated in an Australian setting to address the issues raised and better inform the policy debate.

Other limitations of the Gorn and Goldberg trial used as evidence include the inability to control for age as in the original study, and we have assumed that the results apply equally to all ages as the age range involved in the trial was quite narrow (5–8 years). The nature of advertising has also altered in the intervening years. The cumulative effects of other promotional activity apart from TV advertising cannot be ignored.[10] The relative importance of family values and habits must also be taken into consideration.[38]

The only evaluated population-wide action to decrease TV advertisements to children is the Quebec experience. In 1980, Quebec passed a regulation to restrict all commercial advertisements for sweets or foods in addition to toys directed at children $\leqslant$13 years. An evaluation of the changes in regulation found a reduced number of high-sugar breakfast cereals in households exposed to less advertising.[25] However, the study results were limited as they were unable to control for important confounding factors of family size and cereal box size. The recent UK strategy restricting advertising to children was informed by reviews of international regulation (acknowledged as culturally specific) and evaluations. The Office of Communication (Ofcom) recognized both the ethical and realistic difficulties of conducting formal trial-based evaluations to inform policy,[7] which explains the absence of other useful international evaluations of the effect of restrictive regulations.

There is also likely to be concern with regard to the generalizability of international findings to local settings.[7] Behavioural interventions may work differently in other countries because of cultural and educational factors, as well as because of current practice in obesity prevention. The impact on total BMI units and DALYs will depend on population size and structure, existing BMI distributions and rates of disease within countries.[20] Costs are likely to vary depending on the degree of current regulation of advertising in place. For these reasons, implementation of the intervention should be accompanied by appropriate evaluation.

Some commentators have expressed concern that a decrease in TV station revenue due to a reduction in food advertising to children would have a negative impact on the quality of children's programming.[39] However, the Quebec experience was examined for impact of advertising on children's programme variety and quantity, and the impact was found to be far less than expected.[25]

The method used in this study to convert the change in energy balance of food to a change in weight and BMI in children was novel and recently published.[18] The approach taken by Swinburn *et al.* for estimating the impact of changes in energy intake on weight gain differs from the approaches published by other researchers such as Wang *et al.* and is thus not directly comparable.[40] Swinburn *et al.*'s approach can be used to estimate the expected change in population weight when a population moves from one level of energy intake to another, allowing sufficient time for the population weight to arrive at a new settling point (equilibrium). In contrast, the approach used by Wang *et al.* (and Hill[41]) can be used to estimate changes in weight resulting from a daily gap between energy intake and energy expenditure—with the daily energy gap sustained over several years. We believe that Swinburn *et al.*'s approach is better suited to the type of intervention examined in this study and it has been validated against data from three longitudinal studies (mean duration: 3.4 years), showing that the equations predicted weight gain to within 0.5%.

This notwithstanding, it is possible to make some rough comparisons between the Swinburn *et al.* method and the Wang *et al.* method. Wang *et al.* estimated that a 131 kcal per day energy intake excess over energy expenditure (energy gap) would explain the increase in weight in 2- to 7-year olds of 0.43 kg per year over a 10-year period. Using Swinburn *et al.*'s method, an increased energy intake of 131 kcal per day over 2 years would result in an approximate increase in weight in 2- to 7-year olds of about 0.81 kg. The 2-year period between settling points is chosen because the half-life of the time taken for a population to arrive at a new settling point for weight is approximately 1 year,[42] indicating that the 0.81 kg change in weight estimated using Swinburn *et al.*'s equation can be compared with a 0.86 kg change in weight using Wang *et al.*'s methods (0.43 kg per year for 2 years).

We chose to be conservative in our analysis, using the Ludwig method to assess the impact of reduced sweetened beverages, because it generated lower BMI change results than did the Swinburn *et al.* method.

Relying on the classification of sugary breakfast cereals and all fruit juices regardless of sugar content compared with other foods and beverages, respectively, has introduced the potential to understate the difference in energy density and importance of EDNP/other foods in the diet of Australian children. The most recently analysed national survey of Australian children's food consumption was conducted some years ago in 1995, but a more recent (2007) national survey indicated that total energy intake has not increased greatly since then. However, if the relative contribution of EDNP foods has increased in 2007, the impact of the intervention would be greater and the cost-effectiveness ratio would be improved. For these reasons, this analysis should also be regarded as conservative.

Conclusion

Restricting televised advertisements targeting children could potentially be one of the most cost-effective population-based obesity prevention interventions available to governments today. Despite its economic credentials from a public health perspective, this initiative involved genuine concerns for some important stakeholders, which need to be addressed in a constructive manner. The second-stage filter analysis identified that the key decision points for implementing this intervention were twofold. There was an identified need to accompany implementation with an appropriate evaluation plan under the current Australian conditions, as the best available evidence was limited. Second, there was the need to address conflicting ideological positions with regard to the responsibility of individuals, industry and the government towards children in the public interest. This paper adds economic evidence to the growing international public support for government intervention to protect children by regulation.

Conflict of interest

The authors declare no conflict of interest.

Disclaimer

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