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REVIEW

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The effectiveness of nurse-led interventions to prevent childhood and adolescent overweight and obesity: A systematic review of randomised trials

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Abstract

Background: Obesity among children and adolescents continues to rise worldwide. Despite the efforts of the healthcare workforce, limited high-quality evidence has been put forward demonstrating effective childhood obesity interventions. The role of nurses as primary actors in childhood obesity prevention has also been under-researched given the size of the workforce and their growing involvement in chronic disease prevention.

Aim: To examine the effectiveness of nurse-led interventions to prevent childhood and adolescent overweight and obesity.

Design: A systematic review of randomised trials.

Data sources: Medline, CINAHL, EMBASE, Cochrane (CENTRAL), ProQuest Central and SCOPUS were searched from inception to March 2020.

Review methods: This review was informed by the Cochrane handbook for systematic reviews of interventions.

Results: Twenty-six publications representing 18 discrete studies were included (nine primary prevention and nine secondary prevention). Nurse-led interventions were conducted in diverse settings, were multifaceted, often involved parents and used education, counselling and motivational interviewing to target behaviour change in children and adolescents' diet and physical activity. Most studies did not determine that nurse-led interventions were more effective than their comparator(s) in preventing childhood and adolescent overweight and obesity.

Conclusions: Nurse-led interventions to prevent juvenile obesity are feasible but have not yet determined effectiveness. With adequate training, nurses could make better use of existing clinical and situational opportunities to assist in the effort to prevent childhood obesity.

KEYWORDS
adolescent, body mass index, child, nurses, obesity, overweight, prevention, randomised controlled trials, systematic review

1 | INTRODUCTION

Obesity among children and adolescents is a global issue. The number of obese children worldwide is predicted to reach 250 million by 2030, or one in five children, up from the current figure of 150 million (World Obesity Federation, 2019). Since 1975, the global prevalence of childhood and adolescent overweight and obesity has risen from 4% to 18% (World Health Organisation, 2020). No country has reported a reduction in obesity rates in the last three decades (Ng et al., 2014), and only one in 10 countries is predicted to have a 50% chance of meeting WHO's target of no rise in childhood obesity between 2010 and 2025 (World Obesity Federation, 2019).

The link between childhood obesity and obesity in adulthood is strong and related to the early onset of diabetes, fatty liver disease, cardiovascular disease and multiple cancers (Biro & Wien, 2010; World Cancer Research Fund (WCRF), & American Institute for Cancer Research (AICR), 2018). There is a substantial cost-burden associated with childhood obesity, which is compounded by its lasting effects into adolescence and adulthood (Lobstein et al., 2004). For example, the total lifetime excess cost of childhood obesity has been estimated at €150,000, resulting from both direct healthcare costs to the individual and indirect costs from losses in productivity (Hamilton et al., 2018). Although much effort has been devoted into childhood obesity prevention across the healthcare workforce (Hennessy et al., 2019), limited high-quality evidence has demonstrated clinically meaningful reductions in childhood obesity-related outcomes (Rajjo et al., 2017). The role of nurses as primary actors in childhood obesity prevention has also been underresearched given their growing contribution towards chronic disease management (Sargent et al., 2012) and their position as the largest registered health workforce worldwide (World Health Organization, 2018).

1.1 | Background

Increases in population weight and obesity have been attributed to an obesogenic environment, one which promotes sedentary behaviour coupled with easy access to high-energy-dense foods (Swinburn et al., 2011). In addition to diet, children and adolescents are more sedentary (Global Health Observatory data repository - World Health Organisation, 2019), with the majority not taking the recommended daily 60 min of moderate to vigorous-intensity physical activity (PA; World Health Organisation, 2011). This problem has been amplified during the COVID-19 pandemic due to mandatory lockdowns and forced school closures, which is often the only outlet for organised PA for children (Cuschieri & Grech, 2020). While international, national and state policies to address the obesity epidemic are required at a population level, major environmental changes take time to be implemented. Meanwhile, the proportion of people who are overweight and obese continues to rise.

Impact

What problem did the study address?

- Interventions to adequately prevent childhood and adolescent overweight and obesity are largely unsuccessful.
- The effectiveness of nurse-led interventions to prevent childhood and adolescent overweight and obesity warrants investigation.

What were the main findings?

- There are limited rigorous, nurse-led interventions focusing on the prevention of childhood and adolescent overweight and obesity.
- Nurses readily facilitate the delivery of childhood obesity interventions but are underrepresented as stake holders in their conceptualisation. Few nurse-led interventions have demonstrated effectiveness in the prevention of childhood obesity.

Where and on whom will the research have an impact?

- Given the size and geographical spread of the nursing workforce and their growing contribution towards chronic disease prevention, nurses are well positioned to lead and contribute in childhood and adolescent obesity prevention.

Countless childhood obesity interventions have been trialled with some determining effectiveness (Chai et al., 2019; Hennessy et al., 2019; Liu et al., 2019). However, very few studies have been able to demonstrate clinically meaningful reductions in obesity-related outcomes. Prior reviews on childhood obesity interventions have focused on their setting (Liu et al., 2019), their mode of delivery (Chai et al., 2019) and the provider responsible for their delivery (Hennessy et al., 2019). The prevailing recommendations from these reviews are the need for high-dose, multicomponent interventions targeting the family, delivered in a variety of settings. Nurses operate in a variety of settings, including primary care, hospitals, schools and the general community. Nursing models are increasingly moving towards preventive care, particularly in the primary healthcare setting where nurses represent a growing proportion of the healthcare workforce devoted to chronic disease prevention and management (Sargent et al., 2012). Despite this significant presence, scarce evidence has been put forward to evaluate the effectiveness of nurse-delivered interventions to prevent obesity in either adult or juvenile populations (Sargent et al., 2012). Only one prior review has investigated the effectiveness of school nurses in childhood and adolescent obesity prevention, showing minimal effectiveness (Schroeder et al., 2016). Building on this evidence, the present review considered all types of nurses acting in a leading role to prevent childhood and adolescent obesity in both clinical and community settings.

2 | THE REVIEW

2.1 | Aims

The aim of this systematic review was to determine the effectiveness of nurse-led interventions to prevent childhood and adolescent overweight and obesity.

2.2 | Design

This review was informed by the Cochrane handbook for systematic reviews of interventions (Higgins et al., 2019). A PICOS (Population, Intervention, Comparator, Outcome, Study) framework was used to conceptualise the search strategy and develop search strings. Each concept of the search strategy was mapped to a MeSH term appropriate to each database. The concepts broadly represented: children and adolescents, nurse-led interventions, weight-related outcomes and randomised (controlled) trials. Search strings included a mix of MeSH headings and key words. The search string used for MEDLINE is described in the supplementary file.

2.3 | Search methods

A systematic search was performed in the following electronic databases: MEDLINE, CINAHL, EMBASE, Cochrane (CENTRAL), ProQuest Central and SCOPUS. Databases were searched from inception to March 2020, and records were restricted to peer-reviewed journal articles, human studies and English language only. The protocol for this review was registered with the International Prospective Register of Systematic Reviews (PROSPERO); CRD42020138969. Reporting has been structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

2.3.1 | Inclusion criteria

Randomised trials evaluating the effectiveness of nurse-led interventions to prevent child and adolescent overweight and obesity were included in this review. Children and adolescents were defined as persons ≤18 years of age at study baseline. Effectiveness was determined by assessing the between-group difference in means of the following weight-related outcome measures: body mass index (BMI), BMI standard deviation score (BMI SDS), *z*-BMI or BMI *z*-score (BMI adjusted for age and sex) and weight-for-length (WFL) percentile. Prenatal studies were eligible for inclusion provided the offspring's weight-related outcomes were the primary outcome(s) of the study. Interventions were classified as 'nurse-led' if it could reasonably be determined that nurses had a dominant role in their delivery. For example, where nurses were part of a multidisciplinary team, predominance was established using the specified number of nurse contacts or measures of contact time with nurses relative to other interventionists. Interventions where nurses had an equal or minority role (e.g., screening prospective participants or collecting anthropometric measurements) were not eligible for inclusion. Trials that compared two or more interventions, compared different 'doses' of the same intervention or compared interventions against standard care were eligible for inclusion, provided at least one arm of the trial was clearly nurse-led. Relevant pilot studies, secondary analyses of trial data and follow-up publications of randomised trials were eligible for inclusion provided weight-related outcomes were a targeted objective of the intervention. Conference proceedings, grey literature, protocol papers and systematic reviews were not eligible for inclusion. In the case of primary prevention studies, participants were required to be healthy at baseline. In the case of secondary prevention studies, participants were required to be 'otherwise healthy'. Therefore, other than being overweight or obese, participants could not have other pre-existing illnesses or diseases.

2.3.2 | Screening

Database searches were undertaken by one reviewer (I.K.). Abstract screening was blinded and undertaken independently by two reviewers (I.K. and M.D.) using the Rayyan screening tool (Ouzzani et al., 2016). Potentially eligible articles identified during abstract screening were retrieved in full and independently assessed according to the eligibility criteria by two reviewers (I.K. and L.W.). Disagreements were resolved by discussion. The reference lists of all included studies and related systematic reviews were hand searched to ensure completeness.

2.4 | Quality appraisal

The methodological quality of all included studies (and their follow-up publications) was appraised using the Risk of Bias (RoB) tool (version 2.0) developed by Cochrane (The Cochrane Collaboration, 2019). Individually randomised (parallel group) trials were assessed using the standard RoB2.0 tool (The Cochrane Collaboration, 2019), which addresses bias across five domains: (1) the randomisation process, (2) deviations from intended interventions, (3) missing outcome data, (4) outcome measurement and (5) outcome reporting. Clustered-randomised trials were assessed using the clustered-variant of the RoB2.0 tool (Higgins et al., 2016), which includes additional questions unique to cluster-specific study designs. This variant covers the initial five bias domains and an additional domain: 'the timing of identification and recruitment of individual participants in relation to timing of randomisation'. Each bias domain asks a series of questions related to the procedures undertaken in the study. Based on the responses to these questions, the algorithm in the accompanying guides suggest marking a bias domain as either 'low risk', 'some concerns' or 'high risk' (Higgins et al., 2016; The Cochrane Collaboration, 2019). Quality appraisal was undertaken

independently by two reviewers (I.K. and L.W.). Disagreements were resolved by deliberation. Publication bias was not addressed.

2.5 | Data abstraction

Data were extracted by one reviewer (I.K.). Included studies were grouped by primary or secondary prevention and study characteristics were reported separately to study results. The following data pertaining to study characteristics were extracted: primary author, year, country, study design and setting, population demographics at baseline, intervention and timeframe, nurse type and role, and comparator group(s). The following data pertaining to study results were extracted: outcome measure, duration of follow-up, number of participants from each group used in the analysis, the mean difference of the stated outcome between the experimental and comparator group(s), presented with 95% confidence intervals (CIs) or the stated *p* value (where 95% CIs were not presented) and key findings.

Where possible, population demographics reflected the sample prior to randomisation or the start of the intervention. Where included studies only provided demographics of the analysed sample, these data were used. Duration of follow-up was defined as the length of time from the first outcome measurement (baseline) to the final outcome measurement. Where follow-up publications presented additional data points to an original study, these were documented for completeness.

2.6 | Synthesis

Given the heterogeneity of studies included in this review, meta-analysis was not pursued. Heterogeneity was assessed in consideration of substantial differences in demographic characteristics (particularly subjects' ages), length of follow-up, outcome measures and types and dosage of interventions. In lieu, a narrative synthesis of results was conducted, where studies were broadly grouped by either primary or secondary prevention. Results were then discussed in groupings based on similar types of interventions used across primary or secondary prevention studies.

3 | RESULTS

3.1 | Systematic search results

The PRISMA flow diagram representing study selection is described in Figure 1. The search strategy returned 1,195 records, with seven further records identified through hand searching. After removing duplicates (n = 516) and screening abstracts, 102 articles remained, which were retrieved and assessed in-full for eligibility. The titles of all full-text articles excluded during assessment (n = 76) is presented in the supplementary file, along with the primary reason for their exclusion. In total, 26 published articles (representing 18 discrete studies) were deemed eligible for inclusion in the structured synthesis. Five of these studies (and two follow-up publications) were identified by hand searching the reference lists of included studies, related articles and reviews (Hennessy et al., 2019; Hollinghurst et al., 2014).

3.2 | Summary of quality appraisal

The methodological quality of the included studies (and their follow-up publications) was generally poor, with most publications (n = 19, 73%) judged as having high bias (Chahal et al.s, 2017; Christie et al., 2017; Döring et al., 2016; Enö Persson et al., 2018; Ford, Bergh, et al., 2010; Forsell et al., 2019; Jonsdottir et al., 2014; Kokkvoll et al., 2014, 2015, 2019; Kong et al., 2014; Lakshman et al., 2018; Marild et al., 2013; Paul et al., 2011, 2018; Savage et al., 2016; Taylor et al., 2017; Wen et al., 2012, 2015), six showing 'some concerns' (Alkon et al., 2014; De Vries et al., 2015; Pbert et al., 2013, 2016; Rifas-Shiman et al., 2017; Taveras et al., 2011), and only one receiving a low-bias rating (Taylor et al., 2018). In some cases, the scores for individual domains varied between the source study and subsequent publication(s). However, in all but one study, the overall bias assessment score of follow-up publications mirrored the final rating of their source study. For clustered randomised (controlled) trials, the only source of high bias was the domain related to missing outcome data. By contrast, there were several sources of high bias across the domains for individually randomised (controlled) trials, including randomisation, deviations from intended interventions, missing outcome data and the reporting of outcome data. Across all but three individually randomised (controlled) trials, the description, treatment and analysis of missing outcome data resulted in a high bias score. A comprehensive list of scores for each study and their follow-up publications are included in the supplementary file.

3.3 | Publication bias

As meta-analysis was not conducted, testing for publication bias was deemed superfluous. However, given that most included studies (13/18, 72.2%) reported non-significant findings, publication bias was unlikely.

3.4 | Effects of nurse-led primary prevention interventions

In total, nine of the 18 included studies evaluated the effect of a nurse-led intervention to prevent childhood overweight and obesity (Alkon et al., 2014; De Vries et al., 2015; Döring et al., 2016; Jonsdottir et al., 2014; Lakshman et al., 2018; Paul et al., 2011; Savage et al., 2016; Taylor et al., 2017; Wen et al., 2012). A full description of their characteristics and results are presented in the Table 1.

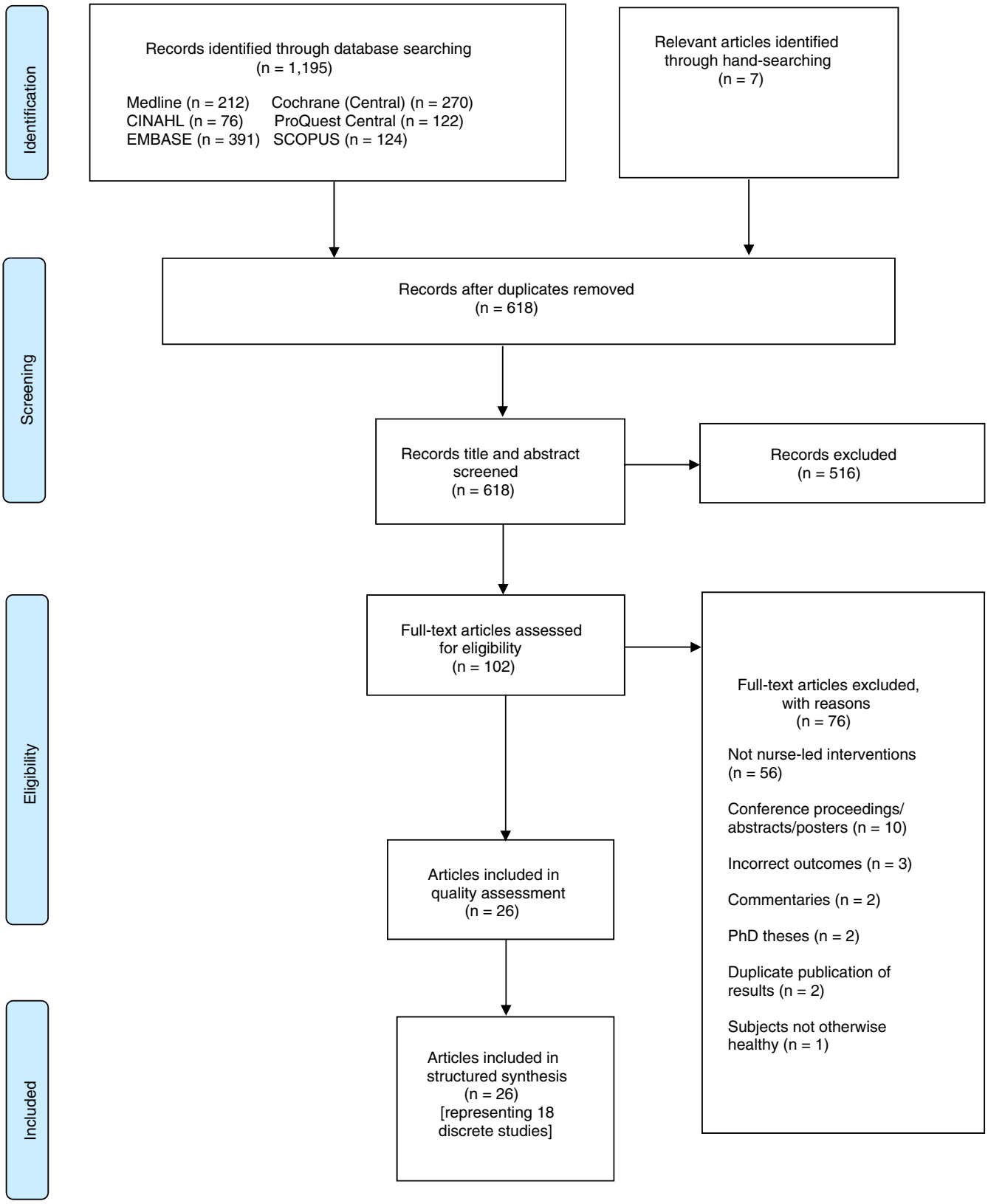

FIGURE 1 PRISMA flow diagram

TABLE 1 Overview of included studies

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Primary prevention Alkon et al. (2014) USA	Cluster-RCT conducted across 18 childcare centres Children: *n* = 552, male (52%), female (44%)[e], overweight (18%), obese (20%), age range: 3–5 years Parents: *n* = 552, White (46%), Black (16%), Latino (17%), Asian (14%), other (7%). Education: <high school (34%) and ≥high school (66%)	▪ Five, 1-h workshops for childcare staff and 1 equivalent parental workshop delivered by nurse childcare health consultants. Onsite and offsite consultations with centres over 7 months ▪ Intervention focused on improving the quality of children's nutrition and increasing their physical activity (PA) during their time in the childcare centres ▪ Nurse conducted health and safety assessments, provided educational workshops and updated nutrition and physical activity policies in the childcare centres ▪ Wait-list control group received the intervention after 1 year	Difference in mean *z*-BMI after 7 months (99:110)	−0.14 (−0.26 to −0.02)[f] After excluding extreme outliers and adjusting for cluster location, parental education and family income, difference in mean *z*-BMI was significantly different between the intervention and control groups at 7-month follow-up
De Vries et al. (2015) Netherlands	Cluster-RCT conducted in the home and at Well Baby Clinics Infants: *n* = 161, male (53%), female (47%), age range: 2 weeks Parents: *n* = 296. Education: <high school (55%), high school and vocational training (18%), ≥university (27%)	▪ One home visit with a paediatric nurse at 2 weeks old and 4 in-clinic sessions at 2, 4, 8 and 11 months old ▪ Intervention focused on increasing PA and stimulating motor development in infants by delivering recommendations to parents during 5 separate visits over 11 months ▪ ▪ Recommendations were developed by physiotherapists and included: 1 h of playtime per day, use of colourful toys, variation of surroundings, encouraging crawling (at 8 months) and encouraging walking (at 11 months) ▪ Well Baby Clinic Nurse (paediatric nurse) taught parents about daily infant care and developing food habits during clinical visits and they delivered the interventional recommendations during clinical and home visits ▪ Control group received usual care in-clinic which consisted of anthropometric measurements, immunisations, nutritional advice and the provision of general health and developmental information	Difference in mean BMI at 29 months old (89:54)	−0.2 (95% CIs not shown)[g],[h] $p = 0.28$ The addition of a PA-based intervention to usual care did not result in a significant difference in mean BMI between groups at 29 months old

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Döring et al. (2016) and Enö Persson et al. (2018) Sweden	Cluster-RCT in 59 child healthcare centres (CHCs) across 8 counties Children: *n* = 1,041, male (53%), female (47%), $\bar{\bar{x}}$ BMI =17, age range: 9–10 months Primiparous mothers: *n* = 1,039, $\bar{\bar{x}}$ age: ~30 years old. Education: primary (3%), secondary (34%), >secondary (63%)	▪ Nine motivational interviewing (MI) sessions conducted by Registered Nurses with mothers (6 individual, 1 group and 2 via telephone) over ~39 months ▪ MI sessions were delivered alongside regular check-ups at CHCs ▪ Using cognitive behavioural therapy (CBT) techniques, MI sessions helped mothers to set goals to change unhealthy behaviours, promote healthy food habits and promote PA for the benefit of their children ▪ Usual care control group received regular age-related health check-ups at 9–10 months and 1.5, 2, 3, 4, 5–5.5 years old	Difference in mean BMI after 39 and 51 months (448:700) at 39 months (436:655) at months	0.11 (−0.31 to 0.08)[g] at 39 months −0.13 (−0.37 to 0.11)[g] at 51 months The addition of 9 MI sessions to usual care did not result in significant differences in mean BMI between groups at either 39- or 51-month follow-up
Jonsdottir et al. (2014) Iceland	RCT delivered in a healthcare centre Infants: *n* = 119, male (46%), female (54%), $\bar{\bar{x}}$ birth weight (kg) =3.70, age range: 4 months old Mothers: *n* = 119, $\bar{\bar{x}}$ age =29.9, university educated (55%)	▪ The nurse lactation consultant advised mothers in the experimental group to exclusively breastfeed her infant from 4 to 6 months of age thereby delaying the introduction of complementary foods until 6 months of age. ▪ The nurse lactation consultant provided breastfeeding counselling to subjects in both arms of the trial and provided advice on the introduction of complementary foods from 4 months old onwards to mothers in the comparator group ▪ Participants' outcomes were measured at 10 routine healthcare centre visits up to 38 months of age	Difference in mean z-BMI at 18 and 29–38 months old (46:48)	0.0009 (−0.38 to 0.39)[g] at 18 months −0.15 (−0.53 to 0.24)[g] at 29–38 months Delaying the introduction of complementary foods by 2 months did not result in a significant difference in mean z-BMI between groups at either 18 months or 29–38 months of age
Lakshman et al. (2018) UK	Parallel-group RCT conducted in the home and research centre setting Infants: *n* = 669, Male (54%), Female (46%), $\bar{\bar{x}}$ BMISDS (−0.07), age range; 2–14 weeks Mothers: *n* = 669, $\bar{\bar{x}}$ age =31.6 years old, Education[e]; some secondary (2%), some high school (37%), high school (21%), university (36%). Race; White (93%) and non-White (7%)	▪ Intervention was delivered by a research nurse to parents over 6 months and focused on promoting responsive feeding, healthy weaning and reducing infant intake of formula milk to prevent excess weight gain during infancy ▪ Three, 30–45 min in-person consultations delivered at baseline and at age 4 and 6 months, and two, 15- to 20-min phone consultations delivered at age 3 and 6 months. Consultations were framed using social cognitive theory and included motivational and action planning and coping components ▪ Nurses helped parents set feeding goals, develop action plans to achieve those goals and improve their overall monitoring of their infant's weight gain ▪ Control group received the same number of contacts with research nurses, where general issues regarding infant feeding, weaning and health were discussed	Difference in mean BMISDS at 6 and 12 months old (304:312) at 6 months (293:293) at 12 months	−0.07 (−0.17 to 0.04)[g] at 6 months −0.01 (−0.14 to 0.12)[g] at 12 months A specialised intervention which reduced formula milk intake did not result in significant differences in mean BMISDS between groups at either 6 or 12 months old

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Paul et al. (2011) USA	Pilot randomised trial using a 2 × 2 factorial design conducted in the home and research centre setting Infants: *n* = 160, male (50%), female (50%), birth weight for gestational age *z*-score (SD) = −0.17 (0.98), age range: 2–3 months Primiparous mothers: *n* = 160. Race[e]; White (86%), Black (7%), Hispanic (8%), Asian (6%). Education: university graduate (58%), some technical school or university (22%), high school or less (20%), $\bar{x}$ age (SD) = 27 (5) years old	▪ Intervention 1: delivered 2- to 3-week post-birth by a research nurse where parents learned alternate soothing techniques to improve infant's duration of sleep and reduce feeding as a first response to distress ▪ Intervention 2: delivered 2- to 3-week post-birth by a research nurse where parents were educated on infants hunger and satiety cues and the appropriate timing for the introduction of solid food ▪ At 4- to 6-month post-birth, parents were educated on methods to overcome infant's fussy eating to promote the consumption of healthy solid foods ▪ Nurses gave hands-on demonstrations of infant feeding techniques and reviewed sleep and feeding diary cards and survey responses related to infant behaviour, maternal mental health and parenting ▪ Comparator group received Nurse home-visits to provide guidance on feeding and general infant care and received handouts detailing standard paediatric dietary information	Difference in mean weight-for-length (WFL) percentile after 12 months (22[a], 29[b], 29[c]:30[d])	33rd[a], 50th[b], 56th[c], 50th[d] ANOVA $p = 0.009$ After excluding participants who did not receive the first and second home visits and adjusting for intended breastfeeding duration, total sleep duration at age 3 weeks, number of daily feeds at age 16 weeks and maternal pre-pregnancy BMI, there was a significant difference between groups in terms of mean WFL percentile at 12-month follow-up, with the group receiving both the feeding and sleeping interventions recording the lowest mean WFL percentile
Savage et al. (2016) and Paul et al. (2018) USA	RCT in the home and research centre setting Infants: *n* = 279, male (52%), female (48%), age range: 2 weeks old Primiparous mothers: *n* = 279, $\bar{x}$ age =28.7 years old. Race: White (88%), Black (6%), Asian (3%), other (3%). Education: ≤high school (11%), some university (26%), ≥university (63%)	▪ Information-based toolkit teaching parents how to respond to their newborn's dietary and sleep needs. Toolkit was mailed out 2-week post-birth ▪ Home visits delivered by research nurses to provide counselling and hands-on demonstrations of feeding, soothing and playing. Home visits were delivered at 3- to 4, 16-, 28- and 40-week post-birth ▪ Nurses counselled mothers on various topics, including infant sleeping habits, feeding, portion sizes, regulating infant emotions, establishing routines, promoting healthy behaviours, healthy eating and age-appropriate physical activity, as well as limiting infant's screen time ▪ Phone contact with nurses to reinforce the intervention, delivered at 18- and 30-month post-birth and Research Centre visits at 1- and 2-year post-birth ▪ Nurses collected anthropometrics and administered surveys ▪ Comparator group received a dose-matched, nurse-led intervention in the home which focused on child safety and injury prevention	Difference in mean BMI at 12 months old (140:139) at 12 months Difference in mean *z*-BMI at 24 and 36 months old (116:116) at 24 months (140:139) at 36 months	~ −0.4 (~ −0.7 to ~ −0.1) at 12 months −0.21 (−0.65 to 0.06)[g] at 24 months −0.30 (−0.57 to −0.03)[g] at 36 months After imputing data for participants who did not receive the first home visit, and adjusting for maternal pre-pregnancy BMI, maternal age, child sex, child birthweight and weight-for-length at the 3- to 4-week study visit, there was a significant difference in mean BMI between groups at 12-month follow-up and mean *z*-BMI 36 month old After excluding participants who did not receive the first home visit and those who withdrew from the study and adjusting for marital status, household income, maternal age at enrolment and maternal pre-pregnancy BMI, there was no significant difference in mean *z*-BMI between groups at 24 months old

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Taylor et al. (2017) and Taylor et al. (2018) New Zealand	RCT with 4 arms delivered in the home and clinic setting Infants: *n* = 802, male (51.3%), female (48.8%), $\overset{\text{!!}}{x}$ birth weight (SD) (kg) = 3.56 (0.48), age range; birth Mothers: *n* = 802, $\overset{\text{!!}}{x}$ age (SD) = 31.6 (5.2). Race: White (85.7%), Indigenous (7.3%), Asian (4.9%), other (2.1%). Education: high school or less (24.3%), post-secondary (14.6%), university or higher (61.1%)	▪ All interventions: Seven well-child care visits over 2 years ▪ Intervention 1: Eight additional parent contacts; 3 with a registered lactation consultant, 3 with a child exercise specialist and 2 with one or more of well child nurses, dietitians and nutritionists. Intervention educated and supported parents on topics of breastfeeding, infant physical activity and the timing of the introduction of solid foods ▪ Intervention 2: Two additional parent contacts with a research nurse within the first 6 months, with additional contacts available as required based on infant sleep needs. Intervention was education-based and focused on the development of appropriate infant sleep habits as relayed by the research nurse ▪ Intervention 3: Interventions 1 and 2 combined for a total of 9 additional parent contacts ▪ Comparator group received government funded well child care consisting of 7 home and clinical visits with a well child nurse from 2 weeks to 2 years old at pre-specified intervals (2–4 weeks, 6 weeks, 3, 5, 9–10, 15 and 24 months)	Difference in mean *z*-BMI at 24, 42 and 60 months old (167[a], 177[b], 163[c]:179[d]) at 24 months (143[a], 165[b], 147[c]: 161[d]) at 42 months (128[a], 156[b], 131[c]:142[d]) at 60 months	(0.72 ± 0.87)[a], (0.92 ± 0.96)[b], (0.68 ± 0.88)[c], (0.77 ± 0.86)[d] $p = 0.104$ at 24 months[f] a vs. d: −0.18 (−0.37 to 0.02), b vs. d: 0.15 (−0.04 to 0.34), c vs. d: −0.16 (−0.36 to 0.04) at 42 months[g] a vs. d: 0.06 (−0.29 to 0.16), b vs. d: 0.25 (0.04 to 0.47), c vs. d: −0.14 (−0.36 to 0.09) at 60 months[g] The addition of a food, activity and breastfeeding intervention or a sleep intervention or both interventions to usual care did not result in significant differences in mean *z*-BMI at either 24, 42 or 60 months of age
Wen et al. (2012) and Wen et al. (2015) Australia	Parallel-group RCT conducted in the Home Infants: *n* = 667, age range; 30-week gestation to newborn Primiparous mothers: *n* = 667, age ranges; ≤24 (42%), 25–29 (34%), ≥30 (24%). Education; ≤high school (21%), vocational training or diploma (55%), university (24%)	▪ Eight, 1–2 h, home visits delivered by a community nurse at 30- to 36-week gestation and 1, 3, 5, 9, 12, 18 and 24 months of age ▪ Intervention was designed to reduce behavioural risk factors for childhood obesity by improving infant feeding practices, reducing screen time, encouraging active play time and improving eating practices. Nurses also discussed maternal concerns relating to their newborn and collected baseline anthropometrics at household visits ▪ Comparator group received mailed home-safety pamphlets at 6 and 12 months and received usual postnatal care, which includes at least one community nurse visit, within one month of birth, for general support in the home	Difference in mean *z*-BMI at 24, 42 and 60 months old (236:229) at 24 months (210:205) at 42 months (191:178) at 60 months	−0.29 (−0.50 to −0.07)[f] at 24 months 0.08 (−0.12 to 0.28)[f] at 42 months 0.17 (−0.0004 to 0.36)[f] at 60 months The addition of an intervention targeting improved infant feeding and increased PA to usual post-natal care resulted in a significant difference in mean *z*-BMI between groups at 2 years old. However, this significant difference was not sustained at either 42 or 60 months of age

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Secondary prevention Chahal et al. (2017) Canada	Randomised clinical trial in an outpatient paediatric lipid clinic Dyslipidaemic children and adolescents: *n* = 34, male (63%), female (37%), $\bar{x}$ BMI = 30.4, age range: 10–17 years	▪ Four, 30–45 min, in-person, MI sessions delivered by a nurse practitioner (NP) over 6 months and 4- and 5- to 10-min follow-up phone calls, 2 weeks after each session to reinforce progress and answer questions ▪ Adolescents and parents attended an educational class about PA and healthy eating ▪ MIs conducted with adolescents and their parents to help develop a plan to effect behaviour change. This was done by identifying adolescent's personal strengths and level of self-efficacy ▪ NPs developed a management plan and delivered MI counselling sessions to adolescents and their parents in the experimental group or adolescents alone in the comparator group	Difference in mean BMI after 6 months (16:16)	0.5 (95% CIs not shown)[f] $p = 0.32$ At 6-month follow-up, there was no significant difference in the reduction of mean BMI between the adolescent group who received MIs with their parents and the adolescent group who received MIs alone
Christie et al. (2017) UK	Randomised (efficacy) trial in the local community (experimental group) and general practice (control group) setting Adolescents: *n* = 174, male (49%), female (61%). Race[e]: White or mixed (46%), Black (30%), Asian (20%), unknown (5%), $\bar{x}$ BMI = 32, age range; 12–18 years	▪ Twelve session, weight-management programme delivered by graduate mental health workers to families over a 6-month period. Sessions focused on developing self-esteem and self-efficacy and improving adolescents' motivation for lifestyle change ▪ Mental health workers used an MI and solution-focused approach to counselling and session content included: changing eating behaviours, decreasing sedentary behaviour, improving nutritional intake and addressing emotional triggers for eating ▪ Control group received a 40- to 60-min educational session on healthy eating, PA and eating behaviours delivered by a primary care nurse and trained NP	Difference in mean BMI after 6 and 12 months (87:87) at 6 months (60:55) at 12 months	−0.11 (−0.62 to 0.40)[f] after 6 months −0.22 (−1.05 to 0.61)[f] after 12 months After adjusting for baseline anthropometrics, there was no significant difference in the reduction of mean BMI between the mental health worker-led experimental group and the nurse-led comparator group at 6- or 12-month follow-up

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Ford, Bergh, et al. (2010) UK	RCT in a Hospital-based Obesity Clinic and the Home Children and adolescents: *n* = 106, male (44%), female (56%). Race: White (88%), non-White (12%), $\bar{x}$ BMI = 33.8, age range; 9–17 years	▪ Consultations with a research nurse once a week for 6 weeks, once a fortnight for the following 6 weeks and once every 6 weeks thereafter, up to the end of the intervention at 12 months ▪ During consultations, participants were trained by the nurse to use a Mandometer (computerised weighing scale that measures depletion of food weight and encourages correct eating speed via audio vocalisation) and were encouraged to use it once per day to build positive eating habits by reducing food intake and lowering eating speed ▪ Paediatric dietitians provided 4 dietary consultations over 12 months and a clinician provided 3 consultations every 4 months to emphasise the importance of good eating habits and PA ▪ Nurse telephoned patients to offer support and encouragement every second week from Week 12 to the end of 12 months ▪ Control group attended the obesity clinic for a family consultation with a multidisciplinary team composed of a paediatric dietitian, an exercise specialist and a clinician, four times over 12 months where MI-based techniques were used during consultations to emphasise the importance of increasing PA and improving diet to bring about positive lifestyle changes	Difference in mean BMISDS after 12 and 18 months (45:46) at 12 months (44:43) at 18 months	−0.24 (−0.36 to −0.11)[f] at 12 months −0.27 (−0.11 to −0.43)[f] at 18 months At 12-month follow-up, mean BMISDS was significantly lower in the nurse-led intervention group as compared to the multidisciplinary team-led comparator group, even after adjusting for baseline anthropometrics. This decrease appeared to be sustained among those with available data at 18 months
Kokkvoll et al. (2014), Kokkvoll et al. (2015) and Kokkvoll et al. (2019) Finland	Randomised trial in a Hospital (inpatient and outpatient), specialised camps and the local community Overweight and obese children: *n* = 97, male (54%), female (46%), overweight (23%), obese (77%), childhood BMI corresponding to an adult BMI of ≥27.5, age range: 6– years Parents: *n* = 162, ≥13 years of education (27%)	▪ Both interventions consisted of MI and family therapy with the aim of helping families increase PA, decrease sedentary activity and increase their intake of healthy foods ▪ 30 min of counselling by a paediatric nurse followed by a 30-min examination and clinical interview with a paediatric consultant in the hospital ▪ Consultation with nutritionist after 1–2 months ▪ Counselling with public health nurses at 1, 2, 5, 8, 10, 15 and 18 months in the local community ▪ Counselling with a paediatric nurse and paediatric consultant at 3, 12, 24 and 36 months in the hospital ▪ Experimental intervention: Delivered to families individually and as a group and included a 3-day inpatient programme focusing on diet and PA, a 4-day camp at 4- to 6-months, community-based counselling with a public health nurse, 60 min of group-based PA twice a week, and group sessions with other participating families and a multidisciplinary team (paediatric nurse, psychiatric nurse, nutritionist, coach, clinical educationalist, paediatric consultant, physiotherapist) ▪ Comparator group received a modified nurse-led intervention assisted by a paediatrician and nutritionist which was delivered to families individually. Contact time totalled 8 h over 12 months	Difference in mean BMI after 12, 24 and 36 months (46:45) at 12, 24 and 36 months	−0.39 (−0.96 to 0.17)[h] at 12 months −0.9 (−1.9 to 0.2)[g h] at 24 months −0.82 (−1.96 to 0.33)[f] at 36 months Adding 28 h of contact time with a multidisciplinary team and adding a physical activity component totalling 38 h to a nurse-led intervention did not lead to a significant difference in mean BMI between the experimental and comparator group at either 12-, 24- or 36-month follow-up

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Kong et al. (2014) China (Hong Kong)	Randomised clinical trial at the Cinical Trial Centre at The Chinese University of Hong Kong Obese adolescents: *n* = 104, male (43%), female (57%), BMI ≥95th percentile for age, sex and region, BMI $\bar{x}$ (SD) = 30.4 (3.9), age range: 15–18 years	▪ A dietitian delivered one, 1-h counselling session at week 0, followed by six, 20-min, counselling sessions at week 2, 4, 6, 8, 16 and 24. Furthermore, five, 10- to 15-min, phone calls were delivered over the 6-month intervention period to monitor progress ▪ Counselling included: a full behavioural assessment of diet and lifestyle, advice to reach intended weight loss goals and the prescription of a personalised low calorie, low glycaemic index diet which targeted a 20% restriction on usual caloric intake ▪ Dietitian prescribed 30 min of PA, at least 3 times per week ▪ Research nurses delivered equivalent counselling sessions to the comparator group over the same timeframe. Nurse-led counselling included: dietary advice centred around the standard food pyramid and specific advice to limit dietary fat and avoid high-caloric foods to reduce overall energy intake	Difference in mean BMI after 6 months (34:27)	0.82 −1.96 to 0.33)[f] After adjusting for baseline anthropometrics, age, sex and physical activity levels, there was no significant difference in the reduction of mean BMI between the dietitian-led experimental group and the nurse-led comparator group at 6-month follow-up
Marild et al. (2013) and Forsell et al. (2019) Sweden	Randomised trial in 4 outpatient paediatric clinics Pre-pubertal children and pubertal adolescents: *n* = 55, male (45%), female (55%), obese (95%), overweight (5%), $\bar{x}$ BMI SDS = 3.21, age range; 8–13 years	▪ Twelve, 1-h MI sessions (10 individual, 2 group) delivered over one year to parents by Paediatric nurses, dietitians and physiotherapists ▪ MI sessions encouraged behaviour changes in diet and PA and reinforced dietary and behavioural guidance regarding sleep, screen-time and sedentary behaviour ▪ CBT was used to establish and monitor treatment goals ▪ Paediatric Nurses conducted 4/12 MI sessions in the experimental group and 8/12 MI sessions in the comparator group, with the remainder conducted by a dietitian	Difference in mean BMISDS at 12 and 48 months (28:27) at 6 months (27:29) at 48 months	−0.03 (95% CIs not shown)[f] p = 0.94 at 12 months −0.22 (−0.59 to 0.16)[f] at 48 months
Pbert et al. (2013) USA	Pair-matched cluster-RCT delivered in 6 public High schools Adolescents: *n* = 82, male (30%), female (70%). Race[e]; White (77%), Hispanic (15%), Black (10%), BMI ≥ 85th percentile for age and sex, $\bar{x}$age (SD) = 15.8 (1.02) years old	▪ Six, 1-on−1 school nurse-led counselling sessions lasting 18–29 min, conducted over 2 months ▪ Counselling involved CBT techniques to support behaviour change relating to diet and PA. Counselling aimed to improve health knowledge, self-control and self-efficacy ▪ Comparator group received 6, 1-on−1 school nurse visits lasting ~9 min conducted over 2 months during which they reviewed their behaviour changes, were weighed and received educational pamphlets on weight loss	Difference in mean BMI after 2 and 6 months (42:40) at both 2 and 6 months	−0.09 (−0.82 to 0.65)[g] after 2 months −0.22 (−1.23 to 0.80)[e, g] after 6 months At both 2- and 6-month follow-ups, there was no significant difference in mean BMI between the intervention and comparator group, suggesting that short term behavioural changes brought on by the intervention did not translate to meaningful reductions in BMI

(Continues)

TABLE 1 (Continued)

Study and country	Study design and baseline characteristics	Intervention(s) for experimental and control groups	Outcome(s) and (Nx:Nc) analysed	Key result(s) and findings
Pbert et al. (2016) USA	Pair-matched cluster-RCT in 8 public High schools Adolescents: *n* = 111, male (38%), female (62%). Race[e]; White (63%), Hispanic (32%), Black (20%), BMI ≥ 85th percentile for age and sex, $\bar{\bar{x}}$ age = 16.4 years old	▪ Six one-on-one school nurse-led counselling sessions lasting 30 min, conducted over 6 weeks, followed by one session per month for 6 months ▪ Weight management counselling focused on healthy eating and engagement with PA ▪ PA sessions delivered by physical education teachers or school nurses, conducted 3 times per week for 8 months and included group sports, games and non-competitive fitness activities ▪ Comparator group received 12, one-on-one school nurse visits during the same timeframe as the experimental group. During visits, student's behaviour changes were reviewed, they were weighed, and they received educational pamphlets on weight loss	Difference in mean BMI after 8 months (54:57)	−0.14 (−1.09 to 0.81)[f] Adding a physical activity component to a counselling intervention using school nurses did not lead to a significant difference in the reduction of mean BMI between the experimental and comparator group
Taveras et al. (2011) and Rifas-Shiman et al. (2017) USA	Cluster-RCT across 10 paediatric practices Children: *n* = 475, male (52%), female (48%). Race: White (57%), Black (19%), Latino (17%), other (8%), $\bar{\bar{x}}$ BMI (SD) = 19.2 (2.4), overweight (44%), obese (56%), age range: 2–6 years Parents: Normal weight (4%), overweight (43%), obese (54%). Education: <college graduate (38%), college graduate (62%)	▪ MI-based intervention delivered by a paediatric NP to the parent(s) over 2 years which targeted a reduction in television viewing time and unhealthy food consumption ▪ Year 1: Four, 25-min in-person MIs delivered during well child consultations and three, 15-min phone-based follow-ups ▪ Year 2: Two in-person visits ▪ Usual care control group attended annual well child care visits	Difference in mean BMI at 12 and 24 months (253:192) at 12 months (249:192) at 24 months	−0.21 (−0.50 to 0.07)[f] at 12 months −0.08 (−0.53 to 0.36)[f] at 24 months After adjusting for baseline anthropometric measures, age, sex, race, parental education and income, there was no significant difference between the intervention and control groups in terms of mean BMI averted at either 12 or 24-month follow-up

Abbreviations: $\bar{\bar{x}}$ = sample mean; ANOVA, analysis of variance; BMI, body mass index; BMISDS, body mass index standard deviation score; CBT, cognitive behavioural therapy; CHC, child healthcare centre(s); CI, confidence interval; kg, kilogram; MI, motivational interview; *n*, number; Nc, number in comparator group; NP, nurse practitioner; Nx, number in experimental group(s); PA, physical activity; RCT, randomised controlled trial; SD, standard deviation; UK, United Kingdom; USA, United States of America; WFL, weight-for-length; *z*-BMI, body mass index adjusted for age and sex.

[a]Received interventions 1 and 2.

[b]Received intervention 1.

[c]Received intervention 2.

[d]Received no intervention.

[e]Proportions may not sum to 100% due to missing data or mixed-race identity.

[f]Per-protocol analysis.

[g]Intention-to-treat or modified intention-to-treat analysis.

[h]Not (adequately) adjusted for baseline demographics, anthropometrics or other potential confounders.

3.4.1 | Infant feeding, sleep and play

The majority of nurse-led primary prevention studies focused on infants below the age of one (De Vries et al., 2015; Jonsdottir et al., 2014; Lakshman et al., 2018; Paul et al., 2011; Savage et al., 2016; Taylor et al., 2017; Wen et al., 2012). Interventions focused on a combination of infant feeding (including breastfeeding) sleep and play (PA). In De Vries et al. (2015), paediatric nurses delivered an educational intervention, over an 11-month period, concerning daily infant care, developing food habits, and stimulating motor development. At 29 months old, there was no significant difference in infant mean BMI in the intervention group. In Jonsdottir et al. (2014), the intervention, delivered by a Nurse lactation consultant, consisted of mothers exclusively breastfeeding until 6 months old, relative to the control group who did so only until 4 months old. The results did not show a significant difference in infant BMI at either 18- or 29- to 38-month follow-up for the prolonged breastfeeding group. A similar intervention, delivered by a Research Nurse in Lakshman et al. (2018), focused on the promotion of responsive feeding, healthy weaning and reduced intake of formula milk and found no significant difference in mean BMISDS at either 6 or 12 months old. By contrast, Paul et al. (2011) combined two interventions on infant soothing techniques, duration of sleep and education on infant satiety cues for hunger and reported a significant difference in mean WFL percentile after 12-month follow-up, when compared to infants who received only the sleep component or the hunger satiety component of the combined intervention. Another multiintervention study (Taylor et al., 2017) combined an educational intervention involving components on breastfeeding, PA and the timing of introduction of solid foods, with an intervention on infant sleep habits, and found no significant difference between intervention groups in terms of mean *z*-BMI at either 24, 42 or 60 months of age (Taylor et al., 2017, 2018). In Savage et al. (2016), research nurses provided hands-on demonstrations with mothers on infant feeding, soothing and playing during home visits. Additionally, nurses counselled mothers on sleeping habits, feeding, portion sizes, age-appropriate PA and regulating infant emotions. At 12 months old, infants in the intervention group had a significantly lower mean BMI: ~ −0.4 (~ −0.7 to ~ −0.1) relative to the control group. However, this significant difference was not maintained at either 24- or 36-month follow-up (Paul et al., 2018). Lastly, in Wen et al. (2012), a community nurse delivered an intervention targeting improved infant feeding, active play time and reduced screen time during eight home visits over a period of 2 years. At 24 months, there was a significant difference in mean *z*-BMI in children whose mothers received the intervention: −0.29, (−0.50 to −0.07). However, this effect was not sustained at 42 or 60 months old (Wen et al., 2015).

3.4.2 | Motivational interviews

Motivational interviewing (MI) techniques were applied in one primary prevention study targeting primiparous mothers (Döring et al., 2016) attending child healthcare centres. The intervention consisted of nine MI sessions conducted by registered nurses, delivered over a 39-month period. MI sessions adopted a cognitive behavioural therapy (CBT) approach, oriented towards goal-setting to reduce unhealthy behaviours and promoted healthy food habits and PA for the benefit of their 9- to 10-month-old infants. At 39- and 51-month follow-up, there was no significant difference in mean BMI of children whose mothers received the intervention (Döring et al., 2016; Enö Persson et al., 2018).

3.4.3 | Childhood nutrition and PA

Only one primary prevention study targeted children above the age of one (Alkon et al., 2014). This cluster-RCT was conducted across 18 childcare centres and focused on children between 3 and 5 years old. The intervention consisted of educational workshops delievered to childcare staff delivered by a nurse childcare health consultant. These workshops centred on improving children's nutrition and increasing their PA while at the childcare centre. After 7-month follow-up, the difference in mean *z*-BMI was significantly lower amongst childcare centres who received the intervention: −0.14 (−0.26 to −0.02).

3.5 | Effects of nurse-led secondary prevention interventions

In total, nine of the 18 included studies evaluated the effect of a nurse-led intervention to manage childhood and adolescent overweight and obesity (Chahal et al., 2017; Christie et al., 2017; Ford, Bergh, et al., 2010; Kokkvoll et al., 2014; Kong et al., 2014; Marild et al., 2013; Pbert et al., 2013, 2016; Taveras et al., 2011). A full description of their characteristics and results is presented in the Table 1.

3.5.1 | Motivational interviews

The majority of secondary prevention studies delivered an MI-based intervention for the benefit of children and adolescents (Chahal et al., 2017; Christie et al., 2017; Kokkvoll et al., 2014; Marild et al., 2013; Taveras et al., 2011). In Chahal et al. (2017), four MI sessions were delivered by a nurse practitioner (NP) to children and adolescents (and their parents) over a 6-month period. The focus of the MIs was to develop a plan to effect behaviour change by focusing on personal strengths and self-efficacy. The experimental group received MIs with their parents, whereas the comparator group received MIs alone. At 6-month follow-up, there was no significant difference between groups in terms of mean BMI. In Taveras et al. (2011), an MI-based intervention was delivered by a paediatric NP over 2 years to parents of 2- to 6-year-olds attending paediatric practices. MI sessions targeted a reduction in television viewing time and unhealthy food consumption. The control group received standard care. There

was no difference in mean BMI between groups at either 12- or 24-month follow-up. Similarly, in Marild et al. (2013), 12 MIs were delivered exclusively to parents of 8- to 13-year-olds over a 1-year period. MI sessions adopted a CBT approach and encouraged behaviour changes in the diet and PA level of the child and reinforced dietary and behavioural guidance regarding sleep, screen-time and sedentary behaviour. MIs were mostly delivered by dietitians and physiotherapists in the experimental group but were predominantly nurse-delivered in the comparator group. At both 12- and 48-month follow-ups, there was no significant difference between groups in terms of mean BMISDS suggesting that adding a physiotherapist to a nurse-led intervention, with the view of further promoting PA, did not lead to a significant reduction in mean BMI for the experimental group. Similarly, in Christie et al. (2017), the comparator group received a 40- to 60-min educational session on healthy eating and PA by a primary care nurse and trained NP. By contrast, the experimental group received a MI-based intervention and weight management programme delivered by mental health workers. The intervention delivered to the experimental group focused on changing eating behaviours, decreasing sedentariness and improving nutritional intake. At both 6- and 12-month follow-ups, there was no significant difference between groups in terms of mean BMI. Lastly in Kokkvoll et al. (2014), both the experimental and comparator group received multicomponent interventions which included MI-based counselling with the aim of helping families increase PA, decrease sedentary activity and increase their intake of healthy foods. This was supplemented with counselling provided by public health nurses in the local community and paediatric nurses in a hospital setting. In addition, the experimental group attended a 3-day inpatient programme, 4-day camp and scheduled PA activities with a multidisciplinary team over a 12-month period. Adding 28 h of contact time with a multidisciplinary team and adding a PA component totalling 38 h to a nurse-led intervention did not lead to a significant difference in mean BMI between the experimental and comparator group at either 12-, 24- or 36-month follow-up (Kokkvoll et al., 2014, 2015, 2019).

3.5.2 | Counselling

A counselling-based intervention was conducted in three secondary prevention studies (Kong et al., 2014; Pbert et al., 2013, 2016). In Kong et al. (2014), the experimental group received a dietician-led counselling intervention which included a behavioural assessment of diet and lifestyle and education to reduce caloric intake and increase PA. The comparator group consisted of nurse-led counselling sessions which focused on dietary advice centred around the standard food pyramid. At 6-month follow-up, there was no significant difference between groups in terms of mean BMI. In Pbert et al. (2013 and 2016), counselling-based interventions were delivered to adolescents by school nurses in high schools. Counselling involved CBT techniques to support behaviour change relating to diet and PA. The goal of counselling was to improve health knowledge, self-control and self-efficacy. Control groups visited the school nurse where anthropometric measurements were taken and behaviour change intentions were discussed. At both 2- and 6-month follow-ups, there was no significant difference in terms of mean BMI between groups (Pbert et al., 2013). In Pbert et al.'s follow-up study (2016), a PA component was added to the counselling-based intervention. PA sessions were delivered by physical education teachers or school nurses three times per week over an 8-month period. Adding a PA component to the counselling-based intervention did not result in a significant difference in mean BMI between groups at 8-month follow-up.

3.5.3 | Eating device

The intervention in Ford, Bergh, et al. (2010) was highly specialised and involved 12 consultations with a research nurse during which children and adolescents (ages 9–17) were taught how to use a Mandometer eating device. A Mandometer is a computerised weighing scale that measures depletion of food weight and encourages correct eating speed via audio vocalisation. Obese children and adolescents were encouraged to use this device daily to reduce food intake and build positive eating habits. The control group received an MI-based intervention targeting improved diet and increased PA delivered by a multidisciplinary team. At both 12- and 18-month follow-ups, there was a significant difference between the intervention and control groups in terms of mean BMISDS: −0.24 (−0.36 to −0.11) and −0.27 (−0.11 to −0.43), respectively. Of the nine included secondary prevention studies, this was the only one to demonstrate a significant reduction in obesity-related outcomes.

4 | DISCUSSION

Interventions to prevent childhood overweight and obesity have the potential to mitigate the trajectory of obesity into adulthood, thereby improving long-term quality of life, reducing risk for chronic disease and lowering future healthcare costs (Oude Luttikhuis et al., 2009; US Preventive Services Task Force, 2010). Comprehensive, high-intensity behavioural interventions for childhood obesity, compared with usual clinical care, have demonstrated effectiveness in reducing obesity-related outcomes (Chai et al., 2019). However, inroads into clinically meaningful reductions are yet to be achieved (Ho et al., 2013). This problem is amplified by the slow adoption of expert recommendations and nationally standardised performance measures in relation to the prevention and management of overweight and obesity in children and young people (Australian College of Nursing (ACN), 2020).

Nurses have the potential to facilitate the delivery of interventions across community, health and education settings, by virtue of the size, scale and adaptability of the workforce. In this review, nurse-led interventions were conducted in the home, childcare, primary care and school settings. Nurses delivered complex multicomponent interventions and were often the leading or most utilised

member of a multidisciplinary team. Interventions were diverse and included counselling and MIs, the development of nutritional and PA guidelines and the establishment of workshops, all with the aim of promoting lifestyle and behaviour change in children and their parents.

Despite nurses' leading roles in the delivery of childhood obesity interventions, they were heavily underrepresented in their conceptualisation. For example, nurses were only included in a consultative capacity in three of the 18 included studies. In Wen et al. (2012), their home-based intervention was conceptualised following wide consultation with community-based child and family health nurses who had experience in providing home visits to first time mothers within the community. Similarly, in Pbert et al. (2013 and 2016), their school-based interventions were conceptualised following focus-group consultation with school nurses. Paradoxically, in nearly all cases, interventions were designed by the research team (doctors, nutritionists, epidemiologists, public health experts) but carried out by nurses, typically following a brief training period with the intervention. The failure to leverage nurse knowledge, training, practice and experience in the design of these interventions may have been a contributing factor to the lack of observed effect. Therefore, future studies should look to integrate nurses into the design of these interventions to improve intervention fidelity.

Eight of the nine included primary prevention studies focused on infants below the age of one (De Vries et al., 2015; Döring et al., 2016; Jonsdottir et al., 2014; Lakshman et al., 2018; Paul et al., 2011; Savage et al., 2016; Taylor et al., 2017; Wen et al., 2012). This shift in obesity prevention paradigms to early infancy emphasises the unique opportunity afforded to health professionals such as maternal child health (MCH) nurses to provide early obesity interventions. As MCH nurses have regular consultations with parents where they provide advice on infant feeding, they could be leveraged to provide other obesity prevention strategies at a critical juncture of a child's life, if given additional training and education. This overlap in opportunities has previously been discussed in an Australian study which determined that while MCH nurses were suitable professionals to provide obesity interventions, they were underutilised in their delivery (Laws et al., 2015). Similarly, other nurses in routine contact with parents, children or adolescents in a school, community or clinical setting could be leveraged to provide childhood and adolescent obesity interventions as part of routine healthcare practice. As nurses provide care across the life course, they could be used to prevent obesity from birth through to adolescence as part of their model of care in the prevention of chronic disease.

Overall, prevention studies for childhood overweight and obesity reported small to moderate decreases in weight-related outcomes. However, significant differences between groups were not consistently established. Notably, only one secondary prevention study reported a significantly different decrease in BMISDS between groups at both 12 and 18 months: −0.24 (−0.36 to −0.11) and −0.27 (−0.43 to −0.11), respectively (Ford, Bergh, et al., 2010). In this study, the nurse-led obesity intervention was more effective at reducing mean BMISDS than the multidisciplinary-led comparator obesity intervention. In the included secondary prevention studies, nurses were more likely to be leading but working with other healthcare professionals in either or both the experimental and comparator/control groups. This makes it difficult to render a verdict on the direct effect of nurses' roles in delivering these interventions, and the optimal mix of healthcare professionals best suited to tackle this problem.

Several included studies demonstrated no significant difference in terms of obesity prevention/reduction between nurse-led interventions and interventions delivered by other healthcare professionals (Christie et al., 2017; De Vries et al., 2015; Döring et al., 2016). To improve and widen access to interventions, further studies should attempt to investigate whether nurses can have a better (or at least no worse effect) in reducing childhood and adolescent obesity comparative to other healthcare professionals, such as those identified in this review: doctors, dietitians, nutritionists, exercise specialists, physiotherapists, clinicians and psychologists.

Although five of the 18 included studies (27.8%) found statistically significant improvements in weight-related outcomes between groups, most improvements were modest and not sustained over time. In this context, it is important to distinguish between statistical significance versus clinical significance. Similarly, change in BMI is often used as a proxy measure for change in percentage of body fat, and the use of BMI for the assessment of adiposity in early life is not without challenge (Marild et al., 2013; Wells & Fewtrell, 2006). Necessarily, many of the studies were designed to detect a statistically significant reduction in BMI where other measures may have been more appropriate from a clinical perspective. For example, it has been suggested that a decrease of 0.25 in BMISDS is the minimum clinically significant marker for improvements in body composition and cardiometabolic risk for adolescents who are already obese (Ford et al., 2010). However, a decrease of ≥0.5 BMISDS accrue greater clinical benefits (Ford, Hunt, et al., 2010). Ong et al. (2000) state that a difference of 0.67 (BMI *z*-score) is commonly used in evaluating associations with later morbidity in epidemiologic studies. The reality is that even small reductions in weight can improve longer term health outcomes and the value of raising awareness and changing behaviours have the potential to affect life-long improvements. The difficulty is capturing these potential and actual changes in RCTs, and the value of running a process evaluation to capture qualitative data across an intervention could provide valuable insight into the impact of an intervention.

The interventions reviewed broadly focused on behavioural factors with goals to reduce energy intake and increase energy expenditure. While these are important factors, understanding the context of obesity from a population perspective is imperative. Societal, cultural and economic influences on obesity and PA are important considerations (Crawford et al., 2001). Factors include socio-economic status, race, PA, dietary patterns, maternal factors and the home environment (Crawford et al., 2001). Socio-economic factors were highlighted as important variables in understanding rates of obesity and the inverse relationship between obesity and socio-economic status is well documented (Drewnowski & Specter, 2004). Money

to purchase foods that are not energy dense is a major barrier for people on low incomes (Drewnowski & Specter, 2004). Therefore, interventions that take a 'one-size-fits all' approach are unlikely to be effective across diverse cultural and socio-demographic groups, representative of today's society. It was notable that participants' culture and socio-economic status was rarely a key feature in the design of interventions, despite their link to many outcomes reported in this review. For example, numerous studies reported on ethnicity as background data but did not report subanalysis by ethnicity or perhaps could not due to homogeneity of samples. All these potential factors should be accounted for in the design of future studies to better understand their potential effects, which will also serve to enhance the generalisability of findings.

In this review, consistency with which the interventions were delivered and the quantity of the intervention to which participants were exposed differed across interventions. The outcomes could be attributed to the variations in programme implementation. Greater understanding of the optimal treatment 'dose' is needed, such as the number of sessions, length of intervention and impact on outcomes. A further common issue is the duration of follow-up data to determine if the changes reported post-intervention were maintained. Follow-up in this review ranged from 6 to 60 months (mode 12 months) for primary prevention studies and 2–48 months (mode 12 months) for secondary prevention studies.

The effectiveness of parental involvement was mixed. It is important that the intensity, duration and activities that parents were involved in are reported across studies. This should include the reporting of proportions of parents that were involved and remained engaged throughout follow-up. Qualitative work might capture parents' perceptions of their child's obesity status prior to participating in obesity interventions to help their children remain engaged. Additionally, qualitative data may help improve the understanding of what involvement in the study parents do and do not find acceptable. Closer monitoring of parental activities could also assist in understanding the effectiveness of parental involvement to effect obesity reduction/prevention in their children.

4.1 | Limitations

This systematic review aimed to present the results of intention-to-treat (ITT) analyses. Results of ITT analyses present an unbiased estimate of effect for an intervention, thus making them the most reliable indicator of its effectiveness in the real-world setting, which is necessary for policy development (McCoy, 2017). In many of the reported studies, the simple definition of ITT 'once randomised always analysed' was misrepresented or misunderstood (McCoy, 2017). Many studies referred to ITT analyses, or implied their analyses were ITT, when they were either modified-ITT analyses or some form of per-protocol analysis. This reflects the need for the application of more sophisticated methods and transparency in reporting of results to help the healthcare community make better-informed decisions as to the effect of these interventions.

While RCTs are the gold-standard in study design, their application in pragmatic settings often leads to a difficulty in the interpretation of intervention effects. This is particularly true where comparator groups are effectively ethically required to receive some form of intervention, beyond what is expected in usual care. Operating under these constraints, it can be difficult to demonstrate a clear effect of nurse-led interventions on weight-related outcomes using an RCT framework. Therefore, future studies investigating the effectiveness of nurse-led interventions should look to use wait-list controls who receive the intervention after a pre-specified period of time, as this would allow for a better demarcation of effects, while also preserving ethical integrity.

5 | CONCLUSION

This review has identified that relatively few interventions have harnessed the potential of nurses to lead interventions to reduce the burden of overweight and obesity among children and young people. However, the ability of nurses to lead programmes across a range of settings was evident. There are numerous methodological issues that need to be addressed in order to determine the effectiveness of primary and secondary prevention programmes to reduce the burden of overweight and obesity. The research to date has illustrated a number of potential directions that should be further explored, in particular the opportunity afforded to early childcare nurses and the general need to involve nurses as stakeholders in the design of interventions. Childhood obesity is a serious issue that warrants the resources necessary to find effective prevention strategies.

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CONFLICTS OF INTEREST

None to declare.

AUTHOR CONTRIBUTIONS

L.W.: Conceptualisation, methodology, screening, bias assessment, write-up and review. I.K.: Methodology, literature search, screening, data extraction, data analysis, bias assessment, write-up and review. M.D.: Methodology, literature search, screening and review. R.Q., J.H., C.G. and E.D.W.: Conceptualisation and review.

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Author elects to not share data.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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