

SHORT THESIS FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY (PHD)

**Developmental characteristics of
preterm children at 1 and 2 years of
corrected age: a prospective cohort
study**

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The PhD Defense takes place at the classroom of
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INTRODUCTION

Our early experiences play a role in the development of our cognitive, motor and language skills; they have an impact on our path of life, our behaviour and our later mental and physical health. It is a professionally justified endeavour to approach children from the moment of birth with an interventionist approach. Based on the plasticity of nervous system, a well-timed intervention can also positively influence the later path of life (Mlinkó, 2018).

We consider prematurity as one of the most common biologically determined risk factors, which, in addition to chronic neonatal morbidities (Agarwal et al., 2018; Asztalos et al., 2017), can be the source of many problems that may appear during the later years of life (Kereki, 2020). By monitoring the development, notable problems can be filtered out quickly, and appropriate interventions can be started in time. We act in the most circumspect way when we map early sensorimotor, social-emotional, language and cognitive skills (Danis et al., 2011).

AIMS

1. aim: To describe the psychomotor characteristics of preterm infants at 1 and 2 years of corrected age

- 1 year: assessment of risk for developmental delays on the cognitive, receptive and expressive communication, fine and gross motor areas (Bayley-III Screening Test).
- 2 year: assessment of developmental delays on the cognitive, language, motor, social-emotional and adaptive behaviour areas (Bayley-III Diagnostic Test).

2. aim: Examination of the influencing factors of development

- Examining the associations between breastfeeding, duration of breastfeeding and psychomotor development.
- Examining the relationships between childhood and partner abuse suffered by the mother, psychomotor development, gestational age, birth weight, and Apgar-scores.

- Examination of the potential association between mode of conception, pregnancy planning and psychomotor outcomes.
- Examination of the mother's attributions, perceptions, representations of care (BMBI/CMBI; H-MORS-SF; H-PBI; IIQ) in connection with the psychomotor development, gestational age, birth weight and Apgar-values.
- To examine the infants' emotional and behavioural difficulties (SDQ) in connection with the psychomotor development, the perinatal, neonatal and parental factors.
- To explore the associations between the higher number of sociodemographic risk factors, developmental delays (Bayley-III Diagnostic Test), emotional and behavioural difficulties (SDQ).

3. aim: To examine the extent to which perinatal, neonatal, sociodemographic, and psychomotor development indices measured at the age of 1 are able to predict infants' development indices at the age of 2.

METHODS

Procedure

Our research was authorized by the Medical Research Council of Hungary (12053-2/2018/EKU). During our prospective cohort longitudinal study, we examined children born prematurely (< 37 weeks) at 1 and 2 years of corrected age using the Bayley-III tests. The examinations took place at the *Child Rehabilitation, Pediatric Psychology and Psychosomatic Unit of the Department of Pediatrics, Clinical Center of the University of Debrecen* as part of outpatient psychological care. The psychomotor developmental examinations and the psychological questionnaires were taken in parallel.

In the *first stage* of the research, in addition to the developmental examinations (Bayley-III Screening Test) at 1 year of corrected age, our battery of questionnaires consist of psychological questionnaires, as well as our self-compiled anamnestic and demographic questionnaire, were taken. We also gathered the chronic neonatal morbidities by retrospectively viewing the neonatal database. In the *second stage* of the research, when the

children who had been examined at the age of 1 turned to 2 of corrected age, they were recalled, at which time the complete test battery of the Bayley-III was carried out, and psychological questionnaires were also used.

The developmental examinations followed by result discussions, during which the parents were informed in detail about their child's performance. The parents had the opportunity to ask their questions about the examination or parenting/development, and in case of the necessity of intervention, they could obtain extensive information.

Sample

First study period

In the first stage of our study, all preterm infants (N = 781) born between December 2016 and August 2018 at the *Obstetrics and Gynecology Clinic the Clinical Center of the University of Debrecen* were invited to examinations. 568 children were dropped out from the sampling procedure (severe damage, neonatal death, declined to participate, move, etc.), thus our sample consisted of 213 infants and parents. Before the completion of first study period, we conducted several

statistical analyses (N = 154; N = 171) and formed subsamples (Szele & Nagy, 2022; Szele et al., 2022). Our first study period were between December 2017 and December 2019.

Second study period

In our second study period, during the corrected 2-year follow-up, 140 low birth weight preterm infants and their parents were participated, among those who also took part at the corrected 1-year screening. The second phase of our study was carried out between December 2018 and March 2020. We also analysed our results on an expanded sample (N = 438) supplemented by a member of our *Clinical Child Psychology and Preventive Health Psychology Research Working Group* (Nagy et al., 2022).

Measures

First study period

We informed ourselves about the sample's perinatal, neonatal and sociodemographic characteristics by retrospectively new-borns' hospital discharge papers as well by applying a psychological anamnesis and a self-devised questionnaire. At 1 year of corrected age,

developmental examinations were administered by the *Bayley-III Screening* test, which can distinguish high, moderate and low risk for developmental delay in cognitive, receptive and expressive communication, fine and gross motor skills (Bayley, 2005, Kő et al., 2017). The battery of questionnaires for mothers/caregivers contained the following:

- Hungarian version of Mothers' Object Relations Scale – Short Form, H-MORS-SF (Danis et al., 2005)
- Infant Intentionality Questionnaire, IIQ (Reznick & Feldman, 1998)
- Baby/Child - Mother Bonding Instrument, BMBI/CMBI (Danis et al., 2005)
- Hungarian-Parental Bonding Instrument, H-PBI (Parker et al., 1979; Tóth & Gervai, 1999)

Second study period

During examinations of 2 year-olds of corrected age, the *Bayley-III Diagnostic test* (complete test battery) was administered (Cognitive, Language, Motor, Social-Emotional, Adaptive Behaviour Scales). We gained

information about the social-emotional and adaptive behaviour development through questionnaires completed by parents/caregivers. The battery of questionnaires for mothers/caregivers contained the following:

- Hungarian version of Mothers' Object Relations Scale – Short Form, H-MORS-SF (Danis et al., 2005)
- Baby/Child - Mother Bonding Instrument, BMBI/CMBI (Danis et al., 2005)
- Strength and Difficulties, SDQ, (Goodman, 1997; Goodman et al., 1998)
- UNICEF Child Deprivation Index (UNICEF Innocenti Research Centre, 2012)

Statistical analyses

All statistical analysis were performed by the software IBM SPSS Statistics 27 (IBM SPSS Statistics, IBM Corporation, Armonk, NY). We used descriptive statistics to describe the perinatal, neonatal, sociodemographic data, the results of parental questionnaires, and the results of the Bayley-III Screening and Diagnostic tests. To test the associations between our

variables, Pearson's and Spearman's rank correlation tests, independent-samples t-test, Welch's t-test, Mann-Whitney and Chi-square (χ^2) tests and one- and multi-way analysis of variance (ANOVA) were used.

To identify the predictor variables of psychomotor performance at 2 years of corrected age, we devised a regression model. During our multivariate linear regression procedure, we applied both Stepwise and Backward methods order to select the appropriate set of explanatory variables. We set the significance level for the entry criterion to 10 % and for the removal criterion 15 % in the stepwise and backward algorithms. We chose to use the logit-transformed values of the dependent variables as a basis. During the study conducted on our extended sample (N = 438), we developed an agglomerative variable, the “Multiple Risk Index” from the assessed sociodemographic risk factors. The index scores are ranged from 0 to 6 based on the numbers of sociodemographic risk factors the children are exposed to.

RESULTS

Characteristics of the sample

First study period

Regarding the territorial distribution of our corrected 1-year-old sample (N = 213), it covered three Hungarian regions: Northern Great Plain region, North Hungary region and Southern Great Plain region. According to the birth weight classification recommended by WHO (1962), the distribution of our sample (LBW: 2500-1500 grams (n = 109), VLBW: 1500-1000 grams (n = 63), ELBW: < 1000 grams (n = 41)) was uneven, so we considered it appropriate to treat the sample as an aggregate preterm group. The mean birth weight of the children was between 260 and 2490 g (M = 1620.42, SD = 576.40), and the mean gestational age of the children was between 24 and 36 weeks (M = 31.96, SD = 3.30), the gender ratio was nearly balanced (110 male – 51.64 %). Majority of children (69.48%) were born with section caesarea. Gemini (n = 82), trigemini (n = 7) and quadrigemini (n = 4) pregnancies also occurred. Chronic neonatal morbidities were

underrepresented in our sample (BPD – 8.45 %; IVH – 4.22 %; NEC – 0.46 %; ROP – 4.22 %).

1. subsample (N = 154) (Szele & Nagy, 2022)

In our subsample of 154 infants, we examined the association between breastfeeding and psychomotor outcomes. The gender ratio was nearly balanced (73 females, 81 males), the mean birth weight of the children was between 540 and 2490 g (M= 1802.27, SD = 543), and the mean gestational age of the children was between 24 and 36 weeks (M = 32.81, SD = 3.09). In our sample, 99 (64.28 %) mothers were able to breastfeed their newborns, while 53 (34.41 %) mothers failed to start breastfeeding. In 2 cases we had no information about breastfeeding.

2. subsample (N = 171) (Szele et al., 2022)

In our subsample of 171 infants, we examined the potential associations between mode of conception, pregnancy planning and psychomotor outcomes. The gender ratio was close to equal (83 females, 88 males); the mean birth weight of infants was between 260 and 2490 g (M = 1735.56, SD = 579.74), gestational age of our sample

was also low ($M = 32.53$, $SD = 3.27$). In our sample, 47 (27.48 %) children were conceived through medically assisted reproduction with 124 (72.51 %) infants conceived naturally, without any medical assistance. Examining the distribution of the sample from the point of view of pregnancy planning, 87.13 % of the infants ($n = 149$) were intended pregnancies. We identified unplanned pregnancies in 17 cases (9.94 %) and we did not get any information about pregnancy planning in 5 cases (2.92 %).

Second study period

The birth weight of the 140 children participating in the second study phase ranged between 380 and 2490 grams (with sample mean $1690.07 \pm SD 592.49$), with gestational age between 24 and 36 weeks (32.34 ± 3.23). Distribution of sexes was almost uniform (73 boys, 67 girls). 68.57 % of the sample was born with section caesarean. Almost half of the examined children (42.85 %) were born from gemini pregnancies, and 4 children each from trigemi and quadrigemi pregnancies. Chronic neonatal morbidities occurred in low numbers (BPD –

6.42 %; IVH – 4.28 %; NEC – 0.71 %; ROP – 3.57 %) (Nagy et al., 2021).

Extended sample (N = 438) (Nagy et al., 2022)

In our extended sample of 438 children, we examined the associations between the higher number of SES risk factors (primary education of the mother, below average self-reported socioeconomic status, subjective (income does not cover the expenses) and objective (<100.000 HUF monthly income) evaluation of financial situation, Roma ethnicity and ‘deprived’ status), the developmental delay (Bayley-III) and the emotional, behavioural difficulties (SDQ). All of the children were premature with low birth weight (< 2500) at the age of 24–29 months.

Psychomotor characteristics of preterm children at 1 and 2 years of corrected age

In our full sample at 1 year of corrected age (N = 213), the *risk of high developmental delay* was negligible, ranging between 0% (cognitive subscale) and 2.81 % (expressive communication and fine motor subscales). The *risk of moderate delay* was already represented in a

higher proportion, from 9.85 % (cognitive subscale) to 28.63 % (expressive communication subscale). Our sample mainly showed lower scores on the language (Rec, Exp) and fine motor subscales. The ELBW/extremely preterm groups performed lower on the examined developmental subscales.

Children's performance at the age of 2 can be classified as belonging to the average zone. The highest average composite score was observed on the Cognitive Scale ($M = 104.82$, $SD = 16.92$), followed by the Language ($M = 96.85$, $SD = 18.11$) and Motor Scales ($M = 101.02$, $SD = 11.98$). Examination of the scaled scores of the two subscales of the Language Scale revealed lower scores on the expressive communication subscale ($M = 8.80$, $SD = 3.48$) compared with the receptive communication subscale ($M = 10.05$, $SD = 3.11$). With regard to the Motor Scale, scores of the gross motor subscale were found to be lower ($M = 9.25$, $SD = 1.95$) than those of the fine motor subscale ($M = 11.04$, $SD = 2.70$). Based on the parental questionnaires, the Social-Emotional ($M = 109.52$, $SD = 19.16$) and Adaptive Behaviour ($M = 108.72$, $SD = 16.40$) scales showed

outstanding values. In our sample 7.85 % (N = 11) of the children showed severe, while and 34.28 % (N = 48) showed mild developmental delay in at least one of the Bayley-III scales. The ELBW/extremely preterm groups performed lower on the examined developmental scales.

Factors affecting development

Breastfeeding (Szele & Nagy, 2022): We found a higher average performance of breastfed children on the cognitive, expressive communication, fine and gross motor subscales of Bayley-III Screening test. For the cognitive ($U = 2047.5; p = 0.023$) and fine motor subscales ($U = 2096.0; p = 0.037$), the differences were found to be significant between breastfed and non-breastfed children based on the Mann-Whitney tests. We identified significant positive correlations between the duration of breastfeeding and the cognitive ($r = 0.218; p = 0.07$), expressive communication ($r = 0.209; p = 0.01$), and fine motor ($r = 0.181, p = 0.026$) skills. The two groups showed significant differences in mean value for gestational age ($M \pm SD_{\text{breastfed}} = 33.70 \pm 2.37$ weeks; $M \pm SD_{\text{non-breastfed}} = 31.00 \pm 3.63$ weeks) and birth weight ($M \pm SD_{\text{breastfed}} =$

1967.88 ± 451.01 g; $M \pm SD_{\text{non-breastfed}} = 1487.92 \pm 581.44$ g) (P-value < 0.001), but no difference for the mean maternal age ($M \pm SD_{\text{breastfed}} = 30.52 \pm 6.48$ years; $M \pm SD_{\text{non-breastfed}} = 30.89 \pm 5.45$ years; $p = 0.723$).

Mode of conception and pregnancy planning (Szele et al., 2022): At the level of descriptive statistics (mean ± std. dev.), MAR group (1860.85 ± 407.78 g; 32.87 ± 1.97 weeks) had higher mean values at the birth weight and gestational age. Examining the psychomotor development, we found that the results of infants conceived by MAR was above average in all developmental areas compared to naturally conceived peers. Significant differences ($p < 0.05$) were found at receptive communication and gross motor subscales. Infants conceived by MAR had higher Apgar-scores and their mothers were older in average than in the naturally conceived group.

Examining the mean birth weight and gestational age of planned (1740.53 ± 579.08 g; 32.41 ± 3.28 weeks) and unplanned (1562.35 ± 527.63 g; 32.41 ± 3.14 weeks) infants we identified higher birth weight in the planned group. Examining the subscales of Bayley Screening Test,

planned infants showed higher scores for all variables. The Mann-Whitney tests showed significant differences ($p < 0.05$) between planned and unplanned pregnancies on cognitive, receptive and expressive communication subscales. Mothers in the unplanned group were younger in average; analysing the percentage relative frequencies one can see single marital status was higher, while marriage was lower than in the planned group.

According to the results of ANOVA, concerning the receptive communication subscale, the pregnancy planning variable had a significant role ($F = 9.513$, $p = 0.002$); for the expressive communication subscale, MAR showed a weak, but significant relationship ($F = 2.902$; $p = 0.090$) as it can be detected only with a first-order error ($p < 0.01$). Interaction of gestational age with the MAR variable had an explanatory power on the expressive communication subscale ($F = 3.491$; $p = 0.017$). Concerning the gross motor subscale, birth weight ($F = 9.352$; $p = 0.000$) and pregnancy planning ($F = 6.132$; $p = 0.014$) variables had an independent and joint impact ($F = 2.629$; $p = 0.075$).

Maltreatment: According to our results, all forms of childhood abuse appeared in our sample; psychological abuse occurred in the highest proportion in the childhood of mothers. We found a negative correlation between the frequency of physical abuse and gross motor subscale ($r = -0.160$), as well as the frequency of sexual abuse and receptive communication subscale ($r = -0.158$). In the case of partner abuse, due to the low frequency values of positive cases, we did not include the variables in further analyses.

Mother-child relationship: According to the results of the two-scale version of the H-MORS-SF ($M \pm SD$), in our sample the values of "warmth" variable (30.40 ± 4.04) was higher than values of "invasion" ($7, 50 \pm 3.90$). Based on the results of the BMBI/CMBI questionnaire, the "warmth, care" scale proved to be more pronounced (29.37 ± 3.03), the "overprotection, control" scale was significantly lower (14.71 ± 4.70). The results of the H-PBI show that, on average, the "warmth" scale was the highest (29.00 ± 7.27), followed by "authoritarianism" (7.58 ± 3.84) and "protectiveness" (6.59 ± 4.14) scales. According to the results of the four scales of the IIQ,

"positive intentionality" (4.08 ± 0.67), "negative intentionality" (1.83 ± 0.85), "self-awareness" (3.66 ± 0.80) and "awareness directed to others" (3.81 ± 0.80), parents prefer to judge their child as someone who can intentionally behave positively and who is aware of others' feelings, thoughts, beliefs and goals. Cognitive ($p = 0.004$) and expressive communication ($p = 0.047$) skills showed a significant, positive correlation with the "warmth" scale of the H-MORS-SF. Similar, positive correlations were found between the "warmth, care" subscale of the BMBI/CMBI and the receptive ($p = 0.019$), expressive communication ($p = 0.024$), and fine motor ($p = 0.042$) subscales. Overprotective, controlling behaviour was associated with significantly lower developmental scores on the cognitive ($p = 0.031$) and expressive communication ($p = 0.015$) subscales. The "protectiveness" subscale of the H-PBI also showed a negative correlation with the expressive communication ($p = 0.007$) subscale. Based on the results of IIQ, we could establish significant positive correlations between the "self-awareness" scale, expressive communication ($p = 0.047$) and fine motor ($p = 0.026$) subscales. Analysing the

correlations between the scales of the BMBI/CMBI and H-PBI questionnaires, a significant negative correlation was found between the BMBI/CMBI "warmth, care" and "protectiveness" scales of H-PBI ($p = 0.017$; $r^2 = -0.189$); while a significant positive ($p = 0.001$; $r^2 = 0.06$) correlation was identified between the "overprotection, control" scale of BMBI/CMBI and the "protectiveness" scale of H-PBI.

Considering our 2-year-old results, we found similar trends in the values of questionnaires. A significant positive correlation was identified between the "warmth, care" scale of the BMBI/CMBI and the 2-year-old Social-Emotional and Adaptive Behaviour Scales, by contrast, between the "overprotection, control" scale and the Cognitive, Language, Motor, and Social-Emotional Scales there is a negative correlation. The "invasion" scale of H-MORS-SF showed a significant negative correlation with the receptive communication subscale, the Social-Emotional and Adaptive Behaviour Scales, while the "warmth" scale had a significant negative relationship with the Cognitive, Language and Motor Scales, and

significant positive relationship with the Social-Emotional and Adaptive Behaviour Scales.

Emotional and behavioural characteristics (Nagy et al., 2022): Examining the emotional and behavioural difficulties of children in our extended sample, the mothers reported most of the problems about hyperactivity/inattention ($M = 4.60$; $SD = 2.15$). Based on the total problem scores of SDQ, 36.6% of the children had problems in the assessed scales. Significant differences were found between the birth weight categories regarding SDQ scores ($\Sigma: H = 17.083$; $p < 0.001$) by Kruskal-Wallis test. Parents of lower birth weight children reported significantly more hyperactivity/inattention problems ($r = -0.199$; $p < 0.001$), emotional symptoms ($r = -0.149$; $p = 0.004$), and peer problems ($r = -0.119$; $p < 0.021$) at 2 years old.

Sociodemographic characteristics (Nagy et al., 2022): In our extended sample, we examined the psychomotor development, emotional and behavioural difficulties of the sample, regarding the main demographic variables (maternal education, self-reported socioeconomic status, subjective and objective evaluation

of financial situation, child deprivation, and ethnicity) (Spearman's rank correlation). On Bayley-III subscales, the children's performance showed significant mild-moderate correlations with the subjective and objective evaluation of the financial situation of the family, self-reported socioeconomic status and child deprivation, except for the correlation between expressive communication and child deprivation.

The lower the maternal education, the self-reported socioeconomic status, and the subjective and objective evaluation of financial situation of the family are, the more internalizing and externalizing problems (SDQ) the parents reported. As well as, the more favourable the demographic variables are the lower problem and deprivation scores are occurred. The correlations (r ranged from -0.040 to -0.316) showed mild/moderate associations.

Roma children ($n = 51$) showed significantly lower performance on the subscales of expressive communication ($M = 7.7$ vs. 6.7 ; $p = 0.011$), receptive communication ($M = 8.8$ vs. 6.9 ; $p < 0.001$), fine motor skills ($M = 9.0$ vs. 6.9 ; $p < 0.001$) and gross motor skills

($M = 8.0$ vs. 7.1 ; $p = 0.002$). Primary caregivers of Roma children reported more behavioural ($U = 3900.5$; $p < 0.001$), hyperactivity/inattention problems ($U = 4643.0$; $p < 0.001$) and peer ($U = 5012.0$; $p = 0.001$) problems, moreover less prosocial behaviour ($U = 5696.5$; $p = 0.022$).

Significant differences (Mann-Whitney tests) were detected between deprived and not deprived children regarding their performance on all the three Bayley-III scales: cognitive skills ($U = 6719.5$; $p = 0.001$); language skills ($U = 7315.5$; $p = 0.015$); and motor skills ($U = 7373.0$; $p = 0.019$). Regarding SDQ, children who are deprived of more than two essential needs were reported to have significantly more hyperactivity/inattention problems ($U = 5369.5$; $p = 0.001$), peer problems ($U = 6013.5$; $p = 0.020$) and less prosocial behaviour ($U = 5160.0$; $p < 0.001$) compared to the not deprived group.

We developed an agglomerative variable, the “Multiple Risk Index” from the assessed sociodemographic risk factors. There is a negative correlation between the number of SES risk factors and the performance on Bayley-III (Σ Bayley-III: $r = -0.322$; $p <$

0.001), whereas more risk factors are associated with higher SDQ problem scores ($r = 0.323$; $p < 0.001$). A linear growth of the developmental delay rates was observed (in both mild and severe cases) regarding the number of SES factors.

Predictive power of 1-year variables

Fifty to ninety percent of our dependent variables (Cognitive, Language, Motor, Social-Emotional, and Adaptive Behaviour Scales) and their variance (R^2 coefficient of determination) are accounted for by our devised models, suggesting that they possess sufficient explanatory power. In case of the 2 years' *Cognitive Scale* we were able to identify three perinatal variables (gestational age, mode of conception and 5-minute Apgar) with explanatory power, one neonatal variable (BPD), one sociodemographic variable (higher level of maternal education) with the Cognitive Scale at 2 years of age as well as three developmental characteristics (two Bayley-III Screening Test variables at 1 year (receptive and expressive communication variables) and participation in development). Among these variables, the strongest

significance ($p < 0.05$) was found in receptive and expressive communication skills, higher level of maternal education and BPD. In the *Language Scale*, we identified two Bayley-III Screening Test variables at year 1 as predictor variables: receptive and expressive communication skills. In both predictor variables a monotonically increasing relationship was found with major significance ($p_{\text{rec}} = 0.001$, $p_{\text{exp}} = 0.009$) values. In the *Motor Scale*, we identified one perinatal (mode of conception) and two Bayley-III Screening test variables (receptive and expressive communication variables). Remarkable significance (0.000) was found in the relationship between expressive communication skills at 1 year of corrected age and the motor skills at 2 years of corrected age (Nagy et al., 2021).

In case of *social-emotional skills* we identified three perinatal variables (birth weight, pregnancy planning, and 10-minute Apgar), two neonatal (BPD, and RDS), and four developmental characteristics (participation in development, receptive and expressive communication skills, as well as gross motor skills) at the age of 1. At 5 % significance level receptive communication and gross

motor skills, birth weight, 10-minute Apgar value, participation in development as well as BPD and RDS variables were significant. In terms of the *Adaptive Behaviour Scale* seven perinatal (gestational age, birth weight, 1-, 5-, and 10 minute Apgar, pregnancy planning, and mode of conception), two sociodemographic (average social situation, and secondary level maternal education), and five developmental characteristics (four Bayley-III screening test variables (cognitive, receptive communication, fine and gross motor skills) and breastfeeding) were identified. Most identified predictor variables were significant at 5% level (Nagy et al., 2021).

DISCUSSION

1. Psychomotor characteristics of preterm children at 1 and 2 years of corrected age

According to the Bayley-III Screening Test results at the corrected age of 1, receptive, expressive communication and fine motor subscales showed the lowest scores and were the most outstanding in terms of risk for developmental delay. This result is consistent with

literature findings, regarding preterm infants having significantly lower cognitive, language and motor skills (Benassi et al., 2016; Ionio et al., 2016). Presumably, motor problems negatively affect communication skills, such as face-to-face interaction, joint attention and early linguistic acquisition (Benassi et al., 2016; Sansavini et al., 2014).

The results (full Bayley-III) were low for the Language Scale and the Motor Scale, especially those for the expressive communication and gross motor skills at 2 years of corrected age. Almost one quarter of our sample showed moderate/mild developmental delays. The results of the Social-Emotional and Adaptive Behaviour Scales were prominent among the five main Bayley-III scales in terms of scores.

In our extended sample (N = 438), we also identified lower Language and Motor Scales especially in expressive communication and gross motor subscales; more than a quarter of our sample had mild or severe developmental delay. LBW and VLBW children performed better on all scales than ELBW children. In accordance with previous studies (Constantinou et al., 2005; Nagy & Kenyhercz,

2020), we found positive correlation between birth weight and developmental indicators. The areas of expressive communication and gross motor skills emerge out in terms of lower performance, regardless of the birth weight. Overall, we can conclude that preterm children show the largest deficits mostly in language and motor development.

2. Factors affecting development

During our research, we examined a number of variables that we assumed were related to early psychomotor development. In our sample, the *breastfed children* had better cognitive and fine motor skills at 1 year of corrected age. The more the duration of breastfeeding was the better performance measured on cognitive, expressive and fine motor subscales. Our results are consistent with literature findings that emphasize both the short- and long-term positive effects of breastfeeding on the child's psychological and intellectual development (e.g. Horta et al., 2015; Jardí et al., 2018; Nagy et al., 2021).

Infants who were conceived by MAR performed not only similarly but also much better than naturally conceived children. We can assume that these children may have experienced greater parental attention and care from the moment of conception, factors that may have contributed to higher psychomotor outcomes. Based on the literature findings parents may perceive their infants more fragile due to the health outcomes, the long conception procedure, so they pay more attention and care of them, which can be reflected in higher neurodevelopmental outcomes in the early years of life. The financial and emotional efforts to have a baby conceived by MAR can also contribute to the higher care in parenting (Barbuscia & Mills, 2017; Carson et al., 2011).

Unplanned children showed significantly lower language and cognitive skills, even at 1 year of corrected age. Review of studies about pregnancy planning shows that there is relatively scarce international research where long-term developmental pathways are followed. This line of our research is considered completely groundbreaking in Hungary. Many factors can adversely affect the

development of a child born from an unplanned/unintended pregnancy (Abajobir et al., 2017).

Due to the low frequency values, less clear correlations can be described between certain forms of *maltreatment* and psychomotor development. Children of mothers who were physically and sexually abused in childhood were characterized by lower gross motor and receptive communication skills. Furthermore, the more frequent the experience of psychological abuse and neglect was in the mother's life history, the more unfavourable indicators (gestational age, birth weight, Apgar-values) were identified. According to the literature, in many cases these mothers have lower mental health indicators and may tend to have insensitive and inconsistent behaviour with their children (Martins & Gaffan, 2000), which may indirectly affect the child's development.

Examining the variables of the *mother-child relationship*, we can conclude that the mothers in our sample had mostly positive perceptions about their preterm children; their own care representations and intentions were also mostly positive. The higher the

positive emotions (H-MORS-SF) attributed to their children, the higher cognitive and expressive communication scores could be identified. Furthermore, the more the mother felt that she was giving her child warmth and care (BMBI/CMBI), the higher language and fine motor skills we experienced. By contrast, overprotective, controlling behaviour was associated with significantly lower developmental values of the cognitive and expressive communication skills. Furthermore, the more the mother judged that her child was aware of her own feelings and thoughts, the higher expressive communication and fine motor skills we identified. The more the mother experienced overprotective parental treatment, the less she perceived her own behaviour as warmth in her relationship with the child, and the more inclined she was to incorporate overprotective, restrictive treatment into her own behaviour. According to Bakonyi et al. (2020), mothers with preterm children are less attuned to their children's needs, rather they care according to predetermined structures and conditions. We can assume that mothers who exhibit overprotective and controlling behaviour are less likely to allow their child's

cognitive activities and autonomy to develop which may be the reason for the lower psychomotor development scores in our sample. Nevertheless, the development of maternal identity can even take years (Stern, 1995), so the issue of maternal attunement and connection deserves special attention in early prevention.

Examination of *strengths and difficulties* (SDQ) showed that ~37 % of the children fell into one of the problematic ranges. The higher the proportion of hyperactivity/inattention, peer relationship problems and behaviour problems, and the higher the overall SDQ problem score, the lower the social-emotional and adaptive behaviour skills were identified concerning developmental outcomes. Based on birth weight, we only observed differences in our extended sample – in case of children born with a lower weight, hyperactivity/inattention, peer relationship and emotional symptoms occurred in a higher proportion. The less favourable sociodemographic variables associated with more internalizing and externalizing problems. Similarly to previous studies (Kenyhercz & Nagy, 2020; Reijneveld et al., 2006) we can conclude that LBW children are at risk

not only of cognitive deficits but mental health problems as well, especially regarding social skills and hyperactivity/inattention symptoms. Previous studies identified higher risk of ADHD diagnosis among school-aged children compared to the control (Bhutta et al., 2002; Franz et al., 2018). However, the present research draws the attention to the fact that similar difficulties are already noticeable at the age of 2 (in 33-39% of the sample). Screening and treating these difficulties can help optimize the child's development and improve the family's quality of life.

3. Predictive power of 1-year variables

The coefficients of determination have high explanatory value (50–90%) of the models created using multivariate regression analysis. Our predictor variables were derived in four larger areas, such as perinatal, neonatal, sociodemographic, and 1-year-old developmental characteristics. It should be emphasized that the language subscales at the age of 1 remained in our models for all outcome variables, and it can also be observed that the two language subscales (receptive and

expressive communication) alone explained at least 50 % of our variables, which effect was strengthened if several variables was included in the model (50-90 %). Apparently, these two skills involve numerous essential characteristics, acting as relevant indicators in predicting later development. In our sample, language skills at the age of 1 there were stable predictors of all areas of psychomotor development at 2 years: when language development was lower at 1 year, lower cognitive, language, motor, social-emotional and adaptive behaviour skills were identified at 2 years of corrected age. Language and communication skills play an important role in children's general learning skills and contribute to the dynamic development of cognitive, motor, social-emotional and adaptive behaviour skills (Crais, 2010). Nevertheless, it is important to point out that language development cannot be separated from ecological factors such as culture, the quality of the social and home environment, whether it is a high or low stimulus environment, as well as the individual characteristics of both the child and the parents (Bronfenbrenner & Morris, 1998; Chapman, 2000).

SUMMARY

In our research, we have examined the psychomotor development at 1 and 2 years of corrected age of a cohort of preterm infants, the perinatal, neonatal and sociodemographic factors influencing their development, as well as the predictor variables of development measured at year 2. Our research is regarded as much-needed due to conducting studies such as the association between pregnancy planning and early psychomotor development, as well as the examination of predictive power of the Bayley-III Screening Test. Results of our regression models draw the attention to the importance of measuring early language skills, as well as to their close association with other areas of development. Receptive and expressive communication skills at the age of 1 have proved to be important indicators in predicting later development. Among children showing developmental delay in language skills, it is essential to begin interventions as early as possible and to integrate them into speech development groups.

Our study also supports the relevance of using the Bayley-III Screening Test in early developmental examinations, since the Screening Test uses the same parameters and tools as the diagnostic test version, and its subtests are the part of the Diagnostic Test – the tasks that measure the cognitive, receptive and expressive communication, fine and gross motor skills in the best way were selected into the tool. Based on our results, we can say that even at the age of 1, the test can provide bases that can contribute to the developmental plan and the selection of directions. Based on our experience and research results, we recommend the Bayley-III Screening Test to carry out among ELBW children at the corrected age of 1, and the Bayley-III Diagnostic Test at the corrected age of 2. Among VLBW and LBW children we recommend taking the Screening Test at the corrected age of 2. With these proposals, we would like to contribute to the formulation of professional protocols and guidelines. Furthermore, we consider the organization of parent groups to be important, both for a preventive and interventional point of view.

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List of publications related to the dissertation

1. Nagy, B. E., Kenyhercz, F., **Szele, A. S.**: Developmental characteristics and mental health of low birth weight children at 2 years in relation to sociodemographic risk factors.
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