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REVIEW

Impact of Parent Engagement in Childhood Obesity Prevention Interventions on Anthropometric Indices among Preschool Children: A Systematic Review

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Abstract

Background: Home environment, modeling of weight-related behaviors, and general parenting style are very important predictors of obesity in children. The effect of parent engagement in prevention of obesity in children is not clear. The main objective of this systematic review was to address the effects of parent engagement in obesity prevention interventions on anthropometric changes among preschool children.

Methods: PubMed/Medline, Cochrane Library, ISI Web of Knowledge, Scopus, Science Direct, and Google Scholar were searched. Eligible studies were randomized controlled trials in last 10 years (from 2008 until February 14, 2018), which had a parent engagement in obesity prevention interventions (as an intervention) and children's anthropometric indices (as an outcome).

Results: Twenty-six studies were included. Half of studies targeted both parents and children, and the rest targeted only parents. Types of interventions ranged from a simple motivational interviewing to professional skill training approaches. Studies that targeted overweight or obese children in their intervention containing training sessions followed by maintenance for parents and those that focused on individual support for overweight children and their parents, resulted in higher improvement in BMI and other outcomes.

Conclusions: Anthropometric indices and BMI are not appropriate for reflecting the effectiveness of parent engagement in obesity prevention interventions. Having an individual component in the intervention and focusing more on parents vs. children in the intervention may result in improvement in anthropometric outcomes. Focusing on weight-related behaviors as the main outcome in both, children and parents, rather than anthropometric indices, is highly recommended for future reviews.

Keywords: BMI; body weight regulation; childhood obesity; engagement; parent; systematic review

Introduction

Childhood overweight and obesity are associated with a higher risk of developing noncommunicable diseases at a younger age, as well as premature death in adulthood.[1,2] According to UNICEF/WHO/World Bank joint child malnutrition estimates database in 2017, around 5.6% of children are overweight globally, while this prevalence is, respectively, by 3.2%, 5%, and 6.1% in low-, middle-, and high-income countries.[3] The number of overweight children has increased the most in the lower middle-income countries based on financial year 2017 World Bank income classification.[3] Even in developed countries that have a plateau prevalence of overweight and obesity, rates of obesity continue to increase among people of low socioeconomic status, due to growing economic and

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health inequities.[4] Urgent action is required to stop childhood obesity by keeping these facts in mind that childhood obesity persists into adulthood and healthy eating habits, which are established during childhood, persist into adulthood.[5]

According to literature, promising strategies for prevention of childhood obesity are those that include both physical activity and dietary habits, and mainly focus on establishing an encouraging environment in preschool- and school-based settings, which are aligned with home and community components.[6] Therefore, traditional health education cannot overcome the rapid rise of childhood obesity alone and conducting a health promotion approach, which includes active engagement of all target population and stakeholders, is associated with more promising outcomes.[7]

Home environment that contrives a healthy lifestyle (such as availability and accessibility to healthy foods at home) and modeling of weight-related behaviors (such as dietary, activity, sedentary, and sleep habits),[8–12] as well as general parenting style (structured or controlling)[13] are important predictors of child physical activity and eating patterns, and therefore obesity in toddlers and preschool children.[5] Therefore, family-based interventions, which are addressing both general and health-related parenting behaviors and strengthening parental impact, are key approaches for prevention and management of childhood overweight and obesity, as well as establishment of sustainable healthier eating patterns among children.

Engagement of parents is recognized as the gold standard of prevention and treatment of obesity.[14,15] Intervention studies, which have a parental engagement component, have addressed a wide range of psychological, behavioral, and anthropometric indices of both children and parents, as well as feasibility, acceptability, and sustainability of interventions. The latest systematic review, which was published in 2015,[15] focused on dietary habits and physical activity as main outcomes. In this review, we have targeted anthropometric changes as outcome and we have selected wider and more comprehensive keywords for search. Finding the best type of parent education as well as the most effective duration of intervention and follow-up is necessary for designing programs by policy makers. The main objective of this systematic review was to address the effects of obesity prevention studies, which were designed for parents or had a parental engagement component on anthropometric changes (as the main outcome) among preschool children.

Materials and Methods

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement guidelines for this systematic review.[16]

Search Strategy

Multiple databases, including PubMed/Medline, the Cochrane Library, ISI Web of Knowledge, Scopus, Science Direct, and Google Scholar, as well as gray literature in the Cochrane Handbook, The Grey Literature Report, and Open Grey were searched for original articles. The search strategy was adapted for each database as needed. The main key words were as follows: ''childhood obesity'' or ''pediatric obesity'' or ''children obesity'' or ''BMI'' combined with ''parental education'' or ''parental involvement'' or ''parental empowerment'' or ''parental engagement''(Appendix). Mentioned databases were searched to find out all randomized controlled trials (RCTs) with parental engagement as an exposure and children's anthropometric indices as an outcome, which have been published in last 10 years (from 2008 until February 14, 2018). Only articles that have been published in English were entered. Reference list of all systematic reviews that have been published in the last 3 years was also searched manually.

Selection Criteria (Inclusion and Exclusion Criteria)

Inclusion criteria were as follows: all RCTs published in English, which assessed the effect of parent engagement (intervention) on BMI (the main outcome of interest) and other anthropometric indices of preschool children (population), such as BMI percentile, BMI z-score, weight, height, waist circumference, and waist-by-height ratio. All RCT studies that included preschool children (2–6-year-old children) entered in this review provided that the specific outcome of interest was reported separately for this age group. Conference articles, book chapters, reviews, and all kinds of studies (other than RCT) were excluded. Duplicate studies were also removed by title and abstract screening (Fig. 1).

Data Extraction

Two reviewers (A.M. and M.E.) independently extracted the required data. First author's name, publication year, country, population, intervention and control type, sample size in each group, outcome of interest, duration of follow-up, and final results were excluded. Due to broad type of intervention, meta-analysis was not conducted.

Quality Assessment

The quality of included studies was assessed using Jadad scale.[17,18] It contains three main questions about randomization, blinding, and dropouts. The score range is 0 to 5, in which 0 refers to the study without any description about the mentioned three topics. Score 5 belongs to the study with complete and precise description about randomization, double blinding, and dropouts. Minimum score of three means the appropriate quality.[18] Quality assessment was done by two authors separately (M.K. and M.E.) and any disagreement was solved by consensus.

Results

Focusing on anthropometric indices for evaluating the effectiveness of obesity prevention, intervention studies result in varieties of findings that make the conclusion

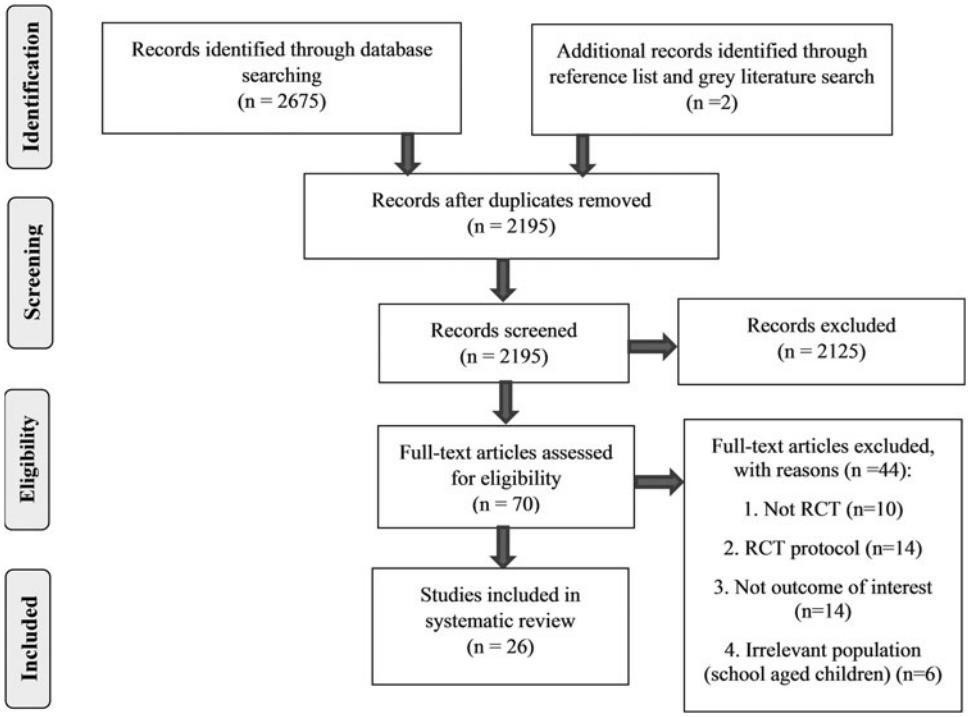

Figure 1. PRISMA flow chart for selection of studies. RCT, Randomized Controlled Trial.

difficult. Types of interventions, main findings regarding anthropometric changes, and sustainability of the results were diverse and different.

Summary of Searches

By searching the above-mentioned databases, we initially found 2677 articles. Around 2195 remained after removing duplicate publications. Two authors (A.M. and M.E.) independently screened the titles and abstracts and 2125 articles were excluded due to irrelevant topic and non-RCT studies. The full texts of the remaining 70 articles were reviewed in depth. We found 10 non-RCT studies (including 2 review articles, 2 quasi-experimental, and 6 before-after trials) and excluded them. Other 34 articles were also excluded due to reporting only RCT protocol ($n = 14$), not reporting anthropometric indices as the outcome of interest ($n = 14$), and studies about inappropriate population such as school-aged children ($n = 6$) (Fig. 1). Finally, 26 articles were included in this systematic review.

Risk of Bias Assessment

In most of the studies, participants could not be blinded according to the nature of interventions (parent engagement). Therefore, we considered an article as ''double blind'' if two of the assessors, data collectors or analyzers, were blind. Most of the included studies had appropriate quality according to Jadad scoring. Only seven studies had low quality. There were inadequate descriptions about randomization method in these studies.[15,19–24] Quality of articles is shown in detail in Table 1.

Characteristics of the Included Studies

Table 2 shows the characteristics of included studies; 15 out of 26 (57%) studies were conducted in the United States. Other reports were from Australia (4 studies), Sweden (3 studies), Canada (2 studies), and Germany (2 studies). There were no studies from Asian and African countries.

There are varieties of methods to engage parents in a weight-related education strategy. In 13 studies, target population for intervention was both parents and children.[19,21,23,25–34] Among these studies, only four had significant improvement in the main outcome. Other 11 studies targeted only parents and the remaining 2 articles focused on both parents and educators.[20,35] Furthermore, it was found that 6 out of 12 studies with significant improvement in anthropometric indices only focused on parents.[20,22–25,30,31,35–39] It seems that intervention on parents and educators had better effects on anthropometric indices than interfering directly on children. We also categorized the studies into two main categories: studies of obesity treatment and studies of obesity prevention. We found that 13 studies had treatment component and the same amount focused on prevention.

The age range of children was 2–18 years, whose parents were included in the studies. However, all the studies comprised the preschool age and presented the outcomes separately in each age group. The reported results in this review are related to the target preschool age.

Similar to type of intervention and age range, variety exists in outcome measurements as well. Most of studies

Table 1. Quality Assessment of the Included Studies Using the Jadad Scale

First author	Was the study described as randomized?[a]	Was the study described as a double blind?[a]	Was there a description of withdrawal and dropouts?[a]	The randomization scheme described and appropriate[a]	The method of double blinding described and appropriate[a]	The randomization scheme described and inappropriate[b]	The method of double blinding described and inappropriate[b]	Total score
Stark[25]	1	—	1	1	—	—	—	3
Wald[24]	1	—	1	—	—	—	—	2
Taveras[40]	1	1	1	1	1	—	—	5
Nystrom[44]	1	—	1	1	—	—	—	3
Lumeng[26]	1	1	1	1	1	—	—	5
Skouteris[27]	1	—	1	1	—	—	—	3
Nyberg[34]	1	—	1	—	—	—	—	2
Hart[41]	1	—	1	1	—	—	—	3
Haines[28]	1	—	1	1	—	—	—	3
French[21]	1	—	—	—	—	—	—	1
Foster[43]	1	—	1	1	—	—	—	3
Davis[29]	1	—	1	1	—	—	—	3
Walton[42]	1	—	1	1	—	—	—	3
Taylor[39]	1	—	1	1	—	—	—	3
Nyberg[23]	1	—	1	1	—	—	—	3
Stark[30]	1	—	1	1	—	—	—	3
Small[22]	1	—	1	—	—	—	—	2
Natale[19]	1	—	—	—	—	—	—	1
Markert[35]	1	—	1	1	—	—	—	3
Haines[38]	1	—	1	1	—	—	—	3
Quattrin[37]	1	—	1	1	—	—	—	3
Barkin[31]	1	—	1	1	—	—	—	3
West[36]	1	—	1	1	—	—	—	3
Okely[32]	1	—	1	1	—	—	—	3
Klein[20]	1	—	—	—	—	—	—	1
Davis[33]	1	—	1	—	—	—	—	2

[a]Yes: +1; no: 0.

[b]Yes: −1; no: 0.

focused mainly on children outcomes, while some others evaluated parental measures as well.[24,26,28,30,34,36,38,40–42] A number of studies have exclusively selected the overweight or obese children and their parents for intervention,[21,24,25,29,30,32,35–37,39,40,43] and the rest have targeted all children, regardless of their current weight or BMI. Seven out of 12 studies that targeted overweight or obese children in their intervention resulted in higher improvement in outcomes (especially anthropometric outcomes).[24,25,30,35–37,39] The duration of interventions ranged between 6 and 24 months. Among those studies that had a follow-up component, it ranged between 6 weeks[41] and 12 months.[24,27,32,36] Duration of intervention was less than 6 months in most of the studies,[19–23,25–32,34,36–38,41–43] and only six studies had intervention duration of 12 months or more.[24,33,35,39,40,44] Improvement in anthropometric indices was seen in 3 out of 6 studies with intervention period of 12 months and more.[24,35,39] This result was seen in 9 out of 20 studies with equal or less than 6-month intervention period.[20,22,23,25,30,31,36–38] It seems that there is no remarkable difference between the duration of intervention and anthropometric outcomes.

Table 2. Characteristics of the Included Studies

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Stark et al.[25]	US	Parents and their 2–5-year-old children, above 95% for BMI	$N=151$, 3 groups ($N=47$ in LAUNCH; $N=50$ in motivational interviewing, $N=54$ in standard care)	T	LAUNCH (18-session clinic and home-based behavioral intervention) for parents, consisting 3-months intensive treatment and 3-month maintenance treatment, as well as simultaneous child group education about healthy eating, opportunities for PA, and exposure to a variety of fruits and vegetables	(A) Motivational interviewing (18-session parent-only intervention) (B) Standard Care (informed caregivers of their child's weight status. Neither the children nor caregivers received any treatment)	(1) BMIz (2) BMI percentile (3) Percent over the 50th percentile BMI	—	—	(1) Significant greater decrease in LAUNCH participants compared with A ($p<0.001$) and B ($p<0.004$); (2) Change of −2 percentile points for LAUNCH, −0.21 for A, and −0.77 for B; (3) A decrease of −4.45% in LAUNCH, increases of 2.43% and 1.45% in A and B, respectively.
Wald et al.[24]	US	Parents of children with BMI ≥85th, 3–7 years who were seen for a health visit in the last 6 months	$N=73$ child-parent dyads, 2 groups ($N=38$ in intervention; $N=35$ in control)	T	6 in-person group sessions and a customized website over 12 months	Customary care	(1) BMI z-scores	(2) Healthy behavior changes (3) Increased parent self-efficacy (4) Feasibility of the intervention to promote healthy behavior change measured by attendance	12 months	(1) Larger decrease in IG ($p=0.02$); (2) Percent of children who reduced their screen time by ≥15% did not differ significantly between two groups (27% vs. 31%, $p=1.00$); (3) Parental sense of competency did not differ significantly between two groups ($p=0.82$); (4) Participation did not meet the hypothesized level of 70% at any visit. Rates of attendance were 66%, 71%, 63%, and 46%, for visits at 3, 6, 9, and 12 months. respectively.
Taveras et al.[40]	US	Parents of children with BMI ≥85th, 2–12 years	$N=721$, 2 groups ($N=320$ in intervention; $N=321$ in control)	T	Enhanced primary care plus tailored individual health coaching (twice-weekly text messages and telephone or video contacts every other month) for 1 year	Enhanced primary care	(1) One-year changes in age- and sex-specific BMI z-score	(2) Child health-related QoL (3) Parental resource empowerment	—	(1) Slightly more improvement in IG ($p=0.39$); (2) Significant improvements in IG (no significant differences between two groups); (3) Increased in both groups (no statistically significant differences between two groups).
Nystrom et al.[44]	Sweden	Parents of healthy 4-year-old children	$N=315$, 2 groups ($N=156$ in intervention; $N=159$ in control)	P	mHealth program (MINISTOP extensive program of information and support and behavior change techniques, through a smartphone in 12 themes) during 6 months	Pamphlet on healthy eating and physical activity in preschool-aged children	(1) Weight and height (z-score)	(2) Intakes of fruits, vegetables, candy, and sweetened beverages (3) Physical activity and sedentary behavior (4) Fat mass index	6 months	(1) No statistically significant between two groups ($p=0.92$); (2–4) Decrease in the mean intake of sweetened beverages in the IG ($p=0.049$). No differences in other food intakes and sedentary time; Children in IG had higher odds of increasing the composite score for six dietary or activity behaviors (excluding FMI) (OR: 1.99; $p=0.008$).

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Lumeng et al.[26]	US	Parents and their 3–5-year-old children	$N=697$, 3 groups ($N=218$ in HS; $N=224$ in HS+POPS; $N=255$ in HS+POPS+IYS)	P	(A) HS+POPS+IYS (6 months) (B) HS+POPS (3 months)	(C) HS classrooms	(1) BMI and child BMI z-score	(2) Child self-regulation (3) Dietary intake, outdoor play, screen time (4) Parent nutrition knowledge and nutrition self-efficacy	6 months	(1) 2.1% reduction in obesity prevalence in A, 2.9% reduction in B, 0.8% increase in C (not significant); (2) Greater improvement in child teacher-reported self-regulation in A compared with others ($p<0.001$); (3) A resulted in greater decline in consumption of SSB than HS (no more effect of A and B on any secondary outcomes).
Skouteris et al.[27]	Australia	Parents and their 20–42-month child	$N=201$, 2 groups ($N=104$ in intervention; $N=97$ in control)	P	10 weekly 90-minute workshops relating to nutrition, physical activity, parenting, and lifestyle behaviors for parents	No intervention	(1) Child BMI z-score	(2) Physical activity and sedentary behaviors (3) Child food neophobia (4) Child daily dietary intake (5) Child eating habits	12 months	(1, 2) No significant differences between two groups; (3) Lower food neophobia in the IG at Time 2 ($p=0.05$) and Time 4 ($p=0.03$); (4, 5) Significant group differences for intake of vegetables (on the servings "yesterday" variable, $p=0.01$), high-energy snack foods ($p=0.03$), and satiety responsiveness ($p=0.047$), but not for any other dietary behavior or eating habits; At 12-month follow-up, intervention children exhibited less neophobia than controls ($p=0.03$)
Nyberg et al.[34]	Sweden	Parents and their 6-year-old children	$N=243$, 2 groups ($N=131$ in intervention; $N=112$ in control)	P	6-month intervention, including (a) Health information for parents, (b) Motivational Interviewing with parents, and (c) Teacher-led classroom activities with children	Routine programs	(1) Weight, height, BMI (2) Prevalence of underweight, normal weight, overweight, and obesity	(2) Physical activity (3) Health behavior (4) Parental self-efficacy	6 months	(1) No significant differences between two groups; (2) No significant differences between two groups; (3) At time 2 (directly after intervention), there was a significantly higher number of "servings of vegetables usually eaten each day" in the IG compared to the CG ($p=0.003$), but at time 3 (after follow-up), there was no difference; (4) No differences between two groups.

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Hart et al.[41]	Australia	Parents of 2–6-year-old children	*N*=372, 4 groups (*N* in A=97; *N* in B=113; *N* in C=91; *N* in D=84)	P	(A) CBCC resource pack and a 2-hour session workshop (B) CBCC resource pack only (C) Nutrition-only resource	(D) No interventions	(1) Child BMIz, (2) Parent BMI and weight status	(3) Parenting variables relevant to child body image and eating patterns (4) Evaluation questions	6 weeks	(1) Slight decrease in A and B, slight increase in C and D; no significant differences between groups at 6 weeks ($p=0.27$); (2) NA; (3) Significant differences between groups at 6 weeks on Knowledge Test BEC, Parenting Intentions BEC, four of the six parental feeding practices (instrumental feeding, emotional feeding, pushing to eat, and weight restriction); Three of four family meal time scales showed no difference (atmosphere, schedules, frequency); The television item demonstrated a significant difference between groups; (4) Reading the resource in C was significantly higher than A and B, and reading in B was higher than A.
Haines et al.[28]	Canada	Parents and their 2–5-year-old children	*N*=112 families, 2 groups (*N*=56 in intervention and 56 in control)	P	9 weekly (1) group parenting sessions, (2) children's sessions, and (3) homework assignments	Publically available educational materials on promoting healthful behaviors among preschoolers were mailed weekly for 9 weeks	(1) Children's weight and height	(2) Parenting skills (3) Feeding behaviors (4) Children's weight-related behaviors	9 months	(1) BMI decreased in both groups. After adjusting for age and sex, the difference was minimally changed ($p=0.41$); (2) Parents in both groups experienced similar mean changes in parental confidence (self-efficacy) and in level of parental warmth; (3) Reduction in use of restrictive feeding behaviors in IG; (4) No statistically significant difference between two groups. They were in the desired direction at 9-month follow-up.
French et al.[21]	US	Parents and their 5–12-year-old children (BMI >85%)	*N*=40, 2 groups (*N*=25 in intervention; *N*=15 in control)	T	6 month noncaloric beverage delivery and television locking devices, followed by 5 monthly telephone calls	No interventions	(1) BMI z-score	(2) TV viewing (3) Sugar sweetened beverage intake	5 months	(1) No significant effects between two groups at 6 months; (2) Decreased significantly at follow-up ($p<0.01$); (3) Marginally significantly decreased in IG ($p<0.09$).

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Foster et al.[43]	US	Parents of 2–5-year-old obese children (BMI >95%)	$N=60$, 2 groups ($N=30$ in intervention; $N=30$ in control)	T	6-month parent mentor intervention (Mentor coaching, monthly phone calls, and monthly community meetings)	Community health worker (not received any home visits or follow-up phone calls)	(1) BMI z-score change	(2) Sleep (3) Dietary intake	6 months	(1) No difference in mean change between two groups; significant reduction in each group; (2) No differences between groups; significant increase from baseline to 6 months ($p=0.04$), then a decrease from 6 to 12 months ($p=0.002$), resulting in overall no difference between baseline and 12 months; (3) Significant reduction in sugary beverage intake overall at 6 months, not by group ($p=0.96$), with significance occurring between baseline and end of intervention ($p=0.001$), sustained with no change at 12 months (no changes in vegetable or grain intake).
Davis et al.[29]	US	Parents and their 2–18-year-old children (BMI >85%)	$N=96$, 2 groups ($N=54$ in intervention; $N=42$ in control)	T	*Healthy Hawks* Super Intervention (12 consecutive weekly sessions, each lasting 2 hours) Children joined a class of their peers; Each session introduced a new behavioral topic	Weekly exercise forum (not received the *Healthy Hawks* Super intervention)	(1) Parent BMI, (2) Child BMI z-score	(3) Child diet (4) Child physical activity	—	(1) No group×time interaction was found ($p=0.42$); (2) No group×time interaction was found ($p=0.3$); (3) No group×time interactions were found; (4) No group×time interactions were found ($p=0.73$).
Walton et al.[42]	Canada	Parents of 2–5-year-old children	$N=54$ parent-child dyads, 2 groups ($N=29$ in intervention; $N=25$ in control)	P	9 week PTT (a family-based obesity prevention intervention that embeds strategies to improve preschoolers' nutrition and physical activity behaviors within an existing, empirically tested general parenting program)	Attention-matched control: SHS (Supervising for Home Safety) program is a 9-week group-based program focusing on child injury prevention	(1) Child's BMI	(2) Feasibility and acceptability of PTT within the Canadian context (3) Comparing parenting (4) Child health behaviors	9 months	(1) No significant difference between groups; (2) Completion rate for the evaluation was also high, supporting the feasibility of the evaluation procedure; (3) PTT parents reported less parental stress at postintervention ($p=0.001$); more self-efficacy in managing their child when the child's behavior became aggressive ($p=0.003$); greater parental warmth at postintervention ($p=0.01$); larger decrease in their use of food as reward ($p=0.01$); No effect on parental ability to follow through on discipline or for self-efficacy; 4) No effect on hours of child sleep/night or SSB consumption.

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Taylor et al.[39]	US	Families of 4–8 overweight and obese children (BMI ≥85th percentile)	$N=271$, 2 groups ($N=104$ in intervention; $N=102$ in control)	T	TP: single multidisciplinary session to develop specific goals suitable for each family, then met with a mentor each month for 12 months, and every third month for another 12 months	UC: personalized feedback and generalized advice regarding healthy lifestyles at baseline and 6 months	(1) Anthropometry	(2) Dietary intake (3) Accelerometry (4) Questionnaire on QoL, child's behavior	—	(1) BMI, BMI z-score and waist circumference at 24 months were significantly lower in TP; (2) TP children consumed more fruit and vegetables ($p=0.03$) and fewer noncore foods ($p=0.02$); (3) TP children were more physically active ($p=0.03$); No differences in parental feeding practices, QoL, child sleep, or behavior.
Nyberg et al.[23]	Sweden	Parents and their 6-year-old preschoolers	$N=378$, 2 groups ($N=185$ in intervention; $N=193$ in control)	P	6-month intervention included (1) Health information for parents (2) Motivational Interviewing with parents (3) Teacher-led classroom activities with children	—	(1) Anthropometry	(2) Dietary habits (3) Physical activity habits	5 months	(1) No significant intervention effect was detected for BMI SDS at T2 (after intervention) or T3 (5 months after intervention). Children in the IG had significantly lower BMI SDS at T2 ($p=0.03$) compared to obese children in CG; (2) Significant intervention effects were found regarding consumption of unhealthy foods ($p=0.01$) and unhealthy drinks ($p=0.01$). The effect on intake of unhealthy foods was sustained for boys ($p=0.03$); (3) No significant intervention effect was detected on any of the measurements of physical activity at T2. At T3, IG was sedentary, less during entire week and weekend ($p<0.05$).
Stark et al.[30]	US	Parents and their 2–5-year-old children with BMI percentile of >95	$N=42$, 3 groups ($N=15$ in LAUNCH-HV; $N=14$ in LAUNCH; $N=13$ in PC)	T	(A) LAUNCH-HV (home visit) (Clinic- and Home-Based Behavioral Intervention: Stage 3 obesity intervention criteria): 18 sessions consisting two phases of intensive (12 weekly sessions alternating between group-based clinic sessions (parent and child concurrent groups) and individual home visit); and maintenance (B) LAUNCH (Clinic-Based Intervention without home visit: exceeding Stage 3	Stage 1 intervention: PC: one 45-minute visit to explain BMI and BMI percentiles, and to review the child's growth chart	(1) Child and parent weight and height	(2) Children's dietary intake, Home food environment, children's physical activity, parenting styles and dimensions, child feeding habits	6 months	(1) LAUNCH-HV demonstrated a significantly greater decrease on the BMI z-score pre- to post-treatment compared with PC ($p=0.007$), whereas LAUNCH-clinic was not significantly different from PC ($p=0.08$); (2) Similar results were found for other outcomes; BMIz continued to be significantly lower at month 12 for LAUNCH-HV compared with PC.

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Small et al.[22]	US	Parents of 4–8-year-old children (overweight/ obese preschool/ early school aged)	$N=67$, 2 groups ($N=34$ in intervention; $N=33$ in control)	T	4 intervention sessions (separated by 4–6 weeks): educational information about establishment of healthy habits in children, nutrition, increasing physical activity and decreasing sedentary time, and age-specific information regarding the child's behavior in response to change	4 sessions: age-appropriate, evidence-based health and safety information (e.g., care for thermal injuries, first-aid care, and care for insect bites and stings)	Child waist, waist-by-height ratio, BMI) immediately, 3 months, and 6 months after the intervention	—	3 months	Reduction in waist circumference and waist-by-height ratio immediately after the intervention in IG that persisted for 3 and 6 months. BMI and BMI percentile were not differentially affected.
Natale et al.[19]	US	Parents and their 2–5-year multiethnic children	$N=307$, 2 groups ($N=238$ in intervention; $N=69$ in control)	P	6-month intervention: multidimensional approach with a child care teacher-based component, a family-based component, and environmental changes	Attention control program	(1) Height and weight at baseline and at 3, 6, and 12 months	(2) Nutrition data	6 months	(1) Mean BMI z-score increased in both groups, but less in the IG (not significant). As parents carried out the intervention at home, BMI significantly decreased among children ($p<0.001$); (2) IG children consumed less junk food, ate more fresh fruits and vegetables, drank less juice, and drank more 1% milk compared to children at control sites at 6 months.
Markert et al.[35]	Germany	Parents or caregivers of 4–17-year-old children (BMI >90%)	$N=289$, 2 groups ($N=145$ in intervention; $N=144$ in control)	T	Computer-aided telephone counseling for 1 year, supported by mailed newsletters (14 obligatory telephone calls every 3–4 weeks) and 2 optional coaching telephone sessions for parents at the end of the intervention	—	(1) Change in BMI-SDS	(2) Eating behavior, physical activity, media consumption, QoL	—	(1) Mean change was significant between two groups (by PPS) and not significant (by FAS); 2) Scores for eating patterns ($p=0.01$), media consumption ($p=0.007$), physical activity ($p=9\times10^{-9}$), QoL ($p=5\times10^{-8}$) decreased with age, independent of group or change in BMI-SDS.
Haines et al.[38]	US	Parents of children 2–5 years of age, who had a television (TV) in the room where he or she slept	$N=121$, 2 groups ($N=62$ in intervention; $N=59$ in control)	P	6-month intervention consistsof (1) motivational coaching at home and by phone, (2) mailed educational materials, and (3) text messages	Mailed materials focused on child development	(1) Change in age- and sex-adjusted BMI	(2) Parent report of frequency of family meals (times/week) (3) Presence of TV in room where child slept (baseline to 6 months) (4) Child sleep duration (hours/ day) (5) Child weekday and weekend day TV viewing (hours/ day)	—	(1) BMI decreased in the IG and increased in the CG ($p=0.05$); (2, 3) No significant intervention effect; (4) Increased in the IG and decreased in CG ($p=0.03$); (5) Larger decreases in weekend TV viewing; among children in the IG compared with the CG ($p=0.02$); Weekday TV viewing also decreased more among children in the IG (not significant).

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Quattrin et al.[37]	US	Parents with BMI ≥27 who have 2–5-year children with BMI ≥85%)	*N*=105, 2 groups (*N*=52 in intervention; *N*=53 in control)	T	Dietary and physical/ sedentary activity education to parents over 6 months (10 group meetings and 8 calls)+behavioral modification	Dietary and physical/ sedentary activity education to parents over 6 months (10 group meetings and 8 calls), without behavioral modification	Changes in child percent over BMI (%OBMI) and z-BMI	—	—	IG had greater %OBMI and z-BMI decreases at 3 and 6 months compared with CG ($p=0.002$); A greater BMI reduction over time was in parents in IG ($p<0.001$); Child %OBMI and parent BMI changes were correlated ($r=0.31$; $p=0.003$); Children with greater baseline %OBMI were more likely to have a greater %OBMI decrease over time ($p=0.02$).
Barkin et al.[31]	US	Parent and their 2–6-year-old children	*N*=106, 2 groups (*N*=54 in intervention; *N*=52 in control)	P	12 weekly 90-minute skills-building sessions for parents and preschool-aged children to improve nutritional family habits, increase physical activity, and decrease media use	A brief school readiness program	Height, weight, BMI	—	3 months	Controlling for child age, gender, and baseline BMI, the effect of the treatment condition on postintervention absolute BMI was statistically significant ($p<0.001$); The intervention effect was strongest for obese children.
West et al.[36]	Australia	Parents of overweight and obese 4-11-year-old children	*N*=101, 2 groups (*N*=52 in intervention; *N*=49 in control)	T	Group Lifestyle Triple P 12-week intervention consists of nine 90-minute group sessions and three 20-minute telephone sessions. All sessions used an active skills training process within a self-regulation framework. Each parent received a workbook summarizing the session content	Waitlist control	(1) Child BMI z score	(2) Weight-related problem behavior (3) Parenting self-efficacy (4) Ineffective parenting	12 months	(1) Significant decrease; (2, 4) Decreased; (3) Increased; 25%–35% of families in IG showed reliable positive changes compared to less than 9% of families in CG.
Okely et al.[32]	Australia	Parents and their overweight/ obese 5.5- to 9.9- year-old children	*N*=165, 3 groups (*N*=60 in A; *N*=42 in B; *N*=63 in C)	T	(A) Combination of Diet+Activity. All groups received 10 weekly face-to-face sessions followed by 3 monthly relapse-prevention phone calls	(B) Parent-centered dietary program (Diet) (C) Child-centered physical activity program (Activity) All groups received 10 weekly face-to-face sessions followed by 3 monthly relapse-prevention phone calls	(1) Change in BMI z-score and waist circumference	(2) Metabolic profiles (3) Blood pressure	12 months	(1) All three groups reduced their BMI z-score and waist circumference z-score at 6 months, and reductions were maintained at 12 months. B and A group had a greater reduction in BMI z-score; (2) No differences between groups at 6 or 12 months; (3) Compared with those in A group, C group had a greater reduction in systolic BP at 12 months, and B group had a smaller decrease in insulin at 6 months (not maintained at 12 months).

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Table 2. Characteristics of the Included Studies *continued*

Authors, Year	Country	Population	Sample size, No. of groups	Study group[a]	Type of intervention	Type of control	Anthropometric outcome	Other outcomes	Duration of follow up	Result
Klein et al.[20]	Germany	Parents and educators of children from kindergartens	$N=1050$, 2 groups ($N=688$ in intervention; $N=362$ in control)	P	A standardized information meeting for parents and educators concerning test results, major evidence-based key guidelines of a healthy lifestyle, and its importance for the development of children (6 months)	No intervention	(1) BMI	(2) Motor abilities	—	(1) Decrease in the IG occurred only in boys ($p<0.001$); BMI decreased in IG and increased in CG. Differences between IG and CG occurred in overweight and normal-weight boys; (2) Children of both groups achieved significantly better results in the follow-up measurements in all test items ($p<0.001$), except the sit and reach, which significantly improved in IG ($p<0.001$); Children of the CG showed greater improvement in the one leg stand ($p<0.001$); In the other tests, no significant differences could be observed.
Davis et al.[33]	US	Parents and their 3–6-year-old children	$N=20$ centers, 2 groups ($n=8$ in intervention and $n=8$ in control) 945 children in intervention and 871 children in CGs	P	CHILE: Intervention program included a classroom curriculum, teacher and food service training, family engagement, grocery store participation, and health care provider support	No intervention	(1) Weight, height	—	—	(1) Overall BMIz increased from baseline ($p<0.001$) for children with baseline BMI percentile <85%, but did not increase for children with baseline BMI percentile ≥85% ($p=0.57$).

[a]Studies were categorized into two main categories: studies of obesity treatment (T) and studies of obesity prevention (P).

BEC, body image and eating patterns in childhood; BMI SDS, BMI standard deviation score; CBCC, confident body, confident child; CG, control group; FAS, full analysis set; FMI, fat mass index; HS, head start; IG, intervention group; IYS, incredible years series; NA, not assessed; PA, physical activity; PC, pediatrician counseling; POPS, preschool obesity prevention series; PPS, per protocol set; PTT, parents and tots together; QoL, quality of life; SSB, sugar-sweetened beverage; TP, tailored package; UC, usual care.

There were large varieties in type of interventions, ranging from a simple motivational interviewing to professional skill training approaches. Training materials were also different, which contained mobile text messaging or email or website, group workshops or individual training sessions, as well as counseling and behavioral modification. Studies that had simultaneous intervention for children were also various in both strategy and material, ranging from teacher-led classroom activities and homework assignments[23,28,34] to noncaloric beverage delivery and television locking devices.[21]

Effects of interventions are very diverse. Generally, those studies that include training sessions continued with maintenance, and those that include individual support for overweight or obese participants led to better outcome. Fourteen studies included individual component in their intervention (such as motivational interview, text messages, and telephone contact).[21,23,25,30,32,34–40,43,44] These studies showed better results in anthropometric outcomes compared to those without individual components.

By dividing the results into two groups of treatment and prevention approaches, we found that the only prevention approach, which had significant effect on anthropometric indices, was intervention that consists of motivational coaching at home and by phone, mailed educational materials, and text messages. More information is shown in Table 3.

Discussion

This systematic review gathers all RCTs during the last 10 years (2008–2018), which have included a parent engagement component in the intervention to primarily or secondarily prevent overweight and obesity among preschool children. Current systematic review shows that anthropometric indices, especially BMI as the main index in the field of obesity, are not appropriate for reflecting the effectiveness of parent engagement in obesity prevention interventions. Further to this finding, those studies that contain training sessions followed by maintenance for

Table 3. Summary of Treatment/Prevention Approaches with Their Main Findings

Treatment approaches	Treatment main findings
LAUNCH (clinic- and home-based behavioral intervention)[a] LAUNCH (home visit)[a] LAUNCH (clinic-based behavioral intervention)[b] Group sessions and a customized website[a] Diet+Activity[c] Noncaloric beverage delivery and television locking devices[b] Parent mentor intervention (Mentor coaching)with monthly phone call and meeting[b] Single multidisciplinary session and then met a mentor[a] Educational information about healthy habits and physical activity[b] Computer-aided telephone counseling[c] Group sessions and telephone sessions[a]	[a]Significant and large reduction in BMI [b]No significant or slight reduction in BMI [c]Contradictory/inconsistent results (e.g., significant result in one study and nonsignificant in another, significant reduction by PPS and nonsignificant by FAS, reduction in some anthropometric indices and no change in others)
Prevention approaches	**Prevention main findings**
mHealth program (extensive program of information and behavior change techniques, through a smartphone)[b] HS+POPS (±IYS)[b] Workshops relating to nutrition/physical activity/parenting and lifestyle[b] Intervention including health information/motivational interviewing, teacher-led classroom activities with children[b] CBCC resource pack[b] Group parenting and children's sessions with homework assignments[b] Multidimensional approach with a child care teacher-based component, a family-based component, and environmental changes[c] Intervention consists of motivational coaching at home and by phone, mailed educational materials, and text messages[a] Meetings (sessions) for parents concerning key guidelines of a healthy lifestyle to improve nutritional family habits, increase physical activity, and decrease media use[c] Intervention program included a classroom curriculum, teacher and food service training, family engagement, grocery store participation, and health care provider support[b]	[a]Significant and large reduction in BMI [b]No significant or slight reduction in BMI [c]Contradictory/inconsistent results (e.g., significant result only in boy, reduction in some anthropometric indices, and no change in others)

BMI, body mass index; CBCC, Confident Body, Confident Child; FAS, full analysis set; HS, Head Start; IYS, Incredible Years Series, POPS, Preschool Obesity Prevention Series; PPS, per protocol set.

parents as well as those that focus on individual consultation for overweight children, resulted in more improvement in outcome measures such as weight reduction, increased physical activity level, decreased consumption of sugar-sweetened beverages, and higher consumption of fruit and vegetables.

Authors found that intervention on parents and educators might have better results than intervention on both parents and children. Including children in intervention programs needs to be discussed. According to two systematic reviews, targeting only parents in the treatment of childhood obesity is comparable to interventions that include both, parents and children.[45,46] This is aligned with the current finding. A potential reason to this finding could be related to the age of children. Although the preschool age is shown to be a very important age to target for obesity prevention programs,[5] it is also important to take into account that children do not have an adequate autonomy to choose healthy food in this age. They follow what is available and is provided for them. However, based on current systematic review, among studies that included children in their intervention program through educational sessions or teacher-led classes or home assignments, regarding follow-up results, a higher sustainability and longer maintenance are detected, especially in weight-related behaviors such as physical activity, less sedentary behavior, less food neophobia, less screen time, and milk consumption.

Current review found that training sessions, which have been followed by maintenance for parents and personalized guidance and support for parents and overweight children, might be a key approach that results in better outcomes. There is no doubt that participation of parents is valuable and useful in training purposes of preschoolers. Since eating and activity habits, almost always have an ''at-home'' component, it becomes necessary to engage parents in the establishment of health-related behaviors in children. Targeting individual eating habits, parenting approaches, and offering personalized, brief support along with generalizing clinic-taught behavioral management strategies into the real natural home environment can be effective strategies.[30,39] The main justification to this finding refers to the well-known correlation between parenting approaches and childhood obesity.

Two main approaches have been introduced in general parenting styles, which are ''control'' vs. ''structure.''[47] ''Control'' refers to power-based, compulsive strategies that parents use to manipulate children's behaviors, while ''structure'' is to organize the environment by the use of clear and consistent limits that predict the child's determination.[48] It is well documented that parental ''control'' approaches such as restricting child's food intake is counterproductive and increases the child's temptation to restricted foods, resulting in promotion of long-term dysregulated eating behaviors and obesity.[49–51] Equipping parents with both knowledge and skill of parenting approaches helps them to distinguish between strategies that potentially exacerbate children's unhealthy feeding behaviors from practices that help children for better self-regulatory skills.[47] Poor self-regulation is recognized as a risk factor for the development of obesity in children.[47]

This review reveals that, although the quality of more than 70% of included studies was ''good,'' about half of the studies could not show significant changes in children's BMI. Justification to this finding needs a deeper investigation through both implementation and outcome. It is important to note that although anthropometry—especially BMI—is the most frequent outcome measure in obesity preventive intervention studies,[6] the results of BMI changes are varied among studies. Maybe improvement in anthropometric indices through weight control interventions happens when children become older and develop more autonomy in their weight-related behaviors,[26] or maybe the duration of interventions is not long enough to show impact on BMI, especially in older children. However, this study indicated no remarkable difference between the duration of intervention and anthropometric outcomes, and about 50% of both studies achieved appropriate results in anthropometric indices with long-term (12 months or more) and short-term (6 months or less) interventions.

This review also indicated that those studies that contained personal and individual components (such as telephone or short messages contacts) achieved better results on anthropometric outcomes to some extent. This may reflect the fact that a better understanding of being monitored resulted in more adherence to the intervention and more likely to achieve an appropriate result.

Current results also indicated that the most significant reduction in BMI is mainly found in studies that targeted the overweight or obese children (not the whole population of children). Thus, parents and caregivers can steer the environment toward self-regulatory behaviors in later years. Further point here is that according to the American Academy of Pediatrics guideline, even in children with BMI percentile >95% with no health risk, it is not suggested to decrease weight, while the best approach is weight maintenance.[52] Therefore, changes in BMI cannot truly reflect the efficacy and sustainability of the program, because decreasing weight is not basically the main target in prevention and treatment of childhood obesity. It seems that focusing on improvements that are related to eating behavior, physical activity, and self-regulation in children as well as parenting behavior and home environment might lead to more reliable results and conclusion.

The other potential reason to null results refers to accuracy and validity of implementation. Based on individual-level implementation science model,[53] three stages of ''delivery, receipt, and enactment'' must be reported to not blame on intervention components or materials in unsatisfying outcomes.[54] Thus, it is necessary to make sure that all the three stages of implementation are completely performed through process evaluation for a successful implementation of the training material. Furthermore, engaging parents is better to be aligned with motivation for seeking health information and readiness for change. It is well documented that parents frequently do not even

recognize that their child is overweight or obese.[55,56] Failure to parent engagement and insufficient motivation might reflect an unreal sense of emotional well-being and strong social support, which decreases the motivation of parents for seeking health information.[57]

The main strength of this systematic review is inclusion of RCTs that provide more reliable results. The main limitation of this review was the diversity across the studies in terms of type and duration of interventions, as well as outcome measures that did not allow us to run meta-analyses and have pooled results. Another limitation refers to the lack of follow-up results in about half of reviewed studies, which makes it difficult to evaluate the sustainability and long-term effects of interventions, rather than their temporary results.

Conclusions

Anthropometric indices, especially BMI as the main index in the field of obesity, are not appropriate for reflecting the effectiveness of parent engagement in obesity prevention interventions and they are not suggested to be considered the main or primary outcome; however, studies that targeted overweight and obese children in their intervention resulted in a higher improvement in BMI. Studies that contain training sessions followed by maintenance for parents, as well as those that focus on individual support for overweight children and their parents, result in more improvement in outcomes. Authors found some differences in the results of interventions that engage only parents vs. those that include both parents and their children. For future reviews, focusing on improvements is highly recommended in weight-related behaviors as the main outcome in children and parents, rather than anthropometric indices.

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Authors' Contributions

A.M. and M.E. searched databases, extracted data, and wrote the draft of the article. M.N. designed the study and collaborated in final review and approval of the draft. H.V. participated in search strategy and structure of the review, English edition, and critical review of the draft. M.K. and M.E. assessed the quality of the included articles.

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Appendix

For example, in PubMed/Medline database, we found 341 articles using (''childhood obesity'' or ''children obesity'' or ''preschool obesity'' or ''pediatric obesity'' or BMI) and (''parental education'' or ''parental empowerment'' or ''parental involvement'' or ''parental engagement'') during 2008–2018. In Cochrane and ISI databases after limiting the search engine to English articles (excluding review articles) between 2008 and 2018, we found 87 and 330 articles, respectively. Search with adapted combinations of the mentioned key words in Scopus, Science Direct, and Google Scholar resulted in 919, 791, and 107 articles, respectively.