

Motor development problems in infancy predict mental disorders in childhood

a longitudinal cohort study

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4	Motor development problems in infancy predict mental
5	disorders in childhood: a longitudinal cohort study
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- 22 Abstract
- 23
- *Purpose:* To examine whether motor development problems in infancy predicted mental disorders later in childhood,
 taking a wide array of potential confounding variables into consideration.
- 26 Methods: This longitudinal study included an unselected study population of 33,238 newborn children from the
- 27 Copenhagen area, Denmark. Data on the predictor variable: motor development problems at 8-10 months of age, were
- 28 obtained from the community health nurses' systematic evaluation of the child's motor development during a home
- visit and stored in the Child Health Database. Data on outcome, diagnosed mental disorders before the age of 8 years,
- 30 were obtained from the Danish National Patient Register. Potential confounding variables were obtained from the Child
- 31 Health Database, the National Birth Register, and the Civil Registration System.
- 32 *Results:* The prevalence of motor development problems at 8-10 months of age was 19.3%; the incidence of any
- diagnosed mental disorder from 11 months of age to the 8th birthday was 4.0%. Motor development problems were
- 34 associated with an increased risk of being diagnosed with a mental disorder before the 8th birthday, adjusted odds ratio
- 35 (AOR) 1.47 (1.29-1.67). Motor development problems were associated with later neurodevelopmental disorders, AOR
- 36 1.77 (1.52-2.06), in particular autism-spectrum disorders, AOR 1.63 (1.31-2.03), hyperactivity/ attention deficit
- disorders, AOR 1.29 (1.03-1.61) and disorders of intellectual disability, AOR 3.28 (2.39-4.49).
- 38 *Conclusion:* Motor development problems as early at 8-10 months of age were predictive of neurodevelopmental
- 39 disorders before the 8th birthday. The findings call for clinical attention and more research on preventive potentials in
- 40 the community child health care.
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- 42
- 43 *Keywords:* Children; longitudinal study; community health nurses; infants; mental disorders; motor development
- 44 problems.
- 45

46	List of abbreviations			
47				
48	ADHD: Attention deficit hyperactivity disorder			
49	AOR: Adjusted odds ratio			
50	ASD: Autism spectrum disorders			
51	CHN: Community health nurse			
52	CI: Confidence Interval			
53	ICD-10: International classification of diseases, 10 th edition			
54	ID Intellectual disability			
55	OR: Odds Ratio			
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59	What is known			
60				
61	• Children with ASD, ADHD, and ID have high prevalence of early motor development problems.			
62				
63	What is new			
64				
65	• Motor development problems in infancy predicted neuro-developmental disorders before the 8 th birthday			
66	• This observation could improve early identification and prevention of mental health problems in childhood			

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73	
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76	
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78	
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80	interpretation of data. TPP and SWP acquired the data. SWP and TPP performed the analyses. SWP and BEH wrote the
81	first draft of the manuscript. All authors contributed to the writing of the manuscript and a critical revision of the
82	intellectual content. All authors have approved the final version of the manuscript and are accountable for all aspects of
83	the work.
84	
85	Ethical approval: The study was approved by the Danish Data Protection Agency (registration number 10.366,
86	University of Southern Denmark) and complied with national regulations of data protection and consent. Linkage with
87	register data was administered by Statistics Denmark and the involved researchers did not have access to personal
88	identification. According to the Danish legislation, informed consent is not required for register-based studies.
89	
90	Consent to participate: Not applicable.
91	
92	Consent for publication: Not applicable.

94 Introduction

95

96	Available research suggests that motor development problems in infancy may be predictive of childhood			
97	neurodevelopmental disorders, such as autism spectrum disorder (ASD) [1-9], disorders of hyperactivity and inattention			
98	(ADHD) [4, 5, 10-12], and disorders of intellectual disability (ID) [7]. None of the studies published thus far have			
99	explored the predictiveness of systematically assessed motor development regarding the range of mental disorders seen			
100	in childhood and considered unmeasured confounding due to child and family variables [1, 6-10]. Athanasiadou et al.			
101	(2020) suggested that investigating early motor development in infancy could be important for the study of early			
102	biomarkers of common neurodevelopmental disorders [10]. Moreover, there is a need to examine whether the municipa			
103	child health system can be used to identify children who are at a developmental risk regarding severe mental disorders			
104	[11, 13]. Therefore, the aim of this study was to use a large community-based cohort to examine whether motor			
105	development problems in infancy predicted mental disorders later in childhood, taking a wide array of potential			
106	confounding variables into consideration.			
107				
108	Methods			
109				
110	Setting: In Denmark, the municipal health care system offers all families with newborn children a series of home visits			
111	provided free of charge by a community health nurse (CHN) [13]. CHNs are registered nurses with further education			
112	(1½ years) comprising training in the assessment of health and development in children. Approximately 97% of all			
113	families participate in these home visits. Most municipalities comply with the recommendations from the National			
114	Health Authority and offer at least five home visits at (a) a few days after delivery, (b) 1-2 weeks after delivery, (c) 2-3			
115	months after delivery, (d) 4-6 months after delivery and (e) 8-10 months after delivery. CHNs in a range of			
116	municipalities have organized a clinical database-the Child Health Database-with standardized data from their			
117	records. The CHNs use a manual of definitions to ensure comparability and promote validity of the data in their records.			
118	The records include the children's unique person identification numbers, which makes it possible to link the data with			
119	data from national health and sociodemographic registers that cover the total population in Denmark.			
120				
121	Study design and study population: This was a longitudinal study of infants using prospectively collected data from the			
122	Child Health Database and register data from the National Birth Register, the Danish National Patient Register, and the			
123	Civil Registration System. The inclusion criteria were as follows: 1) all children from 16 municipalities in the			

124 Copenhagen region in Denmark born between 1 January 2002 and 31 December 2010 and who had their 8th birthday

before 1 January 2019 (n=47,167) and 2) included in the Child Health Database. The exclusion criteria were as follows:
1) children with a mental disorder diagnosed at a hospital within the first 10 months of the child's life (n=946) and 2)
those with missing data on motor development problems (n=8,634) or any applied control variable (n=4,349), leaving a
final sample of 33,238 children. We chose an eight-year follow-up period to include the first years of schooling and still
benefit from a large study population.

130

131 Measures: The independent variable was motor development problems in infancy. These data stem from the scheduled CHN home visit at 8-10 months of age. The CHN assessed the child's motor development four times in infancy: at 1-2 132 133 weeks, 2-3 months, 4-6 months, and 8-10 months after delivery. We used the last of these assessments because some 134 infants with slow motor development catch up in their milestones during the first year of life. According to the 135 guidelines and the manual for assessments for children at 8-10 months of age, the CHNs expressed a concern in the 136 record if a child did not meet all of the following specific developmental milestones: able to roll over from their back to 137 their stomach and reverse; able to sit independently; able to move things from hand to hand; able to put things into their 138 mouth; able to crawl forwards and/or backwards; and able to pull to a standing position. We summarized the assessment 139 into a dichotomous variable: +/- motor development problems.

140

141 The dependent variable/outcome variable was any mental disorder diagnosed in a hospital setting from 11 months of 142 age to the 8th birthday. These data were obtained from the Danish National Patient Register, which includes all in- and 143 outpatient and emergency hospital contacts with 100% coverage [14]. In these settings, medical doctors conclude, using 144 clinical and paraclinical data, the diagnoses of mental disorders in accordance with the defining criteria of the 145 International Classification of Mental and Behavioral Disorders 10 (ICD-10). Several studies have reported that the 146 Danish National Patient Register is characterized by high validity and reliability [14-16]. We included a range of mental 147 disorders seen in childhood: general developmental disorders or ID (F70-F79); specific developmental disorders (F80-148 F83); pervasive and other developmental disorders (F84-89); hyperkinetic disorders (F90); attention deficit disorder 149 without hyperactivity (F98.8); mood disorders, emotional and stress-related disorders (F30-F34, F38-F45, F48, F93); 150 disorders of eating and sleeping (F50-F51, F 98.2); disorders of behaviour (F91-F92); and disorders of social 151 functioning (F94.1, F94.2, F94.8). We summarized the data into three dichotomous variables: 1) a diagnosed 152 neurodevelopmental disorder, including disorders of ID, ASD and ADHD (yes, no); 2) a diagnosed behavioural or 153 emotional disorder (yes, no); and 3) at least one diagnosed mental disorder before the age of 8 years (yes, no). We also 154 conducted analyses for some specific diagnoses: ASD (F84), disorders of hyperactivity and inattention (F90, F98.8) and 155 ID (F70).

157 The analyses included the following potential confounders: from the National Birth Register: sex, parity (first born vs. 158 later), gestational age (continuous variable, days), birth weight (<2500 g, 2500-3999 g, >3999 g), congenital 159 malformation (yes, no), mother's and father's age at childbirth (<25 vs. ≥25 years), pregnancy complications (yes, no), 160 caesarean section (yes, no), and Apgar score (9-10 vs. less than 9); from the Civil Registration System: parents' education at childbirth (five levels), parents' employment (2, 1 or 0 employed parents), family composition (child lives 161 162 with both parents, yes vs. no), and parents' origin (2, 1 or 0 parents of Danish origin); and from the Child Health 163 Database: concern about the mother's mental health in the first six months after delivery (concern at 0 visits vs. at least 164 one home visit) and concern about the parent-child relationship in the first six months after delivery (concern at 0 visits 165 vs. at least one home visit).

166

156

167 Statistical procedures: We used bivariate contingency tables and chi²-tests to examine the baseline differences between 168 the included and excluded infants. The next step was logistic regression analysis of the association between motor 169 development problems at 8-10 months of age (independent variable) and diagnosed mental disorders from 8-10 months 170 of age to the 8th birthday (dependent variable). We adjusted for the abovementioned potential confounding variables. 171 The assumptions of the regression models were respected: 1) the response variable was binary; 2) the study population 172 was sufficiently large and characterized by independent observations; 3) there were no extreme outliers; and 4) there 173 were no serious problems of collinearity. The main independent variable (motor development problems) was not highly 174 correlated with the other independent variables. The high intercorrelation between the two pairs of confounding 175 variables (mother's and father's age; gestational age and birth weight) hardly affected the examination of the 176 association between motor development problems and mental disorders.

177

178 Results

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Table 1 shows the characteristics of the study population compared with the children excluded because of missing data.
There was a slight although statistically significant overrepresentation of children with diagnosed mental disorders
among the excluded children. Furthermore, more of the excluded children had perinatal risk factors, such as being born
before the 37th week, having a low birth weight, having a caesarean section, and having an Apgar score < 9. More of the</p>
excluded children had young parents, unemployed parents, parents with low educational attainment, parents who were
immigrants or descendants of immigrants, parents who were not living together, mothers for whom the CHN had

186 indicated concern about their mental health in the first six months after delivery, and mothers for whom the CHN had

187 indicated concern about the parent-child relationship in the first six months after delivery.

188

Within the study population of 33,238 children, 6,399 (19.3%) had motor development problems at 8-10 months of age.
The number of children diagnosed with at least one mental disorder from 11 months of age to the 8th birthday was 1,331 (4.0%); 878 (2.6%) were diagnosed with a neurodevelopmental disorder, and 671 (2.0%) were diagnosed with a behavioural or emotional disorder. Among the 6,399 children with motor development problems, 357 (5.6%) were diagnosed with at least one mental disorder, 269 (4.2%) were diagnosed with a neurodevelopmental disorder, and 152 (2.4%) were diagnosed with a behavioural or emotional disorder. The numbers of children with ASD, ADHD, and ID were 122 (1.9%), 111 (1.7%) and 79 (1.2%), respectively.

196

197 Children who had motor development problems at 8-10 months of age had an increased risk of being diagnosed with a mental disorder before their 8th birthday, AOR (95% CI) =1.47 (1.29-1.67) (Table 1). The association between motor 198 199 development problems in infancy and behavioural or emotional disorders was insignificant in the mutually adjusted 200 analysis, AOR 1.13 (0.94-1.36). Children with motor development problems in infancy had an increased risk of any 201 neurodevelopmental disorder, AOR=1.77 (1.52-2.06) and, more specifically, an increased risk of ASD, AOR=1.63 202 (1.31-2.03), disorders of hyperactivity and inattention, AOR=1.29 (1.03-1.61), and ID, AOR=3.28 (2.39-4.49). The 203 estimates were only slightly attenuated when child and family adversities were adjusted for, such as prematurity, 204 pregnancy and birth complications, low parental education, and maternal and relationship problems in infancy. Tables 205 S1-S6 in Online Resource 1 show the full models, i.e., the association between all independent variables and each of the 206 six dichotomous outcome variables.

207

208 Discussion

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210 This longitudinal study showed that motor development problems in infancy were associated with diagnosed

211 neurodevelopmental disorders in childhood but were not associated with behavioural or emotional disorders. Our

findings correspond with the current conceptualization of neurodevelopmental disorders [17]: They are characterized by

- 213 onset in infancy or early childhood; impairments, or delays in the development of functions are strongly related to the
- biological maturation of the central nervous system; and a steady course that does not involve remissions and relapses
- that characterize many other mental disorders [18]. Our findings also correspond with the growing recognition that
- psychosocial and psychomotor problems in infancy are predictive of mental disorders in childhood [3, 4, 6, 10, 11, 19,

20]. Due to the comprehensive data from national registries, it was possible to adjust for an array of potential
confounding variables of suggested importance in the developmental trajectories of neurodevelopmental disorders,
including markers of pre- and perinatal adversities. Notably, the associations between motor development problems at
8-10 months of age and mental disorders were only slightly attenuated when adjusted for many potential confounding
variables.

222

223 Overall, our findings of an elevated risk for neurodevelopmental disorders correspond with those of recent studies of 224 risk factors for ASD and ADHD [1-4, 6-8, 12]. There are several hypotheses about the link between motor development 225 problems in early childhood and later neurodevelopmental disorders, hypotheses that refer to the neurobiological 226 development of the brain [10, 18]. Delays in brain maturation are associated with delays in motor development and 227 specific motor skills. This is in correspondence with our observations of a significant association between motor 228 development problems and neurodevelopmental disorders and ID but no association between motor development 229 problems and disorders of behaviour and emotions. However, the present study was not suited to further explore the 230 possible neurodevelopmental trajectories.

231

The strengths of the study include the large and unselected study population, the use of standardized data on child development from the CHNs' manualized examinations, the use of validated data on child mental disorders, and comprehensive data on child and family variables from population registers, allowing for the extensive control of potential confounding variables.

236

237 One limitation is that the study narrowly focused on motor development problems instead of a wider range of infant 238 development. We chose this narrow focus because the association between motor development problems and mental 239 disorders is an understudied issue, and it would be difficult to maintain focus in a paper that included many aspects of 240 infant development. Furthermore, the study only captured hospital-recorded mental disorders, which misses a large 241 portion of mental disorders in the population. The study may suffer from some selection bias: Participants who were 242 excluded due to missing data about motor development had higher rates of mental disorders and higher prevalences of 243 perinatal and sociodemographic risk factors for mental disorders. Therefore, the study may underestimate the incidence 244 of mental disorders. There were differences between the included and excluded children in many baseline variables. 245 These differences were statistically significant but most of them are not very big. It is highly unlikely that the 246 associations between motor development problems and mental disorders - as they appear in the multivariably adjusted

analyses – were affected by the abovementioned differences between included and excluded children. Furthermore, it
 may be a limitation that the validity of the motor skills examination is unknown, although it follows specific guidelines.

249

From a research point of view, there is a need for insight into the neurodevelopmental mechanisms that connect motor development problems and neurodevelopmental disorders. There is also a need to study how motor development interacts with other infant development problems, such as regulatory problems and parent-child problems, which also predict mental disorders [3-5, 9-12, 19, 20]. In the future, the Child Health Database will include children with an 18year follow-up. At that point in time, it will be interesting to repeat the analyses to study whether motor development problems in infancy are associated with mental disorders in adolescence.

256

From a practice point of view, we need more information on how to help parents and professionals deal with motor development problems in infancy. We also need methods for the assessment of motor development problems that are sensitive to problems related to children's mental health [1]. The early detection of motor development problems would facilitate timely diagnosis and intervention in a critical period of child development. According to Atanasiadou et al. (2020) [10], this would assist clinicians in intervening in a critical period of child development when the brain is rapidly developing, and neuroplasticity is the highest. Furthermore, timely diagnosis and intervention may also contribute to early preventive efforts to help children at risk [10, 18].

264

In conclusion, motor development problems that occur as early at 8-10 months of age are predictive of

266 neurodevelopmental disorders before the 8th birthday. The findings call for clinical attention and more research on the

267 preventive potentials in community child health care.

268

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272	References
273	
274	1. Choi B, Leech KA, Tager-Flusberg H, Nelson CA (2018) Development of fine motor skills is associated with
275	expressive language outcomes in infants at high and low risk for autism spectrum disorder. J Neurodev Disord 10: 14.
276	https://doi: 10.1186/s11689-018-9231-3.
277	
278	2. Fournier KA, Hass CJ, Naik SK, Lodha N, Cauraugh JH 2010) Motor coordination in autism spectrum disorders: a
279	synthesis and meta-analysis. J Autism Dev Disord 40: 1227–40. https://doi: 10.1007/s10803-010-0981-3.
280	
281	3. 1b. Bhat AN, Galloway JC, Landa RJ (2012) Relation between early motor delay and later communication delay in
282	infants at risk for autism. Infant Behav Dev 35: 838-46. https://doi: 10.1016/j.infbeh.2012.07.019.
283	
284	4. Elberling H, Linneberg A, Olsen EM, Houmann T, Rask CU, Goodman R, Skovgaard AM (2014) Infancy predictors
285	of hyperkinetic and pervasive developmental disorders at ages 5-7 years: results from the Copenhagen Child Cohort
286	CCC2000. J Child Psychol Psychiatry 55: 1328-35. https://doi: 10.1111/jcpp.12256.
287	
288	5. Barkley RA (1997) Attention-deficit/hyperactivity disorder, self-regulation, and time: toward a more comprehensive
289	theory. J Dev Behav Pediatr JDBP 18: 271–9.
290	
291	6. LeBarton ES, Landa RJ (2019) Infant motor skill predicts later expressive language and autism spectrum disorder
292	diagnosis. Infant Behav Dev 54: 37-47. https://doi: 10.1016/j.infbeh.2018.11.003.
293	
294	7. Lemcke S, Juul S, Parner ET, Lauritsen MB, Thorsen P (2013) Early signs of autism in toddlers: A follow-up study
295	in the Danish National Birth Cohort. J Autism Dev Disord 43: 2366–75. https://doi: 10.1007/s10803-013-1785-z
296	
297	8. Sacrey L-A, Zwaigenbaum L, Bryson S, Brian J, Smith IM (2018) The reach-to-grasp movement in infants later
298	diagnosed with autism spectrum disorder: a high-risk sibling cohort study. J Neurodev Disord 10: 41. https://doi:
299	10.1186/s11689-018-9259-4.
300	
301	9. West KL (2019) Infant Motor Development in Autism Spectrum Disorder: A Synthesis and Meta-analysis. Child
302	Dev 90; 2053-70. https://doi: 10.1111/cdev.13086.

304	10. Athanasiadou A, Buitelaar JK, Brovedani P, Chorna O, Fulceri F, Guzzetta A, Scattoni ML (2020) Early motor				
305	signs of attention-deficit hyperactivity disorder: a systematic review. Eur Child Adolesc Psychiatry 29: 903-16.				
306	https://doi: 10.1007/s00787-019-01298-5.				
307					
308	11. Lemcke S, Partner ET, Bjerrum M, Thomsen PH, Lauritsen MB (2016) Early development in children that are later				
309	diagnosed with disorders of attention and activity: a longitudinal study in the Danish National Birth Cohort. Eur Child				
310	Adolesc Psychiatry 25: 1055-66. https://doi: 10.1007/s00787-016-0825-6.				
311					
312	12. Kaiser M-L, Schoemaker MM, Albaret J-M, Geuze RH (2015) What is the evidence of impaired motor skills and				
313	motor control among children with attention deficit hyperactivity disorder (ADHD)? Systematic review of the literature				
314	Res Dev Disabil 36C: 338–57. https://doi.org/10.1016/j.ridd.2014.09.023				
315					
316	13. Skovgaard AM, Wilms L, Johansen A, Ammitzbøll J, Holstein BE, Olsen EM (2018) Standardized measuring the				
317	health of infants and toddlers in community health services [In Danish: Standardiseret monitorering af spæd- og				
318	småbørns helbred i de kommunale sundhedsordninger]. Ugeskr Laeger 180. pii: V12170960 (Danish).				
319					
320	14. Mors O, Perto GP, Mortensen PB (2011) The Danish Psychiatric Central Research Register. Scand J Public Health				
321	39 Suppl 7: 54-7. https://doi: 10.1177/1403494810395825.				
322					
323	15. Mohr-Jensen C, Vinkel Koch S, Briciet Lauritsen M, Steinhausen H-C (2016) The validity and reliability of the				
324	diagnosis of hyperkinetic disorders in the Danish Psychiatric Central Research Registry. Eur Psychiatry 35: 16–24.				
325	https:// doi: 10.1016/j.eurpsy.2016.01.2427.				
326					
327	16. Schmidt M, Schmidt SAJ, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT (2015) The Danish National				
328	Patient Registry: a review of content, data quality, and research potential. Clin Epidemiol 7: 449-90. https:// doi:				
329	10.2147/CLEP.S91125.				
330					
331	17. Thapar A, Cooper M, Rutter M (2017) Neurodevelopmental disorders. Lancet Psychiatry 4: 339-46. https://doi:				
332	10.1016/S2215-0366(16)30376-5.				

- 18. Thapar A. Rutter M (2018) Neurodevelopmental disorders. In: Thapar A. Pine D. Leckman JF. Scott S. Snowling
- 335 MJ. Taylor E eds. Rutter's Child and Adolescent Psychiatry. 6. ed. Wiley Blackwell. Oxford, pp 31-40.
- 336
- 19. Skovgaard AM, Olsen EM, Christiansen E, Houmann T, Landorph SL, Jørgensen T (2008) Predictors (0-10
- 338 months) of psychopathology at age 11/2 years a general population study in The Copenhagen Child Cohort CCC 2000.
- 339 J Child Psychol Psychiatry 49: 553-62. https:// doi: 10.1111/j.1469-7610.2007.01860.x.
- 340
- 341 20. Ammitzbøll J, Thygesen LC, Holstein BE, Andersen A, Skovgaard AM (2018) Predictive validity of a service-
- 342 setting based measure to identify infancy mental health problems A population-based cohort study. Eur Child Adolesc
- 343 Psychiatry 26: 711-23. https:// doi: 10.1007/s00787-017-1069-9.
- 344

Table 1 Characteristics of the study population, %	% (n)
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	Included children	Excluded children ¹	
	n=33,238	n=13,929	р
At least one diagnosed mental disorder	4.0 (1.331)	5.4 (754)	< 0.01
Diagnosed disorder of behaviour and emotions	2.0 (671)	3.0 (412)	< 0.01
Diagnosed neurodevelopmental disorder	2.6 (878)	3.4 (472)	< 0.01
Autism-spectrum disorders (F84)	1.3 (423)	1.3 (184)	0.67
Disorders of hyperactivity and inattention (F90, F98.8)	1.4 (453)	1.5 (211)	0.20
Intellectual disability (F70)	0.5 (167)	1.1 (152)	< 0.01
Male sex	51.1 (16,998)	51.7 (7,119)	0.31
First born child	41.1 (13,657)	45.6 (5,017)	< 0.01
Born before 37 th week	6.2 (2,071)	8.2 (1,020)	< 0.01
Birth weight < 2500 g	4.5 (1.500)	6.3 (778)	
2500-3999 g	78.0 (25,938)	78.3 (9,662)	
>3999 g	17.5 (5,800)	15.4 (1,896)	< 0.01
Congenital malformation	6.3 (2,078)	6.6 (917)	0.18
Mother's age < 25	12.1 (4,020)	18.6 (2,589)	< 0.01
Father's age < 25	6.3 (2,077)	13.6 (1,891)	< 0.01
Pregnancy complications	8.4 (2,797)	8.1 (1,126)	0.23
Caesarean section	21.1 (6,999)	20.2 (2,813)	0.04
Apgar score < 9	2.3 (765)	2.9 (356)	< 0.01
Parents' education in five levels: 1 (highest)	28.1 (9,340)	26.4 (3.284)	
2	26.0 (8,651)	22.2 (2.755)	
3	11.3 (3,755)	12.1 (1.504)	
4	25.9 (8,596)	24.0 (2.980)	
5	8.7 (2,896)	15.4 (1.910)	< 0.01
Number of parents in employment: 2	83.7 (27,807)	77.7 (9,081)	
1	13.0 (4,320)	16.6 (1,960)	
0	3.3 (1,111)	6.3 (743)	< 0.01
Number of parents of Danish origin: 2	76.2 (25,328)	66.3 (8,348)	
1	8.8 (2,930)	10.7 (1,347)	
0	15.0 (4,980)	23.0 (2,893)	< 0.01
Child living with both parents	89.0 (29,572)	81.5 (9,515)	< 0.01
Concern about mother's mental health in the first six			
months after delivery	27.4 (9,106)	30.7 (3,498)	< 0.01
Concerns about the parent-child-relationship in the first six			
months after delivery	10.7 (3,563)	14.3 (1,631)	< 0.01

¹ 13,929 is the maximum number. N varies as the number of missing differs

- **Table 2** Crude and adjusted ¹ OR (95% CI) for diagnosed mental disorders from 11 months of age to the 8th birthday by
- 350 motor development problems in infancy (n=33,238)

Outcome measure	Crude OR (95% CI)	Adjusted OR (95% CI)
At least one diagnosed mental disorder	1.57 (1.39-1.78)	1.47 (1.29-1.67)
Disorders of behaviour and emotions	1.23 (1.03-1.48)	1.11 (0.92-1.34)
Diagnosed neurodevelopmental disorder	1.89 (1.63-2.19)	1.79 (1.54-2.08)
Autism-spectrum disorders (F84)	1.71 (1.39-2.12)	1.66 (1.34-2.07)
Disorders of hyperactivity and inattention (F90, F98.8)	1.37 (1.10-1.70)	1.30 (1.04-1.62)
Intellectual disability (F70)	3.80 (2.80-5.16)	3.39 (2.47-4.65)

352 ¹ Adjusted for sex, parity, gestational age, birth weight, congenital malformation, pregnancy complications, caesarean section, Apgar

score, mother's age, father's age, parents' education, family composition, parents' origin, mother's mental health in the first six

354 months after delivery, concerns about the parent-child-relationship in the first six months after delivery