

BMJ Open Associations between sociodemographic and behavioural parameters and child development depending on age and sex: a cross-sectional analysis

Clara Elise Schild ¹, Christof Meigen,¹ Jonas Kappelt,¹ Wieland Kiess,^{1,2} Tanja Poulain ^{1,2}

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¹LIFE Leipzig Research Center for Civilization Diseases, Leipzig University, Leipzig, Germany

²Department of Women and Child Health, Hospital for Children and Adolescents and Center for Paediatric Research (CPL), Leipzig University, Leipzig, Germany

Correspondence to

Clara Elise Schild;
clara-schild@t-online.de

ABSTRACT

Objectives To explore environmental and individual factors that are associated with child development and to investigate whether the strength of these associations differs according to the age of the children.

Design Cross-sectional study.

Setting This study was part of the LIFE Child study, a large cohort study conducted in Leipzig, Germany.

Participants 778 children aged between 0.5 and 6 years (48.6% girls, mean age=2.67 years).

Outcome measures The outcomes were cognitive development, language development, body and hand motor skills, social-emotional development, and tracing skills, measured with a standardised development test. We analysed the associations between development and gestational age, socioeconomic status (SES), sex, behavioural difficulties, siblings, sleep duration, breastfeeding duration and overweight/obesity. We also tested for interactions between these variables and child age or sex.

Results Higher gestational age (b ranging between 0.12 and 0.26) and higher SES (b ranging between 0.08 and 0.21) were associated with better outcomes in almost all developmental domains (all $p < 0.019$). Children with older siblings had improved body and hand motor skills compared with children without older siblings (both $b = 0.55$, all $p < 0.029$). Boys had poorer scores than girls in body and hand motor skills and tracing ($b = -0.45$, -0.68 and -1.5 , all $p < 0.019$). Children with behavioural difficulties had significantly poorer outcomes in most developmental domains. Some of the associations with SES and sex were stronger in older than in younger children. Associations between gestational age and motor development were weaker in older children. We did not find significant associations between child development and sleep duration, breastfeeding duration or overweight/obesity.

Conclusion Some factors had a protective, others an adverse effect on development of children under 6 years of age. The effect of SES and sex increased, while the effect of gestational age decreased with age.

Trial registration number NCT02550236.

INTRODUCTION

In the first 6 years of life, that is, in the phases of infancy, toddlerhood and early childhood,

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The large sample size (n=778) and wide age range (0.5–6 years) of our sample allowed us to compare associations in different age groups.
- ⇒ Development was measured directly by trained study personnel using a standardised test to establish objectivity.
- ⇒ We included many different influencing factors and different aspects of development, including previously little studied areas such as motor skills or social-emotional development.
- ⇒ We studied a sample with above-average socioeconomic status, which is thus relatively homogeneous and not representative of the whole population.
- ⇒ Our sample sizes vary by factor studied (min=259 children), that is, the strength of our large sample does not apply to each of the analyses.

cognitive, language and motor skills develop particularly quickly.¹

In sociocultural theories of development, for example, Vygotsky's concept of the zone of proximal development or ecological systems approaches such as Bronfenbrenner's ecological framework for human development,¹ great importance is attached to children's (social) environment. In addition to the social environment, early child development might also be shaped by complications during and before birth, the presence of siblings and the education, income and behaviour of the parents.¹ Other theories describe the developmental process in stages, for example, Piaget's stages of cognitive development or Erikson's stages of psychosocial development. We look at possible influencing factors and their perhaps changing effect over a period of time that includes several of these developmental stages (sensorimotor and preoperational stage according to Piaget, or trust vs mistrust, autonomy vs shame and doubt, initiative vs guilt according

to Erikson).¹ Because early development is influenced by so many factors and shapes later development,² it is particularly relevant to developmental research.

Low gestational age at birth is a major developmental risk for children.³ Children born prematurely (<37th week of gestation) are at increased risk for developmental delays in cognition, language, motor skills and social-emotional development.⁴⁻⁶ In general, the earlier children are born, the greater their developmental disadvantages.⁷ This phenomenon is stronger in boys than in girls.⁸⁻¹⁰ Two studies even showed a slightly increased risk of language delay,⁵ or scoring below average in a developmental screening test,⁷ in children born mature but before 39 weeks of gestation. While some longitudinal studies show that developmental deficits, for example, language delay, differences in cognition or achievement decrease or disappear as children grow older (at least in children born after the 34th week of gestation),^{5 11} other studies show that differences in academic performance between preterm and term-born infants exist even at school age.^{12 13}

The relationship between a family's socioeconomic status (SES) and their children's development has been examined for decades.¹⁴ Children from poorer social backgrounds were found to show developmental delays^{15 16} from as early as 7 months of age.¹⁷ Several studies have shown that these disadvantages increase over childhood.^{17 18} In line with this assumption, several studies showed an increased risk for achievement gaps in school between children from low-SES and high-SES families.^{14 17 19}

In studies on associations between child development and potential risk factors (eg, social disadvantages, maternal depression) in under 6 year olds, it was repeatedly noticed that girls performed better than boys in developmental tests on language, cognition, motor skills and social-emotional development.^{15 20-22} In Krogh and Væver's study, girls already showed better fine motor skills at 7 months of age.²³

There is already a large body of research on the relationship between poor language development and behavioural difficulties, such as internalising or externalising problems, inattention or hyperactivity.²⁴⁻²⁶ The data on other developmental domains (cognition, motor development) are more limited, although negative associations were also found in these domains.^{27 28}

As children usually spend a lot of time with their siblings and as interactions with older or younger children might affect their own development, several scientists queried an association between the presence of siblings and children's development.²⁹ However, previous study results showed a mixed picture. In some studies, the presence of siblings was negatively associated with the development of communicative, cognitive, gross motor and personal-social skills.^{22 30} Other studies observed positive associations, especially regarding (fine) motor skills.^{31 32}

Poor sleep quantity and quality might also be associated with developmental delays.³³ In experimental studies in

which children were exposed to sleep restriction, weaker performance was observed in demanding cognitive tasks, reaction time measures and working memory.³⁴ Studies examining the effects of different sleep patterns on children's cognitive, language and academic performance revealed mixed results.^{34 35} In some studies, children who slept less or later showed weaker performance.³⁶⁻³⁸ However, other studies found no significant association between sleep duration^{39 40} or sleep disruptions^{40 41} and development.

Breast feeding has many positive effects on infant health,⁴² but there is controversy about the relationship between breastfeeding and cognitive development. While many studies showed a positive effect of breast feeding, there is also some evidence that this effect is largely caused by confounders, most notably maternal SES and intelligence.⁴³ Few studies examined sibling cohorts to exclude as many confounders as possible. One found no significant developmental differences between the breastfed children and their non-breastfed siblings.⁴⁴ In another study, the developmental advantages of breastfed infants remained significant even among discordant sibling pairs.⁴⁵

As overweight and obesity have a high prevalence among children and adolescents in Germany (15.4% of 3-17-year-olds),⁴⁶ it is important to investigate possible effects on health and development. However, so far there is little evidence for a direct effect of being overweight/obese on cognitive development or academic performance. In one study, boys with overweight had weaker math and literacy skills compared with normal-weight peers, while no significant differences were found in girls.⁴⁷ Several studies found no significant effect of overweight/obesity on cognition or academic achievement at all.^{48 49} Interestingly, a study on this topic in very young children aged 6-24 months found significantly lower scores among children with overweight/obesity in the cognitive and motor domains compared with normal-weight children.⁵⁰

The aim of the present study is to investigate the associations of gestational age, SES, child sex, behavioural difficulties, siblings, sleep duration, breast feeding and overweight/obesity with the development of German children. Many of the previous studies on early child development examined only one of the influencing variables and its effect on a single developmental domain at a given age point. Our relatively large sample of 778 children includes children of all ages between 6 months and 6 years and consists of recently collected data (September 2016-October 2020). This allows us to take a look at child development over the entire preschool period. We take into account multiple influencing factors and their effects on the different developmental domains of cognition, language, body and hand motor skills, and social-emotional development. Based on the results of previous studies, we expected higher gestational age, higher SES, longer average sleep duration and longer breastfeeding duration to be positively associated with child

development. We suspected poorer development for boys compared with girls, for children with older siblings and for children showing more behavioural difficulties. We expected no differences in development if children were overweight/obese.

A specific focus was put on possible changes in the strengths of associations depending on child age. We hypothesised the association between SES or sex and development to be more pronounced in older children. In contrast, we expected the association between gestational age and development to be stronger in younger children. We further expected the association between development and gestational age to be more pronounced in boys than girls.

METHODS

Participants and design

Data collection was conducted as part of the LIFE Child study. The LIFE Child study is a large population-based cohort study conducted at the Research Center for Civilization Diseases, Leipzig University. The study focuses on the physical and psychological development of healthy children from the prenatal phase to the age of 20.^{51 52} Study participants are recruited since 2011 at public health centres, hospitals and by word of mouth. In our analysis, we included all children between 0 and 6 years of age who performed the development test as part of the study programme and whose parents provided information on their SES and the gestational age of their children. Data were cross-sectional and only one data point of each child was included. The cross-sectional design was chosen in favour of a larger sample size. If children had participated more than once, only the last visit was taken into account. Data were collected between September 2016 and October 2020. The final sample consisted of 778 0.35–5.63-year-old children with complete developmental

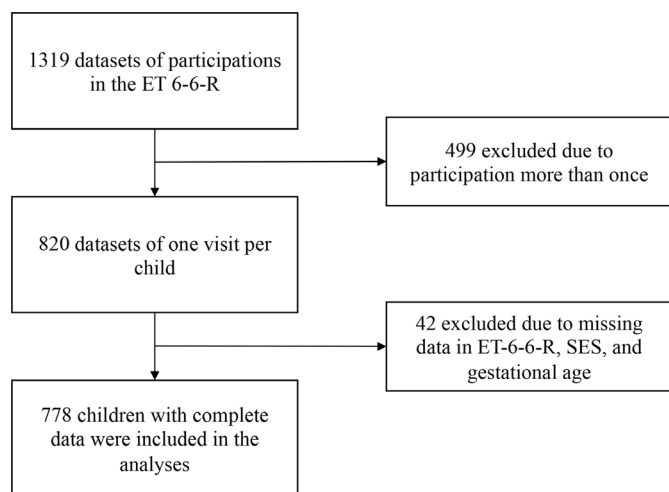


Figure 1 Flow chart of participant selection. ET-6-6 R, Entwicklungstest für Kinder von 6 Monaten bis 6 Jahren - Revision ('development test for children between 6 months and 6 years-revision'); SES, socioeconomic status.

tests (48.6% girls, mean age=2.67 years, see figure 1). Data on variables collected through questionnaires were all provided by the accompanying parents of the children (completed on a computer screen during the study day). All questions included in the analysis are listed in an online supplemental file. Due to specific missings in the parent-reported questionnaires, the sample size was smaller for some analyses (min=259 children aged 0.88–5.9 years, see table 1).

Measures

Development test

In order to assess the development of the children, we applied the revised version of the Entwicklungstest 6 Monate–6 Jahre ('Development Test for Children between 6 Months and 6 Years—Revision', ET 6-6 R).⁵³ This standardised test for children between 6 months and 6 years of age assesses the developmental stage regarding cognition, language, body and hand motor skills as well as social-emotional skills. Children older than 42 months also complete a tracing subtest. Information on social-emotional development is collected through a questionnaire completed by parents. The other domains are assessed using age-specific standardised test items. The number of successfully completed items is converted into a developmental quotient (M=10, SD=3), based on age-specific references.⁵³ The reliability of the test was assessed with internal consistencies between $\alpha=0.66$ and 0.77 depending on the scale studied.⁵³ Clinical validity was demonstrated by significant correlations of the language and cognitive scales with child IQ,⁵⁴ by good discrimination between healthy children and children with stroke, and by significant correlations with the Bayley Scales of Infant Development II.^{55 56} The ET 6-6 R is administered on an additional study day by trained study assistants.

Socioeconomic status

A family's SES was determined on the basis of a parental questionnaire originally developed for the 'Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland' (Study on the health of children and adolescents in Germany, KiGGS).⁵⁷ The questionnaire collects data on parental education, occupational status and equivalent household income.⁵⁷ Information on these three parameters is combined to an SES index ranging between 3 (indicating low SES) and 21 (indicating high SES). Based on cut-off values created in a large representative German sample, the SES index can be categorised as reflecting either low, middle or high family SES. In a representative sample, the distribution of low–middle–high would be expected to be 20%–60%–20%.⁵⁷

Behavioural strengths and difficulties

The parent version of the Strengths and Difficulties Questionnaire (SDQ) was used to assess behavioural strengths and difficulties in children aged 3 years and older.^{58 59} This screening questionnaire comprises five scales, namely emotional problems, hyperactivity/inattention, peer

Table 1 Characteristics of the sample

	n	Distribution	
Age (years)	778		
<2 (infancy and toddlerhood)		349 (44.86%)	
2–6 (early childhood)		429 (55.14%)	
Sex	778		
Female		378 (48.6%)	
Male		400 (51.4%)	
Older siblings	494		
No		269 (54.5%)	
Yes		225 (45.5%)	
Overweight/obesity	767		
No		717 (93.48%)	
Yes		50 (6.52%)	
SES status	778		
High		404 (51.9%)	
Middle		361 (46.4%)	
Low		13 (1.7%)	
		Range	Mean (SD)
Age (years)	778	0.35–5.98	2.67 (1.78)
SES index	778	6.9–21	15.52 (2.95)
Gestational age (weeks)	778	24.29–42.14	39.48 (2.16)
SDQ score	391	0–26	8.52 (4.32)
Sleep time (hours/day)	365	6–16.6	12.18 (1.7)
Breastfeeding duration (months)	259	1–36	11.05 (5.4)
Developmental quotient	778		
Cognition		1–17	10.03 (2.97)
Language		1–15	10.06 (2.65)
Body motor		1–17	9.4 (2.88)
Hand motor		1–16	10.14 (2.76)
Social-emotional		1–17	10.61 (2.68)
Tracing	307	1–18	10.21 (2.99)

SDQ, Strengths and Difficulties Questionnaire; SES, socioeconomic status.

relationship problems, conduct problems and prosocial behaviour. The results of the four different problem scales (all scales but prosocial behaviour) can be combined into a total difficulties score, which ranges from 0 to 40, with higher scores indicating more behavioural difficulties.⁵⁸ This score was used for further analysis. In the representative norming sample of the German version of the SDQ, the internal consistency was $\alpha=0.82$.⁵⁹

Overweight/obesity

Height and weight of all participants were measured by trained study assistants. Body mass index (BMI) was

calculated and converted to standard-deviation scores (BMI-SDS) using age-specific and gender-specific percentiles for German children.⁶⁰ For data analysis, BMI-SDS was categorised as either normal weight (≤ 90 th percentile) or overweight/obesity (>90 th percentile).⁶⁰

Sleep duration

Information on sleep habits was collected using parent questionnaires. For children up to 2 years of age, the Brief Infant Sleep Questionnaire was used.⁶¹ For older children, we applied the Children's Sleep Habits Questionnaire.⁶² From both questionnaires, only the information on sleep duration was considered (see online supplemental file 1). The hours of sleep per day and night were summed to obtain the total sleep time.

Breast feeding, gestational age at birth and siblings

Information on breast feeding was collected using a self-created parent questionnaire. Parents were asked to indicate how many months the child was breast fed, regardless of whether it was exclusively breast fed or not. In another questionnaire, parents provided information on the number of older siblings of the child. From this information, we created a binary variable that indicates whether a child has at least one older sibling or not. Information on gestational age at birth was taken from medical records.

Analysis

Data analysis was performed using the free statistics software R (V.4.0.4).⁶³ We applied linear mixed-effect models to explore associations between the influencing variables and the developmental outcomes in the different domains. Unlike simple linear models, these models allowed us to control for possible sibling relationships within the sample (package lmer). Moreover, all associations were adjusted for age and sex. The developmental quotients in the domains of cognition, language, body motor, hand motor, social-emotional development and tracing were included as dependent variables. Gestational age, sex, SES, the presence of older siblings, overweight/obesity, sleep duration, breastfeeding duration and total difficulties score were included as independent variables. Separate models were calculated for each independent variable.

Following our hypotheses, associations between developmental outcomes and gestational age, sex and SES were checked for interactions with child age at examination. Furthermore, associations between developmental outcomes and gestational age were checked for interaction with sex.

Assuming small effects (R^2 of 0.02) and a power of 0.80, regression analyses with one predictor require 390 participants for effects to reach statistical significance ($p<0.05$).⁶⁴ For all associations, the level of significance was set at $\alpha=0.05$.

Patient and public involvement

Study participants or members of the public were not involved in the design of this study. At regular public

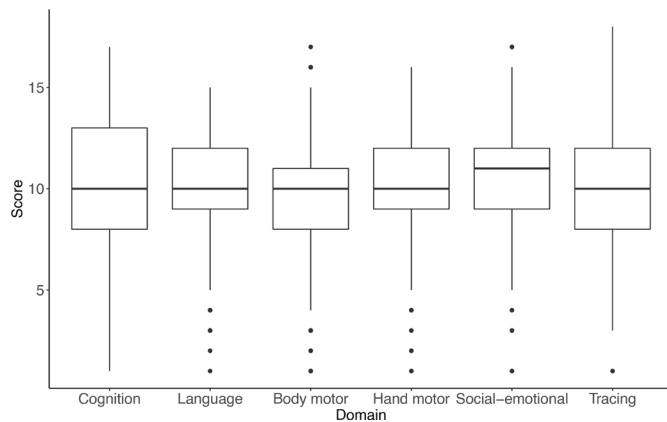


Figure 2 Distribution of scores in the different developmental domains (n=778).

events organised by the LIFE Child study, such as open days, study participants and members of the public are invited to learn about our latest research findings.

RESULTS

Description of the study sample

For each variable, sample size and distribution within the sample are shown in [table 1](#). The majority of the families (51.9%) had high SES, 46.4% had medium SES and 1.7% had low SES. Fifty of 767 children (6.52%) were overweight or obese. Information on siblings was available for 494 children, of whom 269 (54.5%) had no older siblings. The average developmental quotients of the ET 6-6 R ranged from 9.4 (SD=2.88) to 10.61 (SD=2.68, see [figure 2](#)), depending on the developmental domain, and thus correspond approximately to the average for German children.⁵³

Associations between social and individual factors and developmental outcomes

As expected, higher gestational age was associated with better development in the domains of cognition, language, body motor skills, hand motor skills and social-emotional development (b ranging between 0.12 and 0.26, all $p < 0.008$, see [table 2](#)). Only tracing was not significantly associated with gestational age (b=0.05, $p=0.589$).

Also in line with the hypotheses, a higher SES was significantly associated with the developmental outcomes in the domains of cognition, language, body motor skills, social-emotional development and tracing (b ranging from 0.08 to 0.21, all $p < 0.019$). Only developmental scores in the domain of hand motor skills showed no significant association with SES (b=0.06, $p=0.09$).

As expected, boys scored lower than girls in all developmental domains. However, the differences only reached significance in the domains of body and hand motor skills (b=-0.45 and -0.68, $p=0.019$ and <0.001 , respectively) and tracing (b=-1.5, $p < 0.001$, see [table 2](#)).

Compared with gestational age, SES and sex, the other independent variables showed fewer significant associations with the developmental outcomes. Regarding

behavioural difficulties, a higher total difficulties score was significantly associated with poorer performance in the areas of cognition, hand motor skills, social-emotional development and tracing (b ranging between -0.08 and -0.13, all $p < 0.018$).

The presence of older siblings was significantly associated with better motor skills (both b=0.55, both $p < 0.029$), but not with development in other domains (see [table 2](#)).

The associations between developmental outcomes and sleep duration, breastfeeding duration and overweight/obesity were not significant (see [table 2](#)).

Interaction effects of child age and sex

In accordance with our hypotheses, we assessed whether or not associations between developmental outcomes and gestational age, SES and sex differed depending on child age. In the case of SES, significant interactions with age indicated that the positive associations with cognition and language skills were stronger in older children versus younger children (b=0.05 and 0.06, $p=0.008$ and <0.001 , respectively). Other significant interactions showed that the associations between gestational age and body and hand motor skills became weaker as child age increased (b=-0.07 and -0.11, $p=0.018$ and <0.001 , respectively). Finally, the negative associations between male sex and body or hand motor skills were stronger in older children compared with younger children (both b=-0.23, $p=0.034$ and 0.033, respectively).

We also assessed whether the association between developmental outcomes and gestational age differed between boys and girls. A significant interaction indicated that the association between higher gestational age and better hand motor skills was stronger in boys than in girls (b=0.18, $p=0.036$, see [figure 3](#)).

DISCUSSION

The aim of our study was to explore risk and protective factors for early child development in a sample of healthy German children under 6 years of age, that is, in the phases of infancy, toddlerhood and early childhood.¹ As expected for a sample of healthy children, mean development test scores were fairly close to the average for German children. It turned out that our sample contained an above-average number of children from families with high SES.

Factors associated with child development

We found positive significant associations between children's development and higher gestational age, higher SES, and the presence of older siblings. Negative significant associations were found between the performance in some of the developmental domains and male sex and behavioural difficulties. There was no evidence of an association between child development and duration of breast feeding, average sleep duration or overweight/obesity.



Table 2 Associations of social and individual variables with developmental outcomes

	n	Cognition		Language		Body motor		Hand motor		Social-emotional		Tracing†	
		b (95% CI)	P value	b (95% CI)	P value	b (95% CI)	P value	b (95% CI)	P value	b (95% CI)	P value	b (95% CI)	P value
Gestational age	778	0.24 (0.15 to 0.33)***	<0.001	0.19 (0.11 to 0.28)***	<0.001	0.21 (0.12 to 0.30)‡***	<0.001	0.26 (0.17 to 0.34)‡§***	<0.001	0.12 (0.03 to 0.21)**	0.008	0.05 (-0.12 to 0.21)	0.589
SES Score	778	0.12 (0.05 to 0.18)‡**	0.001	0.12 (0.06 to 0.18)‡***	<0.001	0.08 (0.02 to 0.15)*	0.013	0.06 (-0.01 to 0.12)	0.09	0.08 (0.01 to 0.15)*	0.019	0.21 (0.11 to 0.32)***	<0.001
Sex (ref=female)	778	-0.40 (-0.80 to 0.00)	0.050	-0.31 (-0.65 to 0.04)	0.079	-0.45 (-0.83 to -0.07)‡*	0.019	-0.68 (-1.05 to -0.31)‡***	<0.001	-0.26 (-0.63 to 0.10)	0.157	-1.50 (-2.14 to -0.86)***	<0.001
SDQ total-score	391	-0.08 (-0.15 to -0.01)*	0.018	-0.03 (-0.09 to 0.03)	0.372	-0.06 (-0.12 to 0.00)	0.067	-0.09 (-0.15 to -0.04)**	0.001	-0.13 (-0.19 to -0.07)***	<0.001	-0.12 (-0.19 to -0.04)**	0.002
Older siblings (ref=no)	494	-0.07 (-0.59 to 0.45)	0.794	-0.01 (-0.45 to 0.43)	0.958	0.55 (0.06 to 1.04)*	0.029	0.55 (0.08 to 1.03)*	0.024	-0.33 (-0.79 to 0.14)	0.173	-0.25 (-1.37 to 1.13)	0.518
Sleep duration	365	0.09 (-0.12 to 0.3)	0.411	-0.11 (-0.28 to 0.06)	0.217	0.01 (-0.18 to 0.2)	0.932	0.1 (-0.09 to 0.29)	0.317	0.07 (-0.12 to 0.26)	0.451	0.35 (-0.11 to 0.80)	0.138
Breastfeeding duration	259	0.06 (-0.01 to 0.13)	0.101	0.03 (-0.02 to 0.09)	0.244	-0.01 (-0.07 to 0.06)	0.877	0.02 (-0.04 to 0.08)	0.601	0.01 (-0.05 to 0.07)	0.645	-0.04 (-0.12 to 0.05)	0.427
Overweight (ref=no)	767	0.04 (-0.79 to 0.86)	0.927	-0.37 (-1.08 to 0.34)	0.309	-0.10 (-0.87 to 0.69)	0.812	0.20 (-0.56 to 0.96)	0.608	0.42 (-0.34 to 1.19)	0.279	-1.39 (-3.12 to 0.34)	0.117

*p<0.05, **p<0.01, ***p<0.001.

†The tracing subtest is only conducted with children aged 42 months and older, resulting in smaller samples.

‡Significant interaction with child age.

§Significant interaction with child sex.

All associations were adjusted for age and sex. All significant associations, except the association between hand motor skills and older siblings, stayed significant after adjusting for SES and gestational age. SDQ, Strengths and Difficulties Questionnaire; SES, socioeconomic status.

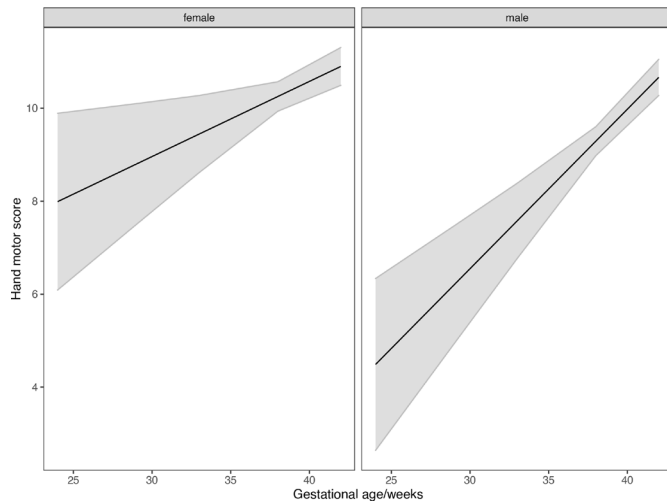


Figure 3 Effect plot illustrating the association (+95% CI) between gestational age and hand motor skills in girls and boys (n=778).

The results regarding gestational age are in line with our expectations. As in other studies, higher gestational age was associated with better development in cognition, language, hand and body motor skills, and social-emotional development.^{4 6 9} These differences might be due to structural brain alterations in preterm infants associated with the disruption of brain growth and maturation in the womb.⁶⁵ Regarding hand motor skills, the association with gestational age was stronger in boys than girls. This confirms the results of previous studies^{8–10} and indicates that boys born prematurely are at particularly high risk for developmental delays. A generally higher vulnerability to adverse outcomes has been observed in preterm boys, the aetiology of which is still insufficiently explained.⁶⁶ Multiple mechanisms likely contribute to this. For example, in animal studies, males were more vulnerable to cell damage from oxidative stress.⁶⁷ Hormonal and immunological sex differences might also play a role.^{68 69} In line with our hypotheses, the association between gestational age and development became weaker with increasing age. This result indicates that the development of children at age 6 is not as affected by gestational age as at earlier age (eg, 0.5 years). This finding is similar to the result of Zambrana *et al* who, however, only investigated language development.⁵ In our study, the interaction effect with child age was significant only in the motor domains. Even if the same trend could be observed in the other developmental domains, this might imply that developmental delays in prematurely born children are more difficult to catch up in the areas of cognition, language and social-emotional skills than in the area of motor skills. When interpreting the results regarding gestational age, it must be noted that our sample contains mainly children born at term and few children with very low gestational age.

As expected, we observed significant positive associations between SES and development in all areas except hand motor skills. This is in line with the results of other

studies.^{15–18} A possible explanation is that a higher SES is associated with more child enrichment, that is, with home and social activities conducive to development, for example, regular reading of books or outdoor activities, which, in turn, might improve child development.¹⁶ As hypothesised, our analysis suggests that during infancy, toddlerhood and early childhood, the association between SES and development becomes stronger as children grow older, especially regarding cognitive and language development. This result is also consistent with the findings of other studies.^{17–19} It seems plausible to consider SES as a social factor that has a greater impact the longer one is exposed to it. A study of representative cohorts (sample sizes ranging from 1813 to 6191) of German children aged between 0 and 15 years examined the trajectories of SES-dependent achievement gaps and showed that these gaps emerge in the preschool years but remain fairly stable thereafter.¹⁷ It is possible, thus, that schools can at least partially compensate for SES differences.^{17 70}

In line with the results of other studies, girls performed better than boys in all developmental areas.^{22 23 30} The differences were significant only in the areas of hand motor skills, tracing, and, more surprisingly, body motor skills. In other studies, girls tended to have greater advantages in all developmental domains except body motor skills.^{22 23 30} The strongest evidence from other studies is on better language skills in girls than in boys.^{71 72} The mechanisms underlying the differences are probably multiple, and two reviews about cognitive or linguistic sex differences, respectively, conclude that biological and environmental factors combine to account for these outcomes, interacting and conditioning each other.^{73 74} Interestingly, our analyses revealed that the observed sex differences became stronger with increasing age. This result is consistent with the tendencies reported in Krogh and Vaever's study,²³ but contradicts other studies that found that differences between males and females were smaller or non-existent in older as compared with younger (preschool) children.^{72 75} We had expected widening developmental differences between boys and girls with increasing age due to the effects of gender socialisation. This trend can also be observed in the differing emotional expression of boys and girls.⁷⁶ However, it is questionable whether this explanation can be applied to our rather surprising results in the area of motor development.

We found significant associations between cognitive development, hand motor skills, social-emotional development and tracing with behavioural difficulties. Other studies also showed these associations.^{27 28 77} These findings are highly relevant as children who have both behavioural and developmental problems are at particular risk of poor school performance.²⁸

Our results showed a positive association between having an older sibling and motor development (hand and body motor skills). This result supports the thesis of Barr and Hayne that children learn by imitating their older siblings,⁷⁸ at least with regard to motor development. We did not find significant associations in the other



developmental domains. However, we did not consider the age gap between siblings or how much time they spent together. Large age gaps and little time together might limit the possibility to learn from each other.

None of the developmental domains were associated with average sleep duration. These results are consistent with the findings of some previous studies,^{37 39–41} but contradict other studies that showed associations between sleep and child development.^{36 38} Importantly, while several studies have found a negative association between sleep deprivation and executive functioning or reaction time,^{79 80} only a few studies found an association between sleep and more general development. Therefore, one might cautiously conclude that sleep deprivation has a short-term effect on performance in cognitively demanding tasks, but no medium-term or long-term effect on child development.

Similar to sleep, we observed no significant association between development and breastfeeding duration. In the ongoing debate on this topic, our results thus support the assumption that a potential positive association between development and breast feeding is not causally related to breast feeding but may be influenced by a women's SES and educational level, suggesting that socioeconomically advantaged women may breast feed longer than less educated women.^{43 44} In line with this assumption, an association could not be seen in our sample of middle-to-high SES families.

In addition to sleep and breast feeding and as expected, overweight/obesity was not related to child development. This contradicts the results of a study with children below 4 years of age.⁵⁰ However, it is in line with the results of studies on older children, which also found no significant association between overweight/obesity and cognitive development or school performance.^{48 49}

Strengths and limitations

Our study has some weaknesses. We studied a sample with above-average SES, which is thus relatively homogeneous and not representative of the whole population. This could lead to an underestimation of low SES as a risk factor for child development. Our sample sizes vary by factor studied (min=259 children), so the strength of our large sample does not apply to each of the analyses. Furthermore, some of the questionnaires constructed for the LIFE Child study have not been validated. As a weakness of the cross-sectional design of our study, we cannot draw causal conclusions from our results.

Conclusion

Low gestational age, low SES, being a boy and behavioural difficulties are risk factors for healthy and age-appropriate development, and their importance changes during child development. Having older siblings may improve motor development in children, while sleep duration, breastfeeding duration and overweight/obesity do not seem to affect the development of children below school age. For future research, we suggest focusing on the mechanisms

underlying the well-established associations. The knowledge gained in this and other studies must be shared with those entrusted with children and their development. This enables parents, educators and paediatricians, among others, to monitor the development of children growing up in conditions of risk, bearing in mind that children may be affected by several disadvantages at the same time. The best strategies to address the developmental risks must be well reflected in order to avoid possible discrimination or stereotyping through interventions themselves. One possibility to reduce social disadvantages would be the introduction of early, comprehensive, free and high-quality institutional childcare. Moreover, high-frequency checks (home visits) by paediatricians for early identification and intervention in children at risk (eg, prematurely born children) would be helpful.

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ORCID iDs

Clara Elise Schild <http://orcid.org/0000-0001-9770-3906>

Tanja Poulain <http://orcid.org/0000-0003-3825-5829>

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