Preventing obesity in pre-school children: a literature review

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ABSTRACT

Background Obesity in children is increasing worldwide, impacting on both long- and short-term health. Obesity prevention is an important contemporary public health priority and is firmly on the Government's agenda in the UK. Prevention involves addressing the main risk factors of diet and physical inactivity and also involves a wide range of environmental factors including access to sport and leisure, family life, diet, education and information.

Methods A literature review undertaken on preventing obesity in children aged <5.

Results The review confirms that there is a limited and immature evidence and lack of comprehensive evidence on effective strategies to prevent obesity in younger children. The overall quality of studies is poor.

Conclusions The need remains for structured, focused and systematic research on child obesity prevention. Well-designed studies examining a range of interventions remain a priority. The findings in this review support the recommendations in the National Institute for Health and Clinical Excellence (NICE) guidelines on obesity.

Keywords childhood obesity

Introduction

Child obesity will continue to be a problem without improved understanding of key factors operative during early childhood and identification of effective interventions. The UK Government has responded to rising childhood obesity with a Public Service Agreement target to ‘halt the year on year rise in obesity among children aged under 11 by 2010’.2

Primary Care Trusts (PCTs) now measure primary school children in the reception year (age, 4–5 years) and year 6 (age, 10–11 years).3 Many Local Authorities (LAs) have incorporated targets to reduce childhood obesity into Local Area Agreements.4

Strategic Health Authorities (SHAs), PCTs and LAs are expected to use the best available evidence in establishing plans to tackle child obesity.5 The Wanless Report identified that the evidence base was particularly weak on interventions to reduce health inequalities due to obesity.6 The recent NICE guidance reinforces that ‘for children and young people, it is accepted that the evidence base is far from complete’.7

At regional and local level, further information is needed on effective interventions. This review of the prevention of obesity in pre-school children has been conducted to inform such policy.

Methods

A broad scoping search was undertaken to identify key terms, to assess the breadth and depth of the literature and to establish a broad structure for the review. The search strategy was refined and candidate studies identified by searching PubMed (restricted to reviews), Cochrane and the Department of Health (DH) library catalogue. Inclusion criteria were obesity defined by body mass index (BMI), weight-for-height index and/or skinfold thickness, <5 years, some form of intervention and some assessment of effectiveness. Drug therapy was excluded and searches were restricted to English language. Titles and abstracts were assessed for relevance and where abstracts were unavailable and/or the relevance of the paper uncertain from the title, the full paper was obtained. Further candidate articles were identified from citations and review articles that specifically
addressed obesity prevention in pre-school children. Assessment of studies was undertaken with an academic colleague from the University of Birmingham with experience in systematic reviewing.

Given the relatively underdeveloped field of work, with a small crop of peer reviewed papers, Internet searches using the ‘Google’ search engine were undertaken using the term ‘Interventions Preventing Obesity in Preschool Children’. There were 35 100 hits. Following discussions with West Midlands Health Technology Assessment Collaboration, a pragmatic approach was adopted and the first 200 results reviewed.

A data extraction form was developed by the author and was applied to all included papers. Data extracted included the objective and type of study, the setting, sample, intervention undertaken, measures used to evaluate impact, results and the author’s comments on the studies. The types of studies ranged from simple observational methods to higher order studies—one randomized control trial (RCT) and two cohort studies.

Results and review of papers

The literature search identified 832 papers. Six papers met the inclusion criteria (Fig. 1). Excluded papers after full review and reasons for rejection are available from the author.

The interventions identified in included papers were grouped around themes developed from the scoping search viz breastfeeding,8 physical activity,9,10 family-based interventions11,12 and professional support.13 Characteristics of the included studies are given in Table 1. The quality of each study was assessed in terms of study design including subject numbers, randomization, control for confounding and minimization of bias.

Armstrong and Reilly8 tested the hypothesis that breastfeeding is associated with a reduced risk of child obesity in a large, well-conducted cohort study in Scotland, using a population-based sample of 32 000 children. The authors examined the health records of children born in 1995 and 1996 who had undergone routine health screenings as part of the ‘Child Health Surveillance Programme’. During a screening at 6–8 weeks, the health worker asked the mother whether the baby was breastfed only, formula-fed only or fed both breast milk and formula. During a similar screening at 39–42 months, the health worker measured the child’s height and weight and calculated the BMI. The prevalence of obesity was significantly lower among breastfed children compared with formula-fed children. This association persisted after adjustment for deprivation, birth weight and sex. The adjusted odds ratio (OR) for obesity was 0.70 (95% CI, 0.61–0.80). The findings suggest that breastfeeding is associated with a modest, but significant, reduction in childhood obesity risk. The authors also suggest that the reduction in risk is present in early childhood. There are limitations to the study given lack of information on other risk factors for obesity, including diet (once children began eating food), parental weight and physical activity.

Mo-suwan et al.9 evaluated the effect of a school-based aerobic exercise programme on the obesity indexes of pre-school children in Thailand in a RCT. A total of 292 second-year elementary school pupils from two nursery

![Fig. 1 Schematic of literature survey.](image-url)
schools were included: 147 (34 from school 1 and 113 from school 2) in the exercise group and 145 (45 from school 1 and 100 from school 2) in the control group. The mean age of the children was 4.5 years. Trained staff encouraged children in the exercise group to take part in a specially designed 30-week exercise programme. One school provided extra swimming for 1 h a week. Weight, height and triceps skinfold (TSF) thickness were measured four times throughout the study. Prevalence of obesity in both the exercise and control groups decreased. The exercise group decreased from 12.2% at baseline to 8.8% (Wilcoxon signed-rank test, \(P = 0.058\)), whereas the control group decreased from 11.7 to 9.7% (Wilcoxon signed-rank test, \(P = 0.179\)). The reduction in obesity in the exercise group was not significant, but was greater than the control group. A gender difference in the response of BMI to exercise was observed. Girls in the exercise group had a significantly lower likelihood of having an increasing BMI slope than the control girls (OR, 0.32; 95% CI, 0.18–0.56). The effect in boys had the opposite direction of study intention.

Daily dietary intake was not recorded and control of dietary intake may have added benefit. Parental guidance may also have reinforced activity. The study was relatively short and may reflect short-term change. The process of randomization was unclear, as was the sample size calculation and blinding was impossible with intervention and control conducted in each setting leading to the possibility of 'contamination'. In school 1, there was an extra swimming class and it is not clear how this was controlled for. Other confounders could have been explored including ethnicity and parents’ BMI. There are potential biases including children being recruited on teacher’s advice, some family reported baseline data and measurement bias (adapted measures used and TSF measurement may not be accurate). There were 104 non-participating children, and it would be interesting to see whether their characteristics differed from those included.

Moore et al.10 examined the effect of pre-school physical activity on the change in body fatness from pre-school to first grade in the USA in a longitudinal study. This study was part of the ‘Framingham Children’s Study’ looking at childhood cardiovascular risk behaviours and began in 1987 with 106 children aged 3–5 years (mean, 4 years) and their parents. The authors analysed 97 healthy children with complete data from study entry into first grade. Physical activity of children and parents was assessed twice per year for five consecutive years using an electronic motion sensor. Each child also had yearly measurements of TSF thickness. Active girls i.e. those with above-median activity levels, had a better outcome and gained 1.0 mm in their TSF thickness from baseline to first grade, whereas inactive girls gained 1.75 mm TSF thickness. Active boys lost an average of 0.75 mm in their TSF thickness, whereas inactive boys gained 0.25 mm in their TSF thickness. Inactive pre-schoolers were almost four times as likely to have larger triceps during follow-up. Inactive preschoolers who were initially fatter were nearly six times as likely to have larger triceps during follow-up.

When age, television viewing, energy intake, baseline triceps and parents’ BMI were controlled for, inactive preschoolers were 3.8 (95% CI, 1.4–10.6) times as likely as active pre-schoolers to have an increasing triceps slope during follow-up, rather than a stable or decreasing slope. This relative risk estimate was slightly higher for children with more body fat at baseline.

The study suggests that physical activity can affect obesity early in life and found a strong effect of low levels of physical activity on body fatness. Limitations include the small number of subjects and possible measurement bias.

Drucker et al.11 examined the relationship between maternal parenting style, maternal eating cues and a child’s eating behaviour during mealtime in the USA in an observational study using data collected as part of the ‘Stanford Infant Growth Study’, an ongoing longitudinal study. Seventy-seven children (mean age, 3.5 years) were included and visited the laboratory with their mothers for a videotaped lunch. Videotapes were coded for the child’s eating rate and maternal parenting style, measured as the level of maternal control and support and the number and type of eating prompts given during a meal. The number and rate of verbal and physical encouragements and discouragements were significantly related to measures of general maternal parenting style and meal duration.

The rates of food offers, food presentations and total prompts were significantly positively related to the child’s rate of calorie intake. A mother’s level of support or control was not related to the child’s eating behaviour. Although general maternal parenting style did not predict the child’s eating behaviour, these behaviours were related to the frequency of maternal prompts, which, in turn, were significantly related to the number of calories eaten and the time spent eating. Children who ate fast had mothers who delivered eating prompts more frequently. The authors suggest that children’s BMI was significantly and negatively correlated with total discouragement per minute \(r = 0.23, P \leq 0.05\) but not with other maternal prompts. Limitations include the representativeness of the study sample with participants being mainly white, older, working and well-educated mothers. The mother’s prompts may also be in response to the child’s behaviour rather than encouraging or discouraging certain eating behaviours. The total number of calories consumed was imputed from one meal in a
<table>
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<th>Study</th>
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<td>Armstrong and Reilly</td>
<td>Cohort</td>
<td>32 000 children</td>
<td>Breast-feeding</td>
<td>Prevalence of obesity significantly lower in breast-fed children. Association persisted after adjustment for socio-economic status, birth weight and sex. Adjusted odds ratio for obesity (BMI ≥ 98th percentile) 0.70 (95% CI, 0.61–0.80). Results suggest breast-feeding associated with reduction in childhood obesity risk. The results suggest children fed only breast milk for first 6–8 weeks of life less likely to be obese than children fed only formula in same time frame. Breast-fed children 30% less likely to have BMIs in obese range at age 39–42 months than counterparts fed formula. The researchers accounted for age, sex, birth weight and socio-economic status.</td>
<td>Confounders. Researchers did not have information on other risk factors for obesity e.g. diet (once children began eating food), parental weight, physical activity, and cultural factors.</td>
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<td>Mo-suwan et al.</td>
<td>RCT</td>
<td>292 pre-school children; mean age, 4.5 years</td>
<td>Physical activity</td>
<td>Prevalence of obesity of both exercise and control groups decreased. Exercise group decreased from 12.2% at baseline to 8.8% (Wilcoxon signed-rank test, ( P = 0.058 )). Control group decreased from 11.7 to 9.7% (Wilcoxon signed-rank test, ( P = 0.179 )). Reduction of obesity in exercise group not significant (( P = 0.057 )) but greater than control group. Sex difference in response of BMI to exercise observed: girls in exercise group had lower likelihood of increasing BMI slope than control girls (OR, 0.32; 95% CI, 0.18–0.56). Effect in boys had opposite direction of study intention. Study suggests a 29.6-week school-based exercise programme can prevent BMI gain in girls and may induce a remission of obesity in pre-school-age children, but no statistically significant differences between children who exercised and those in control group, although the prevalence of obesity decreased in both groups. Swimming may be effective in preventing obesity.</td>
<td>Multiple testing, regression analysis questionable as results not significant. No ( P )-values included for girls. Daily dietary intake not recorded. No control of dietary intake that may have added benefit. Parental guidance may have reinforced healthy eating/activity and could have supplemented the pre-school-based programme. Study was short and may reflect a short term.</td>
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<td>Moore et al.</td>
<td>Longitudinal/cohort</td>
<td>The Framingham Children’s Study, a longitudinal study of childhood cardiovascular risk behaviours, began in 1987 with the enrolment of 106 children aged 3–5 years (mean age of total sample, 4.0 years) and their parents. The analyses included 97 healthy children with complete data from study entry into first grade.</td>
<td>Physical activity</td>
<td>On average, active girls (i.e. those with above-median activity levels) gained 1.0 mm in their triceps skinfolds from baseline to first grade, whereas inactive girls gained 1.75 mm. Active boys lost an average of 0.75 mm in their triceps, whereas inactive boys gained 0.25 mm. Inactive pre-schoolers were almost four times as likely to have larger triceps during follow-up. Inactive pre-schoolers who were fatter to start with fared the worst, being nearly six times as likely to have larger triceps during follow-up. When age, television viewing, energy intake, baseline triceps and parents' BMIs were controlled for, inactive pre-schoolers who were fatter to start with fared the worst, being nearly six times as likely to have larger triceps during follow-up. Inactive pre-schoolers were 3.8 (95% CI, 1.4–10.6) times as likely as active pre-schoolers to have an increasing triceps slope during follow-up (rather than a stable or decreasing slope). This relative risk estimate was slightly higher for children with more body fat at baseline. In this study, pre-school-aged children with low levels of physical activity gained substantially more subcutaneous fat than did more active children.</td>
<td>The study suggests physical activity can affect obesity early in life. The study found a strong effect of low levels of physical activity on body fatness. The monitors used should capture all types of physical activity and so could provide more accurate measurements. A limitation of this study is the number of subjects and possible effect measurement modification by baseline body fatness. The authors retained stratification of this variable so the estimated effect of activity within categories of baseline body fat may be less precise.</td>
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<td>Drucker et al.</td>
<td>Observational</td>
<td>77 children (39 girls, 38 boys), aged 3.5 years.</td>
<td>Mothers behaviour</td>
<td>Verbal and physical encouragements and discouragements significantly related to measures of general maternal parenting style and meal duration. Rates of food offers, food presentations and total prompts all significantly related to the child's rate of calorie intake. Mother's level of support or control not related to eating behaviour. General maternal parenting style did not predict eating behaviour, but the frequency of maternal eating prompts was significantly related to number of calories eaten and time spent eating. Children who ate the fastest had mothers who delivered eating prompts at higher frequency. Child's BMI significantly correlated with total discouragement per minute ($r = 0.23, P &lt; 0.05$) but not with other maternal prompts.</td>
<td>75 children were white. Older well educated mothers: mean age of mother 33. 80% of mothers had college degree. 65% working. Causality cannot be inferred as mother's prompts may be in response to the child's behaviour rather than encouraging or discouraging certain eating behaviours. Total number of calories consumed from one meal only taken in a laboratory setting and may not represent everyday eating behaviour. Setting may have influenced the mother and child's behaviour. BMI significantly correlated with total discouragement per minute ($r = 0.23, P &lt; 0.05$), but not with other maternal prompts. This result is questionable given that they also suggest that maternal BMI correlated weakly with the rate of maternal verbal discouragements ($r = 0.22, P &lt; 0.05$).</td>
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<td>Study</td>
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<td>Baughcum et al.(^\text{12})</td>
<td>Study 1: 453 mothers with a child who, at the time of survey, was 11–24 month old. Study 2: 634 mothers of children 23 – 60 month old.</td>
<td>Results did not suggest there is a particular ‘feeding style’ associated with overweight. Differences found in feeding behaviours between high- and low-income mothers. No significant difference between boys and girls in prevalence of overweight (20 versus 22(%), (P = 0.53)). Prevalence of maternal obesity higher in low-income mothers (27 versus 11(%), (P &lt; 0.001)) and their children more often overweight (26 versus 13(%), (P = 0.001)). Obese mothers no more likely than non-obese mothers to have overweight children (26 versus 20(%), (P = 0.19)). Mother who breast-fed for longer than 6 months no less likely to have overweight children than mothers who breast-fed for shorter duration (14 versus 18(%), (P = \text{not significant} [\text{NS}])). Obese mothers, mothers in low-income group and mothers of children who were overweight reported higher levels of concern about overeating and being overweight. Obese mothers and mothers in low-income groups reported a significantly higher degree of age-inappropriate feeding and a significantly lower degree of structure during feeding interactions. Mothers of overweight children were significantly less concerned about their children being underweight. After controlling for family income, there was no evidence that obese mothers had a different ‘feeding style’.</td>
<td>Possible errors in measurement of height and weight could have occurred in busy clinical settings. Several self-report items included which may bias the findings e.g. smoking and breast-feeding history. Validity of the tools and low internal consistency make it difficult to detect differences in factors scores between overweight and non-overweight children. Inadequate variability in the scores for some factors (responses skewed in one direction), which limited the likelihood that the factor would discriminate between the feeding behaviours in mothers with overweight children and those of mothers without overweight children. No cognitive interviewing during item development.</td>
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<td>Harvey-Berino et al.(^\text{13})</td>
<td>Observational</td>
<td>43 mother/child pairs</td>
<td>Differences not significant. Children in the home visiting group had significantly decreased energy intake ((-316 \pm 835 \text{ versus } 197 \pm 608 \text{ kcal/day}, P &lt; 0.05)). Scores on the restriction subscale of the Child Feeding Questionnaire decreased significantly in the home visiting group ((-0.22 \pm 0.42 \text{ versus } 0.08 \pm 0.63, P &lt; 0.05)), indicating that mothers in the home-visiting group were engaging in less restrictive child feeding practices over time.</td>
<td>Small sample size and short in duration. Intervention may have been too diffuse to be effective given the timeline. Number of measures relied on self-reporting. Representativeness of the sample is questionable, given the mothers’ age, level of education and employment, breast-feeding rates, and the use of daycare facilities.</td>
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laboratory setting and may not be representative of everyday eating behaviour. The setting may also have influenced behaviours.

In a large observational study, Baughcum et al. developed and analysed two new instruments to assess maternal feeding practices and beliefs. The ‘Infant Feeding Questionnaire’ (IFQ) assessed feeding during the first year of life and was administered to 453 mothers of children aged 11–23 months. The ‘Pre-Schooler Feeding Questionnaire’ (PFQ) assessed feeding of young children between ages of 2–5 years (mean age of children, 39.5 months). Scores were calculated and linked with the children’s measured and mothers’ self-reported weight and height. Scores from the IFQ and PFQ were compared between obese and non-obese mothers, between those who did and did not have an overweight child and between those who had low and high incomes. There was no significant difference between boys and girls in the prevalence of overweight or obesity in high-risk Native-American children compared with other breastfeeding mothers (14 versus 18%, $P = 0.05$). Mothers who breast-fed for longer than 3 months were no less likely to have an overweight child than other breastfeeding mothers (14 versus 18%, $P = 0.53$). Within the low-income group mothers, the prevalence of maternal obesity was higher (27 versus 11%, $P < 0.001$), and their children were more often overweight (26 versus 19%, $P = 0.001$). However, overall obese mothers were no more likely than non-obese mothers to have overweight children (26 versus 20%, $P = 0.19$), and this was true when high and low income groups were examined separately.

Mothers who breast-fed for longer than 3 months were no less likely to have an overweight child than other breastfeeding mothers (14 versus 18%, $P = 0.05$, data not shown). Low-income group mothers introduced solids earlier, but there was no evidence that early introduction of solids or the practice of adding cereal to the bottle was associated with overweight beyond infancy. After controlling for family income, there was no evidence that obese mothers had a different feeding style and the study did not suggest that there is a particular feeding style associated with overweight in young children. The only suggested difference in feeding style for obese mothers was the tendency to give children less control over feeding.

Harvey-Berino and Rourke conducted a low-powered observational study to determine whether maternal participation in a home-visiting obesity prevention plus parenting support (OPPS) intervention would reduce the prevalence of obesity in high-risk Native-American children compared with a parenting support (PS) only intervention. Forty-three mother/child pairs were recruited. Mothers were 26.5 ± 5 years old with a mean BMI of 29.9 ± 3. Children (23 males) were 22 ± 8 months old with mean weight-for-height $z$-scores (WHZ) of 0.73 ± 1.4. Mothers were randomly assigned to a 16-week OPPS intervention or PS alone. The only difference was the focus of the lessons. The intervention was delivered one-on-one in homes by an indigenous peer educator.

Baseline and 16 week assessments included weight and height dietary intake, physical activity, parental feeding style and maternal outcome expectations, self-efficacy and intention to change diet and exercise behaviours. Children in the OPPS group gained less weight over 4 months than those in PS, but differences were not significant. WHZ scores decreased in the PS condition and increased among the OPPS group ($-0.27 ± 1.1$ versus $0.31 ± 1.1$, $P = 0.06$), although this is not significant. Children in the OPPS condition significantly decreased energy intake ($-316 ± 835$ versus $197 ± 608$ kcal/day, $P < 0.05$). Scores on the Child Feeding Questionnaire decreased significantly in the OPPS condition ($-0.22 ± 0.42$ versus $0.08 ± 0.63$, $P < 0.05$), indicating that mothers in the OPPS group were engaging in less restrictive child-feeding practices over time. The authors considered a home-visiting programme focused on changing lifestyle behaviours and improving parenting skills, which showed promise for obesity prevention in high-risk children. Limitations include small sample size, short duration and the representativeness of the sample, including maternal age, education, employment, breast-feeding rates and childcare.

Discussion

What is already known on this topic

NICE guidance reinforces that the pre-school years are a key time for shaping attitudes and behaviours; that opportunities for children to be active and to develop healthy eating habits are important as well as the need to involve parents and carers. While there is a need for policy and practice to be evidence based, the review has considered some interventions that are good public health practice per se and should be encouraged in any case, for example, breast feeding and physical activity. As Wanless stated ‘the need for action is too pressing for the lack of a comprehensive evidence-base to be used as an excuse for inertia. Instead, current public health policy and practice, which includes a multitude of promising initiatives, should be evaluated as a series of natural experiments’.

What this study adds

The review confirms that there is a limited and immature evidence and a lack of comprehensive evidence on effective strategies to prevent obesity in younger children. There are some interesting individual studies that enhance and support recent NICE guidance around activity, family-based interventions and breast-feeding. The study reinforces that prevention of
child obesity requires comprehensive, sustained and evidence-based action. Improvements in the evidence base are needed looking at points of intervention, such as those identified in this review, along with evaluation of those interventions. The evidence that childhood obesity persists into adulthood may justify shorter term monitoring at this age.

**Limitations of this study**

The review shows that the overall quality of studies is poor, there is no consistent research theme, inconsistent results across studies and compared with clinical decision-making where the evidence base is dominated by RCTs with high internal validity, the evidence base for child obesity prevention is poor. The better quality studies tend to show small, but significantly beneficial, effects particularly for physical activity and breast-feeding suggesting that research should be focused in these areas. The lower order RCT by Mo-suwan shows promise and results suggesting swimming may be effective in preventing obesity are worthy of follow-up. The longitudinal study by Armstrong et al indicates that breast-feeding is potentially useful for population-based strategies aimed at obesity prevention in children aged <5 years. However, caution is required in translating this research into local practice, given the different settings of the studies and the challenges in applying research including RCTs back into a community setting.

With family-based interventions the need exists for good quality longitudinal studies that carefully assess child growth as well as parental control over infant feeding practices and activity levels. The preliminary results of an unpublished RCT on the effectiveness of a multi-component family-based intervention suggest significant improvements in moderately obese older children (P.M. Sacher, unpublished results).

The findings from some studies suggest there are implications for the development of obesity in children and a correlation is evident between certain parental–child interactions and the relative weight and activity levels of the children. Future research should investigate the types of food being encouraged or discouraged and the intensity of children’s activity levels. If findings are replicated in different settings it may, for example, explain the equivocal literature on the influence of children’s physical activity on weight. Overweight children may in fact engage in equal frequency of activity, but less intensely.

Child obesity will continue to be a problem without improved understanding of key factors likely to be operative during very early childhood and without identification of those where intervention would have the greatest effect.

Greater effort is still required to establish an evidence-based approach to issues surrounding obesity in children.

**References**


