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DURATION OF BREASTFEEDING AND PSYCHOMOTOR DEVELOPMENT IN 1-YEAR-OLD CHILDREN – POLISH MOTHER AND CHILD COHORT STUDY

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Abstract

Objectives: The objective of this study was to evaluate the association between breastfeeding duration and child neurodevelopment based on the Polish Mother and Child Cohort Study. **Material and Methods:** The current analysis included 501 mother–child pairs. The analysis evaluating the association between the length of breastfeeding and child neurodevelopment considered the following variables: maternal age and body mass index, weight gain during pregnancy, parental level of education, marital status, socioeconomic status, child gender, birthweight, type of delivery, preterm delivery, pre- and postnatal exposure to tobacco constituents and child day care attendance. Psychomotor development was assessed in 1-year-olds on the *Bayley Scales of Infant and Toddler Development.* **Results:** The length of breastfeeding correlated positively with maternal age at delivery ($\varrho = 0.13$), maternal and paternal level of education ($\varrho = 0.2$ and $\varrho = 0.14$ respectively), birthweight ($\varrho = 0.1$) and marital status ($\varrho = 0.16$) ($p < 0.05$). A negative correlation between the length of breastfeeding and maternal smoking status during the first year after delivery ($\varrho = –0.19$) and weight gain during pregnancy ($r = –0.1$) was observed ($p < 0.05$). The association between the duration of breastfeeding and child development was not statistically significant in the model with the inclusion of confounding variables. A significant association between language development and maternal level of education ($p = 0.004$), gender of the child ($p = 0.0007$) and maternal weight gain during pregnancy ($p = 0.01$) was found. A negative association between cognitive development and maternal salivary cotinine during pregnancy ($p = 0.03$) and a negative association between motor development and maternal smoking status during the first year after delivery ($p = 0.007$) were also found. **Conclusions:** This study found no significant association between the duration of breastfeeding and child development after adjustment for confounders. Int J Occup Med Environ Health. 2019;32(2):175–84

Key words:
children, neurodevelopment, duration of breastfeeding, child psychomotor development, *Bayley Scales of Infant and Toddler Development*, 1-year-old children

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INTRODUCTION

Child cognitive development has genetic background [1]. In addition, it may be beneficially influenced by environmental and lifestyle-related factors (adequate nutrition, parental attention, stimulation at home) [2]. Many studies report positive associations between breastfeeding and child neurodevelopment [3–7] and suggest that longer duration of breastfeeding benefits child psychomotor development [8,9]. In some studies, however, the correlation between breastfeeding and psychomotor development of children is not statistically significant after adjustment for confounding variables [10–14].

It is not clear whether the better psychomotor development is due to the beneficial properties of breast milk or residual confounding. Positive effects of breastfeeding on child neurodevelopment were hypothesized to be mediated by long-chain polyunsaturated fatty acids (PUFA) which are present in human milk, but not in cow's milk or most infant formulas [14]. Yet a systematic review of all randomized trials where maternal diet was supplemented with PUFAs during pregnancy failed to confirm such an effect [14–16]. The meta-analysis by Jain et al. implied that < 25% of studies into this topic had adjusted for sociodemographic confounders [17]. In addition, the latest systematic review by Walfisch et al. also pointed out that much of the reported effect of breastfeeding on child neurodevelopment is due to confounding and concluded that future studies should attempt to rigorously control for all important confounders [14]. Among a variety of factors, demographic and IQ differences between mothers who breastfeed and those who choose not to are the most frequently underlined.

The aim of this study was to evaluate whether duration of breastfeeding is associated with child neurodevelopment, taking into account confounders such as maternal age, pre-pregnancy body mass index (BMI), weight gain during pregnancy, parental level of education, marital status, socioeconomic status, pre- and postnatal exposure to tobacco constituents, child gender, birthweight, type of delivery, preterm delivery and child day care attendance.

MATERIAL AND METHODS

Study design and population

The present study was part of the Polish Mother and Child Cohort (REPRO_PL), a multicenter prospective cohort study performed in different regions of Poland looking into environmental factors contributing to pregnancy outcomes, children's health and neurodevelopment that had been established in 2007–2011. The study was approved by the Ethical Committee of the Nofer Institute of Occupational Medicine, Łódź, Poland (Decisions No. 7/2007 and 3/2008). Written informed consent was obtained from all participants included in the study.

Women were recruited during the first trimester of pregnancy at maternity units in selected regions of Poland provided they fulfilled the following inclusion criteria: single pregnancy up to 12 weeks of gestation, no assisted conception, no pregnancy complications and no chronic diseases as specified in the study protocol. Questionnaires and biological samples (saliva for smoking status assessment) were collected during pregnancy (weeks: 8–12, 20–24 and 30–34) and at birth. The questionnaires covered sociodemographic data, medical and reproductive history, and information about environmental, lifestyle and occupational factors. Each child's exposure to environmental factors, health status and neurodevelopment were assessed a year after the child's birth. The current analysis, taking into account the availability of data, was restricted to 501 (out of 538; 93%) children. The study procedures are described in detail elsewhere [18,19].

Child neurodevelopment assessment

The *Bayley Scales of Infant and Toddler Development* were applied to assess children's neurodevelopment at around

12 (±1.5) months. Details regarding child psychomotor assessment have been published before [19–23]. Examination was performed at pediatric medical centers at 2 university hospitals in Łódź and Legnica. The testing was done in the presence of the mother or a relative by a trained psychologist or a child development specialist. The current analysis has focused on child cognitive, language and motor development. Child psychomotor development measured by raw score/chronological age was yielded with each subtest, and composite scores for language, motor scales and a composite score equivalent for the cognitive scale were generated on the basis of such data [19].

Confounding variables

The covariates considered in the analysis were as follows: maternal age at delivery, pre-pregnancy BMI, weight gain during pregnancy, parental level of education (highest level of completed education), marital status, socioeconomic status, maternal salivary cotinine during pregnancy, child passive smoking status within 1 year after birth (based on maternal smoking status during the first year after delivery and child urinary cotinine at 1 year of age), child gender, birthweight, type of delivery, preterm delivery and child day care attendance. Details regarding the assessment of the variables have been published previously [20–23].

Statistical analysis

Continuous variables were described as the mean and standard deviation (SD), whereas categorical variables – as absolute and relative frequencies. Correlations between the length of breastfeeding and selected variables were assessed using Spearman's ϱ. The false discovery rate (FDR) for the correlations was controlled at the level of 0.05 with the Benjamini and Hochberg correction for testing multiple hypotheses. The association between Bayley test results and length of breastfeeding was assessed in the following steps:

1. Univariate regression models were built.
2. Potential covariates were listed based on the literature review and previous assessments done based on REPRO_PL cohort [20–23]. The confounding effect of the examiner who performed the test was also included. Potential covariates were evaluated with the mean of Spearman's ϱ ($p < 0.1$).
3. The initially identified covariates were included in the multivariate model and a multivariate backward stepwise regression analysis was carried out to yield models explaining Bayley test results.

P-value < 0.05 was considered statistically significant in the final analyses. The analyses were performed using STATISTICA 12.5 Software (StatSoft, Tulsa, OK, USA).

RESULTS

Descriptive analysis

Parental and child characteristics are presented in Table 1. The mean maternal age at delivery was 28.8±4.4 years and pre-pregnancy BMI was 22.4±3.7 kg/m^2. The mean maternal weight gain over pregnancy was 12.4±4.7 kg. Most of the mothers (62%) and 38.8% of the fathers had a university degree. A high proportion of the women were married (75.1%). About 70% of parents had a middle socioeconomic status, while about 11% of the mothers had a low socioeconomic status and 19% had a high socioeconomic status. About 12% of the mothers were active smokers during pregnancy. Forty-six percent of the mothers breastfed > 6 months, while 10% declared no breastfeeding of their child.

On average, the children were born at the 39th week of gestation with the mean birth weight of 3.33 kg. About 53% of the children were girls. Sixty-four percent of the mothers had vaginal delivery. Although 83% of the mothers declared that they didn't smoke during the first year after delivery, about 50% of the children had a passive smoking status (resulting from parental or other household member smoking).

Table 1. Sociodemographic characteristics of parents and children who participated in the study

Variable	Respondents	
	n (%)	M±SD
Parents		
maternal age at delivery (N = 501) [years]		28.8±4.4
maternal pre-pregnancy BMI (N = 501) [kg/m^2]		22.4±3.7
maternal weight gain over pregnancy [kg] (N = 477)		12.4±4.7
maternal level of education (N = 500)		
primary/vocational	21 (4.2)	
secondary	169 (33.8)	
university	310 (62.0)	
paternal level of education (N = 492)		
primary/vocational	24 (4.9)	
secondary	277 (56.3)	
university	191 (38.8)	
marital status (N = 497)		
married	373 (75.1)	
unmarried	124 (24.9)	
socioeconomic status (N = 494)		
low	55 (11.1)	
middle	345 (69.8)	
high	94 (19.0)	
maternal smoking status during pregnancy (N = 501)		
yes	60 (12)	
no	441 (88)	
maternal smoking status during the first year after delivery (N = 497)		
yes	87 (17.5)	
no	410 (82.5)	
breastfeeding (N = 501)		
0 months	52 (10.4)	
≤ 3 months	133 (26.5)	
> 3 and ≤ 6 months	85 (17.0)	
> 6 months	231 (46.1)	
Children		
birthweight (N = 431) [kg]		3.33±0.48
gender of the child (N = 501)		
girl	265 (52.9)	
boy	236 (47.1)	

Table 1. Sociodemographic characteristics of parents and children who participated in the study – cont.

Variable	Respondents	
	n (%)	M±SD
Children – cont.		
type of delivery (N = 449)		
vaginal	287 (63.9)	
caesarean	162 (36.1)	
preterm delivery (before 38th week) (N = 501)		
yes	51 (10.2)	
no	450 (89.8)	
day care attendance (N = 463)		
yes	34 (7.3)	
no	429 (92.7)	
child passive smoking status (N = 501)		
yes	251 (50.1)	
no	250 (49.9)	

Inferential analysis

Correlations of breastfeeding with selected sociodemographic and child variables are presented in Table 2. Breastfeeding correlated positively with maternal age at delivery ($\varrho = 0.13$), maternal and paternal levels of education ($\varrho = 0.2$ and $\varrho = 0.14$ respectively), birthweight ($\varrho = 0.1$), and marital status ($\varrho = 0.16$) (Benjamini and Hochberg corrected $p < 0.05$), while a negative breastfeeding correlation with the maternal smoking status during the first year after delivery ($\varrho = –0.19$) and maternal weight gain over pregnancy ($\varrho = –0.1$) was observed (Benjamini and Hochberg corrected $p < 0.05$). No significant correlations between breastfeeding and maternal pre-pregnancy BMI, socioeconomic status, gender of the child, type of delivery, preterm delivery and day care attendance were found. The correlation between breastfeeding and child passive smoking status was of borderline significance.

Table 3 shows the association between the duration of breastfeeding and child development, adjusted for confounders. The association between the duration of breastfeeding and child development was not statistically significant. The association between language development and maternal level of education ($p = 0.004$), gender of the child ($p = 0.0007$) and maternal weight gain during pregnancy ($p = 0.01$) was found. In addition, negative associations between maternal salivary cotinine during pregnancy and cognitive development ($p = 0.03$), as well as maternal smoking status during the first year after delivery and child motor development ($p = 0.007$) were found.

DISCUSSION

In the study group, a multivariate analysis showed that maternal level of education, gender of the child, maternal weight gain during pregnancy and maternal smoking status during pregnancy and after delivery were significant confounders of the association between the duration of breastfeeding and 1-year-old child psychomotor development. As opposed to several studies [3–9] the association between the duration of breastfeeding and 1-year-old-child psychomotor development was not confirmed. Other authors observed that the duration of breastfeeding did not predict child psychomotor development [24]. Der et al.

Table 2. Correlations between breastfeeding and selected sociodemographic variables

Variable	Spearman's ϱ	p
Parents		
mother		
age at delivery	**0.13**	**0.0026**
pre-pregnancy BMI	–0.08	0.0752
weight gain over pregnancy	**–0.10**	**0.0437**
level of education	**0.20**	**< 0.0001**
marital status (married – 1, unmarried – 0)	**0.16**	**0.0003**
socioeconomic status	0.03	0.5251
smoking during the first year after delivery (yes – 1, no – 0)	**–0.19**	**< 0.0001**
father		
level of education	**0.14**	**0.0015**
Children		
birthweight	**0.10**	**0.0285**
gender of the child (girl – 1, boy – 0)	–0.03	0.4901
type of delivery (caesarean – 1, vaginal – 0)	–0.09	0.0536
preterm delivery (before 38 week) (yes – 1, no – 0)	–0.06	0.1683
day care attendance (yes – 1, no – 0)	–0.06	0.2197
child passive smoking status (yes – 1, no – 0)	–0.09	0.0518

Bolded – significant correlations which survived Benjamini and Hochberg correction for testing multiple hypotheses (false discovery rate = 0.05). The corrected significance level is 0.0179.

concluded that breastfeeding has little or no effect on the child's intelligence [25].

The prospective study design constitutes an important advantage of this study. Additionally, a series of detailed questionnaires (and biomarker measurements) made it possible to reliably assess the confounding variables. Restricting this study population to healthy women allowed the authors to eliminate additional confounding factors, though the authors had to consider the possibility that other unmeasured risk factors (e.g., children's maternal relationship and home environment) produced associations between the exposures of interest and child neurodevelopment. In the current analysis, the authors assessed multiple aspects of child neurodevelopment by a well-standardized and widely used tool for early and fairly comprehensive measures. This analysis included important potential confounders of the relationship between the duration of breastfeeding and 1-year-old child psychomotor development.

Multiple linear models were constructed in this study, incorporating many confounders, showing statistically significant correlations between language development and maternal level of education, gender of the child and maternal weight gain during pregnancy and between motor development and maternal smoking status after delivery as well as between cognitive development and maternal smoking during pregnancy. Most of the observed associations between breastfeeding and cognitive development in other studies were the result of confounding by maternal intelligence [14]; the level of cognitive stimulation at home, mother's educational attainment and family financial hardship all have independent effects.

Table 3. Association between length of breastfeeding and child cognitive, language, and motor development

Variable	Development								
	cognitive			language			motor		
	model characteristics	β (95% CI)	p	model characteristics	β (95% CI)	p	model characteristics	β (95% CI)	p
Univariate models									
length of breastfeeding	F(1, 499) = 0.78 R^2 = 0.002	0.04 (–0.05–0.13)	0.3772	F(1, 499) = 1.97 R^2 = 0.004	0.06 (–0.02–0.15)	0.1607	F(1, 499) = 2.38 R^2 = 0.005	0.07 (–0.02–0.16)	0.1234
Multivariate models[a]									
length of breastfeeding	F(5, 454) = 12.54 p < 0.0001 R^2 = 0.121	0.03 (–0.06–0.11)	0.5254	F(7, 433) = 29.31 p < 0.0001 R^2 = 0.321	0.05 (–0.03–0.12)	0.2600	F(5, 491) = 22.81 p < 0.0001 R^2 = 0.189	0.05 (–0.04–0.13)	0.2672
Covariates the models are adjusted to:									
maternal salivary cotinine during pregnancy		–0.10 (–0.18–(–0.01))	0.0331						
maternal level of education					0.12 (0.04–0.20)	0.0041			
gender of the child (girl – 1, boy – 0)					0.14 (0.06–0.21)	0.0007			
maternal weight gain over pregnancy					–0.10 (–0.18–(–0.02))	0.0119			
maternal smoking status during the first year after delivery (yes – 1, no – 0)								–0.11 (–0.19–(–0.03))	0.0070

[a] Each multivariate model is also adjusted for examiner.

Der et al. [25] and Home et al. [26] showed that maternal IQ and/or educational level are the factors impacting on the child's mental abilities. In this analysis, the authors found that maternal education correlated significantly with language development. Mothers with a higher level of education are more likely to provide a stimulating environment for their infants.

The role of maternal weight gain in the psychomotor development of children has received no attention and a majority of studies consider maternal weight gain only in terms of premature birth rates. The observed negative correlation between the language development function and maternal weight gain, similarly to another study [27], was not clear. The maternal weight gain was found to be associated with offspring being overweight; it was probably the latter factor that might have been implicated in the poorer language function.

In current study, the authors observed that gender of the child (girls) was a significant confounder of an association between the duration of breastfeeding and language development. Whitehouse et al. concluded that breastfeeding for longer periods in early life has a positive effect on language development in middle childhood [28]. In another study [29], it was demonstrated that breastfed children had *Peabody Picture Vocabulary Test* scores that were 6.6 pts higher than those of children who were not breastfeed. Authors revealed that, among mothers with education beyond high school, the test scores in adjusted models were 2.2 pts higher for breastfed children; among mothers with a high school diploma or less, there were no significant differences in children's test scores by breastfeeding status.

In addition, a negative association between maternal smoking status during the first year after delivery and child motor development was found. Other studies have produced similar results [30,31].

Several limitations of this study should be noted. It needs to be pointed out that, although the Bayley test is wildly used for child neurodevelopment assessment within first years of life, for 1-year-old infants it could be less reliable and more situation sensitive for them than for older children. In the current study, the authors repeated child psychomotor assessment at the age of 2 years; however, due to the smaller sample size, the data was not included in the analysis. Similarly, taking into consideration that only 52 women in the examined cohort declared that their children were not breastfed, the analysis was limited solely to the length of breastfeeding. In addition, as the information regarding breastfeeding was collected at the time of child psychomotor assessment, some recall bias cannot be excluded. Parental IQ assessment was not performed in this cohort but the authors used the parents' educational levels as a proxy of this variable. Finally, the *Home Observation Measurement of the Environment* (HOME) should be addressed as the additional confounder in the analysis. Unfortunately such data was not available for 1-year-olds. It needs to be pointed out that REPRO_PL cohort is still an ongoing study which provides the opportunity to include more questions/scales evaluating parent-child interactions or family functioning.

CONCLUSIONS

In this study the authors have shown that exclusive breastfeeding for ≥ 6 months was not associated with psychomotor development in 1-year-old children, following adjustment for multiple confounders: maternal level of education, gender of the child, maternal weight gain and maternal smoking status. The authors suspect that the beneficial effects of breastfeeding duration on children's neurodevelopment may emerge only when breastfeeding occurs in conjunction with other positive parenting behavior.

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