Cost Effectiveness Analysis of Childhood Obesity Primary Prevention Programmes: A Systematic Review

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ABSTRACT

BACKGROUND: Childhood obesity is associated with enormous health consequences and costs to society. This study aims to systematically review the studies on Cost Effectiveness Analysis (CEA) of primary prevention programmes of childhood obesity, discussing the gaps and providing recommendations for future research.

METHODS: All the studies on the cost effectiveness evaluation of primary prevention of obesity among children were included. Studies were retrieved from MEDLINE and Google Scholar, up to 31st March 2012, with only English language papers being eligible. The quality of the retrieved studies was evaluated by using the Drummond scale.

RESULTS: Eight studies were included, five of which concerning community-based intervention programmes, while three school-based programmes. Fifty-percent of the studies, 3 school-based and 1 community-based primary prevention programme reported the intervention being cost effective. The studies were heterogeneous in terms of study design, quality, target population and outcome measures. Use of the Drummond scale showed that the eight studies were of low-medium quality.

CONCLUSIONS: Although model-based studies may be considered as practical measures applicable to different type of programmes and settings, we auspicate for a convergence towards the use of homogenous clinical and outcome measures in order to properly evaluate the added value of obesity primary prevention programmes in childhood.

Key words: cost-effectiveness, childhood obesity, overweight, primary prevention, systemic review.

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INTRODUCTION

Childhood obesity is associated with enormous health consequences and costs to society [1]. It is not only a health but also an economic impact phenomenon [2]. Overall, the evidence suggests that the prevention of obesity is the most realistic, efficient and cost-effective approach to avoid childhood and adult obesity [3]. This is due to the relative lack of success

of treating obesity once it has fully developed. Long-term outcome data on the effectiveness of treatment approaches are limited [4], also in view of the cumulative consequences of obesity on health over time, which are not reversed completely with weight loss [5]. Thus, in order to achieve the greatest impact on the health, and to reduce economic costs associated with obesity, more attention needs to be placed to the prevention strategies [1, 6-8].

In view of the increasing prevalence of childhood obesity in the world [9], there's a consensus on the need for investments in the primary prevention programmes of obesity among children. Primary prevention should be based on the promotion of a healthy and active lifestyle, so to keep children within a range of body weight considered to be healthy [10]. Almost all the primary prevention strategies focus on the promotion of the physical activity and diet interventions. These strategies should be culture specific, ethnical, and consider the socio-economical aspects of the targeting population. Additionally, reducing sedentary behaviour, like watching television and playing computer games, and encouraging free play has been more effective than focusing on forced exercise or reducing food intake. Primary prevention activities can be initiated at home and in preschool institutions, schools or after-school care services [11-12].

Although there is a considerable amount of literature on the efficacy and effectiveness of both primary interventions of obesity in children, few programmes have included economic evaluations so far. The critical information that policymakers and educators need is how to achieve the greatest reduction in obesity for the fixed budget they have available or, in other words, how they can achieve the greatest "bang for the buck". Cost-Effectiveness Analysis (CEA) is the method that can answer this question because it compares various interventions in terms of their costs per unit of benefit [13-14].

Systematic reviews on evidence based prevention studies can be used to summarize the results of studies evaluating cost effectiveness of prevention programme. The quality of the published reports is also necessary to implement an accurately and reliably assessment of prevention interventions.

This study aims to systematically review all the existing literature on the cost-effectiveness evaluation of childhood obesity primary prevention in order to address which are - from an economic point of view – the most appropriate primary interventions of childhood obesity.

METHODS

Eligibility Criteria and Study Selection

This review was drafted according to Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) statement [15-17]. We systematically reviewed all published studies in English till 31st March 2012, dealing with cost-effectiveness evaluation of primary prevention programmes for preventing childhood obesity.

Pre-established inclusion and exclusion criteria have been defined and reported below. For the source of clinical and economical outcomes, randomized controlled trials (RCT), cohort studies and model based studies were included. Studies measuring the cost of intervention per Disability Adjusted Life Years (DALY) saved, and Quality Adjusted Life Years (QALY) saved, cost of intervention per kilogramme (kg) weight gain prevented, or % reduction in Body Fat (BF), were eligible for inclusion.

Exclusion criteria were defined as follows:

1. Short notes, editorials, study protocols, and abstracts from conferences.
2. Studies which do not measure and link clinical outcomes to economical outcomes are excluded.

Information Sources and Search

The search in MEDLINE and Google Scholar was conducted by using the following key words: cost-effectiveness, childhood overweight, primary prevention.

Summary Measures

Health outcome measures were stated in DALYs, QALYs, body mass index (BMI) scores, kilogrammes (kg) weight gain prevented and % body fat reduction given the cost of the primary prevention programmes designed and

implemented for childhood obesity. Economical measures adopted were cost of intervention per DALY or QALY saved in Cost Effectiveness (CER) and Incremental Cost Effectiveness (ICER) ratios, cost of intervention per kg weight gain prevented or % of body fat reduction.

Quality assessment

We used the Drummond checklist to further evaluate the quality of the 8 studies included in the systematic review [18]. The checklist assessed the quality of an economic evaluation considering the following areas: study design, data collection, analysis and interpretation of results. All of the 35 items were explored by two independent reviewers (S.E., W.M.) for each of the included study.

RESULTS

Results of literature search

Figure 1 represents the flow of information resulting from the systematic review. The searches produced a total of 5089 titles and abstracts for review. MEDLINE search returned 9 papers, of which only one [19] was determined as eligible and accessible for assessment. Of the 170 screened articles coming from the Google Scholar search two were immediately excluded. Of the remaining 168 full text articles, 164 were not considered meeting the eligibility criteria, while four [20-23] were included for assessment in this study. By screening the references of the four eligible papers, we finally included three additional papers [24-26].

In total, 8 studies were eligible and their main characteristics are reported in Table 1. Half of the studies [19, 24-26] used DALYs as health outcome measures, while three [20- 21, 23] measured cost effectiveness in QALYs and one calculated cost per % point body fat reduction [22].

Studies description

Five of the studies reported on the cost-effectiveness of community-based intervention programmes, while three were school-based programmes. Overall, the studies largely differed according to the age groups, the outcome measures, the study designs, and included cost components, which limits the comparability. Potential sources of heterogeneity were explored through qualitative assessment of the study population, as later described.

The study by Wang et al. was the first to assess cost effectiveness of a school-based primary prevention programme reporting the cost per QALY saved and the net cost to society of such programme [20]. The programme included an interdisciplinary curriculum approach, which infuses intervention material into major subject areas and physical education, using grade- and subject-appropriate skills and competencies. The trial showed a significant decrease in the prevalence of obesity among a large sample of girls during the two-year intervention, while no significant difference was observed among boys. Three categories of costs were measured: intervention costs that are incurred during programme calculated retrospectively, medical care costs associated with adulthood overweight, and costs of productivity loss associated with adulthood overweight. Results showed a cost of US$4,305 per QALY saved and a net saving to society of US$7,313. Results remained cost-effective under all scenarios considered and cost-saving under most scenarios.

The second study included was a controlled trial conducted in El Paso, Texas during the years 2000-2002 [21]. Brown et al. evaluated the cost effectiveness of the Coordinated Approach to Child Health (CATCH), a school based intervention programme. The programme included a classroom curriculum at each grade level, a physical education programme, modifications to school service, and family- and home-based programme. Over the three years, overweight and at-risk of overweight prevalence increase was significantly lower in the CATCH intervention schools than in the controls. Using National Health and Nutrition Survey I (NHANES) and follow-up data, the number of obesity cases avoided for ages 40-64 with a lifetime obesity progression model was predicted. Then, costs associated with obesity and QALYs after the age of 40 in 2004 dollars were estimated. Labour productivity costs, medical costs and QALYs were calculated for CER and were also used for the calculation of NB. The CER was US$900 (US$903 using Hispanic parameters)

TABLE 1

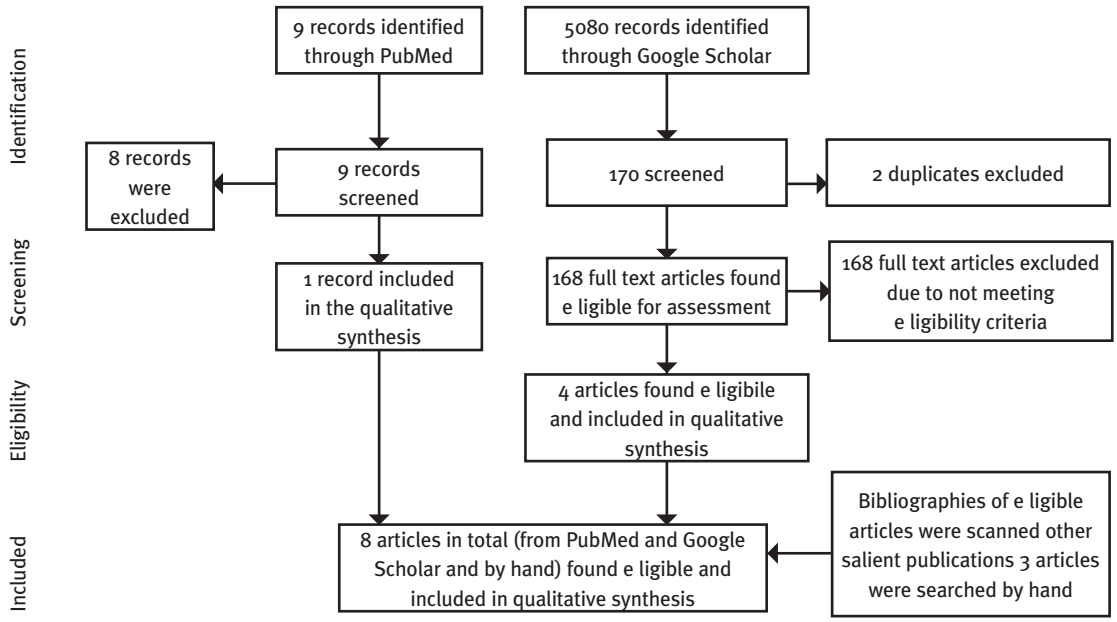
CHARACTERISTICS OF THE 8 INCLUDED STUDIES ON COST EFFECTIVENESS ANALYSIS (CEA) OF PRIMARY PREVENTION PROGRAMMES OF CHILDHOOD OBESITY

REFERENCE	COUNTRY	INTERVENTION AND SETTING	INTERVENTION TARGET	TARGET POPULATION	STUDY APPROACH	TIME HORIZON	RESULTS	RECRUITED SAMPLE (STUDY TARGET POPULATION OR INTERVENTION VS. CONTROL GROUPS)
Wang et al.(2003)[20]	USA	Planet Health	N,PA	Middle-school age children	RCT, CEA	2 years	Cost of US$4,305 per QALY saved (net saving: US$7,313 to society) Obesity prevalence decreased from 23.6% to 20.4%) OR= 0.47 (95%CI: 0.24; 0.93)	10 middle schools in 4 communities (Boston, Massachusetts) randomly assigned to either 5 interventions or 5 control schools. 4 intervention schools and 4 matched control schools randomly selected. The control schools had 473 participants (224 girls and 249 boys). The intervention schools had 423 participants (199 girls and 224 boys). Students of 18 US elementary schools were randomly assigned to intervention and control arms. A total of 601 subjects (48% boys and 52% girls; 312 intervention and 289 control) were tested. 7 primary schools servicing the intervention (n = 4) and control (n = 3) communities. Target population: all children aged 5-14 years. For WSB 2143 children recruited to the 307 walking school buses. The modelled intervention reached 7,840 children aged 5 to 7 years. The modelled intervention reached an average of 25 children participating per site, making a total of 82,500 children. Based on the proportion of Victorian primary school children in years 5 and 6, modelled intervention reached 267,700 children.
Brown et.al (2007)[21]	USA	CATCH	PE	Children aged 8-11	RCT, CEA	2 years	Cost of US$900 per QALY. NB was US$68,125 (US$43,239 using Hispanic Parameters), all in 2004 dollars. This is much lower than the benchmark for CER of US$30,000 and higher than the NB of US$0. Both were robust to sensitivity analyses.	
Wang et al. (2008)[22]	USA	Fit Kid	N,PA	Elementary school children	RCT, CEA	3 year	US$ 317/ % point BF reduction Students attending 40% of the intervention reduced %BF by 0.76% (95% CI: 0.09-1.42) at an additional cost of $317/student, significant reduction in %BF at a relatively low cost.	
McAuley et.al. (2009)[23]	NZ	APPLE	N,PA	Children aged 5-12 years	RCT, CEA	2 years	Significant reduction in BMI −0.26 (95% CI: −0.32; −0.21) No difference in HRQoL and no QALYgain. Response rates at each measurement point:81–89% in control, 85-92% in intervention schools.	
ACE-Obesity Magnus et.al. (2009)[24]	AU	Reducing TV advertising of EDNP foods.	N	Children aged 5-14	Model-based, CEA	LT	Gross cost per DALY saved: AU$3.70 $3.70 (95% CI: $2.40;$7.70) Net cost per DALY saved dominant. Cost effective.	
ACE-Obesity Moodie et.al. (2009)[19]	AU	WSB	PA	Children aged 5-7	Model-based, CEA	LT	AU$0.76 million/DALY saved. Not cost-effective.	
ACE-Obesity Moodie et.al. (2010)[25]	AU	Active After-School Communities Programme	PA	Schools and approved OOS hours care services.	Model-based, CEA	LT	Cost per DALY saved of AU$82,000 Not cost-effective.	
ACE-Obesity Moodie et.al. (2011)[26]	AU	TravelSMART	PA	Children aged 10-11	Model-based, CEA	LT	ICER of AU$117,000 per DALY saved. Not cost- effective.	

Australia, AU; New Zealand, NZ; Nutrition,N; PA, Physical Activity; PE, Physical Education; LT, Lifetime; USA, United States of America; Out Of School, OOS.

FIGURE 1

FLOW OF INFORMATION FOR SYSTEMATIC REVIEW



and the NB was US$68,125 (US$43,239 using Hispanic parameters). The calculated CER resulted much lower than the threshold for CER of US$30,000 and higher than the NB of $0 and thus the programme considered the intervention as cost effective.

The study of Wang et al. [22] assessed the cost effectiveness of a 3-years (after-) school based prevention programme named "FitKid Project", designed to prevent obesity among elementary schools students. The intervention included physical activity, healthy snacks, homework assistance, and academic improvement. Net intervention costs were calculated by subtracting the usual after-school care costs from the intervention costs. The effectiveness of the intervention was measured as %BF reduction compared with a control condition. Results showed that the reduction in %BF was not significant among students attending less than 40% of the intervention sessions. Per capita intervention costs were estimated dividing the total intervention costs by the 182 students who attended at least 40% of the sessions to avoid overestimating the cost effectiveness of the intervention.

McAuley et al. assessed the cost effectiveness of "A Pilot Programme for Lifestyle and Exercise" Project (The APPLE), 2-year controlled community-based obesity prevention initiative utilizing activity coordinators in schools and nutrition promotion in New Zealand children, with the purpose to prevent excessive weight gain in 5-12 years old children by enhancing opportunities for healthy and non-curricular physical activity [23]. According to two-year findings, intervention children reported a significant lower BMI values compared with control children. No differences in health-related quality of life were observed in the current study, thus were unable to calculate QALYs. The remaining four studies [19, 24-26] included were model-based cost effectiveness studies on primary prevention addressing childhood obesity as a part of Assessing Cost Effectiveness-Obesity (ACE) project. Following a societal perspective, a simulation-modelling technique was used to obtain the cost-effectiveness ratio and its 95% confidence intervals. Benefits were modelled as changes in BMI and DALYs saved. Intervention costs were compared to future health-care cost offsets in terms of reduced prevalence of obesity-related health conditions.

Among the 4 studies mentioned, Magnus et al. performed the cost effectiveness of a community-based primary prevention approach: banning in Australia television (TV) advertisements for energy-dense, nutrient poor food and beverages during children's peak

viewing times [24]. The intervention - was 'dominant', because it resulted in both a health gain and a cost offset compared with current practice.

The other model based study by Moodie et al. assessed cost-effectiveness of the obesity primary prevention "Walking School Bus" (WSB) programme in Australia, aiming to increase the number of primary school children walking to school [19]. The evidence base was judged as 'weak' as there were no available data documenting the increase in the number of children walking due to the intervention. Under current modelling assumptions, the WSB programme was not considered to be a cost-effective measure to reduce childhood obesity.

Active After-School Communities (AASC) programme, under the ACE-Obesity Project, was modelled for a 1-year time horizon for Australian primary school children. The intervention focused on the recruitment of children who were previously inactive during the after-school period, so the current practice comparator equated with no intervention. Physical activity co-ordinators were appointed to work with national, state, and regional sporting organizations to develop and deliver a physical activity programme specific to the needs of each school/service. Selected sites were required to offer 2–3 sessions per week [25]. The programme, however, was not cost-effective under base-case modelling assumptions.

The last study from the ACE project was about the TravelSMART Schools (TSS) Curriculum- a school based programme, aiming to assess the increase active transport in 10- to 11-years-old Australian children as an obesity prevention measure [26]. The modelled intervention was based on the TSS programme, a curriculum-based programme specifically targeted at children in years 5 and 6 (age 10 and 11 years). It aimed to decrease traffic congestion around schools, increase physical activity levels and the community capacity to work together by planning more active ways for children to travel to school. The result of such intervention was not cost-effective under base-run modelling assumptions.

Quality of the included studies

The results of the qualitative evaluations reported in Table 2. Over all, according to Drummond's checklist, all of the included studies were judged to be of low-medium quality.

Four of the seven items related to the study design were totally adherent in the 8 studies. As for the remaining questions, Moodie [19] and Magnus [24] clearly stated the economic importance of the research question. We documented a clear justification for the choice of form of economic evaluation in relation to the questions addressed in McAuley [23] and Moodie [19]. No other than Moodie [25] and Moodie [26] stated the rationale for choosing the alternative programmes or interventions compared.

All of the studies presented many similar lacks in the data collection section, being totally adherent to 6 of the items explored. Item deficiencies have been highlighted referring to details of the method of synthesis or meta-analysis of estimates, details of the subjects from whom valuations were obtained, justification in the choice of model used and the key parameters on which it was based, and productivity changes reporting and importance.

Four studies [20-23, 25] reported separately quantities of resources from their unit costs, while only McAuley [23] and Moodie[19] clearly provided for details of currency of price adjustments for inflation or currency conversion. Details of any model used were not clearly given by Wang [22].

Lastly, the inconsistency for items number 25, 28 and 30 documented further methodological limits in the analysis and the interpretation of results for all of the eight studies [19-26]. Particularly, Wang [22] was not adherent to all of this section items, except three. A scarce adherence was documented as well for items 24 and 27. Incremental analysis as well as answer to the study question was not clearly reported for three studies [20-22]. On the opposite, all included studies provided for appropriate caveats and data report following in the conclusions. Items 22, 23, 26 where adherent in all of the studies except Wang 2008. Major outcomes are correctly presented in all study except three [19, 22- 23].

DISCUSSION

Primary prevention schemes for childhood obesity are diverse and complex. Therefore heterogeneity issues should be considered cautiously. In this review, in addition to the sources of heterogeneity such as population,

TABLE 2

EVALUATION OF THE QUALITY OF THE INCLUDED STUDIES

	REFEREE'S CHECKLIST	STUDY ID							
	ITEM	WANG 2003	BROWN 2007	WANG 2008	MCAULEY 2009	MOODIE 2009	MAGNUS 2009	MOODIE 2010	MOODIE 2011
STUDY DESIGN	(I) The research question is stated	Y	Y	Y	Y	Y	Y	Y	Y
	(2) The economic importance of the research question is stated	NC	NC	NC	NC	Y	Y	N	N
	(3) The viewpoint(s) of the analysis are clearly stated and justified	Y	Y	Y	Y	Y	Y	Y	Y
	(4) The rationale for choosing the alternative programmes or interventions compared is stated	N	N	N	N	N	N	Y	Y
	(5) The alternatives being compared are clearly described	Y	Y	Y	Y	Y	Y	Y	Y
	(6) The form of economic evaluation used is stated	Y	Y	Y	Y	Y	Y	Y	Y
	(7) The choice of form of economic evaluation is justified in relation to the questions addressed	NC	NC	NC	Y	Y	N	N	N
DATA COLLECTION	(8) The source(s) of effectiveness estimates used are stated	Y	Y	Y	Y	Y	Y	Y	Y
	(9) Details of the design and results of effectiveness study are given (if based on a single study)	Y	Y	Y	Y	Y	Y	Y	Y
	(10) Details of the method of synthesis or meta-analysis of estimates are given (overview)	N	N	N	N	N	N	N	N
	(11) The primary outcome measure(s) for the economic evaluation are clearly stated	Y	Y	Y	Y	Y	Y	Y	Y
	(12) Methods to value health states and other benefits are stated	Y1	Y5	N	Y	Y	Y	Y	Y
	(13) Details of the subjects from whom valuations were obtained are given	NC	NC	N	N	N	N	N	N
	(14) Productivity changes (if included) are reported separately	N	N	N	N	N	N	N	N
	(15) The relevance of productivity changes to the study question is discussed	N	NC	N	N	N	N	N	N
	(16) Quantities of resources are reported separately from their unit costs	Y	NC6	Y	Y	N	N	Y8	NC
	(17) Methods for the estimation of quantities and unit costs are described	Y2	Y	Y	Y	Y	Y	Y	Y
	(18) Currency and price data are recorded	Y	Y	Y	Y	Y	Y	Y	Y

TABLE 2 (CONTINUED)

EVALUATION OF THE QUALITY OF THE INCLUDED STUDIES

	REFEREE'S CHECKLIST	STUDY ID							
	ITEM	WANG 2003	BROWN 2007	WANG 2008	MCAULEY 2009	MOODIE 2009	MAGNUS 2009	MOODIE 2010	MOODIE 2011
DATA COLLECTION	(19) Details of currency of price adjustments for inflation or currency conversion are given	N	N	N	Y	Y	NC	N	N
	(20) Details of any model used are given	Y	Y	NC	Y	Y	Y	Y	Y
	(21) The choice of model used and the key parameters on which it is based are justified	N	N	N	N	NC	N	N	N
ANALYSIS AND INTERPRETATION OF RESULTS	(22) Time horizon of costs and benefits is stated	Y	Y	NC	Y	Y	Y	Y	Y
	(23) The discount rate(s) is stated	Y	Y	N	Y	Y	Y	Y	Y
	(24) The choice of rate(s) is justified	NC[3]	N	N	N	Y	N	Y	N
	(25) An explanation is given if costs or benefits are not discounted	N[4]	N	N	N[7]	N	N	N	N
	(26) Details of statistical tests and confidence intervals are given for stochastic data	Y	Y	NC	Y	Y	Y	Y	Y
	(27) The approach to sensitivity analysis is given	Y	Y	N	N	Y	N	N	Y
	(28) The choice of variables for sensitivity analysis is justified	N	N	NC	N	N	N	N	N
	(29) The ranges over which the variables are varied are stated	Y	Y	Y	Y	Y	Y	Y	Y
	(30) Relevant alternatives are compared	N	N	N	N	N	N	N	N
	(31) Incremental analysis is reported	NC	NC	NC	Y	Y	Y	Y	Y
	(32) Major outcomes are presented in a disaggregated as well as aggregated form	Y	Y	N	N	N	Y	Y	Y[9]
	(33) The answer to the study question is given	NC	NC	N	Y	Y	Y	Y	Y
	(34) Conclusions follow from the data reported	Y	Y	Y	Y	Y	Y	Y	Y
	(35) Conclusions are accompanied by the appropriate caveats	Y	Y	Y	Y	Y	Y	Y	Y

Legend: Y= yes; N= not; NC= not clear.

[1]National Center for Health Statistics developed a health and activity limitation index for measuring YHL, [2]Values provided by Harvard Prevention Research Centre, [3]Only Ref.14 is stated for annual discount rate, [4] No explanation for not discounting benefits, [5]QALY weights were estimated using National Health Interview Survey (NHIS) data, [6]Trainer unit cost suppressed for confidentiality, [7]No explanation for not discounting benefits, [8]Reported in Supplementary table S1, [9]Presented in Table 4

outcomes, intervention and comparators, the context in which the programme implemented and any theory supporting the study needs to be taken into consideration.

The limited evidence on the cost effectiveness of interventions may partly be attributed to the lack of outcome measures that are amenable in health economic evaluations. Much of the evidence on the effectiveness of prevention strategies concerns crude measures such as average weight loss rather than response rates with short follow-up. In clinical research, more information from quality-of-life questionnaires throughout the intervention and follow-up period would help assess how valuable any clinical improvement is to the individual. This would allow greater comparison between types of intervention and improve assumptions made in cost-effectiveness analyses [27]. Although model-based studies may be considered as practical measures applicable to many different type of programmes and settings, a need of oversimplification on the programmes' structure was suggested by the review. Also retrospectively collected cost data may not be reliable due to loss of information or lack of registration. However, cost effectiveness studies with long term follow-up and run in parallel will contribute to results. Convergence towards the use of homogenous clinical and outcome measures may encourage comparing and reaching a conclusion about the cost effectiveness of childhood obesity primary prevention programmes. Another limit affecting the review was the low-medium quality of all of the included studies. Deficiencies were documented in the study design, data collection and analysis and interpretation of results sections, giving a not strong consistency to the systematic review.

CONCLUSION

Future studies of better methodological approach of higher economical quality are needed to be published to implement the most appropriate primary interventions into childhood obesity and to better support a decision-making process, oriented by CEA.

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