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Overweight and obesity in early childhood affect weight status in the middle childhood years

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Abstract

Background: Overweight and obesity in the preschool years has become an established problem in Sweden.

Objectives: To study the development of weight status between the ages of 4-5 and 10-11 in two groups of different socioeconomic belongings and to create an overview of weight management programs for very young children.

Method: The study population was a group of children born in 1999, living in Lund or Burlöv. The 10 year-measurements were obtained through the School Health Care charts and later linked with data from the Child Health Care. Body Mass Index (BMI) was calculated and interpreted according to Cole et al (2000). The literature search was performed in Medline.

Results: Analysis included 798 children, showing that a significant part of the overweight/obese preschool children remained so at the age of 10 (Lund: 47.1%, Burlöv: 75.0%). Normal weight children most often did not change weight category (Lund: 90.8%, Burlöv: 82.1%). Living in a municipality with a lower socioeconomic status may have a negative impact on both the ability to resolve a weight problem and the risk of developing overweight. Seven studies of great diversity were included in the literature overview. All studies did involve parents and tried to modify diet habits and/or physical activity in some way.

Conclusion: Overweight at the age of 4-5 years is a strong predictive factor of being overweight at the age of 10. This correlation may be reinforced for a child living in a community with a lower socioeconomic status. More research is needed to define in what way early childhood overweight could be managed successfully.

Sammanfattning

Övervikt och fetma hos barn är ett växande problem i Sverige, liksom i resten av världen. Det har tidigare visats att barn som är överviktiga i tidig ålder löper stor risk att förbli överviktiga längre fram i tiden. Det är möjligt att insatser för överviktiga barn tidigt i livet skulle kunna förebygga ihållande övervikt och fetma upp i åldrarna.

Syftet med denna studie var att kartlägga utvecklingen av viktstatus mellan åldrarna 4-5 och 10-11 i två grupper med skilda socioekonomisk bakgrund samt att göra en sammanställning av studier som har provat åtgärdsprogram på överviktiga barn i förskoleåldern.

Den undersökta gruppen var barn födda 1999 som bodde i Lund och Burlöv, två kommuner med olika socioekonomisk profil, där Lund var bedömd att ha en högre socioekonomisk status och Burlöv en lägre. Uppgifter om längd och vikt från när barnen var 10 år inhämtades från skolhälsovårdsjournaler. Data fanns sedan tidigare insamlad från barnhälsovården och varje enskilt barns viktutveckling kunde följas. Body Mass Index (BMI) räknades ut och barnen klassades som normalviktigt, överviktigt eller fet enligt specifika gränser baserat på ålder och kön (Cole et al 2000).

Sammanlagt ingick 798 barn i analysen av utvecklingen av viktstatus. En betydande del av de barn som varit överviktiga/feta i 4-5 års ålder hade förblivit det vid 10 års ålder. I Lund var siffran 47.1 % och motsvarande siffra i Burlöv var 75.0 %. En stor majoritet av de som varit normalviktiga i förskoleåldern var även normalviktiga vid uppföljningen, 90.8 % i Lund och 82.1 % i Burlöv. Ett barn som tillhörde Burlövs kommun hade en relativt ökad risk att förbli överviktig upp i åldrarna eller att utveckla övervikt efter 4-5 års ålder, jämfört med ett barn som bodde i Lund.

Litteratursökningen, som gjordes i databasen Medline, resulterade i sju studier med program som prövats på överviktiga och feta barn i tidig ålder. Studierna var publicerade mellan 2007 och 2011 och varierade i längd, intensitet och innehåll. Alla studierna hade dock gemensamt att de framför allt riktade sig till föräldrarna och att de på olika vis försökte förändra kostvanor och/eller mängden av fysisk aktivitet.

Sammanfattningsvis har övervikt/fetma vid 4-5 års ålder ett starkt samband med övervikt/fetma vid 10 års ålder. Det här sambandet förstärks ytterligare om ett barn bor i ett samhälle med en lägre socioekonomisk status. Mer forskning behövs för att kunna klargöra på vilket sätt övervikt skulle kunna åtgärdas framgångsrikt hos barn redan i förskoleåldern.

Introduction

Overweight and obesity in the early childhood years (0-5 years) has become a worldwide problem with an overall global prevalence estimate of 6.7 % in 2010 according to a WHO report [1]. The percentage is calculated higher for developed countries exclusively, 11.7 % in 2010, while the developing countries have had the greatest rise from 1990 to 2010, an increase of 65 %, resulting in a prevalence estimate of 6.1 % [1].

In Sweden, the prevalence of overweight and obesity has increased steadily in all age groups during the last decades [2], but recent studies indicate that the epidemic may be leveling off among Swedish 10-year-olds [3-4]. This is in accordance with a report from the Swedish National Institute of Public Health saying that the prevalence of overweight (including obesity) among Swedish 10-year-olds was stable around 22 % from the academic year 2003/04 to 2007/08, while the obesity prevalence decreased from 4.9 % to 3.9 % [5]. In the county of Västerbotten in 2007/08 there had been a significant decrease of overweight among preschool children over the last five years, but numbers were still high with 19.0 % overweight among 4-year-old girls and 14.2 % among age equivalent boys, with obesity prevalence at 3.1 % and 2.3 % respectively [6].

Predictors of pediatric overweight and obesity

Many predictors and risk factors should be considered concerning childhood overweight and obesity. Early determinants that seem to affect childhood weight status are parental BMI, smoking during pregnancy, high birth weight and infantile growth pattern [7-9], while there are diverging results concerning the potential protective effect of breastfeeding [7, 10-11]. Especially, one or both parents being overweight or obese are strong predictive factors of childhood overweight and obesity [7-9, 12]. A systematic review by *Silventoinen et al*, of twin studies and adoption studies came to conclusion that both genetics and environmental factors seem to play a part in this correlation [13]. A lower socioeconomic status could have a negative effect on the prevalence of overweight and obesity [4, 7, 9, 14-15], although, it has been proposed that this effect will not show until after the age of 3 years [8].

Development of weight status over time

Several studies have tried to analyze the impact of early childhood overweight on later childhood and adolescence overweight.

Overweight and obesity among children during the preschool years correlate with an increased risk of being overweight at the age of eleven and twelve compared to children who were of normal weight during the same period of childhood [16-17]. A prospective cohort study analyzed the stability of BMI during childhood and found that the majority of children aged five to ten years at baseline remained in the same weight category (normal weight, overweight or obese) at follow-up three years later [18]. Other studies confirm that it is more likely for overweight preschool children to remain overweight in early adolescence rather than achieve normal weight [19-20]. This development of weight status during the middle childhood years, that is, whether the children are able to resolve their overweight problem or not, has also been associated to parental weight status and socioeconomic status [12].

A study by *Lagström et al*, showed that children who were overweight at age 13 deviated early on the growth charts. The mean age of established overweight was as early as five years for girls and eight years for boys [21].

Obesity prevention and treatment

There are numerous reviews evaluating primary prevention programs for preschool children, that is, programs intended to prevent the very onset of overweight and obesity, and thereby a lower incidence and prevalence [22-27].

At the other end of the spectrum, there is the established *disease*, obesity, which needs to be treated. In a recent Cochrane review of obesity treatment programs only six out of 64 studies had an age range that included children younger than six years. None of the mean ages of study participants in these six studies was under 7.5 years [28].

According to the Swedish national register of childhood obesity (BORIS) the mean age of patients at their first visit to initiate obesity treatment was 10.4 years in 2009 [29].

The Child Health Care should try to establish a healthy lifestyle for all children according to the regional policy. BMI registrations are made at the age of four, and children aged 4-6 years with obesity should be observed and remitted to a doctor. Those with overweight in these early ages normally don't get any specific intervention [30].

It is possible that something in between primary prevention and obesity treatment, a so called *secondary* prevention, could help overweight children in early ages to resolve their weight problem before it gets too serious, and thereby prevent sustained overweight and obesity in adolescence and adulthood. This project therefore aimed to:

- (1) Explore the development of weight status between the ages 4-5 and 10-11 in a group of children who lived in the municipalities of Lund and Burlöv in 2004-2005.
- (2) See if possible diverse outcomes were correlated to socioeconomic status.
- (3) Create an overview of studies of secondary prevention programs for overweight or obese children, younger than 10 years, that in some extent included preschool children (younger than 6 years).

Hence, answering the following question: How does weight status at 4-5 years correlate with weight status at the age of 10 while comparing groups of diverse socioeconomic belongings, and what are the possibilities of managing overweight children in early childhood?

Method

Study population

The study population was a group of children born in 1999. In 2004-05 they lived in Lund or Burlöv, two municipalities representing different levels of socioeconomic status in southern Sweden. The children were already a part of a big study of overweight and obesity and had had their weight and height registered at the Child Health Care Centers continuously.

Data collection

In Lund, the data of weight and height from when the children were 10-11 years (age range set to 9.5-11.75) and 8-9 years (age range set to 7.5-9.75) were obtained through the computerized charts of the School Health Care. All children registered in the Child Health Care data were searched for and those who were, or had been, registered in a school run by the city of Lund (that is, not independent schools) could be found.

In Burlöv, the data was obtained from the School Health Care charts on location, assuming that the majority of the children attended 6th grade. Values from the charts of all children born in 1999 were obtained and then later linked with the existing Child Health Care data.

Only children with registered weight and height at both assessment points (4-5 years and 10-11 years) were relevant in the main analysis.

Definition of child weight status

The date of birth and the dates of measurements were registered for all values in order to calculate the child's exact age at the time of measurement and thereby use the so called ISO-BMI to define weight status [31]. ISO-BMI is a method widely used in Sweden with age- and sex-specific cut-off values corresponding to overweight (25kg/m^2) and obesity (30kg/m^2) in adults, according to a definition by *Cole et al*, which is based on a reference population from six different countries worldwide [31]. The cut-off values for children aged 2-18 are varying with sex and age (6 months between).

The BMI of each child was calculated with the formula $\text{weight (kg)} / \text{height}^2 \text{ (m)}$. The exact age of the child at the assessment date was rounded to the nearest whole or half year as follows: $\geq x.25$ years rounded to $x.5$ years, $\geq x.75$ years rounded to the next whole year. The existing data with values for the measurements at 4-5 years didn't have exact dates for the collection time, but the child's age was given as x years +/- month(s), and this was rounded to the nearest half or whole year. Those children who didn't have registered +/- month(s) were assumed to have been 4 years and 5 years respectively at the time of measurements.

Children were then defined as normal weight, overweight or obese according to the definition by Cole, depending on BMI value, age and sex.

Socioeconomic status definition

Statistic material on the socioeconomic variables for the two municipalities was collected from Statistics Sweden (Statistiska Centralbyrån)[32], the National Board of Health and Welfare [33], Save the Children [34] and "Välfärdsbeskrivning Lunds kommun 2008" [35]. Explored variables were mean/median income level, level of education, prevalence of child poverty (which is defined by income level and social assistance) [34] and the "relative socioeconomic status" of the municipality (based on for example income level and level of education) from the National Board of Health and Welfare [33].

The aim was primarily to see if Burlöv could be defined as a more socio-economically challenged municipality, and after looking at these parameters it was considered to differ from Lund in socioeconomic status. (See appendix 1)

Statistics and data analysis

The analyses of data were performed in IBM SPSS Statistics 20. To explore correlations between background variables and outcomes Fisher's Exact Test was used. Logistic regression was used to calculate odds ratios. Dichotomous variables were used in all analyses.

Literature search

The literature search was performed in March 2012 in Medline. The search terms were *child, preschool* [MeSH Terms] AND (*overweight* [Title/Abstract] OR *obesity* [Title/Abstract]) AND *intervention* [Title/Abstract]. The search was limited to articles in English. The abstracts of all search results were read to identify articles who met inclusion criteria. Whenever doubts about the article's eligibility, the whole article was read also. The following criteria were used to include or exclude studies.

Inclusion criteria

An intervention of secondary prevention¹ of overweight and obesity in children

Randomized controlled studies or non-randomized controlled studies (pilot studies and cluster-RCTs allowed)

Participants < 10 years

Change in age-and sex-specific BMI z-score or percentile as a primary outcome

Length of intervention \geq 12 weeks

Exclusion criteria

Study not including children younger than 6 years

An intervention of primary prevention

Programs with content of any kind of medical treatment, special diet or surgery

¹ In this case a secondary prevention meant an intervention primarily directed to children who were either overweight or mildly obese, with the aim to prevent further excessive weight gain that otherwise could lead to severe obesity. To separate a secondary prevention from a more conventional obesity treatment the following aspects were considered:

- The intervention had to include children who were *overweight* (possibly including obese participants and/or children at specific risk of becoming overweight, according to BMI measures or other risk factors).
- Studies with participants older than 7 years had to exclude children being severely obese.

Ethical approval

The epidemiological part of this project is a population-based study of prevalence. Social security numbers were used to match data. Data collection included only values of weight and length at different ages, no other information was obtained. Ethical approval was given by the Ethical Review Board for human studies, Lund/Malmö, Sweden.

Results

There was a total amount of 1141 children, found through the child health care lists or the school health care charts. Out of these, 937 children (48 % girls, 52 % boys) belonged to the municipality of Lund and 204 children (55.4 % girls, 44.6 % boys) to Burlöv. Children then varied a bit in having valid numbers for the 4- and/or 5-year-assessments (Lund, n:916, Burlöv, n:161), the 10-year-assessment (Lund, n:710, Burlöv, n:137) and both (Lund, n:700, Burlöv, n:98).

The overall prevalence of overweight and obesity at the 5-year-assessment was 12.8 % and 3.2 % in Lund (n: 865), and 11.4 % and 6.3 % in Burlöv (n: 158) respectively.

At the 10-year assessment point the prevalence in Lund (n: 710) was 14.4 % and 2.1 %, while in Burlöv (n: 137) the prevalence was higher: 23.4 % of the children were overweight and 7.3 % were obese.

700 children from Lund and 98 children from Burlöv were included in the analysis of the development of weight status.

In Lund, 52.9 % of the children who were overweight or obese at 4 and/or 5 years had become normal weight by the age of 10, while the rest were overweight (39.0 %) or obese (8.1 %). In Burlöv, only 25 % had resolved their weight problem while 60 % were overweight and 15 % obese.

The majority of children who were normal weight at 4-5 years remained so at the age of 10. In Lund, 90.8 % had remained normal weight, 8.7 % had become overweight, while 0.5 % had

developed obesity. As for Burlöv, the numbers were a bit different, 82.1 % normal weight, 14.1 % overweight and 3.8 % obese.

A correlation between early childhood overweight and later adiposity was evident. Among overweight and obese 4-5-year-olds in Lund, 47.1 % had remained overweight or obese while only 9.2 % of the normal weight children had changed their weight status (p-value= <0.001). There was a reverse relationship showing that 55.2 % of the overweight 10-year-olds had been overweight already as 4-5-year-olds, while among the normal weight 10-year-olds only 12.3 % had been overweight at the age of 4-5 (p-value= <0.001).

In Burlöv, 75 % of the children who were overweight or obese at 4-5 years remained so at the age of 10, while 17.9 % of the normal weight 4-5-year-olds had become overweight / obese during the same time (p-value= <0.001). 51.7 % of the overweight 10-year-olds had been overweight at 4-5 years compared to 7.2 % of the normal weight 10-year-olds (p-value= <0.001).

The different patterns of weight development in the two municipalities are visualised in Table 1 and Table 2.

There was an increased odds ratio of being overweight at 10 years for those preschool children who were overweight compared to those with normal weight. In Lund the odds ratio (OR) was 8.75 (95%CI: 5.63-13.6 p-value= <0.001), and in Burlöv it was 13.7 (95%CI: 4.28-43.98, p-value= <0.001). When comparing the two municipalities, overweight preschool children in Burlöv showed an OR of 3.38 (95%CI: 1.16-9.81, p-value=0.025) to remain overweight at 10 years compared to overweight preschool children in Lund. For normal weight preschool children the OR to develop overweight was 2.15 (95%CI: 1.13-4.10, p-value= <0.001) if they lived in Burlöv compared to children living in Lund.

Table 1. Weight development of *overweight/obese* 4-5 year-olds

		Overweight/obesity at 10 years		Total
		No	Yes	
Lund	Count	72	64	136
	(%) of overweight/obese 4-5 year-olds	52,9%	47,1%*	100,0%
Burlöv	Count	5	15	20
	(%) of overweight/obese 4-5 year-olds	25,0%	75,0%*	100,0%
Total	Count	77	79	156
	(%) of overweight/obese 4-5 year-olds	49,4%	50,6%	100,0%

*P-value=0.03

Table 2. Weight development of *normal weight* 4-5-year-olds

		Overweight/obesity at 10 years		Total
		No	Yes	
Lund	Count	512	52	564
	% normal weight 4-5-year-olds	90,8%	9,2%*	100,0%
Burlöv	Count	64	14	78
	% normal weight 4-5-year-olds	82,1%	17,9%*	100,0%
Total	Count	576	66	642
	% normal weight 4-5-year-olds	89,7%	10,3%	100,0%

*P-value=0.03

Table 3. Baseline characteristics for those included at the follow-up and those not included.

BASELINE CHARACTERISTICS	LUND		BURLÖV	
	Included (n: 700)	Missing ¹ (n: 216)	Included (n: 98)	Missing ¹ (n: 63)
Gender	Boys: 51 % Girls: 49 %	Boys: 55 % Girls: 45 %	Boys: 45 % Girls: 55 %	Boys: 48 % Girls: 52 %
Weight status 4 years	(n: 671) Normal: 85.8 % Overweight: 11.9 % Obese: 2.2 %	(n: 205) Normal: 84.4 % Overweight: 13.7 % Obese: 2.0 %	(n: 97) Normal: 84.2 % Overweight: 12.6 % Obese: 3.2 %	(n: 61) Normal: 86.9 % Overweight: 13.1 % Obese: 0 %
Weight status 5 years	(n: 672) Normal: 84.4 % Overweight: 13.1 % Obese: 2.5 %	(n: 193) Normal: 82.4 % Overweight: 11.9 % Obese: 5.7 %	(n: 95) Normal: 80.4 % Overweight: 12.4 % Obese: 7.2 %	(n: 61) Normal: 85.2 % Overweight: 9.8 % Obese: 4.9 %
Mean age at 10- year- assessment	10.5 years SD: 0.4 Range: 9.5-11.7		10.4 years SD: 0.3 Range: 9.8-11.3	

¹Children missing at the follow-up were in some cases found in the School Health Care but didn't have the measurements registered.

Literature study

Seven studies were identified as eligible with the inclusion criteria (see table 4). Four of them were conducted in the USA and three in Australia. Publication dates ranged from 2007 to 2011.

Three studies were primarily parent-focused, three studies were family-focused (directed to both parents and child), and one study compared a parent-focused intervention, a child-focused intervention and a combination of both.

Parent-focused interventions

Schwartz et al [36] wanted to try the feasibility of an office-based parent-focused study using motivational interviewing (MI). Eligible children aged 3-7 years were either overweight (excluding obese children) or normal weight with at least one parent being obese ($BMI > 30 \text{ kg/m}^2$). This pilot study consisted of two different intervention groups. One group attended one single 10-15 minute MI session with a physician, while for the intensive intervention group this session was followed by a 45-50 minute MI session with a dietitian.

The intensive group then had the same procedure two months later. Results at 6 months showed no significant difference in BMI percentile decrease between the three groups.

The 1-year-outcome of an RCT, also using motivational interviewing as intervention methodology, has been published by *Taveras et al [37]*. This parent-focused intervention was facilitated by pediatric nurse practitioners and targeted habits of diet and physical activity. Participants, aged 2-6 years, were either overweight (with at least one parent having a BMI $>25 \text{ kg/m}^2$) or obese. One-year-outcomes showed no significant group differences in BMI z-score change.

Magarey et al[38] conducted a study in Australia with participating children being overweight or obese and aged 5-9 years. The intervention was directed to parents and consisted of a Healthy Lifestyle Education facilitated by a dietitian, where half of the participants also attended a parenting skills program in four additional sessions. Both groups showed a significant decrease in BMI z-score, but there was no difference between the two groups. Overall a 10% relative weight loss was achieved at 6 months and this change was maintained at 24 months.

Family-focused interventions

The effect on BMI by reducing television viewing and computer use was explored by *Epstein et al [40]*. Participants, aged 4-7 years, were obese, overweight or in the upper reference interval of normal weight. Screen time budget was reduced by 50% using a TV allowance device, while the control group had free access to sedentary behavior.

There was a significant inter-group difference in the change of BMI z-score at 6 and 12 months, but this significance was lost at 18 and 24 months. However, among families with a low socioeconomic status this change was maintained through 24 months.

McCallum et al [41] described an RCT conducted in a primary care setting with the objective to reduce gain in BMI in overweight and mildly obese children aged 5-9 years.

General practitioners were trained to use a brief solution-focused therapy, which they used to set appropriate healthy lifestyle goals with the family. Parents and children attended four consultations over a 12-week period. There was no significant difference between groups in BMI z-score change from baseline at the 9 and 15 months assessments.

Table 4	Study design	Participants	Weight status definition	Length of intervention	Intensity	Facilitator	Description of intervention and main results	Significant reduction of BMI
Collins et al. 2011. Australia [39]	RCT	Age: 5-9 n: 206 1. Overweight 2. Obese	IOTF ¹	6 months	Weekly group sessions during the first 10 weeks	Dietitians Physical education teachers	A 3-armed study with participants entering a parent-focused dietary-modification program, a child-centered physical activity-program or a combination of both programs (no specific control group). Significant reductions of BMI z-score in all groups compared to baseline.	Yes, at 6, 12 and 24 months.
Epstein et al. 2008. USA [40]	RCT	Age: 4-7 n: 70 1. Overweight 2. Obese 3. Upper interval of normal weight	2000 CDC ² growth charts	24 months	24 hour TV-allowance device	Not specified	With the help of a TV allowance device, budgets for TV viewing and computer use were reduced by 10 % of the baseline amount per month until the budget was reduced by 50 %. Control group had unlimited access to sedentary behavior. Significant reductions of BMI z-score at 6 and 12 months. Lower SES-families had significant results from 6 months through 24 months.	Yes, at 6 and 12 months. Not maintained at 18 and 24 months.
Magarey et al. 2011. Australia [38]	RCT	Age: 5-9 n: 169 1. Overweight 2. Obese	IOTF	6 months	8-12 group sessions and 4 telephone sessions during 6 months	Dietitians	A parent-focused program with group sessions giving recommendations of core food servings, healthy eating, reduced sedentary behaviors and increased activity. Half of the sample had 4 additional sessions of parenting skill training. No specific control group. Significant reduction of BMI z-score compared to baseline. No difference between groups.	Yes, at 6 months. Maintained through 12, 18 and 24 months.
McCallum et al. 2007. Australia [41]	RCT	Age: 5-9 n: 163 1. Overweight 2. Obese	IOTF	3 months	4 consultations during 3 months	General practitioners	Four standard consultations in the primary care with a general practitioner who used a brief, solution-focused approach to set appropriate healthy lifestyle goals together with the family. Targeting change in nutrition, physical activity and sedentary behavior. No significant reduction of BMI z-score.	No. (Follow-up at 9 and 15 months)

	Study design	Participants	Weight status definition	Length of intervention	Intensity	Facilitator	Description of intervention and main results	Significant reduction of BMI
Schwartz et al. 2007. USA [36]	Pilot non-RCT	n:91 Age: 3-7 1. Overweight 2. Normal weight if parent's BMI > 30kg/m ²	2000 CDC growth charts	6 months	1 MI-session <i>or</i> 2x2 MI-sessions	Pediatricians Dietitians	Office-based parent-focused study using motivational interviewing (MI) to change dietary habits and sedentary behavior. Two different intervention-arms: (1) Minimal intervention: At 1 month, MI session à 10-15 min with a pediatrician. (2) Intensive intervention: At 1 and 3 months, MI session with pediatrician for 10-15 min followed by a MI session with dietitian for 45-50 min. No significant reductions of BMI percentile.	No. (Follow-up at 6 months).
Stark et al. 2011. USA [42]	Pilot RCT	Age: 2-5 n: 18 Obese + parent's BMI >25kg/m ²	2000 CDC growth charts	6 months	Weekly sessions during first 12 weeks followed by sessions every other week for another 12 weeks.	Psychologists	Intervention alternating group-based clinic sessions with individual home visits. Parent group addressed three components: <i>dietary education, physical activity, parenting skills.</i> Calorie goals and pedometers with physical activity goals for both children and adults. Child groups had nutrition education, tried new foods, and 15 min of moderate to vigorous activity. Parent and child weighed at each clinic visit. In-home sessions (60-90 min) were designed to support clinic-taught skills. Significant reductions of BMI z-score.	Yes, at 6 months. Maintained through 12 months.
Taveras et al. 2011. USA [37]	Cluster RCT	Age: 2-6 n: 475 1. Obese 2. Overweight if parent's BMI >25kg/m ²	2000 CDC growth charts (probably)	24 months	4 MI-sessions and 3 telephone sessions during first 12 months	Pediatric nurses	Parent-focused study motivational interviewing in primary care with the aim to modify habits of diet and physical activity. Parents had access to an interactive Web site with educational materials, recipes, and other features. No significant reductions of BMI z-score at 12 months.	No. Follow-up at 12 months. (Follow-up planned at 24 months)

¹IOTF: International Obesity Task Force [31]

²CDC: Center for Disease Control and Prevention [43]

Stark et al [42] piloted a study comparing enhanced standard of care (PC) to a clinic- and home-based intervention (LAUNCH). Participants were aged 2-5 years, classified as obese (severe obesity excluded) and had at least one parent with overweight.

The intervention group (LAUNCH) alternated group-based clinic sessions (both parent and child groups) and individual home visits, focusing on dietary education, physical activity and parenting skills. This pilot study showed that children in LAUNCH had significantly greater decrease in BMI z-score and BMI percentile and less weight gain than children in PC group at both 6 and 12 months.

Parent-focused, child-focused and a combination of both

Collins et al [39] conducted a 3-armed RCT comparing three interventions. Participants were overweight or obese 5 to 9-year-olds and their parents. One group participated in a parent-centered dietary-modification program facilitated by dietitians and one group in a child-centered physical activity skill-development program and the last group got a combination of both. Results showed that the parent-centered diet program was significantly more efficacious than the child-centered activity program but not different from the combined program.

Discussion

The follow-up study of 798 children showed clear evidence that overweight and obesity at an early age is a predictive factor for later childhood adiposity. Results from both Lund and Burlöv could show that a significant part of the overweight/obese preschool children remained so at the age of 10 years (47.1 % and 75 % respectively). In Lund, the great majority (90.8%) of normal weight preschool children also stayed in their weight category, while in Burlöv there was a considerable percentage (17.9 %) that had developed overweight/obesity. *Mamun et al [20]*, in Australia, showed similar results exploring the weight development between the age of 5 and 14, with almost two-thirds remaining overweight and 17 % of the normal weight children developing overweight. *Hesketh et al [18]* described an even lower percentage, 19.8 %, of overweight/obese children resolving their weight problem, and only 11.1 % changed from non-overweight to overweight. However, these children were between 5 and 10 years at baseline with follow-up three years later.

The overall prevalence of overweight (including obesity) at 10 years was lower in Lund (16.5 %) than the estimated prevalence for Swedish 10-year-olds during the last years (22 %) [5], while Burlöv had a higher prevalence (30.7%).

There was in fact a significant difference in the outcomes depending on which municipality the child belonged to. Living in Burlöv had a negative impact on both the ability to resolve a weight problem and the chance to remain normal weight through the years. The socioeconomic status of the children was set at a group level and the actual socioeconomic status of the included children could of course not be known. In this case no further analysis could be done to find a correlation to some specific socioeconomic factors, and the possibility of confounders, for example parental overweight, has to be considered.

Overall, it was a big sample of children included in the analysis, which of course strengthens the study. However, there were some limitations. Because of the much smaller sample of children from Burlöv, the weight categories “overweight” and “obesity” were put together as one group most of the time. Therefore, the results have to be interpreted carefully when it comes to the group of children who were overweight/obese at 4-5 years and their development of weight status. There was a statistical significant difference between Lund and Burlöv when comparing the percentage of children remaining overweight or obese, which could also be expressed as an OR of 3.38 comparing Burlöv to Lund. Since the baseline characteristics of the included children differed in the prevalence of obesity at the age of 5 (Burlöv: 7.2 %, Lund: 2.5 %), but showed similar percentage of overweight children, it has to be considered that Burlöv did have a bigger share of obese children at baseline compared to Lund, something that could have affected the outcome. It should also be noted that the ratio of boys and girls differed in the two groups.

The retention rates from baseline to follow-up were 76 % and 61 % for Lund and Burlöv respectively. Some children were found in the charts but didn't have values from the 10-year-assessment. Children who were not found at all were assumed to have moved out of the municipality, to be in an independent school or in a school belonging to another city. It is clear that Lund did have a higher prevalence of obesity at baseline among the missing children compared to the included ones. Burlöv on the other hand, did have a lower prevalence of obesity in the missing-group compared to the included children. These differences are not statistically proven but it is possible that the results would have turned out

a bit differently if the development of weight status could have been explored including these missing children.

Literature study

The included studies were all published after 2007, indicating that this kind of intervention is a quite new approach to manage early childhood overweight, and they were all conducted in the United States or Australia. One study, *Stark et al*, exclusively included children who met the criteria for obesity (although excluding extremely obese children), but since the age group was very young (2-5 years, mean age 4.7) this intervention was considered a secondary prevention anyway [42].

The length of interventions ranged from 6 to 24 months. All studies aimed in one way or another to increase the amount of physical activity and/or change the diet habits of the child and family. The facilitators of interventions showed a great variety including dietitians, psychologists, pediatric nurses, pediatricians, general practitioners and physical education teachers, as did the way interventions were delivered; group sessions, individual MI sessions, telephone sessions, individual home visits, TV allowance device and GP consultations. The intensity of interventions varied considerably, ranging from two occasions of motivational interviewing during 6 months to weekly group or home sessions during three months followed by sessions every other week during three months.

All studies were directed either to the whole family or to the parents exclusively. Two studies, *Magarey et al* and *Stark et al*, even had a special component of parenting skills. The study of *Collins et al*, which included three different types of interventions, had a lower decrease of BMI z-score in the group where only children were involved compared to the groups where parents were involved. It is not evident, however, if this difference depended on the actors of change or the target of intervention (diet versus physical activity).

Three studies, *Schwartz*, *Taveras* and *Stark*, considered the parents' weight status when recruiting children to the trials. This is in accordance with evidence of parental weight status being a strong predictor of childhood overweight and obesity [7-9, 12]. However, only one of these studies, *Stark et al*, actually followed the weight development of both children and adults, weighing them at each clinic visit and having the parents receiving the same intervention components as the children.

Epstein et al. took the socioeconomic status (SES) of the participants in consideration and could show that their intervention helped children of a lower SES to a greater extent than the children with a higher SES. As stated in the introduction, socio-economic status seem to play a part in the prevalence and maintenance of overweight [4, 7, 9, 14-15] and it could obviously be interesting to evaluate an intervention in groups with different socioeconomic background.

The primary aim of this literature overview was to clarify what kind of interventions that have been tried on quite young children with overweight. The quality of the included studies has not been assessed, two studies were pilot studies and only one database was searched.

Because of this, and as the studies were quite diverse in setting, length, intensity and time to follow-up, no further analysis of the outcomes was made. It is hard to come to a conclusion of what kind of intervention that could be successful in helping overweight children at an early age. In the future, more randomized controlled studies of this secondary prevention approach are needed and a systematic literature review should be done.

Conclusion

Overweight at the age of 4-5 years is a strong predictive factor of being overweight or obese at the age of 10, and this correlation is reinforced for a child living in a community with a lower socioeconomic status. More research is needed to define how early and in what way childhood overweight could be managed successfully.

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Appendix 1.

SOCIOECONOMIC STATUS	Burlöv	Lund
Income level (mean), SEK 2009 [32, 35]	232 000	289 000
Income level (median), SEK 2009 [32, 35]	235 000	272 000
Higher education 2006 [32, 35]	30 % (2010)	57,9 %
Unemployed 2006 [32, 35]	9 % (2010)	7,8 %
Child poverty 2006 [34]	17,1 %	10,4 %
Social assistance 2010 [33]	5,8 %	3,0 %
”Relative socio-economic status” 2010 [33]	9	2

Population 20-64 years, (excluding university students in Lund)