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Socioeconomic status, adiposity, and cardiometabolic risk factors at preschool age. A systematic review

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Submitted

ABSTRACT

Objective

Much remains to be understood about the socioeconomic inequalities in cardiovascular disease, of which risk factors originate in childhood. Therefore, this systematic review aims to describe the relation of socioeconomic status (SES) with cardiometabolic risk factors including adiposity at preschool childhood (ages 2 to 5 years) in developed countries.

Design and Methods

PubMed, EMBASE.com, PsycINFO and The Cochrane Library from inception to June, 2012 were searched for associations of SES to cardiometabolic risk factors.

Results

Twenty-five studies were identified, of which the majority (n=24) assessed adiposity. Combining two studies that were identified twice, 11 studies found no association, 6 studies found an inverse association (i.e. higher risk in lower SES), and 5 studies found a mixed association with a mixture of no association, an inverse association or a positive association depending on the used SES-measure. Studies that take ethnicity into account adequately, found no association between adiposity and SES.

Conclusions

At preschool age, there appears to be no association between SES and adiposity. Studies with adequate control for confounding factors are needed to confirm or refute the associations between socioeconomic status and other risk factors for cardiovascular disease. As a socioeconomic gradient seems to emerge after preschool age, this period is crucial for targeting interventions.

INTRODUCTION

There is strong evidence for the link between socioeconomic status (SES) and cardiometabolic risk factors,[35,176,177] that include adiposity, elevated blood pressure, elevated low-density lipoprotein cholesterol, low high-density lipoprotein cholesterol, and elevated blood glucose. Since there is increasing evidence that cardiometabolic risk factors originate in childhood, it is pertinent to clarify the socioeconomic gradient on cardiometabolic risk factors in children.

The socioeconomic gradient in cardiometabolic risk factors is best described for adiposity. A review from 1989 showed that the relationship between SES and childhood adiposity was inconsistent.[178] In view of the increasing prevalence of childhood adiposity in recent decades, Shrewsbury and Wardle (2008)[35] updated this review for children between 5 and 18 years of age and concluded that associations between SES and adiposity in children are predominantly inverse.

However, it is not known to what extent this association already exists in the preschool years. At preschool age, adiposity appears to be a poor indicator of cardiometabolic risk factors.[177] These risk factors, however, may be predictive of the subsequent development of cardiovascular disease.[179,180] Thus understanding socioeconomic influences on cardiometabolic risk factors at the preschool age, besides adiposity indicators, is important.

Therefore, this paper presents a systematic review of the current evidence for the relation of SES to cardiometabolic risk factors at preschool childhood (ages 2 to 5 years) from developed countries. First, we review evidence of associations between SES and obesity/overweight, blood pressure, fat percentage, triglycerides, cholesterol, and insulin sensitivity. Secondly, we discuss implications of these findings and finally we make recommendations for further research.

METHODS

A comprehensive systematic search was done in the bibliographic databases PubMed, EMBASE.com, PsycINFO (via EBSCO) and The Cochrane Library (via Wiley) from inception to June 8, 2012. Search terms included controlled terms from MeSH in PubMed and EMtree in EMBASE.com, thesaurus terms in PsycINFO as well as free text terms. We used free text terms only in The Cochrane library. Search terms expressing 'socioeconomic status' were used in AND-combination with search terms comprising 'cardiometabolic risk factors' and terms for 'preschool children' (Table 6.1).

Table 6.1. Search strategy in PubMed June 8, 2012.

Set	Search terms	Result
#1	"Socioeconomic Factors"[Majr] OR "Income"[Majr] OR "Educational Status"[Majr] OR "Socioeconomic"[tiab] OR "Socio-economic"[tiab] OR "social economic"[tiab] OR SES[tiab] OR "High-Income Population"[tiab] OR "household income"[tiab] OR "parental education"[tiab] OR "maternal education"[tiab] OR "paternal education"[tiab] OR "academic degree"[tiab] OR "academic education"[tiab] OR "academic level"[tiab] OR "educational level"[tiab] OR "education degree"[tiab]	169356
#2	"Exercise Movement Techniques"[Majr] OR "Motor Activity"[Majr] OR "Activities of Daily Living"[Majr] OR "Sports"[Majr] OR "Physical Fitness"[Majr] OR "Exercise"[Majr] OR "Life Style"[Majr] OR "Health Behavior"[Majr] OR "Nutrition Disorders"[Majr] OR "Nutritional Physiological Phenomena"[Majr] OR "Nutritive Value"[Majr] OR "Diet Surveys"[Majr] OR "Food and Beverages"[Majr] OR "Child Behavior"[Mesh] OR "Drinking Behavior"[Mesh:NoExp] OR "Feeding Behavior"[Mesh] OR "Overnutrition"[Mesh] OR "Body Weights and Measures"[Mesh] OR "obese"[tiab] OR obesit*[tiab] OR "overweight"[tiab] OR "Body Mass"[tiab] OR thinness[tiab] OR "Body Fat Distribution"[Mesh] OR "Anthropometry"[Majr:NoExp] OR "Waist-Hip Ratio"[Mesh] OR "Heart Rate"[Majr] OR "Blood Pressure"[Mesh] OR "Hypertension"[Majr:NoExp] OR "Diabetes Mellitus"[Mesh] OR "Prediabetic State"[Mesh] OR "Hyperglycemia"[Majr] OR "Blood Glucose/metabolism"[Majr] OR glucose/blood[Majr] OR "Somatomedins"[Majr] OR "Insulin Coma"[Majr] OR "Cholesterol"[Majr] OR "Health Status Disparities"[Majr] OR ((sport*[tiab] OR exercise*[tiab] OR "physical activity"[tiab] OR "sedentary"[tiab] OR "inactivity"[tiab] OR "inactive"[tiab] OR "sitting"[tiab] OR nutriti*[tiab] OR diet[tiab] OR diets[tiab] OR dietary[tiab] OR food[tiab] OR fruit[tiab] OR meal*[tiab] OR breakfast[tiab] OR supper[tiab] OR tea[tiab] OR dinner[tiab] OR lunch[tiab] OR snack*[tiab] OR eat*[tiab] OR 5-a-day[tiab] OR "Blood Pressure"[tiab] OR "Heart Rate"[tiab] OR (type[tiab] AND (2[tiab] OR II[tiab]) AND diabetes[tiab]) OR "diabetes 2"[tiab] OR "diabetes II"[tiab] OR metabolic control[tiab] OR glycemi*[tiab] OR euglycem*[tiab] OR euglycaem*[tiab] OR normoglycem*[tiab] OR normoglycaem*[tiab] OR hyperglycemi*[tiab] OR glycaemi*[tiab] OR hyperglycaemi*[tiab] OR cholesterol[tiab]) NOT medline[sb])	1850568
#3	"Child, Preschool"[Mesh] OR (preschool*[tiab] AND (child*[tiab] OR schoolchild*[tiab] OR boy[tiab] OR boys[tiab] OR boyhood[tiab] OR girl[tiab] OR girls[tiab] OR girlhood[tiab]))	693020
#4	#1 AND #2 AND #3	3352
#5	#4 NOT ("addresses"[Publication Type] OR "biography"[Publication Type] OR "comment"[Publication Type] OR "directory"[Publication Type] OR "editorial"[Publication Type] OR "festschrift"[Publication Type] OR "interview"[Publication Type] OR "lectures"[Publication Type] OR "legal cases"[Publication Type] OR "legislation"[Publication Type] OR "letter"[Publication Type] OR "news"[Publication Type] OR "newspaper article"[Publication Type] OR "patient education handout"[Publication Type] OR "popular works"[Publication Type] OR "congresses"[Publication Type] OR "consensus development conference"[Publication Type] OR "consensus development conference, nih"[Publication Type] OR "practice guideline"[Publication Type])	3295

Inclusion and exclusion criteria

Studies were included if they met the following criteria: (i) assessment of at least one risk factor for later cardiovascular disease including overweight, obesity, skin fold thickness, hypertension, hypercholesterolemia, insulin sensitivity; (ii) assessment of at least one socioeconomic indicator, including education, occupation, income, neighbourhood indicators, or a composite score from one of these indicators; (iii) age: two to five years old. We excluded studies if they: (i) assessed participants of which the majority was younger or older than two to five years or SES-analysis were not performed in this age range; (ii) assessed from non-high income countries as classified by the World Bank (Gross National Income per capita 2011 > US$12,276)[181]; (iii) assessed only one socioeconomic group or focussed on one ethnic minority group; (iv) certain publication types: editorials, letters, legal cases, meeting reports, and interviews.

Selection process

Two reviewers (GvdB and EPJ) independently screened all potentially relevant titles and abstracts for eligibility. If necessary, the full text article was checked for the eligibility criteria. Differences in judgment were discussed until consensus was achieved. Then the full text of articles was obtained for further review. Results from multivariate analysis, adjusting for participant characteristics (especially race/ethnicity) are preferred over univariate analysis, though studies with univariate analysis only were included as well. In order to describe the association between SES and cardiometabolic risk factors we used the terms inverse association, positive association, and no association. For example, an inverse association was the case if the highest SES group had the lowest adiposity prevalence. P-value < 0.05 was regarded as significant. A flowchart of the selection procedure is depicted in Figure 6.1.

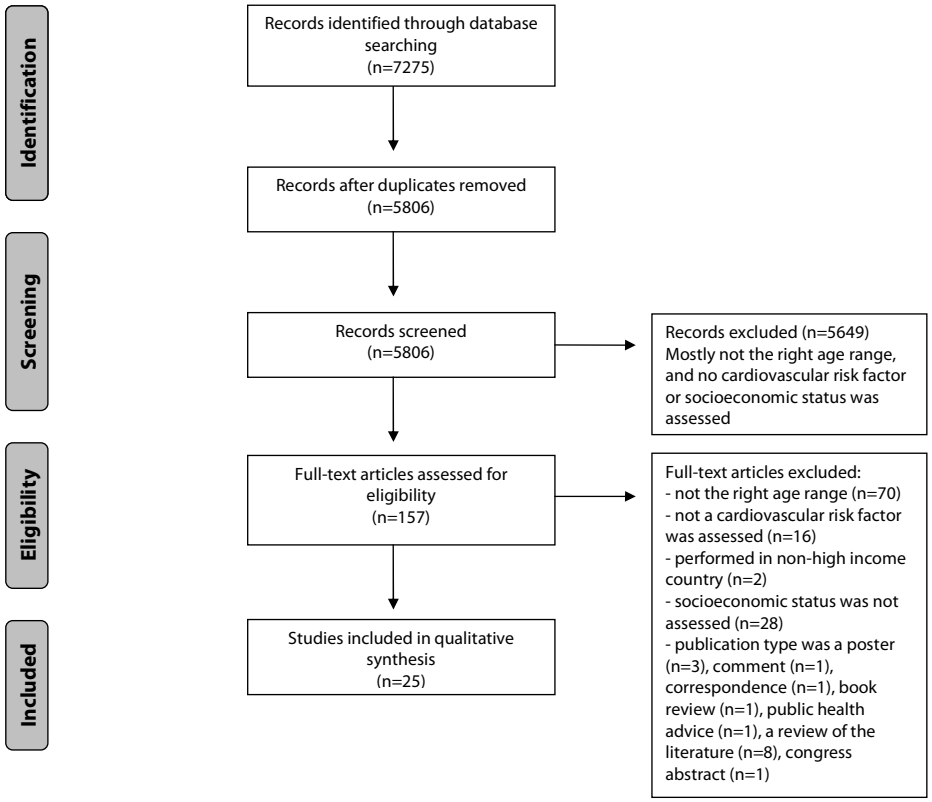

Figure 6.1. Flowchart of the selection procedure

RESULTS

The literature search generated a total of 7275 references: 3295 in PubMed, 2820 in EMBASE.com, 748 in PsycINFO and 412 in The Cochrane Library. After removing duplicates of references that were selected from more than one database, 5806 papers remained. 157 full-text articles were assessed for eligibility and 25 studies were included in qualitative analysis. Studies were excluded because no cardiometabolic risk factors were measured (e.g. diabetes mellitus type I), no SES differences were measured (e.g. only one SES group included), or the majority of examined children were beyond preschool age range.

We identified 25 articles that addressed socioeconomic inequalities in cardiometabolic risk factors in preschool children. The majority of articles assessed socioeconomic inequalities in adiposity (Table 6.2) (n=23), others assessed, blood pressure (n=1), or adiposity and blood pressure (n=1). No studies were found about SES and cholesterol, insulin resistance, triglycer-

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children.

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Household-SES								
Alaimo et al NHAMES III US	Cross-sectional	1988-1994	5200	2-7	Family income (high, middle, low)	Overweight, >85th percentile weight-for-height and IOTF criteria BMI	0 Stratified analyses by race/ethnicity and gender	
Al-Isa, Moussa Kuwait	Cross-sectional	1994-1995	3473	3-5	Parental education Composite score based on parental education, occupation, income, area of residence and number of servants (low, mid, high).	Overweight, 90th – 95th percentile weight-for-height Obesity, ≥ 95th percentile weight-for-height NCHS reference	+ overweight and maternal education - Overweight/obesity and composite measure	
Anderson, Whitaker Early Childhood Longitudinal Study-B US	Prospective cohort	2005	8550	4	Maternal educational level (bachelor, some college, high school, less than high school) Household income-to poverty ratio (5 categories)	Obesity, ≥ 95th percentile BMI US 2000 growth reference	-	
Kitsantas and Gaffney Early Childhood Longitudinal Study-B, UK			7290		Composite score based on parental income and education (low, mid, high)	Overweight, 85th – 95th percentile BMI Obesity, ≥95th percentile BMI US 2000 growth reference		

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children. *(Continued)*

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Household-SES								
Baughcum et al WIC and CPRG US	Cross-sectional	1998-1999	622	2-5	Maternal educational level (high, low)	Overweight, ≥ 90th percentile weight-for-height US CDCP reference	-	
Burgi et al. Ballabeina-study Switzerland	Cross-sectional	2008-2009	485	4-6	Parental educational level (high/middle, low) Maternal/paternal educational level (5 categories)	Overweight, obesity IOTF criteria, BMI Sum of 4 skinfold thicknesses	0	
Ebenegger et al Ballabeina-study Switzerland			542		Parental educational level (low, high) Maternal/Paternal educational level (low, high)	Overweight (including obesity) BMI (definition unknown) Swiss 1989 references Body fat (bioelectronical impedance device; continuous) Percent body fat (bioelectronical impedance device; %)	-	0 Adjustment for parental migrant status

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children. *(Continued)*

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Household-SES								
Broyles SCAN US	Prospective cohort	unknown	345	4	Hollingshead two-factor, composite measure based on education and occupation (5 categories)	BMI (continuous), Triceps and subscapular skinfolds (continuous)	0	
De Spiegelaere et al Belgian	Cross-sectional	1986-1990	675	3 and 5	Parental occupation (5 categories)	Obesity, ≥ 95th percentile BMI French 1991 reference	0 Only Belgian children	
Gerald et al Mobile Pregnancy Study US	Cross-sectional Disadvantaged population from a paediatric clinic	1991	77	2-5	Caretaker's income (continuous, range: 0-2000+) Family per capita income (determined by household size and income) Hollingshead (composite measure of occupation and education from both parents; continuous, range: 8-66)	Weight-for-height ratio (continuous) US NCHS percentiles 1979	0 Exception: - weight-for-height and Hollingshead	

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children. *(Continued)*

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Household-SES								
Gillman et al Project Viva US	Prospective cohort	1999-2002	1110	3	Maternal education (some college or less, ba or bs, graduate) Household income (3 categories, 57 missings)	Overweight, ≥95th percentile BMI US 2000 growth reference		0 Adjustment for 8 variables including race/ethnicity
Hawkins et al Millennium Cohort Study, UK	Prospective cohort	2000-2002	13113	3	Maternal occupation (6 categories) Household income (4 categories)	Overweight (including obesity), IOTF criteria, BMI	-	
Hernandez et al Florida Head Start program US	Retrospective cohort	unknown	309	3-5	Financial status (below poverty, above poverty)	Obesity, > 90th percentile weight-for-height US NCHS reference 1990	0	
Howe et al ALSPAC, UK	Prospective cohort	1991 – 1992	5850 boys 5530 girls	2-6	Maternal education (below O-level, O-level, A-level, degree)	BMI (continuous)	0 for boys + for girls 2y of age - for girls 4 y of age	
Lioret et al INCA survey France	Cross-sectional	1998-1999	242	3-5	Head of household occupation (high, middle, low)	Overweight, obesity IOTF criteria, BMI	0	
Locard et al GREPS France	Case-control	1988-1989	327 cases 704 controls	5	Maternal education (< secondary, secondary, > secondary)	Obesity, > 2 SD weight-for-height Sempe's reference, France 1979	0	

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children. *(Continued)*

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Household-SES								
Manios et al GENESIS, Greece	Retrospective cohort	2003-2004	2374	1-5	Maternal/paternal education (≤9, 10-14, >14 years)	Overweight, 85th – 95th percentile BMI Obesity ≥ 95th percentile BMI US 2000 growth reference IOTF criteria, BMI	0	
Patterson US	Cross-sectional	1983	94	2-5	Maternal/paternal education (4 categories)	Overweight, obesity, > 75th and >90th percentile weight-for-height NHANES standards Triceps skin folds (continuous)	- Adiposity and maternal education 0 Adiposity and paternal education	
Ruijsbroek et al PIAMA-cohort The Netherlands	Prospective cohort	1996 – 1997	3963	3,4,5	Maternal education (low, mid, high)	Overweight (including obesity) IOTF-criteria, BMI	0	
Sherman WIC program US	Cross- sectional	< 1995	377	3-5	Green's two-factor index based on education and occupation of head of household (high, low).	Obesity, ≥ 85th percentile weight-for-height NCHS reference	- Stratified analyses by Mexican-American and Anglo.	

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children. *(Continued)*

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Household-SES								
van Rossem et al Generation R The Netherlands	prospective cohort	2002-2006	2954	2 and 3	Maternal education (4 categories) Household income (high, low)	Overweight, obesity IOTF criteria, BMI	0 only children with a native Dutch mother	0 Adjustment for several prenatal, perinatal and postnatal factors
Wake et al LSAC Australia	Cross-sectional	2004	4934	4-5	Maternal education (< 12, 12, tertiary) Parental occupation (standard classification, 4 categories) Family income (continuous)	Overweight, obesity, ≥ 95 percentile BMI US 2000 growth reference IOTF criteria, BMI Waist circumference (continuous)	-	0 Adjustment for various variables, including aboriginal (yes/no).
Neighbourhood-SES								
Armstrong et al NCHS-P Scotland	Cross-sectional	1998-1999	64484	3-4	Area based from data for overcrowding, unemployment, social class, and car ownership. (7 categories)	Obesity,> 98th percentile BMI UK 1990 reference	-	- Adjustment for birth weight
Nichols et al MaCHS Australia	Retrospective cohort	1999-2007	2: 122410 3.5: 90254	2 and 3.5	SEIFA , index at the postcode of residence level (quartiles)	Overweight, obesity IOTF criteria, BMI	-	- Adjustment for gender, feeding and indigenous or not indigenous

Table 6.2. Studies reporting adiposity by socioeconomic status (SES) in preschool children. *(Continued)*

Authors	Design	Year of cohort recruitment	Sample preschool children	Age	Socioeconomic status (SES)	Adiposity*	Relevant findings in univariate analysis**	Relevant findings in multivariate analysis
Neighbourhood-SES								
Wake et al LSAC Australia	Cross-sectional	2004	4934	4-5	SEIFA, index at the postcode of residence level (quintiles)	Overweight, obesity, ≥ 95 percentile BMI US 2000 growth reference IOTF criteria, BMI Waist circumference (continuous)		- Adjustment for various variables, including aboriginal (yes/no).

*IOTF indicates International Obesity Task Force, NCHS indicates National Center for Health Statistics, CDCP indicates Centers for Disease Control and Prevention, NHANES indicates National Health and Nutrition Examination Survey.

**Indicates no association, - indicates an inverse association, + indicates a positive association

ides or other indicated cardiometabolic risk factors. Selected studies were conducted in the US (n=10), Europe (n=12), Australia (n=2), and Kuwait (n=1).

Socioeconomic status indicators

Most studies measured household levels of SES (n=20), that is parental education,[39,182-193] occupation,[192,194-196] family income,[39,183,187,192,195,197,198] financial status[199] and/or a composite measure of these factors.[182,198,200-202] Four studies used a SES measure at neighbourhood level based on postal code[192,203] or other area-based characteristics.[204,205] Some studies assessed more than one indicator of SES.

Cardiometabolic risk factors

The most frequently evaluated cardiometabolic risk factor was adiposity. Adiposity was indicated by body mass index (BMI) (n=17), weight-for-height-ratio (n=8), skin fold thicknesses (n=3), body fat (n=1), percentage body fat (n=1), and waist circumference (n=1) as can be seen in Table 6.2. BMI was analysed as a continuous variable in two studies, and as a categorical (no adiposity; overweight; obesity) or dichotomous (nonoverweight; overweight) variable in 15 studies. The most commonly used growth reference was the International Obesity Task Force classification (IOTF),[206] especially in recently published articles. In this classification based on an international survey, BMI between 85th and 95th percentile was considered as overweight, and ≥ 95th percentile as obesity. Furthermore, eight studies defined weight status by national references. Eight studies assessed weight-for-height as indicator of adiposity. Other studies measured blood pressure and diabetes mellitus.

Association between socioeconomic status and adiposity

Both the Ballabeina study[185,186] and the Early Childhood Longitudinal Study[183,200] were described twice, but in the following these were considered once. 11 studies found no association between SES and adiposity and 6 studies an inverse association. 3 studies showed a mixed result with no association and an inverse association depending on the indicator of SES.[190,193,198] The Kuwaiti study found a positive association between adiposity and maternal education and an inverse association between adiposity and the composite score of SES.[182] In the ALSPAC cohort, there was no association between BMI and maternal education among boys, but a positive association among girls aged 2 years and an inverse association when the girls were 4 years of age.[193] Studies that found no association most frequently used educational level as an indicator of SES, while studies that found an inverse association most frequently used a neighbourhood or a composite measure of SES. Eight studies took race/ethnicity into account. Six of these studies found no association between adiposity and SES, two studies that assessed race/ethnicity as a dichotomous variable found an inverse association.

Association between socioeconomic status and blood pressure

Two studies examined the relation between blood pressure and SES in preschool children,[202,205] but found no association. Schachter et al.[205] found no association between SES and heart rate as well.

DISCUSSION

This review identified 25 studies about the association of socioeconomic status (SES) and cardiometabolic risk factors in preschool childhood. The majority investigated socioeconomic differences in adiposity and two studies addressed socioeconomic differences in blood pressure. In 11 studies no association was found between SES and adiposity, in 6 an inverse association and in 5 a mixed association.

Comparing studies assessing socioeconomic differences in adiposity is complicated in three ways. Firstly, these studies have used various SES indicators. These indicators may operate via a different pathway to affect cardiometabolic risk factors and the socioeconomic gradient in health may vary by SES-indicator.[100,178] The socioeconomic gradient in adiposity at preschool age differs by SES-indicator as well. Whereas SES at a household level appears not be associated with adiposity, SES at a neighbourhood level is inversely associated with adiposity in three studies. Although the underlying mechanism of neighbourhood influence in developing adiposity is unknown, adiposity can be influenced by neighbourhood above and beyond the individual-level SES.[192] For instance due to ethnic and physical activity related factors,[39,207] which also indicates that ethnicity may be a confounder in this relationship between adiposity and neighbourhood SES. Few studies investigating SES with (mostly nonvalidated) composite measures showed mixed results. For example, the Kuwaiti study found an inverse association between a composite measure of SES and overweight and a positive association between maternal education and overweight. Although parental education was inversely associated with adiposity from 5 years onwards in aforementioned review,[35] at preschool age parental education showed most consistently no association with adiposity.

The second reason why it is complicated to compare the results is that the identified studies have used various measures for adiposity including BMI, weight-for-height, and waist circumference. BMI is the current standard measure, relatively unaffected by height and is a good indicator of adiposity in the pediatric population.[208,209] Weight-for-height measurements do not correlate well with body fat and are affected by height to a greater degree, yet it may serve as a useful tool to estimate abdominal obesity in particular.[210] Other measurements, like skin fold thickness, and bioelectrical impedance analysis often are less accurate.[211] The International Obesity Task Force (IOTF) criteria for overweight and obesity are widely adopted and are useful for comparison, though also national references were used. The majority of studies using the IOTF definition (6 out of 9) found no association between SES and overweight.

Since the relationship between SES and adiposity differs between ethnic groups, comparing studies is complicated thirdly because the majority of the identified studies did not adjust for race/ethnicity. Interestingly, studies that adequately adjust for race/ethnicity and studies that investigated participants with a homogeneous descent found no association between adiposity and SES. It was shown in one study that socioeconomic differences in the prevalence of overweight at age 2 and 3 years were absent, while there were marked ethnic differences.[212] This indicates that at preschool age ethnicity may be more important in the development of overweight than SES.

If ethnicity is taken into account there seems no association between SES and adiposity in preschool children. However, in preschool children several risk factors for adiposity were more frequent in children with a low SES. For example, children of parents with lower SES watched more TV or other media[185,213] and are less likely to eat fruits and vegetables adequately.[214] Household routines like joint eating of meals, adequate night time sleep, and limited screen time were negatively associated with both obesity and low SES.[183] In contrast, there seems little evidence on social patterns of sweetened drinks and snack consumption and physical activity in preschool children.[215] While at preschool age some risk factors may develop, the inverse association between adiposity and SES presumably emerges after preschool age. This was supported by the ALSPAC-study that found that the BMI of preschool children with university degree-educated mothers is decreasing at a faster rate than the other maternal education categories suggesting that socioeconomic differentials in adiposity began to emerge at about age 4 years and becoming stronger with age.[193]

Few studies assessed the association between socioeconomic status and blood pressure and found no association. Although other cardiometabolic risk factors can emerge early in childhood,[216,217] there is no evidence for a socioeconomic gradient in cardiometabolic risk factors other than adiposity at preschool age.

It should be noted that some studies were not designed for the purpose of determining the association between SES and cardiovascular risk factors and therefore only univariate analyses were showed. It is conceivable that results changed in multivariate analyses, especially if analyses were corrected for ethnicity. Although many studies showed no association between SES and adiposity, publication bias may cause under representation in these studies. Also the lower response rate among low SES parents may lead to under representation. Due to this selection bias, studies might fail to show an association. All included studies have serious risk of bias and were therefore each rated as low quality of evidence.[218] Finally, we performed a comprehensive search in various databases, but we have not checked the reference lists of the identified studies additionally to avoid reference bias.

Future research

In our view future research should assess explanatory pathways and mechanisms, especially because the critical period for metabolic programming of future cardiovascular risk is prob-

ably in early childhood.[219] It is of interest whether there are socioeconomic differences in sedentary lifestyle or an increased caloric intake which contribute to the socioeconomic gradient in risk factors after that age. For measuring SES, Braveman et al recommended measuring as much relevant socioeconomic information as possible and considering how potentially important unmeasured socioeconomic factors may affect conclusions.[100] Moreover, race/ethnicity should be assessed adequately. Although many studies addressed socioeconomic differences in adiposity, less is known about the social gradient in other cardiometabolic risk factors. As the SES gradient of adiposity increases, so might the SES gradient of the cardiometabolic risk factors be associated with obesity. Although causality and pathophysiologic mechanisms remain to be established it is imperative that health care providers identify the low SES children so that counselling and treatment of cardiometabolic risk factors can be provided.

CONCLUSION

In conclusion, there seems no association between SES and adiposity at preschool age if ethnicity is taken into account adequately. Since there is no evidence for a socioeconomic gradient in other cardiovascular risk factors, additional studies are required to establish the absence of an association between SES and non-adiposity cardiometabolic risk factors. These studies have to pay attention to the role of ethnicity and the broad construct of SES. In contrast to the association between adiposity and SES from 5 years onwards, there seems no socioeconomic gradient in adiposity at preschool age. This may indicate that the socioeconomic gradient in adiposity emerges after preschool age and that potential interventions should be targeted at this age period to stop the increasing prevalence of adiposity, especially among low SES children.