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Authors
Dhillon, Ashwin
Mayer, Madeline
Kysh, Lynn
et al.

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Cost-effectiveness analysis of individual-level obesity treatment in paediatrics: A scoping review

Ashwin Dhillon[1], **Madeline Mayer**[1], **Lynn Kysh**[2], **D. Steven Fox**[3], **Elizabeth Hegedus**[1], **Alaina P. Vidmar**[1]

[1]Department of Pediatrics, Center for Endocrinology, Diabetes and Metabolism, Children's Hospital Los Angeles and Keck School of Medicine of USC, Los Angeles, California, USA

[2]Innovation Studio, Children's Hospital Los Angeles, Los Angeles, California, USA

[3]Department of Pharmaceutical and Health Economics, Mann School of Pharmacy of the University of Southern California, Los Angeles, California, USA

Summary

Objectives: This scoping review informs a health economics perspective on the treatment of paediatric obesity. The results detail recently published research findings on the cost-effectiveness of paediatric obesity treatments and identify key characteristics of cost-effective interventions.

Methods: A structured search was applied to six databases with no data restriction through March 2023: Medline, Embase, Cochrane CENTRAL, CINAHL, and PsycINFO. Studies that included a cost analysis of an individual level, weight management intervention (behavioural, pharmacotherapy, and surgical) in youth, with obesity, ages 2 to 21 years were eligible for inclusion.

Results: Of the 4371 records identified in the initial search, 353 underwent full-text review, 39 studies met the pre-specified inclusion criteria. The majority were published after 2010 (n = 36/39, 92%) and applied to high-income countries (n = 39/39, 100%). Thirty-five of the studies assessed the cost-effectiveness of lifestyle interventions (90%), and four studies assessed surgical outcomes (10%). No pharmacotherapy studies met eligibility criteria. Although the outcome measures differed across the studies, all four surgical interventions were reported to be cost-effective. Thirty of the 35 (85%) lifestyle modification studies were reported to be cost-effective compared to the study comparator examined.

Conclusions: There is a small amount of evidence that individual-level paediatric obesity treatment interventions are cost-effective and, in some cases cost-saving, with most of this work conducted on behavioural interventions. The economic evaluation of paediatric obesity

Correspondence: Alaina P. Vidmar, Department of Pediatrics, Diabetes & Obesity Program, Center for Endocrinology, Diabetes and Metabolism, Children's Hospital Los Angeles and Keck School of Medicine of USC, Los Angeles, CA 90027, USA. avidmar@chla.usc.edu.

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AD, MM, LK, DSF, EH, and APV conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. All authors read and approved the final version.

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The authors have no financial relationships or conflict of interest relevant to this article to disclose.

interventions poses various methodologic challenges, which should be addressed in future research to fully use the potential of economic evaluation as an aid to decision-making.

Keywords

childhood obesity; cost-effectiveness; weight management

1 | INTRODUCTION

Paediatric obesity continues to increase in both prevalence and severity. The expected results will be extensive personal and societal cost burdens over a child's lifetime.[1–3] Thus, the growing interest in understanding the cost-effectiveness of individual-level weight management strategies for youth living with obesity. Available interventions span three treatment domains: behavioural, pharmacological, and surgical.[4] Recently, the American Academy of Paediatrics released an updated clinical practice guideline for the treatment of youth with obesity.[1] The recommendations include a comprehensive treatment plan that incorporates concurrent use of intensive health and behaviour lifestyle treatment, pharmacotherapy, and surgery, as appropriate. However, very few investigations have been conducted into the cost-effectiveness of implementing these interventions in youth.[1] Health economics is essential to design an effective and affordable large-scale intervention policy to tackle this immense public health concern.[5] Given the significant heterogeneity in treatment outcomes, designing precision interventions tailored to a youth's specific needs and home environment will also be necessary to meaningfully change health outcomes over time. Although some interventions have modest anticipated clinical outcomes, these health benefits may come at a relatively low cost. A thorough cost analysis has the potential to provide clinicians with information that can inform their prescribing practice, facilitate a patient-first approach, and reduce the overall costs of implementation and dissemination at both the individual and health system.[4]

In the past 20 years, there have been very few systematic reviews examining the cost-effectiveness of individual level paediatric obesity interventions in youth with obesity.[6–8] In 2019, Zanganeh et al. conducted a systematic review to appraise the methods used and assess the quality of the economic evaluations published on obesity prevention and/or behavioural treatment intervention in youth with obesity. The eligibility criteria excluded pharmacological and surgical interventions.[6] This review included both prevention and intervention studies, as well as trial- and model-based economic evaluations and showed that most preventative interventions were cost-effective, or even cost-saving. However, there was considerable methodological heterogeneity, rendering any formal meta-analysis of individual level treatment interventions challenging.[6] In the adult literature, most cost-effectiveness work investigated the clinical and cost-effectiveness of weight loss surgery compared with nonsurgical interventions.[9] Recent reviews have highlighted that surgical management was more costly than non-surgical management but also offered the highest efficacy and, thus, the best cost-effectiveness over time. Analogous systematic reviews investigating the cost-effectiveness of obesity interventions in youth remain scarce. Across both adult and paediatric cohorts, most previous systematic reviews found inconclusive evidence regarding the cost-effectiveness of behavioural obesity interventions, mainly due to the insufficient quality of the studies.[7,10,11] Main points of criticism in this regard were inadequate sensitivity analyses, generally poor methodology, inconsistencies due to a lack of clinical evidence, and the low quality of data used to populate economic models, and heterogeneity among study designs, models, and populations.

In 2012, John et al. conducted a systematic review of the economic burden of paediatric obesity. The authors evaluated the cost-effectiveness of behavioural paediatric obesity interventions and described 11 studies that incorporated cost-effectiveness analysis in their outcomes.[7] Their review highlighted that at that time, despite the growing prevalence of paediatric obesity, cost-effectiveness analyses were not being conducted widely on childhood obesity interventions. In addition, there was no consensus or uniformity in the methodologies used to evaluate the cost-effectiveness of individual-level interventions, further limiting the generalizability of the results.[7] Remarkably, despite the prevalence rates of paediatric obesity almost doubling since that initial publication, few studies have yet examined the cost-effectiveness of weight management approaches used in paediatric obesity care.

Given the paucity of literature in this area, this current study aims to conduct a scoping review of the existing literature on the cost-effectiveness of individual-level weight reduction interventions in youth with obesity, ages 2 to 21 years old. Our specific research objectives were to: (1) determine the volume and yearly distribution of studies reporting on the cost-effectiveness of individual-level paediatric weight management interventions in the literature (including behavioural, pharmacological, and surgical approaches); (2) describe the scope (e.g. study design, aims, outcome measures) of eligible studies; (3) capture the various outcome measures (and associated methodologies) used to assess cost-effectiveness; and (4) compare patterns of cost-effectiveness between the different treatment modalities. Understanding the financial ramifications of each intervention type is essential to triage individual youth into the most appropriate treatment(s) they need to prevent both lifelong health problems and avoidable cost.

2 | METHODS

2.1 | PRISMA-ScR framework

A PRISMA-ScR scoping review was conducted to identify the individual-level cost-effectiveness of specific treatments within the following three broad paediatric weight management approaches: behavioural (incorporating changes to nutrition and activity), pharmacotherapies, and bariatric surgery. The methodology for this scoping review adhered to the PRISMA framework.[12] That framework guided structuring the research question, identifying relevant studies, extracting data, and summarizing and reporting the results. Specific scoping review steps outlined by PRISMA-ScR methodology include: (1) identify the research question by clarifying and linking the purpose and research question; (2) identify relevant studies by balancing feasibility with breadth and comprehensiveness; (3) select studies using an iterative team approach to study selection and data extraction; (4) chart the data incorporating numerical summary and qualitative thematic analysis; and (5) collate, summarize and report the results, including the implications for policy, practice or research.

2.2 | Identifying the initial research questions[13]

The focus of the review was to identify cost-effective individual-level weight management interventions in youth. To ensure that a wide range of literature relevant to the topic of interest was captured, the following research question was crafted to guide the search: What is the current literature on the cost-effectiveness of individual-level obesity treatments, including surgical, pharmacotherapy, and behavioural interventions in youth living with obesity?

2.3 | Identifying relevant studies

A structured search was applied to the following bibliographic databases: Medline (OVID), Embase (Elsevier), CINAHL Complete (EBSCO), and PsycINFO (EBSCO). In order to capture grey literature, an additional structured search of Cochrane CENTRAL (Wiley) was included along with the first 200 citations from Google Scholar.[14] A medical librarian (LK) initially created a Medline search strategy using a combination of Medical Subject Headings (MeSH) and keywords for weight management, cost analysis, and paediatrics. No data restrictions or search limitations were added. Weight management included behavioural, surgical, and pharmaceutical interventions. Team members (AD, DSF, and APV) reviewed the strategy and preliminary results to modify and improve the search strategy. With the team's approval, the librarian customized the search using controlled vocabulary and keywords in the databases listed above. The search strategies are included in the supplemental information. All resulting citations were exported into an EndNote X20 library (Clarivate Analytics), and duplicates were removed.[15] No additional efforts were conducted to seek out grey literature, including other study registries, websites, or conference proceedings. On March 4, 2023, the search was repeated in the bibliographic databases to identify any more recent studies.

2.4 | Study selection

To manage the considerable number of references, all search results were imported into Covidence systematic review software (Covidence, Melbourne, Australia; www.covidence.org). Titles and abstracts were first screened by two authors (AD and AV), and then full-text articles were screened by two authors (AD and AV). A third author (LK) was utilized to resolve some of the disagreements (title abstracts: $n = 362$, full-text $n = 22$).

A pilot screening process was conducted with all authors to ensure consistency between reviewers and finalize inclusion criteria. For the initial screening of abstracts, the inclusion criteria were as follows: (1) articles are in English; (2) at least some participants ages 2 to 21 years (3) individual-level interventions (rather than population-level); (4) assessment of clinical effectiveness as relates to a change in weight status (captured through change in weight, body mass index (BMI), BMI z-score, weight in excess of the 95th percentile ($\%BMI_{p95}$), percent weight change); (5) some formal assessment of cost-effectiveness, included were full cost-effectiveness analyses, cost-utility analyses, cost–benefit analyses and cost-consequence analyses. There were no exclusion criteria related to sample size, location, or study design. During subsequent full-text screening, the independent reviewers ensured the following criteria were met for all retrieved studies: (1) publication included full text; (2) publications were peer-reviewed (ineligible article types included: dissertations, conference abstracts, protocols, commentaries); (3) treatment was evaluated as part of a randomized controlled trial, pilot trial that included an intervention arm and comparator arm, or rigorous quality improvement trial for which there was a standard of care group and a comparator group (e.g. observational and case studies were excluded); and (4) article was a primary analysis of clinical effectiveness and cost-effectiveness in youth.

2.5 | Data charting

Before data charting, the study team held weekly consensus meetings led by the two senior team members (AV and DSF). In these meetings, various variables were discussed, and an agreement was reached regarding which variables were extracted. Two reviewers jointly developed a data-charting form to determine which variables to extract. The two reviewers independently charted the data, discussed the results, and continuously updated the data-charting form in an iterative process. Data were extracted into REDcap. The data extracted included sample descriptions, methodology, outcome measures, assessments, and results. Next, two extractors reviewed all the articles and formed the tables (AD and AV). An additional team member double-checked the extracted data and helped revise the tables (MM). Data tables facilitated analysis. Participant characteristics across studies, study design and setting, measures, and results are summarized in Table 1.

2.6 | Ethical considerations

Ethics approval was not pursued because this review is based on published articles. This review was not registered with PROSPERO, an international database of prospectively registered systematic reviews in health and social care since scoping reviews do not meet the criteria for registration (https://www.crd.york.ac.uk/prospero/#aboutpage).

2.7 | Analytic analysis

For each study, the following data were abstracted: study country, number of participants, ages of participants, study design, the definition of obesity, statistical methods, BMI status change, and cost-effectiveness/implementation.

3 | RESULTS

3.1 | Study selection

Upon removal of duplicates, 4371 titles and abstracts were screened for eligibility. A total of 353 underwent full-text review. Of those, 39 studies met the pre-specified inclusion criteria (Figure 1). Table 1 summarized the key characteristics of the 39 included studies. Yearly distribution was as following (Figure 2). Thirty-six studies (92%) were conducted since 2010, with one-third published in the last 5 years. Twenty-three (59%) of the included studies were conducted in the past decade. The four bariatric surgery studies were conducted in 2018, 2017, 2015, and 2010. Included studies were primarily conducted in North America, Australia, and Europe (United States (n = 13, 33%), Australia (n = 8, 21%), the Netherlands (n = 6, 15%), the United Kingdom (n = 6, 15%), China (n = 3, 8%), German (n = 2, 5%), Canada (n = 2, 5%), and Denmark, Finland, and Ireland (n = 1, 3%)). All studies reported a funding source. Approximately 77% (30/39) of studies reported that funding was sourced from governmental institutions. The remainder obtained funding through non-governmental organizations ($n = 7$, 18%), institutional organizations ($n = 1$, 2.5%), industry ($n = 1$, 2.5%), or were not mentioned or applicable ($n = 3$, 8%). Nearly all studies reported a conflict-of-interest statement ($n = 38$, 97%), and of those, 11 (28%) reported some conflict of interest. The most popular reporting standards used by included studies were CHEERS ($n = 5$, 13%), followed by CONSORT ($n = 16$, 41%), and PRISMA ($n = 4$, 10%). Seventeen studies (44%) did not mention using any specific reporting standard. Most studies utilized an intention-to-treat statistical approach ($n = 31$, 79%). Three studies (8%) used a per-protocol and two studies (5%) utilized an as-treated protocol. Six studies (15%) did not mention a statistical approach, which may be partially attributed to the inclusion of review studies.

3.2 | Participants

The target populations were youth ages 2 to 21 years old. Most studies ($n = 31$, 79%) included family participation. One intervention was specifically targeted solely at parents of youth living with obesity as a parent-only intervention.[16] Most studies were conducted in outpatient/clinical facilities ($n = 16$, 41%) or schools ($n = 13$, 33%) and community settings ($n = 6$, 15%). Approximately 60% of studies utilized multiple sites ($n = 24$) and 40% were conducted in a single centre ($n = 15$).

3.3 | Intervention type

Behavioural ($n = 35$, 90%), pharmacotherapy ($n = 0$, 0%), and surgical ($n = 4$, 4%) interventions were included (Figure 3). Intervention content focused on physical activity ($n = 2$, 5%), fruit and vegetable intake ($n = 2$; 5%), and broader health behaviours (i.e. nutrition, physical activity, habit change; $n = (24, 57\%)$). Four of the 35 included economic evaluations had a telehealth component ($n = 4$, 10%).[17–19]

3.4 | Cost effectiveness analysis

3.4.1 | Study characteristics—Table 1 summarizes evidence on the cost-effectiveness outcomes of the interventions. For this review, cost-effectiveness analysis (CEA) was defined as an analysis which assessed incremental costs-effectiveness ratio (ICER) defined as an incremental measure of reduction in the desired outcome, in this case, expressed as reductions in BMI metrics or life-years gained. Cost-utility analysis (CUA) is a variation of CEA where consequences are expressed in metrics combining survival and preference-based health-related quality of life outcomes such as quality-adjusted life years (QALY) or disability-adjusted life years (DALY). Studies that included both CEA and CUA were included. The 15 studies (15/39, 38%) that included measurements of QALY or DALY collected some measure to capture the development of obesity related comorbidities over time. Most studies that conducted a CEA alone used standardized BMI metrics as the primary outcome. In contrast, other studies used measures of behaviour changes such as dietary quality, steps taken, unit increase in physical activity minutes, reduction in body fat, or waist circumference. Approximately half of the studies that completed a CEA also conducted a CUA. Only five studies (13%) used the CHEERS checklist. CHEERS quality scores were determined for each study included by the authors (AV) (Table 1). Most studies identified and reported key features including background and objectives, comparators, time horizons, analytical methods, and study parameters. However, some studies failed to include an explanation or report on some key components of their study analytic design, including setting and location, analytic perspective, discount rate, base currency, price sources, reference year, economic model, or methods to characterize the effects of uncertainty and heterogeneity. All included studies assessed direct costs of obesity interventions that included formal costs of goods and services such as equipment, facilities, staff, materials, and the implementation costs of the interventions themselves. Only three studies accounted for indirect costs or participant time costs.[16,20,21]

Most studies utilized some form of decision analytic modelling that incorporated regression analysis. Twenty-one studies (54%) utilized Markov modelling, seven (18%) used microsimulation, two applied (5%) decision tree modelling, and five applied state-transition models. There was significant heterogeneity in the collection and reporting of cost-utility and cost-effectiveness results. All four surgical studies performed CEA and CUA. For the 35 behavioural studies, 23 performed CEA and five used comparative cost analysis alone. The comparators to which the intervention costs and effects were compared included no intervention ($n = 17$ interventions, 40%), usual care or current practice ($n = 7$, 18%), waitlist control ($n = 1$, 3%), or an alternative program condition ($n = 12$ interventions, 31%). Twenty-nine economic evaluations assessed costs and benefits from a health sector or health system funder perspective (74%), five from a societal perspective (13%), and eight from a payer perspective (21%). Discount rates are reported in Table 1. No studies reported a discount rate of more than 5%. In the United Kingdom and New Zealand 3.5% rates were applied.

Net QALY gained were selected as the measure of health utility benefit for the majority of CUA ($n = 12$). Other CUA employed net DALY saved ($n = 3$). Health-related quality of life instruments used to assess individual benefits and estimate health utility in studies reporting QALYs included: the Quality of Well-Being (QWB) scale, the Short-Form 12-Item (SF-12), and the EQ-5D.[22] Studies undertaking CEA (rather than CUA) quantified benefits in a variety of forms, generally either BMI or BMI z-score reduction or changes in other natural units measuring diet or physical activity (e.g. change in fruit and vegetable consumption). This heterogeneity in outcome measures severely limits the comparability of CEA results between the studies. Assumptions regarding the durability of intervention effects also varied. Finally, discount rates for economic evaluations estimating costs and effects were only reported in 16 studies and ranged between 1% to 5% accounting for both costs and benefits and only two studies adjusted for inflation (Table 1). There was a diversity of time horizons examined across the included studies. Two of the four surgical interventions utilized a lifetime time horizon whereas the remaining two evaluated 3 years and then 3, 4, and 5 years, respectively. Only eight of the 35 (23%) behavioural interventions examined a lifetime time horizon with the remainder examining a fairly short time horizon ranging from 12 weeks to 11 years with the majority less than 2 years.

3.5 | Summary of study outcomes

3.5.1 | Surgical interventions—Four studies examined the cost-effectiveness of bariatric surgery for adolescents with obesity.[23–26] Panca et al. found that with a cost-effectiveness threshold of GBP 30,000 (USD 36,413.86) per QALY, the ICER for RYGB compared to a non-surgical control was €2018/QALY gained for males and €2008 for females. Whereas, for SG compared to non-surgical control, it was €1978/QALY gained for males and €1941 for females utilizing a lifetime cost horizon.[25] Bairdain et al. demonstrated that when compared to non-surgical control bariatric surgery in youth was cost-effective 7 years post-surgery at USD 36,570 per QALY gained.[24] Whereas, Klebanoff et al. found that bariatric surgery resulted in USD 154,684 per QALY at year three and USD 91,032 per QALY at year five.[23] For the studies included that captured surgical interventions, bariatric surgery was cost-effective across all four studies despite differences in the modelled time horizons.

3.5.2 | Behavioural interventions—Thirty of the 35 (85%) lifestyle modification studies were reported to be cost-effective compared to the study comparator examined. Out of the 13 studies conducted in school settings, all were reported as cost effective, whereas four of the six conducted in community settings and 13 of the 16 conducted in hospital settings were considered cost effective compared to the comparator group. By way of example, in Poland, an obesity management program for 6- to 15-year-old children was found to be cost-effective, when compared to standard of care nutrition education, delivered in a paediatric health care setting, with a cost per QALY gained of USD 1606.[27] The cost of removing a child from the group with overweight was PLN 27,758 (USD 6790), and the cost of removing a child from the group with obesity was slightly lower (PLN 23,601/USD 5773). An 11-month, family-based multicomponent outpatient intervention that included two weekly sessions, one focused on nutrition and one on physical activity, in Germany, was also found to be cost-effective when compared to standard clinical care, with a cost per QALY gained of USD 1825.[28] In the United States, an addiction model-based mobile health weight loss intervention, in adolescents with obesity, had a lower cost per BMI unit reduction compared to a multidisciplinary clinical intervention (USD 855.15 vs. USD 1,428.99).[29] In New Zealand, a multi-disciplinary home-based low and high-intensity program was found to be cost-effective when compared to a standard clinical care. Both groups resulted in significant reduction in BMI z-score compared to standard of care at a lower NZD of 939 (USD 555) for the low intensity group and 155 (USD 91.63) for the high intensity group.[30] A family-based general practitioner-mediated intervention targeting children with obesity was found to be cost-effective when compared to a no intervention group, with net cost per DALY saved of AUD 4670 (USD 2,953.73).[31] In the United States, a study compared the costs of parent-only and parent and child treatments and found that the parent-only treatment was less expensive, but the parent and child treatment was more effective at reducing BMI.[16] A 6 week high intensity day camp multi-component lifestyle intervention was compared to a 6 week low intensity standard camp experience and found to be more expensive than standard care, but it also produced greater reduction in BMI, with a cost per BMI unit change of USD 12,880 (ICER was DDK 149,669 per unit decrease in BMIz for the high intensity group versus the low intensity camp experience).[32] Two pilot randomized trials in the United States examined professionally delivered care versus peer-delivered family based weight management treatment and found that utilizing parents as peer interventionists resulted in similar reduction in BMIz score but at a significantly lower cost with a cost per BMI unit change of USD 1399.[20,21] A family-based group treatment for child and parental obesity was cost-effective, with a cost per QALY gained of USD 22,000.[33,34] The LEAP (Live, Eat and Play) trial in the United Kingdom evaluated primary care consultation at home versus a no treatment control group and was found to not be cost-effective, with a cost per QALY gained of USD 52,400. The intervention had high implementation costs with similar reduction in primary outcomes between groups.[35,36]

A cluster-randomized controlled trial in the UK found that The Daily Mile program had an ICER of £3284 (USD 3,986.39) per QALY gained compared to usual practice.[37] Similarly, the "CHIRPY DRAGON" program in China had an ICER of USD 11,503 per QALY gained.[38] Another study in Canada used life-course modelling to estimate the cost-effectiveness of a school-based health promotion program, finding an ICER of CAD 15596 (USD 11,349.73) per QALY gained.[39] The "Physical Activity 4 Everyone" trial in Australia evaluated a multicomponent school-based physical activity intervention and found an ICER of AUD 2703 (USD 1,709.69) per BMI unit prevented.[40] The "Project Energize" program in New Zealand had an ICER of NZD 26,718 (USD 15,804.63) per QALY gained.[41] The "be active eat well" program in Australia had an ICER of AUD 6975 (USD 4,412.41) per QALY gained.[42] Other school-based interventions with favourable cost-effectiveness ratios include the "School-based Overweight Program" in the Netherlands (ICER of €109 [USD 132.30] per BMI unit prevented)[43] and the "URMEL-ICE" program in Germany (ICER of €7028 [USD 8,530.58] per QALY gained).[44] However, a study of a comprehensive intervention in China found that despite resulting in significant reduction in BMI, the intervention had an ICER of USD 2,515,050 per QALY gained, suggesting it may not be cost-effective.[19]

4 | DISCUSSION

This review explores the cost-effectiveness outcomes of individual-level weight management interventions, including behavioural, pharmacologic, and surgical in youth with obesity.[7] A total of 142 relevant papers were published up to March 2023. Despite the growing prevalence of paediatric obesity and the increasing availability of novel behavioural treatment, obesity pharmacotherapy, and increased bariatric surgery rates in this age group, the volume of published cost-effectiveness analysis has remained stable over the past 15 years. However, there were only studies conducted in high-income countries. This could reflect the resources and level of expertise required to conduct these studies. Similar findings were reported in a recent systematic review of weight management interventions in adults with obesity.[45] There is a small amount of evidence that individual-level paediatric obesity treatment interventions are cost-effective and, in some cases cost-saving, with most of this work conducted on behavioural interventions.

Based on the current studies inclusion dates, and eligibility criteria, there were no studies assessing the cost-effectiveness of obesity pharmacotherapy in this age group highlighting the need for additional investigation of individual level cost-effectiveness analysis for obesity pharmacotherapy in youth.[46] However, recently, there were two studies published that reported the cost-effectiveness of obesity pharmacotherapy in adolescents utilizing Markov microsimulation models with costs estimated from the health system perspective.[47,48] While these studies did not include individual level data, given the recent and pending regulatory approvals for multiple highly effective pharmacotherapies, such as the glucagon-like-1-peptide agonist, the results were highly pertinent to the field of paediatric obesity medicine. The economic evaluation completed by Mital et al. suggested that the phentermine-topiramate combination agent was the most cost-effective of all the available FDA approved medication for paediatric obesity due to the high cost of semaglutide despite it being more effective than phentermine-topiramate in terms of weight loss.[48] Lim et al. found that in an economic evaluation of 100,000 simulated adolescents with obesity, no obesity pharmacotherapy was cost effective after 2 years, however high dose phentermine-topiramate was projected to be cost-effective after 5-years with an ICER of USD 56,876 per QALY gained.[47]

This review highlights a diverse international representation of studies assessing the cost-effectiveness of behavioural interventions for paediatric weight management, delivered via schools, community platforms, and hospital settings. Because of substantial differences in the study designs and measurement tools used in these studies, it is not possible to comprehensively rank all the evaluated interventions according to their relative cost-effectiveness. Comparing results from individual cost-effectiveness analyses was also limited by the heterogeneity in methods and outcome units reported. However, this scoping review did identify several themes, including specific components of behavioural interventions that augment cost-effectiveness. Examples of themes identified include, cost saving approaches to implementation via parent delivery; augmentation of efficacy via high intensity versus low intensity programming; utilization of school infrastructure to deliver multi-component interventions; and acknowledgement that the greater treatment efficacy compared to no-treatment control the greater opportunity for cost-efficacy.

Cost-effectiveness evidence is useful primarily when it informs clinical and policy-level decisions. The goal is to make optimal use of (inevitably) limited resources to achieve specified health, economic, and policy goals. Goals will be stakeholder and context dependent. Thus, optimizing outcomes is often a complex, multi-criteria decision analysis problem, not simply an exercise in ranking interventions from most to least cost-effective. However, an essential element is that the evidence on clinical and cost-effectiveness be comparable between interventions. For example, cost-effectiveness measured in US dollar per BMI change (US$/%BMI-Change) cannot be directly compared to cost-effectiveness measured in EURO/QALY. Adapting to local context also requires that investigators report the key underlying cost and utility elements, not just the aggregate results, in order to support that adaptation. Finally, the performance of interventions on other important criteria (notably including overall clinical effectiveness) must also be reported using standardized, comparable metrics. The discussion that follows highlights how the existing evidence falls short on these requirements.

Of the four studies included in this review that investigated weight loss surgery, all four found weight loss surgery likely to be cost-effective and in many cases even cost-saving in this age group.[23,24,26,28] In 2012, Aikenhead et al. conducted a systematic review on the cost-effectiveness of bariatric surgery in youth with obesity. Thirty-seven relevant papers on bariatric surgery effectiveness in 831 children or adolescents were included, spanning 36 years. Mean BMI reduction ranged from 9 to 25 kg/m^2. Evidence on cost-effectiveness was limited to one Australian modelling project, which deemed laparoscopic adjustable gastric banding cost-effective for adolescents when compared to no-surgery. Despite limited formal cost-effectiveness data, the authors concluded that weight loss surgery is likely to be cost-effective and in many cases cost-saving in this age group.[49]

The cost-effectiveness of behavioural interventions for paediatric obesity conducted in hospital settings was studied in various clinical settings including outpatient, inpatient, primary care, and subspecialty care. Parallel to the findings in school and community centres, multi-component interventions were cost-effective in many of the analysed studies, when compared to standard of care or untreated controls. It is noteworthy that, these findings appeared to hold regardless of the age group of participants, the country in which the study was conducted, or the delivery platform of the intervention. A recent systematic review, predominantly focused economic evaluations of Web-based or telephone-delivered interventions for preventing overweight and obesity and/or improving obesity-related behaviours in adults found that virtual obesity interventions were mostly cost-effective, with the cost per BMI unit change ranging from $11 to $3962.[50]

School-based programs that were multi-component and incorporated physical activity, nutrition, and behaviour change curriculum were found to be cost-effective in school-age children in studies conducted in the UK,[37] China,[19,38,51] Canada, Germany, USA,[52]and New Zealand. Similarly, community-delivered multicomponent interventions were consistently cost-effective primarily when delivered by peer or parent facilitators.[53] Of note, one of the challenges of cost-effectiveness analysis is that many of these interventions were compared to other interventions and found to have a similar effect on BMI reduction over the study period. Therefore, achieving cost-effectiveness hinged on their lower implementation costs. This favoured approaches that could be modified to be cost-saving, either by harnessing already available community resources or utilizing peer or parent facilitators to deliver the materials (both to augment efficacy and limit cost). Several studies examined a different aspect of community-based weight management: They altered which individuals received the intervention to determine whether family-based interventions are superior to parent-only interventions, including their relative cost-effectiveness from a societal perspective.[54]

This current study confirms that a meta-analysis of the cost-effectiveness of individual-level paediatric obesity interventions is currently challenging due to the heterogeneity of the available data. There remains an urgent need to design future longitudinal trials that incorporate collection of economic and health utility data overtime to better understand the impact of these interventions not just on clinical outcomes but health and economic outcomes as well. This evidence can help inform population-level interventions to treat this high-risk cohort.[6]

There exists a strong infrastructure to conduct cost effectiveness analyses in individual-level paediatric obesity interventions, with items such as the CHEERS checklist and useful methodological frameworks and study designs.[22] The barriers to execution lie in the lack of expertise among many obesity scientists and clinicians in the implementations of these designs. Successful use of these tools requires cross disciplinary team science integrating health economists into intervention design and implementation to ensure appropriate data is collected and analysed.[22] One specific barrier to conducting cross study meta-analyses, that was highlighted in this review, is the use of multiple measures in CEA and CUA analyses across trials. An emphasis on cross-disciplinary collaboration would allow for the design of integral measures to be included in all cost-effectiveness analyses to ensure inter-study. Development of core data elements is important, not only for CEA and CUA analysis, but also for measurement of adiposity, development of comorbidities, and to capture both the direct and indirect cost of obesity across the lifespan.

4.1 | Limitations

This review has some limitations. It likely that the reported cost-effectiveness of the interventions is context dependent; potentially important effect modifiers include that studies were conducted in different countries with different healthcare systems, and used varying comparator groups, model structures, costing methods and modelling assumptions. In addition, potential bias was introduced by the exclusions of non-English texts and grey literature. This assessment echoes those in a systematic review performed by Zanageh et al. in 2019, which also found limitations in comparing cost analyses due to inconsistencies in methods and outcome measures and suggested standardization of economic evaluation processes. Considerations around how reported benefits differ between various interventions and combinations of interventions and the potential influence of the effect modifiers need to be made before generalizing findings to other settings. While the quality of reporting was quantified, we did not explore the methodological quality of the studies, including any potential sources of bias in the study design or data collection. In addition, the scoping review is subject to publication bias, in that studies that do not show cost effectiveness may be less likely to published impacting the generalizability of these findings.

5 | CONCLUSIONS

With the growing prevalence of paediatric obesity, the need also grows more urgent to identify cost-effective individual level paediatric obesity treatments, especially those that can work in synergy with population-level prevention strategies. This scoping review suggests that there are a number of individual level interventions for paediatric obesity treatment that appear to be both clinically effective and cost-effective.- However, this review also highlights that the existing cost-effectiveness evidence defies comparison of results across interventions due to heterogeneities in country context, evaluation methods, and outcome units reported. Those limitations in turn limit the usefulness of this information, retarding the dissemination and scale-up of these interventions. Thus, there is a clear need to design larger, longitudinal investigations of treatments for paediatric obesity (behavioural, pharmacotherapeutic, and surgical) that incorporate robust cost-effectiveness analyses methods to fill this gap, specifically incorporating paediatric cohorts with obesity. Future studies should consider adopting both standardized and stakeholder relevant outcome measures, such as QALYs, for all individual level interventions of paediatric obesity treatments to improve comparability of results across trials. The research goal should be high quality cost-effectiveness analyses of paediatric weight management interventions that support evidenced-based guidance to the health community on the most cost-effective approach to treating this high-risk cohort of youth.

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DATA AVAILABILITY STATEMENT

The datasets from this study will be available from the corresponding author on written request.

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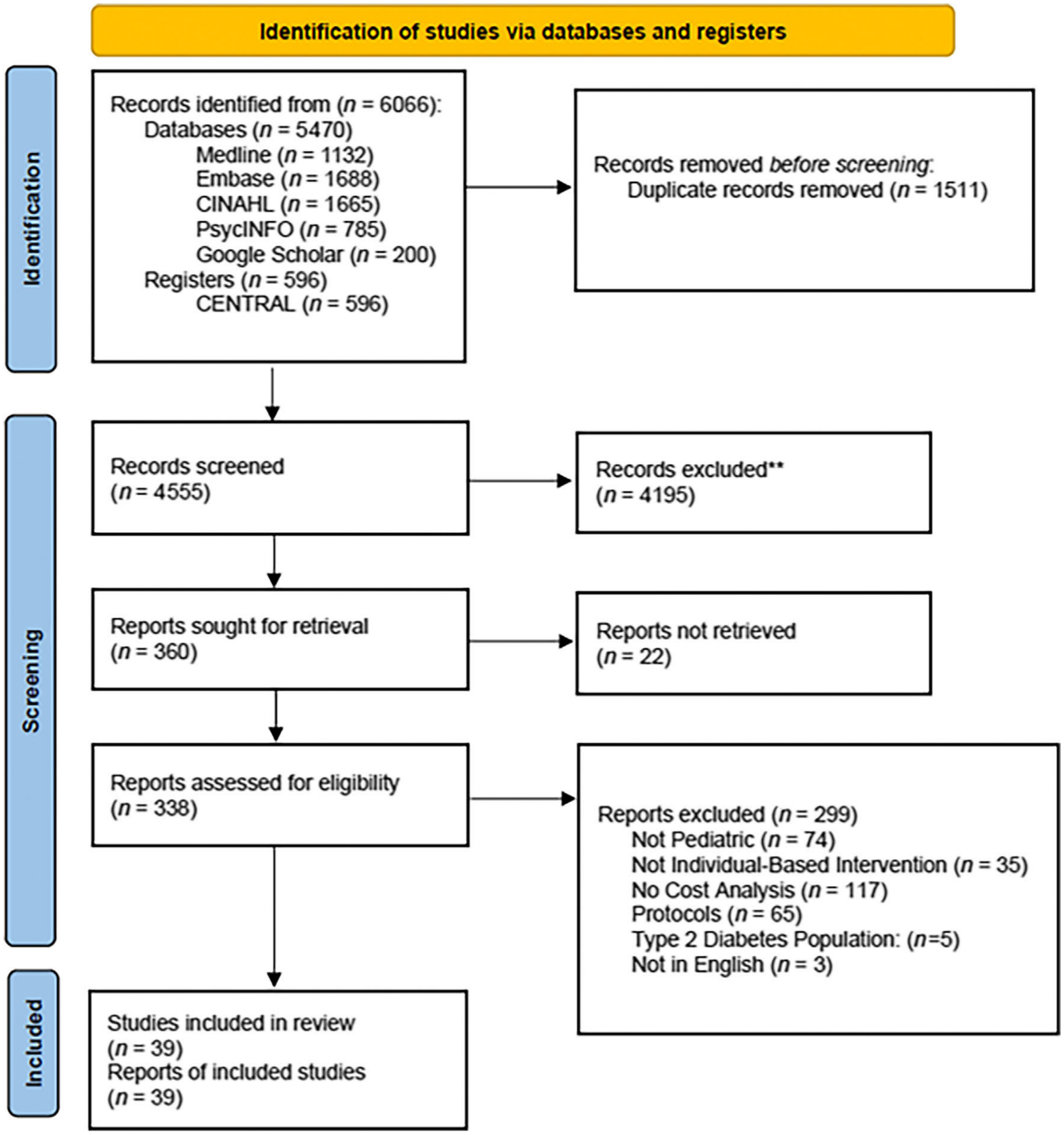

FIGURE 1.
PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

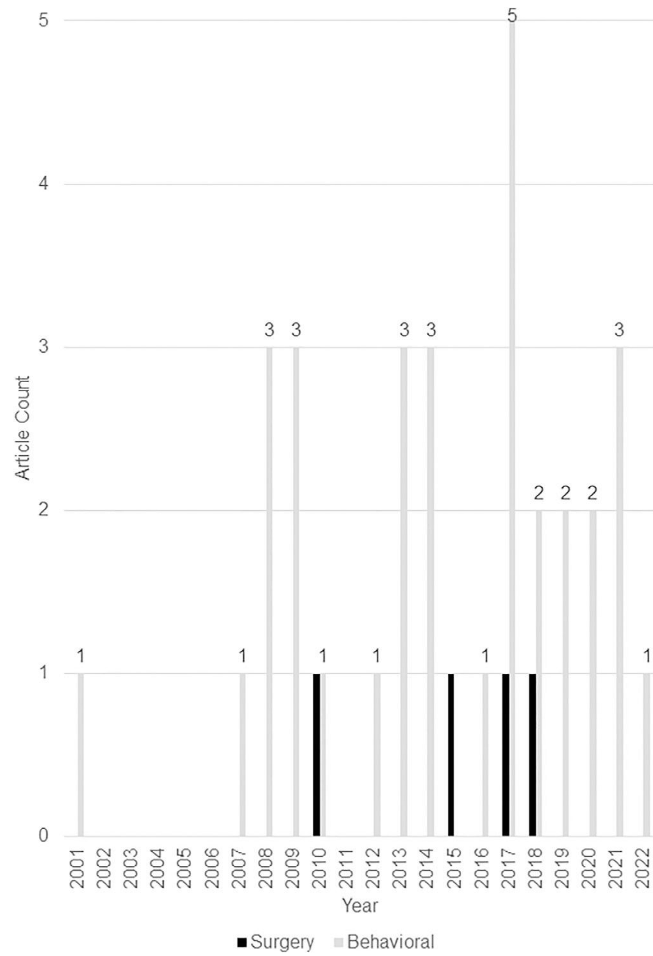

FIGURE 2.

Yearly distribution of article by study type (surgical vs. behavioural obesity treatment). No pharmacotherapy interventions met inclusion criteria.

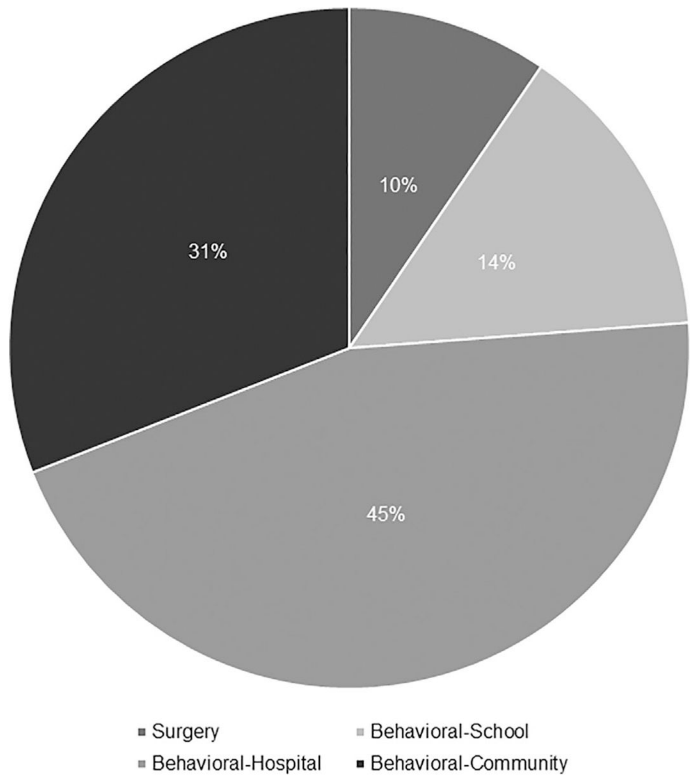

FIGURE 3.
Distribution of study type by obesity treatment.

TABLE 1

Study characteristics and key findings.

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
Surgical interventions										
Klebanoff et al.[23] (2017)	USA	*N* = 228 Age = 14–20 yr Mean BMI 53 kg/m^2 75% female	Markov Model CEA and CUA to assess CE between no surgery and bariatric surgery; state transition model; health care provider perspective	Intervention: Surgery (RYGB vs. LASG) Comparator: to non-surgical control Clinical/Hospital	Markov Model CEA and CUA	3, 4, and 5 yr	BMI Reduction; QALY gained	WTP: $100 000. Discounting 3% cost and benefit	Y	IC fo 15 ga US Q IC fo US Q
Bairdain et al.[24] (2015)	USA	*N* = 11 Age = 15–18 yr Mean BMI of 48.7 kg/m^2 90% female	Markov Model CEA and CUA based on a bariatric multidisciplinary program to project healthcare-related costs and incremental costs per QALY of surgery (LRYGB) vs. no surgery (starting at age 18); Payer perspective	Intervention: RYGB Comparator: No surgery Clinical/Hospital - Single Center	Markov Model CEA and CUA	3, 7 yr	BMI reduction; QALY gained	WTP: $100 000. Discounting 3% costs and benefits	Y	Fu sa US un BM At op ba su de co at pe ga
Panca et al.[25] (2018)	UK	*N* = 18 Age = 14–18 yr Mean BMI 4 kg/ m^2 50% female	Markov Model CEA and CUA; used to estimate lifetime expected costs and QALY of bariatric surgery vs. no surgery. CUA using lifetime expected costs and QALYs	Intervention: Surgery (RYGB or LASG) Comparator: No Surgery Clinical/Hospital - Single Center	Markov Model CEA and CUA	Lifetime	BMI reduction; QALY gained	WTP: £20 000/ QALY gained Discounting 3.5% costs and benefits	Y	IC vs wa Q fo €2 fe IC no €1 ga m €1 fe M re BM wa RY 16
Ananthapavan, J et al.[26] (2010)	AUS	*N* = 28 Age = 14–19 yr BMI >35 kg/m^2 All underwent LAGB	Markov Model CEA and CUA; Economic evaluation to simulate intervention and “Cost-Effectiveness” evaluation to calculate ICER/ DALY	LAGB plus standard care Comparator: No Surgery Clinical/Hospital - Single Center	Markov Model CEA and CUA	Lifetime	DALY; BMI reduction	Not reported Discounting 3% costs and benefits	Y	AU M re AU D
Behavioural										
Behavioural interventions delivered in a hospital setting										
Boutelle et al.[16] (2021)	USA	*N* = 150 Age = 8–12 yr BMI between	Comparative cost analysis between two interventions.	Family, Responsibility, Education,	Comparative Cost Analysis	6 mo	BMIz reduced		Y	PE sh BM

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
		85th and 99.9th percentile, and parent with BMI >25	No formal CEA completed. Only a comparative cost-analysis between FBT and PBT based on BMIz reduction by implementation cost	Support, and Health (FRESH) RCT comparing family-based treatment (FBT) vs. parent-based treatment (PBT)						red ha co pa dy he sec pe (P FE an lin pe (P FE
Tully et al.[17] (2021)	Ireland	*N* = 109 youth Age 14–18 yr BMI ≥98th percentile	Microsimulation analysis to compare costs between mHealth treatment vs. standard multidisciplinary care groups	mHealth vs. face-to-face care	Macrosimulation Model CEA	1 yr	BMIz reduced	WTP not reported Discounting not reported	N	BM red co be gr co ad att ca (S wh co ad th gr €7 22 va de th we tre co Th rat ref 20 €0 co fo wi th ran €3 de th dr stu
Bandurska et al.[27] (2020)	Poland	*N* = 3081 Age = 6–15 yr BMI ≥98th percentile schoolchildren	Markov Model CEA; to evaluate the 6–10-14 for Health weight management program using pharmacoeconomic indicators	6-10-14 for Health weight management program vs. no treatment control	Markov Model CEA	1 yr	BMI% reduction	WTP not reported Discounting not reported	Y	Th re ch ov gr PL (E an re ch ob wa lo PL (E IC €1 bo

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
										pe re
Lier et al.[28] (2020)	Germany	*N* = 226 Age = 5–15 yr BMI ≥98th	Markov Model CEA to analyse return on investment of program by projecting estimated savings	11-month multidisciplinary family-based program. Two weekly meetings: one nutrition education session and one exercise session	Markov Model CEA	1 yr	BMIz reduction	WTP not reported Discounting 3% cost	Y	€2 BM re
Vidmar et al.[29] (2019)	USA	*N* = 18 Age = 14–18 yr BMI ≥95th percentile 75% female	Markov Model CEA; economic evaluation; health care provider perspective	App based intervention vs. standard care	Markov Model CEA	6 mo	BMIz reduction	WTP Not reported Discounting not reported	Y	Pa sm $8 re 0.1 Pa a s $1 BM re 0.1 Cl $1 BM re 0.0
Anderson et al.[30] (2018)	NZ	*N* = 199 Age = 4–15 yr BMI ≥98th percentile or BMI ≥91st percentile with comorbidities	Microsimulation CEA of multidisciplinary child obesity intervention when compared to conventional hospital-based care	High intensity group: weekly sessions for 1 year with 3 home-based assessments and advice; low intensity: 3 home-based assessments and advice only vs. routine well child check	Comparative Cost Analysis and microsimulation CEA	5 yr	BMIz reduction	WTP not reported Discounting not reported	Y	Lo US $8 BM re Hi US $1 BM re
Sharifi et al.[55] (2017)	USA	*N* = 294 Age = 6–12 yr BMI ≥95th percentile	Microsimulation modelled CEA and population health savings impact of Study of Technology to Accelerate Research (STAR) Cluster-RCT intervention	Paediatric practice with EHR-based decision support for primary care providers and self-guided behaviour-change support for parents vs. standard care	Microsimulation Model CEA	lyr	BMI reduction	WTP not reported Discounting not reported	Y	$2 re $1 in co Ex th ye re w ab mi he co 90 ob
Saeiens et al.[21] (2017)	USA	*N* = 59 Age = 7–11 yr (BMI ≥85th percentile) with one parent BMI ≥25	Examine effectiveness, feasibility, and costs of treated parents serving as peer interventionists in FBT	FBT intervention EPICH:FBT delivered by professional vs. peers Parent Partnerships: FBT delivered by a parent vs. peer	Comparative cost analysis	1 yr	Reduction of BMI-z score	WTP not reported Discounting not reported	N	No dif BM re be gr Pr Le pe $4 BM

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
										rec 0.4 Pe pe $6 BM rec 0.2
Larsen et al.[32] (2017)	Denmark	*N* = 115 Age = 6–18 yr BMI ≥85th percentile	Markov Model CEA comparison between intensive and low-intensity weight-loss interventions	Day camp vs. weekly family-based exercise sessions	Markov Model CEA	lyr	BMI Reduction	WTP not reported Discounting not reported	N	IC 24 un
Hollinghurst et al.[56] (2014)	UK	*N* = 143 Age = 5–17 yr BMI >95th percentile	Markov Model CEA; comparison using ICER/0.1 reduction BMI SDS between three studies	Outpatient obesity clinic vs. Primary care clinic vs. Mandometer group	Markov Model CEA	1 yr	BMI SDS reduction	WTP maximum of £2000: WTP range from £0 to 2000 Discounting not reported	Y	IC rec SD £2 SD is eff
Epstein et al.[57] (2014)	USA	*N* = 50 Age = 8–12 yr (BMI ≥85th percentile) with parent BMI ≥25	Markov Model CEA; comparison between two interventions using societal costs (payer plus opportunity costs)	FBT vs. Parent alone/Child Alone	Markov Model CEA	1 year	% overBMI, weight (lbs)	WTP not reported Discounting not reported	Y	Ch $2 pe ov $1 pe ov PC $9 pe ov PC Pa $1 (lb an (P $3 (P
Hollingworth et al.[53] (2012)	UK	*N* = 9956 Age = 4–5 and 10–11 yr BMI >95th percentile	Markov Model CEA; Adaptation of the National Heart Forum economic model to predict lifetime health service costs and outcomes of lifestyle interventions on obesity-related diseases	Hospital or community-based weight-management programs 10 Lifestyle interventions that have been compared with no or minimal intervention in randomized controlled were included	Markov Model CEA	Lifetime	BMI SDS reduction	WTP set at £20 000-£30 000 per QALY Discounting 3.5% costs and benefits	Y	IC 0.1 in IC pe ga
Wake, M et al.[36] (2009)	AUS	*N* = 258 Age = 5–10 yr BMI z-score ≤3.0	Effectiveness and costs were reported separately.	Clinical interventions vs. standard of care	Comparative cost analysis	12 wks	Reduction of BMI	WTP not reported Discounting not reported	Y	AU rec BM to
Wake, M et al.[35] (2008)	AUS	*N* = 163 Age = 5–9 BMI >95th percentile	Cost-sequence analysis of LEAP program to determine CE	Clinic based lifestyle intervention vs. control	Microsimulation Model CEA	3 mo	Reduction in BMI	WTP of $AUD 50000/ DALY saved Discounting not reported	Y	Th LE int fa $4 tha co fa ma in

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References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
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Moodie, M et al.[31] (2008)	AUS	$N = 9685$ Age = 5–9 BMI z-score ≥3.0	Model used to present 95% uncertainty interval around CE	Clinical intervention vs. standard of care	Microsimulation Model CUA	Lifetime	DALY	AUD 50000/ DALY saved Discounting 3% cost and benefits	Y	IC 67 sa
Goldfield, G S et al.[34] (2001)	Canada	$N = 24$ Age = 8–12 BMI ≥95th percentile	CE analysis to provide measure of improvement per dollar spent	Individual and group lifestyle program vs. group treatment group only	Microsimulation CEA	1 yr	Reduction in zBMI and % overweight	WTP not reported Discounting not reported	Y	$1 ov re gr tre vs mi $1 re zB gr $2 mi
Behavioural interventions delivered in a community setting										
Tran et al.[58] (2022)	AUS NZ	$N = 1, 906, 075$ Age = 0–5 yr	Microsimulation modelled CEA and CUA from trial data at age 3.5 to 15 years old	Multi-component (nutrition and physical activity) intervention vs. usual activity	Microsimulation Model CEA and CUA	Lifetime	QALY; BMI unit avoided	WTP of $AUD 50000/ QALY gained discounting 3% costs and benefits	Y	IC AU BM av AU QA
Panca et al.[59] (2018)	UK	$N = 174$ Ages = 12–19 yr discounting 3.5% costs and benefits	CUA to compare costs and outcomes associated with HELP vs. enhanced standard care	Multi-component intervention with 12 one to-one sessions across 6 months delivered by trained graduate health workers in community settings vs. control who	CUA	Lifetime	QALY	WTP set at £20 000-£30 000 per QALY discounting 3.5% costs and benefits	N	IC 63 ga

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
				received a single 1-h one-to-one session						
Makkes et al.[60] (2017)	Netherlands	*N* = 80 Age = 8–19 yr BMI ≥120% of the 95th percentile	Markov Model CEA and CUA from societal perspective comparing two intensive lifestyle treatments	Intensive 1-year lifestyle treatment with an inpatient period of 2 months (short-stay group) or 6 months (long-stay group)	Markov Model CEA and CUA	2 yr	QALY gained; reduction BMI SDS	WTP of 50 000 EUR/ point SDS-BMI WTP of 83 000 EUR/ QALY gained discounting 4% costs and 1.5% benefits	N	IC 46 in £3 QA
Quattrin et al.[33] (2017)	USA	96 youth (BMI ≥25), ages 2–5	Markov Model CEA; completed using percent over BMI	FBT vs. Information controlled	Markov Model CEA	2 yr	Reduction in BMI	WTP reported Discounting not reported	Y	Th so pe $1 an gr me IC ch pa Ol $1 $8 %(Pa IC $1 BM $3 kil
McAuley, K et al.[61] (2010)	NZ	*N* = 279 youth, Ages 5–12	Markov Model CEA and CUA from societal perspective	Lifestyle and Exercise vs. no treatment control	Markov Model CEA and CUA	4 yr	kg weight gain prevented	WTP not reported Discounting 5% cost	Y	$1 we pr ye $6 we pr 13
Janicke, D et al.[20] (2009)	USA	*N* = 93 Ages = 8–14 BMI >85th percentile	Markov Model CEA completed comparing effectiveness of two interventions	Behavioural family-based intervention vs. behavioural parent-only intervention vs. waitlist control	Markov Model CEA	4 and 10 mo	Reduction zBMI	WTP not reported Discounting not reported	Y	$7 0.1 fa $5 on
Behavioural interventions delivered in a school setting										
Zanganeh et al.[19] (2021)	China	*N* = 1641 Age 6–7 yr	Glamm model used to perform CEA and CUA for RCT	Multi-component (nutrition and physical activity) intervention vs. usual activity	Glamm CEA and CUA	lyr	QALY gained	WTP of US $50 000/ QALY gained Discounting not reported	Y	27 (£ BM Pu 88 (£ US QA Pr 73 (£ US QA
Breheny et al.[37] (2018)	UK	*N* = 2000 Ages = 7–10 yr	Linear mixed models utilized to perform CUA	Intervention - Daily Mile Intervention vs.	CUA	Lifetime	QALY gained	WTP of £20 000/ QALY gained	Y	IC pe ga

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
				no treatment control				Discounting not reported		
Bai Li et al.[51] (2019)	China	*N* = 1641 Ages = 5–18 yr	CUA, economic evaluation, institutional perspective	Multi-component (nutrition and physical activity) intervention vs. usual activity	Microsimulation Model CUA	lyr	QALY gained	WTP of £20 000 to 30 000 per QALY Discounting 3% costs and benefits	Y	IC pe ga (U BN ch
Beets et al.[62] (2018)	USA	*N* = 1700 Ages = 5–12 yr	CUA; Trial based economic evaluation	Multicomponent intervention with delayed treatment vs. intermediate treatment	Microsimulation Model CUA	2 yr	MVPA gained	WTP not reported Discounting not reported	Y	Im IC inc M fro $0 pe De for inc M $0 we an ch gi
Ekwaru et al.[39] (2017)	Canada NZ	*N* = 5 elementary schools Ages 5–12	CEA and CUA; State transition model with yearly cycles and capturing 13 chronic diseases; accounting for institutional cost perspective (School focused)	Lifestyle and exercise school - based program vs. no treatment control	State Transition Model CEA and CUA	Lifetime	QALY; excess weight prevented	CAD 50000/ QALY gained discounting *3%* costs and benefits	Y	IC $1 ye we pr IC pe ob pr IC pe ga
Sutherland et al.[40] (2016)	AUS	*N* = 1150 Age = 12–13 (mean age 12 years; 7th grade)	CEA and CUA; RCT alongside economic evaluation accounting for societal perspective	Physical activity intervention vs. no treatment control	Markov Model CEA and CUA	2 yr	MVPA and MET gained; BMI unit avoided; reduction zBMI	WTP not reported Discounting not reported	Y	IC mi M an ga pe IC $1 un IC $5 re zB
Rush et al.[41] (2014)	NZ	*N* = 42 067 Age = 6–11 yr	CUA; Markov model based on results of the RCT accounting for Payer perspective	Multi-component Nutrition and activity intervention vs. no treatment control	Markov Model CUA	Lifetime	QALY	NZD 50000/ QALY discounting 3.5% costs and benefits	Y	IC Q fo ch $2 Q fo ch
Meng et al.[63] (2013)	China	*N* = 8301 Age = 4–12 yr Youth with obesity and with out	CEA within trial economic evaluation that accounted for institutional payment perspective	Multicomponent nutrition intervention vs. physical activity intervention vs. no-treatment control intervention	Microsimulation Model CEA	1 yr	Reduction of BMI and BMIz; case overweight and obesity avoided	WTP Not reported discounting not reported	Y	IC BN re IC BN re IC ca ov

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
										an av
Moodie et al.[42] (2013)	AUS	*N* = 2183 Age = 5–7 yr	CUA with cohort multi-state transition model that accounted for societal perspective	The Walking School Bus program which incorporated increased walking to school vs. no treatment control	Multi-state transition Model CUA	Lifetime	DALY; Reduction BMI	AUD50,000/ DALY saved discounting 3% (cost)	Y	IC 29 av IC 57 sa
Kesztyüs, D et al.[44] (2013)	Germany	*N* = 945 Age = 7–9 yr (mean age 7.3 yr) Youth with and without obesity	Markov Model CEA and CUA within trial economic evaluation that accounted for societal perspective	School based lifestyle intervention that incorporated physical activity, media, teaching activity breaks and academic assignments into school activities vs. no treatment control	Markov Model CEA and CUA	1 yr	Reduction in WHtR and WC	EUR 35/ intervention year; the ICER EUR11.11/cm WC and EUR 18.55/ unit of EHTr gain prevention for the intervention group vs. control Discounting not reported	Y	IC €1 de IC €1 de
Kalavainen, M et al.[64] (2009)	Finland	N = 70 Age = 4–16 yr BMI ≥95th percentile	Markov Model CEA	Family-based group treatment vs. and routine counselling	Markov Model CEA	lyr	Reduction weight for height; decrease BMI SDS	WTP not reported Discounting not reported	Y	IC es €5 ca 1% he de €2 m wl ca 0. de
Wang, LY et al.[65] (2008)	USA	*N* = 601 Age = 8–10 yr (mean age 8.7 yr) BMI ≥95th percentile	CEA, within trial economic evaluation; accounting for societal perspective	Behavioural physical activity and healthy eating after school program vs. standard after school care control arm	Markov Model CEA	1 yr	Reduction in % BF	WTP not reported Discounting not reported	Y	IC 0. re bo stu att lea vis pe fat US pa co co
Brown et al.[43] (2007)	USA	*N = 896* Age = 8–11 yr Youth with and without obesity	CUA that included decision tress excess weight progression model accounting for societal perspective	Lifestyle curriculum vs. control: The CATCH intervention which incorporated nutrition, physical activity and behavioural modification implemented at school and incorporated	Markov Model CUA	26 years	QALY gained	EUR 3000/ QALY gained with ICER ERU 290/QALY Discounting 3% cost	Y	IC QA

References	Country	Target population	Methodology	Intervention; comparator; setting	Study approach	Time horizon	Health gain measure	Willingness to pay discounting	Cost-effective vs. comparator	Ke
				family, home and school components						

Abbreviations: AU$, Australian dollars; AUS, Australia; BMI, Body Mass Index; BMIz, Body Mass Index z-score; CEA, cost effectiveness analysis; CUA, cost-utility analysis; DALY, Disability-Adjusted Life Year; EHR, Electronic health record; FBT, Family Based Therapy; IC, Information Control; ICER, incremental cost effectiveness ratio; LASG, Laparoscopic sleeve gastrectomy; MHealth, Mobile health; mo, months; QALYs, quality-adjusted life years; PBT, Parent Based Therapy; PLN, Polish Zloty; RCT, randomized controlled trial; RYGB, Roux-y gastric bypass; SD, Standard Deviation; UK, United Kingdom; USA, United States of America; USD, United States dollar; yr, years.

[a] CHEERS Quality Score - NA: If the a study did not include a CEA then the CHEERS guidelines are not relevant and thus a CHEERS quality score was quantified.