

A review of risk factors for overweight in preschool children: a policy perspective

Running head: A review of risk factors in preschool children

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Abstract

An increasing number of preschool children are becoming overweight. Although many risk factors have been identified for school-age children, less is known about this young age group. Ecological models have been developed to illustrate how individual characteristics, family characteristics, community-level factors, and policies may influence weight gain. We used this model to review factors that influence overweight in children, aged six months to five years, which are amenable to policy intervention in resource-rich countries. We found strong evidence for a direct association between childhood overweight and maternal prepregnancy body size, maternal smoking during pregnancy, and children's television/media use; strong evidence for an inverse relationship between breastfeeding and overweight and moderate evidence for children's physical activity. There was limited research on community-level factors, policies and interventions. Future policies and interventions should be subject to evaluation and aim to support parents and young children to develop health-related behaviours that may prevent early childhood overweight.

Key words: body mass index, obesity, infant, preschool child, review, public policy

The prevalence of overweight and obesity in preschool children has increased dramatically in recent decades (1,2). Approximately one quarter of children aged 2-5 years from the USA and England are overweight or obese (2,3). Obesity is socially patterned, with children from low socio-economic groups (4,5) or some ethnic minority groups (2) at the greatest risk. Obese children are at greater risk of health and psychosocial problems in childhood and adulthood (6,7) as well as adult obesity (8).

Despite the increasing prevalence of overweight in preschool children, recent reviews have focused on the larger body of research on risk factors in school-age children and adolescents (6,9,10). Most research has examined bivariate relationships between childhood overweight and individual or family risk factors, such as parental overweight (11,12), childhood television use (13,14), and diet (15,16); however, these risk factors often do not occur in isolation. This has led researchers to develop ecological models that conceptualise child weight gain within the context of the child and its family, community and social factors, and social policies and national legislation (Figure 1) (6,9,10).

We used an ecological framework to structure a review of child characteristics, family characteristics, community-level factors, and policies that influence overweight in children aged six months to five years. We focused on factors that are amenable to policy (legislation, regulation, or fiscal) or that have been targeted by governments or national organisations through public health recommendations; however, risk factors which are not amenable to policy, such as genetic factors or individuals' nutrient intake were not

reviewed. We focused on risk factors from resource-rich countries, as policies to address overweight in resource-poor countries are likely to be different.

Search strategy and selection criteria

We identified studies through systematic searches of Medline and Embase with the keywords “body mass index” or “obesity” or “overweight” and “infant” or “preschool child”. These were combined with the following MeSH terms and all subcategories in Medline: “infant nutrition”, “child nutrition”, “exercise”, “television”, “motor activity”, “parents”, “family”, “siblings”, “employment”, “child care”, “child day care centers”, “education”, “transportation”, “residence characteristics”, “housing”, “crime”, “socioeconomic factors”, “restaurant”, “environment”, “recreation”, “safety”, “health policy”. Similar keywords were used to search Embase. Each database was also searched for the free text terms: “physical activity”, “kindergarten”, “nursery”, “restaurant”, “recreation”, “safety”, “food outlet”, “car”, “travel”. We included articles published in English from 1980 to March 2006. Articles from resource-poor countries were included only if the findings were relevant to resource-rich countries.

Our search identified 1923 articles, which were assessed for their relevance. Articles of any methodological design or duration were included if they reported at least one measurement of body size and any of the keyword topics in a sample of children between ages six months to five years. Cochrane reviews, meta-analyses, and other systematic reviews were preferentially included over individual studies. Articles are reviewed within

the following domains: child characteristics, family characteristics, community-level factors, and policy. A summary of intervention studies is also included.

The most common measure of body size at the population level is body mass index (BMI). Since there are differing cut-offs to measure overweight and obesity across studies, we have used the term 'overweight' to define the top portion of the BMI distribution. This definition will vary between studies depending on the reference growth standard and the cut-off used for each distribution; however, a common definition has allowed us to collate studies from different populations in order to evaluate patterns of overweight. Within each domain, articles are grouped according to whether the outcome is a measurement of overweight or a continuous measurement of body size, such as BMI. Studies were not included if they only examined weight gain and no additional measurement of body size. It is also noted whether studies controlled for potential confounding factors, such as socio-economic circumstances, parental size or infant feeding.

Results summary

We identified 59 studies (asterisked in the references) that examined at least one policy-relevant risk factor for overweight in preschool children. Most studies investigated child characteristics, while fewer assessed family characteristics or community-level factors, and none evaluated the impact of a policy on overweight (Table 1). Most studies were cross-sectional and conducted in the USA within the last ten years. Many risk factors lacked standard definitions, which limited our ability to collate the evidence, and few

studies examined risk factors from more than one domain. Furthermore, few studies examined the relationship between a risk factor and overweight by socio-economic circumstances and we were often unable to determine whether sub-groups may be particularly at risk. Ethnic differences were also primarily evaluated in studies from the USA; therefore, we did not separately comment on these findings because the results are not likely to be generalisable to ethnic minority groups in other countries. Policies and data from the UK and USA are provided as examples from resource-rich countries because of the availability and accessibility of information.

Child characteristics

Infant feeding

Breastfeeding

Breastfeeding confers a range of health benefits for mothers and infants (17) and the World Health Organization (WHO) recommends exclusive breastfeeding for the first six months and continuing breastfeeding for up to two years (18). However, breastfeeding rates vary widely across resource-rich countries, with particular disparities for exclusive breastfeeding (19). Data from the UK and USA suggest that approximately 70% of mothers initiate breastfeeding, with less than 15% exclusively breastfeeding at six months (20,21).

Four systematic reviews have investigated the relationship between breastfeeding and later overweight, with three reporting an inverse relationship (16,22,23) and one finding

no consistent relationship (8). No difference was found between follow-up in preschool children, older children, or adults (16,22,23). Two reviews found that an inverse relationship still remained after adjusting for confounding factors, such as parental obesity, maternal smoking, or social class (22,23). There is also evidence of a dose-response relationship between duration of breastfeeding and reduced risk of overweight (16,23). An additional systematic review found no effect of breastfeeding on mean BMI across the life course, after adjustment (24).

We identified eleven additional studies investigating breastfeeding and overweight in preschool children after these reviews were published (25-35). Five studies reported an inverse relationship (25,28,29,33,34), five found no relationship (27,30-32,35), and one reported a direct relationship (26).

Weaning

Although the WHO recommends introducing solid foods into an infant's diet at six months of age (18), evidence suggests that infants are often weaned earlier (36,37). Early weaning is associated with never breastfeeding and an early discontinuation of breastfeeding (36). A systematic review of five studies found no relationship between the age at weaning and fatness in children below age seven years (8). An additional two studies found no consistent relationship between weaning and overweight during infancy (38,39), while one study reported no relationship between weaning and overweight at age five years (32).

Prolonged bottle use

Some children continue to use a bottle into early childhood. In England, approximately 60% of children aged 18 months use a bottle daily (40,41) and up to 10% of children aged 2-5 years from the USA use one (42). The Department of Health (England) and the American Academy of Pediatrics (AAP) recommend that bottle feeding should be discontinued after 12 and 18 months, respectively (43,44). We identified three articles that examined the relationship between prolonged bottle use (defined as using a bottle later than recommended) and overweight in preschool children from the USA (45-47). Two studies found that bottle use in children aged three years was associated with an increased risk of overweight, in both a nationally representative sample and children from a low-income population (45,46). An additional study among primarily white, well-educated families found no difference in mean BMI between children aged three years with prolonged bottle use and those without (47). Only one study adjusted for potential confounding factors (45).

Summary

While there is extensive evidence on the protective association of breastfeeding on overweight, little is known about the relationship between weaning or prolonged bottle use and overweight. Evidence of a dose-response relationship between duration of breastfeeding and overweight (16,23) supports policies to encourage both breastfeeding initiation (18,48,49) and duration (18,49). Breastfeeding is hypothesised to protect against overweight through metabolic programming in early life (16,22,23). Studies on

weaning and prolonged bottle use have often been conducted in restricted populations, which limit the generalisability of these findings. Most studies have also not adjusted for potential confounding factors. Despite these limitations, early weaning has been discouraged because it replaces breast milk (17,18) and prolonged bottle use has been found to increase the likelihood of dental caries (50). This evidence suggests that policies to increase breastfeeding (18,48,49), delay the introduction of solid foods (18), and limit bottle use (43,44) should be considered based on their potential for preventing early childhood overweight and additional health benefits.

Dietary patterns

Many countries recommend that children should consume approximately five servings of fruits and vegetables daily (51,52). Only 12% of children aged 5 years from England are meeting this recommendation and 14% of children are having less than one portion (53). In the USA, the mean daily intake of fruits and vegetables for children aged 2-5 years is 3.5 servings (54), although this is higher than in past decades (55).

Children's consumption of fruit juice, sweetened drinks, and snack foods has increased over the past 20 years (55-57). A recent study from the USA found that children aged 2-3 years from low-income families consume an average of 2.9 sweetened drinks daily (15). Northstone and colleagues found that 48% of 18-month-old children from England consume sweetened fruit drinks daily and 7% consume fizzy drinks (41). Furthermore, between 1977 and 1996 the mean number of snacks consumed per day among children aged 2-5 years has increased from 1.7 to 2.3 (57). The AAP recommends that children

below age 6 months should not consume fruit juice and juice intake should be limited to 4-6 fluid ounces (118-177 mL) for children aged 1-6 years (58). Current dietary guidelines recommend counting only one glass of fruit juice towards dietary requirements (51) and choosing beverages with little added sugar (52).

Drink consumption

We identified seven studies that examined the relationship between excessive fruit juice consumption (defined as ≥ 12 fluid ounces daily [355 mL]) and overweight in preschool children (15,59-64). Two studies reported a direct relationship (61,64) and five reported no relationship (15,59,60,62,63). Most of these studies included small samples and often did not adjust for confounding factors. The largest study followed over 10,000 young children from low-income, ethnically diverse families over one year and found no association between fruit juice consumption and overweight, after adjustment (15).

We identified only two studies that investigated sweetened drink consumption and overweight in preschool children (15,65). Both studies from the USA reported a direct relationship. Welsh and colleagues found that normal weight children who drank at least one sweetened beverage daily were not at an increased risk of becoming overweight over one year; however, overweight children at baseline with high daily sweetened beverage consumption were twice as likely to be overweight at follow-up, after adjustment (15).

Snack food consumption

There is no standard definition of snack foods; specifically, whether sweetened drinks are included. Studies also do not often specify whether they are investigating snack frequency or consumption. We identified five cross-sectional studies from the USA, Europe, and Japan that investigated snack food consumption and overweight in preschool children (29,61,66-68). Four studies reported a direct relationship (29,66-68) and one found an inverse relationship (61).

Two studies from the same Japanese cohort found that overweight children were more likely to not have set snack times than normal-weight children; however, snack frequency was not related to overweight (66,67). Two European studies of preschool children found that snacking was associated with overweight, but the association was removed after adjustment for confounding factors (29,68). In contrast, a study of low-income Mexican-American children found that taking food between meals was associated with a decreased risk of overweight (61). This finding was attributed to cultural reasons, as restricting access to food often occurs in Latino families only after a child is perceived to have a serious weight problem (61).

Summary

Although there have been substantial changes to children's food and beverage patterns over the past 20 years (55-57), there is limited research on the influence of dietary factors on overweight. We found little evidence for a relationship between fruit juice

consumption and early childhood overweight. We cannot draw conclusions between sweetened drink or snack food consumption and overweight based on the few studies we identified, but they appear to be promising areas of research. Studies on snack food consumption often lack a consistent definition of “snacks” and cultural factors appear to be important for understanding their relationship to childhood overweight. Overall, the studies on dietary factors were conducted primarily on children from the USA, had limited sample sizes, and often did not include representative samples. Most studies were cross-sectional and did not adjust for confounding factors. Consumption of foods, such as drinks or snack foods, in addition to regular meals may increase energy intake and contribute to a positive energy imbalance (15,56,57). Policies that recommend limiting sweetened drink consumption (50,52) and introducing juice after the age of six months (58) could prevent the displacement of breast milk and excess energy intake that may contribute to early childhood overweight.

Physical activity/inactivity patterns

Both the UK and USA recommend that children should engage in at least 60 minutes of physical activity daily (52,69). Although there is popular belief that physical activity has decreased and sedentary activities have increased in recent years, there are limited data available currently or across time (70). For example, a national survey using parent report found that approximately one-third of English children aged 5 years are not engaging in at least 60 minutes of physical activity daily (71). In a study using accelerometry, Scottish preschool children are only spending 20-25 minutes per day in moderate to vigorous activity (72). Television viewing and media use has been used as a proxy to

investigate the amount of time children are physically inactive. British children aged 4-6 years currently watch an average of 18.6 hours of television per week (73). Among children aged 2-3 years from the USA, 41% watch 3 or more hours of television daily (74) and 27% of children aged 4-6 years use a computer daily (75). The AAP has recently recommended that parents should limit children's total media time to 1-2 hours daily, remove television sets from children's bedrooms, and discourage television viewing for children less than two years (76).

Physical activity

We identified 17 studies that investigated physical activity and overweight in preschool children (14,29,66,67,77-89). Physical activity was recorded either through a direct measurement of energy expenditure (14,79,83-89), observation (77,79-81,88), or parent report (29,66,67,78,79,82). Seven studies reported an inverse relationship between physical activity levels and body fatness (14,29,66,85-88), eight found no relationship (67,78,79,81-84,89), and one reported a direct relationship (80). An additional study found a direct relationship between physical activity and BMI at age four years, but an inverse relationship at five years (77).

We found that the majority of studies examined physical activity in children aged 3-5 years and there is limited evidence on energy expenditure during infancy. A systematic review of six studies on pre-walking physical activity and fatness in children up to age eight years found little evidence for a relationship (8). An additional two studies reported mixed results (86,89).

Among the cross-sectional studies in children aged 3-5 years, obese children have lower physical activity levels than normal-weight children (66,88) and low levels of physical activity are associated with an increased risk of overweight (29). An additional study of Japanese children found no difference in physical activity between overweight and non-overweight children (67). The studies investigating physical activity levels and a continuous measurement of body size reported mixed results. Children with lower levels of physical activity have higher levels of body fatness than children with higher levels of activity (14,87), while other studies have found no relationship (78,79,81-84). An additional study reported a direct association between physical activity levels and child fatness (80). Most research was conducted with predominantly white populations and potential confounding factors were often not examined.

We identified two longitudinal studies of physical activity and overweight during the preschool years. Moore and colleagues found that physical activity levels at age three years were inversely related to body fatness at five years; furthermore, heavier children with low activity levels were found to gain more weight than lean children with low activity levels (85). Jago and colleagues reported that physical activity levels were positively related to BMI at age four years, but negatively associated with BMI at ages five and six years (77).

Television and media use

We identified nine studies that investigated television viewing (including other media) and overweight in preschool children (13,14,29,65,68,77,82,90,91). Television viewing was measured either through observation (77,91) or parent report (13,14,29,65,68,82,90). Six studies reported a direct relationship between television viewing and body fatness (13,14,29,65,68,90) and three reported no relationship (77,82,91).

The majority of studies on television viewing were cross-sectional. Overweight children watch more television than normal-weight children (65,90) and the number of hours of television viewing is associated with an increased risk of overweight (13,29,68). Children who have a television in their room are also more likely to be overweight than children without one (13). Three cross-sectional studies that examined television viewing and a continuous measurement of body size reported mixed results (14,82,91). Most studies included ethnically diverse populations, but confounding factors were often not examined. A longitudinal study by Jago and colleagues found no relationship between television viewing and BMI at ages four or five years, but there was a significant relationship at age six years (77).

Summary

Despite limited trend data on physical activity or media use, evidence suggests that most preschool children are not complying with current recommendations. We found some evidence for an inverse relationship between physical activity levels and overweight in

preschool children based on longitudinal research and cross-sectional studies. We found evidence for a direct relationship between media use and overweight based primarily on cross-sectional studies. Media use may influence overweight by reducing participation in physical activity (92), influencing food preferences (93), and/or increasing food consumption during viewing (93,94). Although reverse causation could explain these relationships, with childhood overweight leading to lower physical activity and greater sedentary activity, there is little research in this area. There are similar limitations in the evidence base for physical activity and media use, including the lack of a standard definition for exposures and few longitudinal studies. Objective measures of physical activity and media use for large samples need to be developed. Policies that limit media use (76) could also indirectly reduce food and drink intake and subsequent weight gain.

Family characteristics

Parental factors

There is an extensive evidence base to support the relationship between parental overweight and childhood overweight (6,8,11,12). Parental overweight is also related to children's fat intake (84,95), snack food consumption (68,94), and a higher preference for high-fat foods and a lower preference for vegetables (11). Children of overweight parents are also less active (11,80) and more likely to prefer sedentary activities (11) than children of parents with normal weight. The family environment, such as parental modelling of eating, can influence children's dietary behaviours (96). Children's dietary intake is also associated with parental diet (97). School-age children whose parents watch

high amounts of television are also more likely to watch at least two hours of television daily (98,99).

Prepregnancy body size

The prevalence of maternal obesity in early pregnancy or prepregnancy has increased in recent years (100,101). In Scotland, 9.4% of women were obese ($BMI \geq 30$) early in pregnancy in 1990 while 18.9% were obese in 2002/2004 (100). In the USA, 25.9% of women were obese before or early in pregnancy in 2003 (101). Maternal prepregnancy obesity is related to an increased risk of adverse health outcomes for mothers and infants, including gestational diabetes (102) and a baby born large-for-gestational age (102,103).

We identified nine studies that investigated prepregnancy overweight ($BMI \geq 25$) and overweight in preschool children (12,25,27,30,31,89,103-105). Seven studies reported a direct relationship (12,25,27,30,103-105) and two found no relationship (31,89). Two papers reported on a small sample of children who were stratified according to maternal prepregnancy BMI. At age two years, there were no differences in BMI between the high- and low-risk groups (89); however, children in the high risk group had higher BMIs at ages four and six years (12). Approximately half of the studies included ethnically diverse populations and adjusted for confounding factors.

Smoking during pregnancy

While there has been a reduction in maternal smoking during pregnancy over the past 15 years (106,107), in 2000, approximately 12% of mothers from the USA (106) and 20% of mothers from the UK (107) smoked during pregnancy. These figures vary widely by socio-economic and educational factors (106-110). Babies born to mothers who smoke are at an increased risk of low birth weight (106). The USA and UK both have targets to reduce smoking during pregnancy (49,111).

We identified 13 studies that investigated maternal smoking during pregnancy and overweight in preschool children (25-27,29,31,103,104,108-110,112-114). All studies reported a direct relationship. There is also evidence of a dose-response relationship between the number of cigarettes smoked during pregnancy and an increased risk of overweight (108,113,114). However, there are mixed results on the timing of tobacco exposure during pregnancy and risk of overweight (109,114). Most studies included ethnically diverse populations and controlled for confounding factors.

Maternal employment

Employment among women with young children has increased rapidly. Over the last ten years, maternal employment in the UK has increased from 51 to 59% for married/cohabiting mothers with a preschool child and from 23 to 34% for lone parents (115). In the USA, 34% of women with children under age three were employed in 1975, while 57% were employed in 2004 (116). Policies from the UK and USA to reduce child

poverty have increased the number of parents, particularly women, in employment (117,118). Changing patterns of family life have been suggested to be partially responsible for the rising prevalence of overweight in young children (7,119).

We identified only two studies, from the same cohort of Japanese children, that examined maternal employment status and overweight in preschool children (66,67). They found that obese children were more likely to have a mother in full-time employment than children of normal weight, in univariate analyses only.

Indicators of disadvantage

Overweight in pre-school children (4,5), older children (6,120,121) and adults (121) is socially patterned and there is strong evidence that parental circumstances are related to risk factors for childhood overweight. While women from lower socio-economic circumstances or with lower educational levels are less likely to begin and continue breastfeeding (20,21), they are more likely to introduce solid foods before four months (36,37), bottle feed their child for longer (41,42), smoke during pregnancy (106-110), and be overweight early in pregnancy (100). Children from families with lower socio-economic circumstances or educational levels are less likely to eat five or more fruits and vegetables daily (53,54) and are more likely to watch a greater amount of television or other media (74,98). There is limited or inconsistent evidence on social patterns of sweetened drink consumption (41), snack food consumption (29,57), and physical activity (122,123). This evidence suggests that parental circumstances influence the development of children's health-related behaviours early in life.

Summary

Parental, particularly maternal factors, influence the development of overweight in preschool children. We found strong support for the relationship between childhood overweight and maternal overweight pre-pregnancy or smoking during pregnancy. Pre-programming has been proposed as a potential mechanism for the association between childhood overweight and both maternal overweight (27,30,103) or smoking during pregnancy (25,103,108,109,114). This evidence suggests that policies should target women before child-bearing age and continue to encourage smoking cessation during pregnancy (49,111). Future studies should consider the role of both the pre- and post-natal environment. Despite the speculation that an increase in maternal employment is related to the rising rates of childhood overweight, there is limited evidence to support or refute this claim. Additional evidence is needed to address whether changes in policies to encourage parental employment have also influenced infant feeding, food consumption, and physical activity/inactivity patterns. Children from families with lower socio-economic circumstances or educational levels are at a greater risk of overweight due to the social patterning of risk factors for obesity. This evidence can help inform the development of interventions and policies to address health inequalities.

Community-level factors

Neighbourhood factors

The rapid rise in obesity has been attributed primarily to changes in environmental factors rather than genetics (6,124). There are limited data to evaluate diet and physical activity levels over time; however, changes in food consumption patterns (56,124) and the built environment (70,124) may be contributing to a positive energy imbalance across the population. The impact of specific environmental changes on weight gain and their mechanisms remains unclear (124). Neighbourhood characteristics have been found to be independently related to overweight, with children living in more disadvantaged areas at higher risk (4,120). Although both the environment and the perception of the environment influence physical activity levels (120,122), there are mixed findings about the impact of the environment on access to food (125). Recent reviews have found that most studies are cross-sectional and little is known about the long-term impact of the environment on body size (124,125).

We identified three cross-sectional studies that investigated neighbourhood factors and overweight in preschool children from the USA and Australia (82,126,127). Burdette and Whitaker examined the impact of environmental factors on overweight in a sample of over 7000 low-income children aged 3-4 years from the USA (126). They found no relationship between overweight with neighbourhood safety, measured by police-reported crimes, or with children's residential proximity to playgrounds or fast food restaurants. These colleagues have also found no relationship between mothers' perceived level of neighbourhood safety and overweight in a national sample of three-year-old children

(82). Timperio and colleagues examined parental perception of local neighbourhoods and overweight in nearly 300 Australian children aged 5-6 years (127). Over 90% of parents were concerned about stranger danger and road safety, but no perceptions of the neighbourhood were associated with overweight. These studies included representative samples of children and two studies adjusted for confounding factors.

Nursery school or day care factors

The nursery school, kindergarten (hereafter also referred to as a nursery school) or day care environment can influence food intake and physical activity levels in young children. In Britain, approximately 33% of employed parents use centre-based day care, such as a nursery school or crèche (128). In the USA, approximately 24% of employed mothers use centre-based day care for children aged 0-4 years (129). Although over 60% of children from Britain and the USA are also cared for by informal arrangements, such as family members or friends (128,129), there is little research in this area.

We identified two studies, from the same cohort of Japanese children, that examined nursery school attendance and overweight in preschool children (66,67). Neither found a difference in nursery school attendance (yes/no) between children who were obese or of normal weight.

While general policies support healthy eating (51,52) and physical activity (52,69), there are few guidelines for nursery schools or day care providers (130-133) and limited research in these areas. Nursery school and day care settings often provide one or two

main meals for children each day; however, there are few nutritional requirements for meals (130-132). A survey of over 900 schools across the USA found that almost 9% of children in kindergarten (approximately age 4-5 years) didn't have any physical education each week and only 16% had it daily (134). Children's physical activity/inactivity levels also vary by the day care centre (83,135) and attendance (74). Dowda and colleagues reported that children from day care centres that offered frequent field trips and employed college-educated teachers had higher activity levels than children from those without (135). Similarly, Certain and Kahn found that two-year-old children not in day care were more likely to watch at least two hours of television daily than children in centre-based day care (74).

Although we did not identify any studies that examined dietary factors in nursery school or day care and overweight, we located three studies that investigated nursery school-related physical activity and overweight (134,136,137). Timperio and colleagues found no relationship between walking or cycling to school and overweight in Australian children aged 5-6 years (137). Metcalf and colleagues also found no difference in BMI between English children who walked or were driven to nursery school (136). Datar and Sturm examined changes in physical education between kindergarten and first grade (between ages 4-5 to 5-6 years) in a nationally representative sample (134). They found that an additional hour of physical education per week reduced BMI among girls who were overweight, but did not alter BMI in boys or girls who were of normal weight.

Summary

Although the recent rise in obesity has been attributed primarily to environmental changes, there is limited evidence on the impact of neighbourhood-level factors, nursery school, or day care on overweight in young children. There are few data sources on community-level factors and overweight at the population level, both currently and across time. Despite a large portion of young children attending centre-based day care or nursery school, there is little known about their dietary patterns and physical activity levels and there are few policies targeting these areas. A lack of consistent definitions of exposures adds an additional limitation to collating this evidence. Most research is cross-sectional and longitudinal studies are needed to assess the impact of these factors over time.

Furthermore, children living in disadvantaged areas are at a greater risk of overweight and little is known about how multiple influences, such as neighbourhood, family, and individual risk factors may impact on weight gain. Future research that examines the role of the environment, independent of and in addition to family and individual risk factors, can be used to inform community-level interventions. Current and future policies and targets on food intake and physical activity need to include nursery schools and day care centres to support positive health-related behaviours within these environments.

Policy

Policies can influence childhood overweight and its determinants through legislation, regulation, fiscal policy, or recommendations targeted at children, parents, services, and communities. There is limited evidence on the direct relationship between policies and

overweight and we did not identify any related to preschool children; however, more research has been conducted on the impact of policies on the risk factors for overweight. Although policies for preschool children are primarily directed at parents, community-level policies (including day care centres and nursery schools) also influence children's dietary patterns and physical activity levels.

Dietary intake

Despite targets to increase breastfeeding rates (48,49), breastfeeding often remains a barrier for women who are employed (138). While many European countries provide support for employed women who breastfeed, the UK and USA do not comply with even the minimum International Labour Organization standards for protecting and supporting breastfeeding among working mothers (139,140). Furthermore, there is no legislation to protect breastfeeding in public in England and legislation varies by state in the USA. The WHO and national governments have also developed policies aimed at parents on introducing solid foods (18), bottle feeding (43,44), and fruit and vegetable consumption (51,52), and the AAP has created policies on drink consumption (50,58). Evidence suggests that an AAP television recommendation (76) may also indirectly impact on food or drink consumption. Recent reviews of environmental influences on obesity have also recommended regulating television advertising and marketing to children (10,141). In the UK, legislation to limit food promotion to children is currently the subject of active debate (142).

There are limited dietary guidelines in day care centres and nursery schools and little is known about these practices. Nutrition policies currently only govern subsidised meals in England (131) and the USA (132), but do not include other food and beverages that may be served or sold on the premises. The Institute of Medicine (IOM) Committee on Prevention of Obesity in Children and Youth recently recommended that nutritional standards should be established for all food and beverages available in schools, including day care centres and nursery schools (10). Although we did not identify any studies on food policies and overweight or dietary intake in preschool children, government programmes have been developed to improve dietary outcomes (143-145). National programmes provide nutritional support for low-income pregnant women and children up to age five years (143,144). England has also recently created the School Fruit and Vegetable Scheme to provide a free piece of fruit or vegetable to all children aged 4-6 years (145).

Physical activity/inactivity

The UK and USA have developed physical activity guidelines (52,69) and the AAP has also recommended limiting media use (76). Hayne and colleagues suggest that the limited number of community-level policies may reflect the difficulty and time required to alter the built environment; however, increasing neighbourhood safety and opportunities to cycle and walk could improve physical activity levels (141). For example, a government target in England to improve the quality of the built environment (146) may indirectly impact on physical activity levels.

There are few guidelines for physical activity and media use in day care centres and nursery schools and limited research. In the USA, physical activity policies for day care centres are created by each state and often do not provide any duration requirements for physical activity or media (130). Similarly, there are no national standards in the UK related to physical activity levels for children in day care (133). The IOM Committee recently recommended that children should participate in at least 30 minutes of physical activity daily while attending school, including day care and nursery school (10). The only studies we identified that examine the impact of day care or nursery school policies on physical activity or media use have been previously reported. Datar and Sturm found that an additional hour of physical education per week reduced BMI among overweight girls, but did not impact on body size among other children (134). Children's physical activity levels are also related to a day care centres' policies and practices (83,135).

Summary

Despite policies and recommendations targeting diet or physical activity/inactivity among preschool children, there is often limited information available on their implementation, evaluation, or influence on dietary factors, physical activity, and overweight. This evidence is primarily cross-sectional and little is known about the long-term impact of these policies. Although children from lower socio-economic circumstances are at greater risk of overweight, little is known about whether policies differentially affect these children. Furthermore, we found strong evidence that parental factors influence overweight and its risk factors in preschool children. Policies that target breastfeeding (48,49), maternal smoking (49,111), and parental overweight (49), as well as dietary

factors (49,51,52) and physical activity levels (52,69) may indirectly impact on early childhood overweight.

Interventions

A recent systematic review identified 22 interventions to prevent overweight in children under age 18 years and 3 included preschool children (147). Dennison and colleagues conducted a health promotion programme, based in nursery schools and day care centres in the USA, which focused on reducing television viewing in children aged approximately four years and their parents (148). After the seven session programme, they found a decrease in the number of children from the intervention group who watched more than two hours of television daily. Harvey-Berino and Rourke developed a home visiting programme to improve the eating and exercise skills of Native American parents and their children aged 21 months (149). They found that children in the intervention group had less weight gain over the study period and decreased energy intake. Mo-suwan and colleagues evaluated a kindergarten-based physical activity programme for children aged 4-5 years in Thailand (150). After the 30 week intervention, the prevalence of obesity decreased in children from both the intervention and control groups; however, there was a larger decrease in the intervention group. We identified an additional intervention by Fitzgibbon and colleagues, who developed a healthy eating, exercise, and television viewing programme in a preschool setting for ethnic minority, low-income children from the USA (151). At the one- and two-year follow-up, children in the intervention group had smaller increases in BMI compared to children in the control

group, but there were no differences in exercise frequency, television viewing, or dietary factors.

Since parental overweight and health-related behaviours are related to children's dietary intake and physical activity/inactivity (11,68,80,84,94,95,98,99), parental involvement is likely to be an important component of interventions for preschool children. Interventions that target parents and their health-related behaviours, such as smoking or overweight in pregnant women, could also have important implications for preventing overweight; however, we did not identify any interventions that have assessed childhood overweight as an outcome. Recent reviews have suggested that future research should include the views of stakeholders, such as parents or communities, in the development and implementation of interventions, assess the impact of changes to the environment, and whether these changes are sustained after the intervention has concluded (10,147).

Discussion

This review has identified policy-relevant risk factors for overweight in preschool children. We found strong evidence for an association between early childhood overweight and prepregnancy body size, maternal smoking during pregnancy, and children's television/media use. There was also strong evidence for an inverse relationship between breastfeeding and overweight and moderate evidence for children's physical activity. There was limited research within the areas of weaning, prolonged bottle use, drink consumption, snack food consumption, maternal employment, and

community-level factors. Furthermore, we did not identify any policies that have been evaluated for their impact on overweight in preschool children.

While this was not a formal systematic review, it provided a systematic approach to collating a diverse evidence base on risk factors for early childhood overweight. As with all reviews, it was dependent on the availability and quality of the studies in the field. We did not formally assess the quality of these studies, but considered issues of quality while interpreting the evidence. One such issue is the inter-relationship of some risk factors for obesity - for example, women who are overweight (28,30) or smoke (108,109,113) breastfeed for a shorter duration and women from lower socio-economic circumstances are also more likely to be overweight (100) and smoke (106,107). Many studies did not control for potential confounding factors. Furthermore, associations may not indicate causation, particularly in cross-sectional studies which was the dominant study design in this review. Our review considered risk factors as they applied to populations in resource-rich countries. However, the prevalence of overweight is also increasing in resource-poor countries (152) and we found little information on risk factors deriving from such settings.

We found that risk factors for overweight in preschool children and gaps in the evidence base are similar to those identified by reviews in older children (6,9,10). Although our findings have highlighted the role of parents in early childhood overweight, there were limited interventions targeting parents and young children. Few studies considered multi-level factors that influence overweight or based their study of risk factors on a theoretical

model. Although community-level factors and policies are also likely to influence children's food consumption and physical activity patterns, there was limited research in these areas. Despite the evidence that socio-economic circumstances may differentially affect childhood overweight and its risk factors, few studies examined health inequalities. There was also a lack of longitudinal studies and consideration of confounding factors. Future research should address these gaps in the evidence base.

An accumulating body of evidence highlights the importance of obesity prevention in early life. Not only are overweight children at an increased risk of adult obesity (8), but a recent systematic review has demonstrated that early size and growth during infancy is related to an increased risk of obesity during childhood, adolescence, and adulthood (153). Health-related behaviours also develop early in life and often persist across the life course. For example, television viewing during the preschool years is a risk factor for overweight during early childhood (13,14,29,65,68,90) as well as adulthood (154). We also found that maternal factors during pregnancy and infant feeding decisions play a significant role in the development of overweight. Our review suggests that the prevention of early overweight should focus on parents, particularly mothers, and begin before or during infancy. Governments and national organisations need to develop and evaluate policies across domains, such as nursery school or day care and the community, to support a healthy lifestyle in parents and their young children.

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Table 1. Summary of evidence on policy-relevant factors related to overweight in children aged six months to five years (59 studies*).

		# Studies	Study methods			Country			Data collection		
			Cross-sectional	Longitudinal	Other	USA	European	Other	1980-1994†	1995-2005	Unknown
Child characteristics	Breastfeeding‡	11		7	4	7	3	1	2	8	1
	Weaning§	3		3		3				1	2
	Prolonged bottle use	3	3			3			1	1	1
	Drink consumption¶	8	5	3		7	1		3	5	
	Snack food consumption	5	5			1	2	2	3	2	
	Physical activity	17	12	4	1	11	4	2	9	3	5
	Television	9	7	1	1	7	2		3	6	
Family characteristics	Prepregnancy body size	9		8	1	8		1	2	4	3
	Smoking during pregnancy	13		9	4	7	6		4	8	1
	Maternal employment	2	1		1			2	2		
Community-level factors	Neighbourhood factors	3	3			2		1		3	
	School factors	3	2	1		1	1	1		3	
	Day care or nursery school factors	2	1		1			2	2		
Policy		0									

*Some studies examined multiple areas and have been counted more than once within the body of the table.

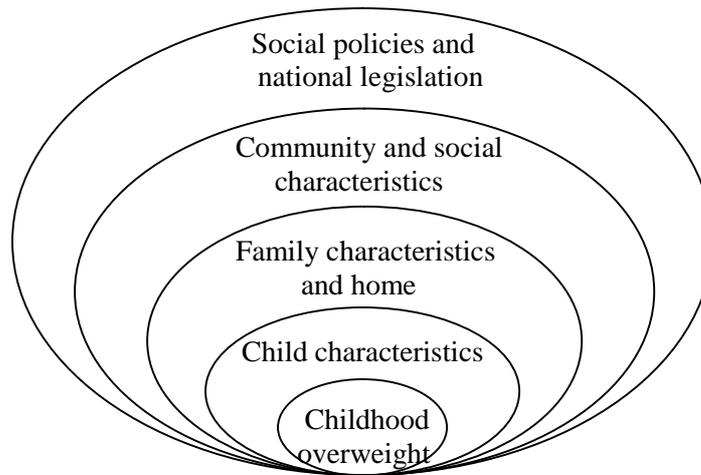
† For those papers published 1994 or earlier and no information is available on the time period of when the data were collected, the data were assumed to be collected within the 1980-1994 time period.

‡The five reviews on breastfeeding and later obesity are excluded from the table.

§ The one review on infant weaning and later obesity is excluded from the table.

¶ One study examined both fruit juice and sweetened drink consumption, but is reported only once.

Figure 1. Influences on childhood overweight: a modified ecological framework based on multiple sources (6,9,10).



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