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Socioeconomic multi-domain health inequalities in Dutch primary school children

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Background: This study assesses socio-economic health inequalities (SEHI) over primary school-age (4- to 12-years old) across 13 outcomes (i.e. body-mass index [BMI], handgrip strength, cardiovascular fitness, current physical conditions, moderate to vigorous physical activity, sleep duration, daily fruit and vegetable consumption, daily breakfast, exposure to smoking, mental strengths and difficulties, self-efficacy, school absenteeism and learning disabilities), covering four health domains (i.e. physical health, health behaviour, mental health and academic health). **Methods:** Multilevel mixed effect (linear and logistic) regression analyses were applied to cross-sectional data of a Dutch quasi-experimental study that included 1403 pupils from nine primary schools. Socioeconomic background (high-middle-low) was indicated by maternal education (n = 976) and parental material deprivation (n = 784). **Results:** Pupils with higher educated mothers had lower BMIs, higher handgrip strength and higher cardiovascular fitness; their parents reported more daily fruit and vegetable consumption, daily breakfast and less exposure to smoking. Furthermore these pupils showed less mental difficulties and less school absenteeism compared with pupils whose mothers had a lower education level. When using parental material deprivation as socio-economic indicator, similar results were found for BMI, cardiovascular fitness, sleep duration, exposure to smoking and mental strengths and difficulties. Socio-economic differences in handgrip strength, cardiovascular fitness and sleep duration were larger in older than in younger pupils. **Conclusions:** Childhood SEHI are clearly found across multiple domains, and some are larger in older than in younger pupils. Interventions aiming to tackle SEHI may therefore need a comprehensive and perhaps more fundamental approach.

Introduction

Socio-economic health inequalities (SEHI) have been assessed less frequently in children than in adults, while from a life-course perspective understanding childhood SEHI can be considered crucial in tackling ongoing SEHI in society.[1,2] Studies that do concern childhood SEHI often address one health outcome only, e.g. body-mass index (BMI),[3] physical fitness[4] and mental health.[5] In most of these studies, health outcomes appeared unfavourable for lower socioeconomic status (SES) groups. A recent World Health Organization report has shown SEHI in adolescents (aged 11–15 years) in a wide range of outcomes.[6] A comprehensive study examining SEHI in primary school-aged children (aged 4–12 years) child health, including the domains of physical health, health behaviour, mental health and academic health, is currently missing.

Identifying age periods of susceptibility to the social environment is considered a critical area for research.[2] Studies concerning the development of SEHI over age have for example focussed on BMI,[3] and found a positive association between SES and birth weight. This association turns into a negative one during early childhood,[7] which then further increases over age.[8] A study that examined a wider spectrum of health outcomes over age,[9] found that childhood SEHI related to injuries (higher incidence in low SES) arose over age. The same study showed a positive association between SES and acute respiratory diseases (higher incidence in high SES) in young children (0- to 6-years old), which changed into a negative association (higher incidence in low SES) over age. Overall, more clarity in how age and SES interact in multiple SEHI domains is needed.

The first aim (first research question, RQ1) of this study is therefore to examine whether primary school-aged children from different SES-backgrounds (based on maternal education and parental material deprivation) show SEHI in a wide range of domains, including physical health, health behaviour, mental health and academic health. The second aim (second research question, RQ2) is to assess whether these SEHI differ across the primary school-age. We hypothesize that SEHI are apparent in all health domains, and are larger between older pupils.

Methods

Study population

We used (cross-sectional) baseline data of 'The Healthy Primary School of the Future' quasi-experimental study,[10] which started in 2015 and targets at improving health in a relatively poor former mining area (Parkstad region, Limburg Province, the Netherlands), by integration of lifestyle interventions in the primary school environment. Schools (n = 53) governed by a local educational board (MOVARE) were approached for participation, lack of support within schools by parents and/or employees were main reasons for schools not to participate.

For 2416 invited pupils (all pupils in nine participating schools were invited), 1403 (58.1%) parents/caregivers (and children who were 12 years of age or older) consented to participate by signing an informed consent form. Reasons for not participating were diverse, e.g. no interest in scientific studies in general or unwillingness to fill in questionnaires. The need for ethical approval was waived by the Medical Ethics Committee Zuyderland, Heerlen (MEC 14-N-142). More information on setting, recruitment and measurements has been published.[10]

Measurements

Baseline data (anthropometric measurements, pupil questionnaires) were gathered at schools by research assistants at the beginning of the school year (September–October 2015). Additional data were obtained by an online parental questionnaire (response from n = 829, 59.1%, pupil's parents at baseline, additional information on maternal education was retrieved from the first follow-up questionnaire in 2016 for 68 pupils, as we assumed maternal education to be stable over time), via public health services (additional information maternal education for 137 pupils) and from school registries (sickness absence). Outcomes were selected by expert opinion.

Socioeconomic status

Maternal education and parental material deprivation were retrieved by parent questionnaires and used as SES-indicator. Maternal education (n = 976) was measured by a single item 'What is the highest level of education you completed?' and classified into three levels: low (n = 185, 19.0%; primary, vocational and lower general secondary education), middle (n = 454, 46.5%; higher general and pre-university secondary education, lower professional education) and high (n = 337, 34.5%; higher professional and academic education). Parental material deprivation (n = 784) was measured by three binary items ('I have enough money to . . .' (i) 'heat my home' (ii) 'pay for sport and club memberships' (iii) 'visit friends/family'), and one five-point item ('meet an unexpected expense of 1000 euros') ranging from 'always' to 'never'.[11] Items were weighted equally and the resulting scores were divided into tertiles: high deprivation (low SES; n = 189, 24.1%), mild deprivation (middle SES; n = 165, 21.0%), and no deprivation (high SES; n = 430, 54.9%).

Physical health

Weight was measured to the nearest 0.1 kg (Weighing Scale 803, Seca, Hamburg, Germany) and height was measured to the nearest 0.1 cm (Stadiometer 213, Seca, Birmingham, UK). BMI Z-scores were based on Dutch reference values (2009).[12] Handgrip strength (g/kg) was measured with a calibrated Jamar Hydraulic hand-dynamometer (model 5030 J1, Jamar, Huthwaite, UK) to the nearest 0.5 kg. All anthropometric measurements were performed twice. The 20-m shuttle run test was used as a (validated) measure of cardiovascular fitness (levels 1: low fitness, to 10: high fitness). Current conditions were assessed via the parent questionnaire in a 17-item current conditions list,[13] including an option to report any other non-listed current conditions (binary variable: 0: did not seek professional help for any current condition, 1: sought professional help for at least one current condition; mental conditions were excluded).

Health behaviour

The percentage of time spend on moderate to vigorous physical activity (MVPA) was measured by accelerometers (Actigraph GT3X+, 30 Hz, processing by ActiLife 6.10.4)[14] during waking hours (6 a.m.–11 p.m.). The first carrying day was not included and only pupils who wore the accelerometer for at least an average time of 8 h/day on 3 weekdays and 1 weekend day (per week) were included (n = 864, 76.7% of 1127 pupils that wore the accelerometer). Further health behaviours were retrieved by parent questionnaire. Sleep duration was reported by one item ('How many hours does your child approximately sleep per night') in average hours per night. Any passive exposure to smoking during the last 12 months (including exposure outside the family home) was reported. Parents were furthermore asked how many days per week their children consumed any fruit (one item), vegetables (two items: raw and cooked vegetables) and breakfast (one item), from which we extracted whether consumption was daily. These dietary habits were additionally reported by pupils in age-adjusted questionnaires.[15]

Mental health

The strengths and difficulties questionnaire (SDQ) is a well-validated parent-report questionnaire that includes subscales for measuring emotional, behavioural, hyperactivity and peer-related difficulties as well as pro-social strengths. Scores were categorized into normal vs. borderline or abnormal (skipping individual items not possible).[16] Self-efficacy was measured by self-report in third to fifth grade by pupils using three five-point Manikin subscales.[17] In fifth grade, self-efficacy was also measured by means of the 24-item five-point 'self-efficacy questionnaire for children' consisting of eight questions for each self-efficacy domain (emotional, social and academic).[18] Total scores were calculated by summing subscales, and were dichotomized using the median. Ten pupils with missing information on items in the 24-item questionnaire were excluded.

Table 1 Sample characteristics included pupils

		Pupils With Information on Maternal Education (*n* = 976)	Pupils With Information on Parental Material Deprivation (*n* = 784)
Age (in years, SD)[a]		7.9 (2.3)	8.0 (2.3)
Male (%)[b]		49.5%	48.2%
SES[c]	Low (%)	19.0%	24.1%
	Middle (%)	46.5%	21.0%
	High (%)	34.5%	54.9%
Ethnicity	Non-western Ethnicity (%)	4.1%	3.6%
Family structure	Does not live with two parents (%)	7.2%	7.3%

a: Included pupils (i.e. those with information on SES) were younger than the total participating group (M = 8.2-years old, SD = 2.3); $t(2377) = 4.13$, $P \leq 0.001$ for maternal education and $t(2185) = 2.35$, $P = 0.02$ for parental material deprivation.
b: Included pupils (i.e. those with information on SES) had the same sex-distribution as the total participating group (48.2% boys); χ^2 (1, n = 2379) = 0.39, P = NS for maternal education and χ^2 (1, n = 2187) $\leq$0.001, P = NS for parental material deprivation.
c: Education level among 25- to 45-old women in 2015 in the whole Netherlands: 12.9% low, 38.8% middle and 48,4% high.[22]

Table 2 Sample characteristics, and age, sex and school (random) adjusted effects of maternal education on pupils' multi-domain health

	n	Mean (SD)/%	SES by Maternal Education			*P*
			Low	Middle	High	
Physical health						
BMI Z-score	780	0.10 (0.97)	Ref b (95%CI)	−0.26 (−0.45, −0.07)	–0.43 (–0.63, –0.24)	<0.001
Handgrip strength (g/kg)	776	376.2 (126.4)	Ref b (95%CI)	9.1 (–10.7, 28.9)	33.0 (12.2, 53.9)	<0.01
Cardiovascular fitness (level1-10)[a,b]	559	4.01 (1.77)	Ref b (95%CI)	0.36 (–0.01, 0.73)	0.91 (0.52, 1.29)	<0.001
Current physical condition[c]	754	29.6%	Ref OR (95%CI)	1.30 (0.82, 2.08)	1.11 (0.68, 1.80)	NS
Health behavior						
Physical activity (MVPA)	640	7.89 (2.65)	Ref b (95%CI)	–0.24 (–0.79, 0.32)	–0.13 (–0.70,0.44)	NS
Sleep duration (hours/night)	752	10.4 (1.09)	Ref b (95%CI)	0.06 (–0.14, 0.25)	0.00 (–0.20, 0.20)	NS
Daily fruit and vegetables (by parents)	767	13.1%	Ref OR (95%CI)	2.18 (1.00–4.76)	2.80 (1.27–6.17)	<0.05
Daily breakfast (by parents)	767	93.5%	Ref OR (95%CI)	4.66 (2.39, 9.03)	6.17 (2.75, 13.87)	<0.001
Passive smoke exposure	752	46.1%	Ref OR (95%CI)	0.44 (0.28,0.69)	0.18 (0.11, 0.29)	<0.001
Mental health						
SDQ (borderline or abnormal)	754	19.6%	Ref OR (95%CI)	0.57 (0.35, 0.90)	0.32 (0.18, 0.55)	<0.001
Self-efficacy (>median[d], total Manikin scale)	352	58.8%	Ref OR (95%CI)	1.62 (0.91, 2.86)	1.86 (1.00, 3.46)	NS
Academic health						
Absenteeism (>5 days)	738	48.1%	Ref OR (95%CI)	0.58 (0.38, 0.88)	0.42 (0.27, 0.65)	<0.001
Learning disabilities[b]	750	7.87%	Ref OR (95%CI)	0.70 (0.36, 1.38)	0.41 (0.18, 0.92)	NS

a: Measured by 20-m shuttle run.
b: A significant sex∗SES interaction was found for the outcomes cardiovascular fitness (boys middle SES b = 0.61, boys high SES b = 1.51, $P < 0.001$; and girls middle SES b = 0.22, girls high SES b = 0.41, not significant) and learning disabilities (boys middle SES OR = 0.60, boys high SES OR = 0.12 $P < 0.01$; and girls middle SES OR = 0.74, girls high SES OR = 1.00, not significant).
c: Current physical conditions included: asthma, chronic bronchitis, allergies, eczema and other skin conditions, frequent abdominal pain, obstipation and bowel disorders, diabetes, frequent complaints of back, knee, ankle, hip, shoulder, wrist and hand, neurological diseases like epilepsy, frequent severe headaches and migraine, cancer, congenital heart disease, ear, nose and throat problems, problems with motor function, urine tract complaints, attachment disorder, metabolic disorders.
d: Total self-efficacy (median = 11) was measured by summing three-item Manikin subscales (ranging from 1: 'cannot do' to 5: 'can do very well', social-subscale median = 4; emotional-subscale median = 3; academic-subscale median = 4).
SES, socio-economic status; SD, standard deviation; Ref b, Reference estimated mean difference; BMI, body-mass index; MVPA, percentage of time spend on moderate and vigorous physical activity; SDQ, strengths and difficulties questionnaire; Ref OR, Reference odds ratio; CI, confidence interval; NS, not significant.

Academic health

We retrieved absenteeism (days/year) over the previous school-year (2014–15) from school registries and, because it was non-normally distributed, transformed it into a binary outcome (>5 days absent, the median being 5.5). Furthermore parents were asked (by questionnaire) whether pupils had received any help or check-up for learning disabilities during the last year.

Statistical methods

We used R 3.3.2[19] in RStudio 1.0.136[20] to perform multilevel mixed-effect (linear and logistic) regression analysis, accounting for school-based clustering (random intercept). All analyses were corrected for age and sex. Analyses were not stratified by sex since only 2 out of the 26 (2 SES-indicators, 13 outcomes) possible interactions with SES were found to be significant ($P < 0.05$, footnote table 2).

RQ1: Multi-domain SEHI. SEHI were assessed by adjusted unstandardized regression coefficients and odds ratios for middle and high SES (low SES as reference). The significance of SEHI was assessed by comparing the model's fit (ANOVA function, chi-square on residual sum of squares) including SES with the model's fit not-including SES.

RQ2: Multi-domain SEHI by age. We tested the SES∗Age interaction by comparing model fits with and without interaction (ANOVA function, chi-square on residual sum of squares). To ensure sufficient power, we only used the five continuous outcomes. Regression coefficients for age were furthermore estimated for the three SES-levels separately. Loess-curves (span = 0.75) were used to visualize the SEHI over age.[21]

Table 3 Sample characteristics, and age, sex and school (random) adjusted effects of parental material deprivation on pupils' multi-domain health

			SES by Parental Material Deprivation			
	n	**Mean (SD)/%**	**Low[a]**	**Middle[a]**	**High[a]**	***P***
Physical health						
BMI Z-score	615	0.08 (0.99)	Ref b (95%CI)	−0.03 (−0.25, 0.20)	−0.29 (−0.48, −0.11)	<0.001
Handgrip strength (g/kg)	622	382.6 (125.3)	Ref b (95%CI)	10.6 (−13.0, 34.2)	23.3 (3.9.7, 42.7)	NS
Cardiovascular fitness (level 1–10)[b]	459	4.07 (1.73)	Ref b (95%CI)	0.20 (−0.23, 0.63)	0.64 (0.43, 0.90)	<0.001
Current physical condition[c]	748	29.9%	Ref OR (95%CI)	0.63 (0.39, 1.00)	0.66 (0.45, 0.96)	NS
Health behavior						
Physical activity (MVPA)	530	7.90 (2.70)	Ref b (95%CI)	0.57 (−0.08, 1.22)	0.25 (−0.28, 0.77)	NS
Sleep duration (hours/night)	751	10.4 (1.09)	Ref b (95%CI)	0.26 (0.06, 0.46)	0.23 (0.06, 0.39)	<0.01
Daily fruit and vegetables (by parents)	751	12.6%	Ref OR (95%CI)	0.41 (0.18–0.93)	1.21 (0.72–2.01)	<0.01
Daily breakfast (by parents)	751	93.1%	Ref OR (95%CI)	1.14 (0.54–2.39)	2.12 (1.08–4.14)	NS
Passive smoke exposure	751	46.5%	Ref OR (95%CI)	0.63 (0.40–0.97)	0.35 (0.24–0.51)	<0.001
Mental health						
SDQ (borderline or abnormal)	751	19.6%	Ref OR (95%CI)	0.50 (0.30–0.84)	0.39 (0.25–0.59)	<0.001
Self-efficacy (>median[d], total Manikin scale)	293	58.0%	Ref OR (95%CI)	0.76 (0.38–1.51)	0.89 (0.50–1.55)	NS
Academic health						
Absenteeism (>5 days)	590	48.3%	Ref OR (95%CI)	0.68 (0.42–1.11)	0.73 (0.49–1.09)	NS
Learning disabilities	747	7.63%	Ref OR (95%CI)	0.92 (0.43–1.97)	0.68 (0.35–1.31)	NS

a: Low SES, high deprivation; Middle SES, mild deprivation; High SES, no deprivation.
b: Measured by 20-m shuttle run.
c: Current physical conditions included: asthma, chronic bronchitis, allergies, eczema and other skin conditions, frequent abdominal pain, obstipation and bowel disorders, diabetes, frequent complaints of back, knee, ankle, hip, shoulder, wrist and hand, neurological diseases like epilepsy, frequent severe headaches and migraine, cancer, congenital heart disease, ear, nose and throat problems, problems with motor function, urine tract complaints, attachment disorder, metabolic disorders.
d: Total self-efficacy (median = 11) was measured by summing three-item Manikin subscales (ranging from 1: 'cannot do' to 5: 'can do very well', social-subscale median = 4; emotional-subscale median = 3; academic-subscale median = 4).
SES, socio-economic status; SD, standard deviation; Ref b, Reference estimated mean difference; BMI, body-mass index; MVPA, percentage of time spend on moderate and vigorous physical activity; SDQ, strengths and difficulties questionnaire; Ref OR, Reference odds ratio; CI, confidence interval; NS, not significant.

Sensitivity analyses

To account for possible clustering within households, we repeated all analyses including only 1 randomly selected child (n = 1072) per household. We furthermore repeated all analyses including ethnicity (Western vs. non-Western) and family structure (living with two parents vs. not living with two parents), to account for their possible relation to health and SES. Analyses were furthermore repeated with different cut-off points for the binary outcomes.

Results

Of 1403 pupils participating, only pupils with information on either maternal education (n = 976, 69.6%) or parental material deprivation (n = 784, 55.9%) were included in the analyses. This included group was younger but had the same percentage boys as the total participating group (table 1, footnote).

RQ1: Multi-domain SEHI

Table 2 (maternal education) and table 3 (parental material deprivation) show the results for the multi-level mixed regression models.

Pupils from higher SES-backgrounds, as assessed by both SES-indicators, had significantly healthier outcomes across all four health domains. That is, in the physical health domain, high SES pupils had lower BMI Z-scores (−0.43, and −0.29 for maternal education and material deprivation respectively, $P < 0.001$), a stronger handgrip (significant by maternal education: 33.0 g/kg, $P < 0.01$), and higher cardiovascular fitness (0.91 and 0.64 higher 20-m shuttle run score by maternal education and material deprivation respectively, $P < 0.001$). There were no significant SES differences in having a current physical condition (odds ratios were 0.63 and 0.66 by material deprivation for the middle and high SES group).

In the health behaviour domain, average sleep duration was significantly higher (0.23 h/night, $P < 0.01$) for pupils with high SES by material deprivation (no effect by maternal education). Significantly more pupils (odds ratio: 2.80, $P < 0.05$) from high SES-background consumed fruit and vegetables on a daily basis (by maternal education) and they more often had breakfast daily (by maternal education, odds ratio: 6.17, $P < 0.001$). The same associations were found when pupils (instead of parents) reported their dietary habits, although these were not all statistically significant (data not shown). Significantly fewer pupils from high SES-backgrounds were exposed to smoking (odds ratios 0.18 and 0.35 by maternal education and material deprivation respectively, $P < 0.001$). There were no SES differences in the percentage of time spend on MVPA.

In the mental health domain, significantly fewer pupils from high SES-backgrounds showed difficulties on the SDQ-questionnaire (odds ratios 0.32 and 0.39 by maternal education and material deprivation respectively, $P < 0.001$). Subscales showed the same associations (data not shown), except for the 'pro-social' subscale. There were no clear SEHI in Self-efficacy, both by the Manikin-scale and the self-efficacy questionnaire (data not shown).

In the academic domain, pupils from high SES-backgrounds were less often absent from school (by maternal education, odds ratio 0.42, $P < 0.001$). Pupils from high SES-background also had lower odds of having learning disabilities (not significant despite a clear dose–response relationship for both SES-indicators).

RQ2: Multi-domain SEHI by age

For handgrip strength, cardiovascular fitness and sleep duration, a significant age∗SES interaction was found, but only by maternal education (figure 1). Handgrip strength differed more strongly between the SES-groups in older age (bAge low SES = 20.6 and bAge high SES = 35.7, $P < 0.05$). The same pattern of results was

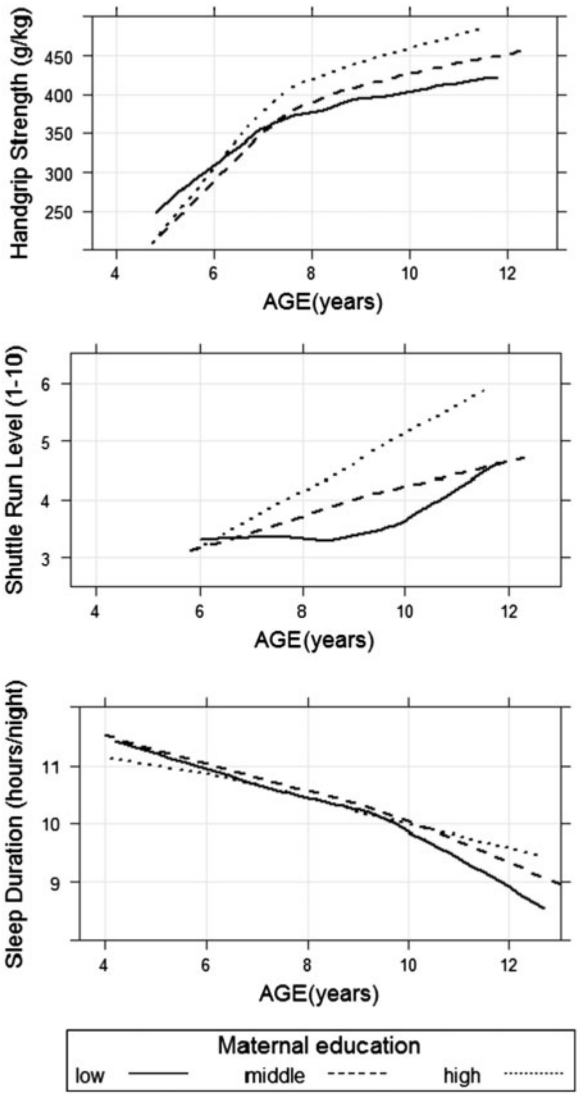

Figure 1 Interaction ($P < 0.05$) between age and maternal education (Loess-curve, span = 0.75) in cross-sectionally measured handgrip strength (g/kg), cardiovascular fitness (20-m shuttle run level 1–10), and sleep duration (hours/night)

found for cardiovascular fitness (bAge low SES = 0.19, bAge high SES = 0.46, $P < 0.05$). Finally, the high SES-group showed a less steep decline in average sleeping hours with increasing age (bAge low SES = −0.29, bAge high SES = −.24, $P < 0.05$) compared with the low SES-group.

Sensitivity analyses

The age∗SES interaction in handgrip strength, lost its significance (direction remained) when ethnicity or family structure was controlled for. This was foremost caused by the smaller sample size in the adjusted analyses. All other significant results remained significant in the same direction.

Discussion

This study extends previous research by demonstrating SEHI across multiple domains in primary school-aged children. Children from middle and high SES-backgrounds, as indicated by both maternal education and parental material deprivation, showed healthier outcomes in the physical health, mental health, health behaviour and academic health domain, as compared with children from low SES-backgrounds. SEHI in handgrip strength, cardiovascular fitness and sleep duration were foremost apparent in older pupils.

Concerning outcomes in the physical health domain, the inverse relation between SES-background and BMI has been reported before.[3] The positive relation between SES and handgrip strength and cardiovascular fitness has also been previously reported, although results differ between sexes, age groups, countries and measures of SES.[4,23] A recent review[24] on common physical conditions in children found an inverse association between SES and children's risk of having a physical condition.

The SEHI in health behaviour found in our study are supported by earlier research (e.g. exposure to smoking,[25] and breakfast consumption).[7,26] These differences may partly explain the inequalities in physical health that we found, although it has also been found that SES contributes to health independently of health behaviour.[2] Earlier research on SEHI in fruit and vegetable consumption has yielded mixed results.[27] Not much research[28] has been done on differences in physical activity (by accelerometry) between SES-groups and results have been inconclusive. SES gradients in sleep duration have been rarely investigated but it has been found that children from higher SES-backgrounds sleep more.[29,30] It is worth noting that lack of sleep may be associated with a higher BMI.[31]

Earlier reviews have shown a negative relationship between SES and mental health, which was often measured by the SDQ.[6] In contrast to our study, both negative and positive relations between SES and self-efficacy among adolescents have been found.[32,33] Apart from the age difference, this inconsistency may be caused by the use of different SES-indicators, as in our results, outcomes for both SES-indicators also seemed to slightly (not significant) point in opposite direction. Furthermore, the Manikin-scale for self-efficacy, which we used for the younger children in this study, has not yet been validated.[18]

The reported SEHI in academic health are relevant as absenteeism and learning disabilities may hamper a pupil to reach its full potential.[34] Importantly, in an earlier Dutch study, was found that more than five days of school absenteeism had a stronger negative effect on pupils from lower SES-backgrounds than in pupils form higher SES-backgrounds.[35] There is substantial research on the relationship between intellectual abilities and SES.[36] Learning disabilities may cause a lower socioeconomic attainment in later life, contributing to an intergenerational transmission of inequality.[37]

SEHI in handgrip strength and cardiovascular fitness, were larger in older than in younger pupils. It is notable that both seem to increase (cross-sectional) faster in the higher SES-group, while there was no socioeconomic widening in the percentage of time spend on MVPA.[38] Sleep duration declined stronger in the lower SES-group, although the Loess-plot suggests that this only occurred in children from 10-years old onward. In contrast to other studies,[3] we did not find a statistically significant effect of SES on BMI by age.

Corroborating our findings, most associations showed a dose–response relationship, i.e. pupils from middle SES-background almost consistently scored between pupils from low and high SES-backgrounds. Furthermore, P-values were often <0.01 and even 0.001, indicating that statistical significance was not merely a result of multiple testing. In addition, the associations for RQ1 were quite robust across multi-health domains and type of SES-indicator. An additional strength of this study is that dietary habits were reported by both pupils and parents. Furthermore, physical activity and BMI were objectively measured instead of self-reported. Finally, the observed relations remained largely similar in sensitivity analyses.

Limitations of this study include the cross-sectional nature of our data. A reversed effect (worse health leading to low SES) underlying our findings is however unlikely, since the child's health probably does not have a major effect on parental SES. Furthermore, the external validity of our results could be questioned, as all schools were part of the same relatively poor former mining area in the

Netherlands and 58% of the pupils consented to participate. Furthermore, not all participating pupils could be included in the analyses because SES-data were incomplete (not all participating pupil's parents completed the online questionnaire). It is common in epidemiological studies that healthy and higher educated persons are more prone to enrol in a study, as such our results may be an underestimation of the real underlying SES-associations. A study examining the external validity of the 'Healthy Primary School of the Future' quasi-experimental study is currently conducted.

This study points to many opportunities for further research. First, as there was still a substantial subgroup within the low SES-group without problems, it would be worthwhile to study factors underlying resilience against negative consequences of having a low SES-background.[32] Secondly, mental and physical health outcomes are rarely considered simultaneously, which is surprising in light of our research demonstrating that SEHI spans across multiple domains. Possible underlying determinants, e.g. chronic stress,[39] deserve more research attention.

Our findings imply that to successfully target SEHI, interventions may need to target more than just one 'problematic' health outcome. For instance, just targeting BMI because it is an outwardly showing and easily measured parameter, may not do justice to the total range of SEHI that children from lower SES-backgrounds face. Furthermore, the possibility of tackling more fundamental causes[40] behind childhood SEHI, e.g. material deprivation, deserves attention. Furthermore, some SEHI appear to widen during primary school-age, which suggests that prevention efforts could already start early in primary school. In this light we are looking forward to the results of any changes that the 'Healthy Primary School of the Future' quasi-experimental study may bring to the pupils.[10]

In conclusion, our results underline the consistency of childhood SEHI across multiple health domains. Taking a more comprehensive and perhaps fundamental intervention approach, and thus looking beyond physical health, may be essential in tackling SEHI and maximize the health of all children in our society.

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Key points

- Primary school pupils with highly educated mothers were found to be advantaged in nine of thirteen health outcomes spanning across physical health, health behaviour, mental health and the academic health domain.
- Primary school pupils without parental material deprivation were found to be advantaged in five of thirteen health outcomes spanning across physical health, health behaviour and the mental health domain.
- Socioeconomic inequalities in handgrip strength, shuttle run level and sleep duration, were found to be more prominent in older pupils.
- Public health policy aiming at tackling childhood health inequalities needs a comprehensive and perhaps more fundamental approach.

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Anaemia and associated factors in homeless children in the Paris region: the ENFAMS survey

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Background: Food insecurity is a major concern in homeless population, however nutritional consequences remain poorly documented, especially for children. The objective of this study was to assess the prevalence of anaemia and to investigate the relation between both food insecurity and dietary intake to moderate-to-severe anaemia (MSA) in homeless sheltered children. **Methods:** In 2013, a cross-sectional survey was conducted on a random sample of 801 sheltered homeless families in the Paris region. Haemoglobin concentration was measured in 630 mother/child dyads and questionnaires administrated to mothers collected socio-demographic, socioeconomic, health and dietary data. Factors associated with MSA were analysed in two stratified child age groups; 0.5–5 and 6–12 years old. **Results:** Anaemia was detected in 39.9% of the children and 50.6% of the mothers, and MSA in 22.3% and 25.6%, respectively. In both age groups, MSA was positively associated with maternal MSA. In the 0.5–5 years group, it was also positively associated with child food insecurity, no cooking facilities and household monthly income. In the 6–12 years group, it was positively associated with household food insecurity and children's age. **Conclusion:** A higher food insecurity score was associated with greater prevalence of moderate-to-severe anaemia in children. Considering the high prevalence of anaemia among homeless mothers and their children, these findings highlight the need for reducing food insecurity in shelters so as to prevent anaemia in this vulnerable population.