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Infant regulatory problems, parenting quality and childhood attention problems

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ABSTRACT

Background and aims: To determine the combined impact of infant multiple/persistent regulatory problems (RPs), parenting quality and maternal mental health on childhood attention problems.
Study design: A prospective, population-based cohort study including 16 paediatric hospitals in Southern Bavaria (Germany).
Subjects: 1459 infants were followed from birth to 8 years of age.
Outcome measures: RPs were assessed at 5 and 20 months using interviews by trained paediatricians; parenting quality was assessed between birth and 5 months using parent interviews and nurses' observations; maternal mental health was assessed at birth and 5 months using standardized parents' interviews; childhood data on attention problems were collected at 8 years, using parent reports and expert behaviour observation ratings.
Results: After correction for gestational age, sex, and socioeconomic status, early RPs ($\beta = 0.079$) and low parenting quality ($\beta = 0.175$) predicted later attention problems ($R^2 = 0.272$). Their impact was additive, such that infants with both multiple/persistent RPs and poor parenting quality showed the highest attention problems 8 years later. However, the impact of RPs on attention was strongest for preterm children. Maternal mental health was a significant moderator of the relationship between parenting quality and attention problems. With adequate maternal mental health, good parenting quality was related to lower attention problems, yet with mental health problems present, the effect of good parenting on attention problems diminished.
Conclusions: Guidance and support for parents of infants with multiple/persistent crying, sleeping or feeding problems may be essential to prevent the development of childhood attention problems, especially when maternal mental health problems are present.

Infants who fuss and cry excessively [1], or who have problems with feeding or sleeping are considered to have regulatory problems (RPs) [2, 3]. Infants with RPs are unable to inhibit a current state such as crying or waking and regulate back to a soothed state, or back to sleep [2, 4]. These infants are thought to be hypersensitive to environmental stimuli while experiencing difficulties regulating their behaviour and adjusting to their environment [5]. It has been shown that RPs predict attention problems in children up to eleven years, yet outcomes were worse for children who also had poor parent-infant relationships and parental psychosocial stress [6, 7]. Infants with multiple/persistent RPs are challenging to parents as their behaviour difficulties increase parental burden. Parents of infants with multiple/persistent RPs often report more mental health problems such as increased distress and depressive symptoms [8–11]. Maternal mental health problems such as depression and anxiety may affect parenting and may be a precursor for RPs [11–13] and important for the child's optimal development of self-

Abbreviations: RPs, regulatory problems; PIRI, parent-infant relationship index; CBCL, Child Behaviour Check List; TRCB, Tester's Rating of Child Behaviour; FIML, full information maximum likelihood

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regulation [4, 11]. On the other hand, multiple/persistent RPs are stressful for parents due to sleep deprivation, insecurity about parenting skills, feelings of helplessness, and frustration with the child [9, 14, 15]. A recent systematic review suggests that maternal depression may be more likely a result of infant RPs, while maternal anxiety is more likely a precursor [16]. The presence of mental health problems may be associated with a higher risk of parents not responding to their dysregulated child in a sensitive and caring manner [9], although the evidence is controversial [3]. Parenting quality, i.e., parents' ability to be in tune with their infant's cues and signals and to respond appropriately and consistently may thus be influenced by child characteristics [17]. In addition, infants with RPs may be more vulnerable to poor parenting than infants with none or single RPs [18, 19]. Taken together, we hypothesize that multiple/persistent RPs, suboptimal parenting and maternal mental health problems in infancy will all be related to higher attention problems in childhood. However, it is possible that these effects are not cumulative, i.e. additive, but alternatively, that these effects interact in a way that those infants with RPs may be particularly vulnerable to poor parenting and maternal mental health problems and thus show a disproportionally increased risk for childhood attention problems [18]. We will thus also examine interaction effects between RPs, parenting and maternal mental health exploratively.

Although the link between early RPs and later attention problems has been replicated across studies, several conceptual and methodological considerations need to be taken into account to advance current knowledge. First, only a few studies have included both early RPs and parenting factors as predictors of later childhood behaviour problems [6, 8, 10]. Second, only one of these studies examined the moderating effect of parenting on the association between infants' RPs and later behaviour problems [6]. Third, most of these studies had short follow-up periods, prohibiting the longitudinal prediction of attention problems at a time when these are most likely to be recognised (i.e., first years of elementary school). Fourth, most of these studies only included parent-reported measures of behaviour problems that may be biased due to continued perception of the child as “difficult”. Therefore, the aim of this large prospective cohort study was to examine the combined effects of early multiple/persistent RPs, parenting quality, and maternal mental health on later attention problems assessed by multiple informants at 8 years of age.

1. Methods

1.1. Design and participants

The Bavarian Longitudinal Study is a prospective whole population study of infants born between January 1985 and March 1986, who required admission to one of 16 paediatric hospitals in Southern Bavaria (Germany) within the first 10 days after birth (n = 7505; 10.6% of all live births) [20]. Additionally, 916 full-term comparisons were recruited in obstetric units in the same catchment area during the same period. After the first phase of the study (birth to 56 months) the decision was made to reduce the sample to allow for a continuation of more intensive psychological and neurological assessments. From the initial sample; all survivors born < 32 weeks and/or < 1500 g birth weight, and a subsample of hospitalized children born ≥ 32 weeks (randomly drawn within the stratification factors sex, family socioeconomic status (SES) and degree of neonatal risk) and 343 healthy term-born control children were selected for assessment at age 8 years (n = 1495). More details on the sampling criteria and infancy dropout rates are provided elsewhere [21]. The sample was further reduced due to missing RPs data in infancy (n = 36) resulting in a final study sample of 1459 children. Ethical approval was obtained from the University of Munich Children's Hospital and the Landesärztekammer Bayern. Informed written consent was provided by parents within 48 h of their child's birth.

1.2. Measures

1.2.1. Multiple or persistent regulatory problems

An interview concerning crying, feeding, and sleeping problems was conducted with parents at 5 and 20 months by trained paediatricians. This interview was evaluated as a reliable and valid assessment of infant regulatory problems [1, 22, 23]. Children who were classified as having multiple RPs had at least 2 problems at 5 months or 20 months: A *crying problem*, a *sleeping problem*, or a *feeding problem*. Persistent RPs were defined as having at least one type of RP at 5 and at 20 months of age. For this study, the variable RPs was dummy coded (0 = no/single RP; 1 = multiple/persistent RPs). For more information see supplement S1.

1.2.2. Parenting quality

Parenting quality was assessed with the Parent–Infant Relationship Index (PIRI) [20, 24], a measure similar to the Boston City Hospital Assessment of Parental Sensitivity [25]. The PIRI contains 8 yes/no items on parenting behaviours and attachment-related parental concerns and feelings, based on a standardized interview with the parent by trained paediatricians and nurses' observations assessed in the neonatal period and at 5 months. Items were summed up so that PIRI-scores could range from 0 to 8 with higher scores indicating poorer parenting quality. For more information see supplement S1.

1.2.3. Maternal mental health

Maternal mental health was assessed neonatally and at 5 months with 1 item ‘maternal mental health’ of the Psychosocial Stress Index (PSI), a 14 item interview-based measure administered by trained paediatricians [20, 24]. During both assessments, maternal mental health was rated as 0 = no problems; 1 = hardly any problems; 2 = mental health problems present. A dummy variable was created with 0 = no/hardly problems (i.e., adequate mental health) and 1 = mental health problems present, in such a way that when mental health problems were present at either or both assessments, it was coded as 1.

1.2.4. Parent-rated attention problems

Parent-rated attention problems were assessed at 8 years using the German version of the Child Behaviour Check List (CBCL) [26, 27]. The attention problems subscale consists of 11 items (e.g., can't concentrate, can't pay attention for long). Each item was rated on a scale from 0 to 2, and then summed across all items, with higher scores indicating more problems (Cronbach's α = 0.72).

1.2.5. Observer-rated attention problems

Psychologists rated the child's behaviour during a comprehensive cognitive assessment (i.e., the Kaufman Assessment Battery for Children) [28] lasting over 1 h using the Tester's Rating of Child Behaviour (TRCB) at 8 years [29]. The task orientation index scale was constructed using the mean of 6 scales (Cronbach's α = 0.85): Attention, robustness and endurance, demandingness (recoded), cooperativeness, compliance, and difficulty (recoded), rated 1 = very low to 9 = very high. The interrater reliability as measured with the intraclass correlation (ICC) ranged from 0.63–0.97 for the 6 task orientation subscales [30].

In addition, the whole research team (psychologist, assistant psychologist, and paediatrician) evaluated the child's attention span using 3 TRCB subscales (attention, robustness and endurance, and demandingness (recoded)), adopting a consensus model based on their observations across the whole assessment day comprising various activities including neurological assessments, motor tasks, interviews, mother-child interaction observations, and tests. This mean TEAM attention index ranged from 1 = very short to 9 = very long attention span (Cronbach's α = 0.85) [29].

1.2.6. Confounders

Gestational age at birth in weeks, sex (0 = male; 1 = female), and family SES were included in the analyses, as these variables are related to RPs, parenting and/or attention problems [3, 6, 10, 12, 31]. Family SES at birth was computed as a weighted composite score of parents' education and occupation (lower/middle/upper class) [32].

1.3. Statistical analysis

Group differences (no/single RP vs. multiple/persistent RPs) and sample descriptives were tested with either *t*-tests for interval scaled variables or chi-square tests for dichotomous variables using SPSS 22.0. Hierarchical linear regression analyses were conducted in Mplus 7.3 using maximum likelihood estimation with robust standard errors (MLR; i.e. robust against non-normality) to evaluate whether multiple/persistent RPs, poor parenting, and maternal mental health were predictive of later attention problems. Overall, 3% of the data were missing and full information maximum likelihood (FIML) estimation was used by default. First, we constructed a latent attention variable using the three attention measures to avoid multiple comparisons by using similar outcomes. To construct this latent variable, TRCB and TEAM attention span were recoded so that for all three measures, a higher score indicated more attention problems (Cronbach's alpha for the three standardized attention measures was 0.73). As both the TRCB and TEAM ratings were observer-ratings of attention on the same day, their error variances were allowed to correlate. Second, the latent variable attention was regressed on RPs, parenting quality, maternal mental health and the confounders gestational age, sex, SES and the interaction effect of RPs*gestational age as research shows that preterm birth may result in developmental deficits related to RPs [12]. Third, we tested whether the interaction effects between RPs, parenting quality, and maternal mental health added to the prediction of attention problems. Fit of the models was tested using chi-square test of model fit, the Root Mean Squared Error of Approximation (RMSEA), and the Comparative Fit Index (CFI). The fit of the models was considered good for a RMSEA close to 0.06 and a CFI close to 0.95 [33].

2. Results

2.1. Sample characteristics

Of the 1459 children, 82.9% (n = 1210) were classified as having no/single RP and 17.1% (n = 249) were classified as having multiple/persistent RPs. Of the infants with multiple and/or persistent RPs, 5.5% had multiple RPs at 5 months (n = 81), 3.0% had multiple RPs at 20 months (n = 44), and 12.9% had persistent RPs from 5 to 20 months (n = 189). Please note that some infants had both multiple RPs and persistent RPs (n = 59), so that these percentages do not add up to 17.1%. Sample descriptives for those with and without multiple/persistent RPs are shown in Table 1. Children with multiple/persistent RPs had a lower mean gestational age but groups did not differ in sex, SES, parenting quality, and maternal mental health. In addition, children with multiple/persistent RPs had higher scores on childhood attention problems and lower scores on attention span, and slightly lower scores on task orientation (mean difference: 0.139, 95% CI: −0.007 to 0.285) than children with no/single RP.

2.2. Predicting childhood attention problems

Both multiple/persistent RPs and poor parenting in infancy, but not postnatal maternal mental health, significantly predicted attention problems 8 years later. In addition, a higher gestational age, being female, and higher SES were associated with lower attention problems. For gestational age, a significant interaction effect showed that RPs were most strongly related to later attention problems for preterm born children. Although maternal mental health did not predict attention problems, the interaction between parenting quality and maternal mental health did, indicating that when maternal mental health problems were present, the effect of parenting quality on attention problems attenuated. In contrast, the interaction effects between RPs and parenting quality and between RPs and maternal mental health were non-significant and were thus removed from the final model (see Table 2). The final model's fit was good: $\chi^2(44) = 102.862$, $p < 0.001$; RMSEA = 0.030; CFI = 0.962, and together, all predictors explained 27.2% of the variance in childhood attention problems. Fig. 1 shows the results of the final structural equation model. Fig. 2A depicts the interaction effect between gestational age (dichotomized using term vs. preterm born children) and RPs, and Fig. 2B depicts the interaction effect of parenting quality (dichotomized with good PIRI (original score = 0) vs. suboptimal PIRI (original score = 1–8)) and maternal mental health on attention problems. It can be seen that when maternal mental health was adequate, good parenting quality was related to lower attention problems, yet when maternal mental health problems were present, the positive effect of good parenting quality on attention problems diminished.

Table 1
Sample descriptives separately for the two RPs groups.

	No/single RP		Multiple/persistent RPs		Group differences
	n	*m*(*sd*)/%	*n*	*m*(*sd*)/%	*p*-Value
Gestational age (weeks)	1210	36.68 (3.99)	249	35.94 (4.78)	0.011
Sex (female)	1210	49.5%	249	48.6%	0.84
SES (low)	1210	33.1%	249	34.5%	0.71
SES (middle)	1210	38.3%	249	35.3%	0.43
SES (high)	1210	28.6%	249	30.1%	0.65
Poor parenting quality	1167	0.50 (0.85)	246	0.59 (0.89)	0.15
Mental health problems	1202	5.1%	248	6.9%	0.28
Attention problems					
CBCL attention problems[a]	1129	2.24 (2.32)	227	2.78 (2.79)	0.002
TRCB task orientation[b]	1120	7.36 (0.96)	216	7.22 (1.17)	0.06
TEAM attention span[b]	1122	6.83 (1.36)	219	6.60 (1.74)	0.030

[a] Higher scores indication more problems.
[b] Higher scores indication less problems; RPs = regulatory problems; SES = socioeconomic status.

3. Discussion

RPs and parenting quality in infancy were both independently related to attention problems measured in childhood, approximately 8 years later. Their effects were additive, so that infants with both

Table 2
Final model predicting childhood attention problems.

Variables	β	95% *CI*		*p*
Poor parenting quality	0.175	0.098	0.252	< 0.001
Parenting*mental health problems	−0.078	−0.141	−0.015	0.016
Maternal mental health problems	−0.010	−0.085	0.065	0.798
RPs (multiple/persistent)	0.079	0.011	0.148	0.023
RPs*gestational age	−0.220	−0.320	−0.121	< 0.001
Gestational age (weeks)	−0.207	−0.283	−0.131	< 0.001
Sex (female)	−0.208	−0.274	−0.142	< 0.001
SES (high)	−0.191	−0.258	−0.124	< 0.001
SES (low)	0.069	−0.003	0.140	0.059

Note. RPs = regulatory problems; β = standardized regression coefficient; 95% CI = 95% confidence interval around β.

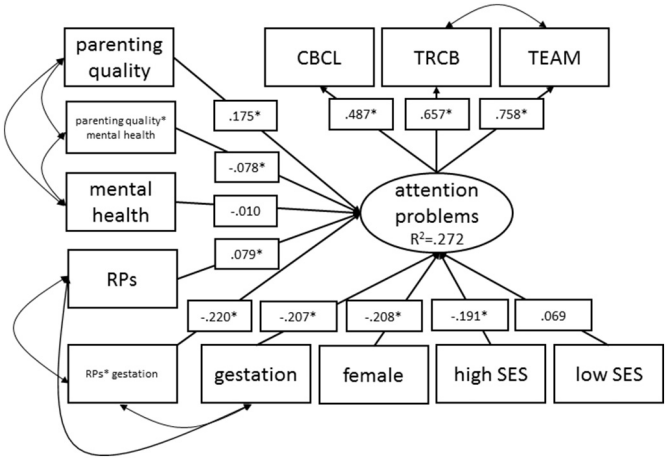

Fig. 1. Final SEM model predicting attention problems.
Note. RPs = regulatory problems; reported in the model are standardized regression coefficients and standardized factor loadings; * = $p < 0.05$.

multiple/persistent RPs and poor parenting quality showed the highest attention problems. Gestational age at birth, sex, and SES were also important predictors of attention problems, yet they did not explain the effects of RPs and parenting quality on attention problems. Importantly, our results indicate that preterm-born children with RPs had the highest attention problems in childhood. Also, postnatal maternal mental health by itself was not related to childhood attention problems. However, when maternal mental health problems were present, the positive effect of good parenting on attention problems diminished.

Although other studies have consistently shown effects of early RPs on childhood attention regulation [7], as far as we are aware, few studies have examined interaction effects of infant RPs with parenting quality and maternal mental health on attention. Consistent with previous research [6], both early multiple/persistent RPs and poor parenting contributed to the development of attention problems. The impact of parenting quality, including early parent-infant relationships, was about twice as large as the impact of RPs, and comparable to the effects of sex and high SES. Additional analyses showed that the relationship between RPs, parenting quality and attention problems only diminished, but not disappeared, when taking into account important background variables such as gestational age, sex and SES. This implies that the effect of parenting quality was additive, that is, on top of the effects found for SES of the family. The moderate effects of lower gestation, male sex, and low SES on higher attention problems were similar to other studies [34, 35]. Inconsistent with previous research [6] was the modest effect of maternal mental health that only added to the prediction of attention problems in interaction with parenting quality. Maternal mental health was measured around birth and not during pregnancy, so it may still be that psychological stress during pregnancy increases the risk for RPs as found previously [36], and thereby impact later attention. Yet, a recent systematic review showed that only maternal anxiety, and not depression, during pregnancy is related to later RPs and depression is more likely a consequence of RPs [16]. Also, our study did not show a significant interaction effect of RPs with parenting, implying only additive effects or disadvantage for infants growing up with both multiple/persistent RPs and poor parenting quality, especially when these infants are also born preterm. A cascade model of development has been suggested whereby RPs provide the starting point for following a trajectory of dysregulated emotions and behaviours such as attention problems in later childhood [6, 31] in which parenting quality may represent an important factor explaining why infants' RPs persist. However, there may be an alternative explanation. Parenting quality was assessed a few months earlier than RPs, so it is possible that early RPs represent a marker for suboptimal parenting, reinforcing a feedback loop of negative interactions consisting of maternal perceptions of her child as having a difficult temperament that in turn influences mother's parenting behaviour and later attention problems. There is previous evidence that early postnatal maternal sensitivity does reduce regulatory problems but once they have developed there is little influence of parenting and regulatory problems across time [3].

The origins and underlying mechanisms of early RPs and subsequent trajectories of dysregulation are not well understood. To date, research has focused on neurodevelopmental, individual, and environmental risk factors such as being born preterm, temperament, and early parenting [3, 37]. One potential mechanism underlying the formation of both temperament and differential vulnerability to environmental influences is proposed by the foetal programming hypothesis, suggesting that adverse intra-uterine environments may result in life-long effects on organs, physiological systems, and their homeostasis [38]. Previous

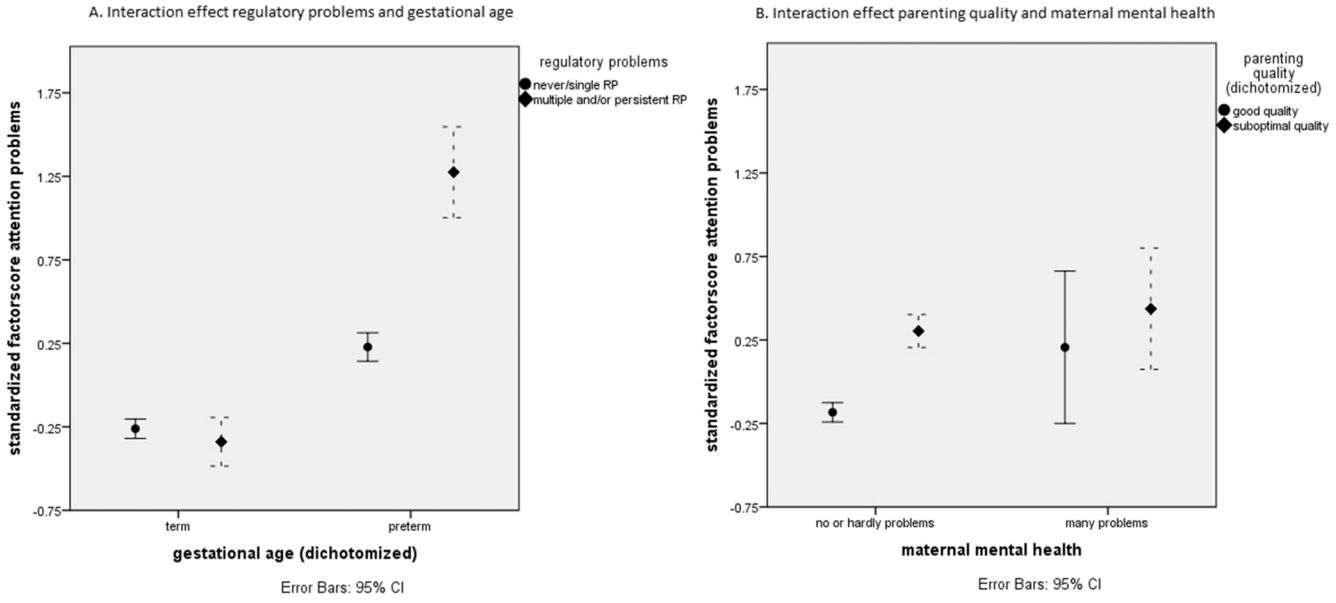

Fig. 2. A and B. Interaction effects between gestational age and RPs (2A), and between parenting quality and maternal mental health (2B) on attention problems.
Note. Error bars represent 95% confidence intervals around β.

research provided evidence that this is not only true for physiological health, but also for behaviour and temperament [39], and specifically that lower gestation is associated with increased multiple/persistent RPs [12, 37]. Our study included a large sample of at-risk children who were born premature, and our results further support the foetal programming hypothesis by showing that the effect of RPs on attention may differ according to gestational age. Accordingly, experiences before and around birth may have programmed infants to show multiple/persistent RPs and later attentional problems [40]. This is also consistent with previous findings of neurodevelopmental vulnerability being important for the development of infant RPs [3, 37].

3.1. Strengths and limitations

The strengths of this study are its prospective design with multiple/persistent RPs, parenting quality, and maternal mental health assessed around birth and thus a long time (eight years) before the assessment of attention problems. Another strength is the use of multiple measures and data sources of attention problems, resulting in robust findings. There are also limitations. Maternal mental health was assessed by a structured interview, yet using only one general question and it is unclear which mental health problems were reported by mothers. Also, the RPs measure was more comprehensive at 5 than 20 months because it additionally included the assessment of age-appropriate crying problems. We created a dichotomous measure of infant RPs, distinguishing only no/single from multiple/persistent RPs. Our study thus does not distinguish between the impact of multiple RPs at one time point, persistent RPs only, RP severity, and whether the influence of parenting quality on later attention varies depending on the severity of RPs. However, previous studies have shown that multiple RPs are more severe in their effect on later dysregulation and behaviour than single RPs and more likely lead to parents seeking help [1, 7, 31]. Finally, notwithstanding the prospective design, the relationships found in this study may not imply causality. Underlying genetic factors related to both RPs and attention problems were not studied.

4. Conclusions

Multiple/persistent RPs and early poor parenting increased the risk for childhood attention problems. It is therefore important to provide early guidance to parents who have infants with multiple/persistent crying, sleeping or feeding problems and in particular for mothers coping with mental health problems [37]. There are a number of ways to support parents who have infants with RPs to ensure positive parent-child interactions. Training parents in co-regulation by supporting sensitive parenting is key, as it entails carefully watching the infant and responding appropriately, consistently, and promptly to the child's needs. For example, interventions for sleep problems usually consist of training parents in co-regulation by using behaviourally-based principles such as positive routine-setting and graduated extinction [41]. Specifically, helping parents in designing a regular predictable routine, giving them clear instructions for how to support regulation of crying and sleep and teaching them how to deal with their own stress and frustration significantly reduced excessive crying in 3–6 month old infants [42]. More successfully dealing with their infant's RPs may reduce parental stress and improve caretaking practices, which in turn may help break a pattern of dysfunctional family interactions.

Financial disclosure & conflicts of interest statement

All authors – Linda Breeman, Julia Jaekel, Nicole Baumann, Peter Bartmann, Josef Bäuml, Mihai Avram, Christian Sorg, Dieter Wolke – report no financial interests or potential conflicts of interest.

Contributor's statement

Linda D. Breeman: Conceptualized and designed the study, drafted the initial manuscript, analysed and interpreted the data, and approved of the final manuscript as submitted.

Julia Jaekel, Nicole Baumann, Peter Bartmann, Josef Bäuml, Mihai Avram, Christian Sorg: Conceptualized and designed the study, reviewed and revised the manuscript, and approved of the final manuscript as submitted.

Dieter Wolke: Conceptualized and designed the study, coordinated and supervised data collection and analysis, interpreted the data, reviewed and revised the manuscript, and approved of the final manuscript as submitted.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.earlhumdev.2018.07.009.

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