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Executive Functions in Preschool Children Born Preterm in Canton Sarajevo, Bosnia and Herzegovina

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Abstract

Background
Preterm born children are at an increased risk for having cognitive and motor impairments at preschool age. In addition to this, children born preterm have a number of deficits in executive functioning. Although there are numerous studies examining executive functions (EF) in preterm born children, few used ecologically valid measures of EF. The goal of the present study was to examine EF in preschool children born preterm.

Materials and Methods
The sample for this study consisted of 40 preschool children aged 5 – 6 years old born preterm, both sexes (21 boys, 19 girls). EFs were measured with Behavior Rating Inventory of Executive Function-Preschool Version, an ecologically valid instrument for EF assessment.

Results
The results of this study revealed that the greatest EF deficits were in the area of emotional control and working memory. There were no gender differences in EF except for the domain of emotional control, with boys having larger deficits.

Conclusion
Given the high rate of EF deficits in preschool children born preterm, it is of utmost importance to provide them with adequate therapeutic modalities early in preschool period. Pediatricians, psychologists and early education specialists should work together in identifying the potential EF problems in preterm born preschool children and in making the programs for ameliorating EF deficits.

Key Words: Bosnia and Herzegovina, Executive functions, Preterm born children, Preschool children.

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1- INTRODUCTION

Preterm birth is an important health issue across the globe. There are approximately 10% of children who are born prematurely (≤ 36 week gestation) and have low birth weight (<2,500gr) (1). The incidence of preterm birth varies in different world regions ranging from 6.2% in Europe to almost 12% in Africa (2). There are numerous demographic risk factors related to preterm birth such as mother younger than 17 years or older than 35, race, low socio-economic status, malnutrition, mother's behavior during pregnancy, etc. (3). Children who are born prematurely have an increased risk for various health and developmental issues, such as respiratory problems (4), delayed motor development (5), delayed language development (6) and executive functions deficits (7). Numerous studies have shown that preterm born children have a number of academic, motor, behavior and language issues at school age (8-10). However, much less is known about the potential problems that children born preterm have at preschool age. One area that is of particular importance to the overall child functioning at preschool age is the development of executive functions (EF).

They are essential to the successful management of almost all of our everyday activities and their development is particularly rapid at preschool age. EFs can be defined as a set of general-purpose control processes that regulate thoughts and behaviors (11). They play a key role in child's cognitive, behavioral and socio-emotional development (12). EFs are regarded as self-regulatory behaviors that are necessary for selecting and sustaining actions and guiding behaviors in the context of rules (13). Defined in this way, it is obvious that EFs are multidimensional construct consisting of many components. However, the researchers are not in complete agreement as how many and what components are actually parts of EFs. There are different conceptualizations and models of EFs. Most researchers agree that the three core EFs are: behavioral inhibition, working memory and cognitive flexibility (14). Research has shown that the school success, especially in math and reading/writing skills can be well predicted by the level of EFs at preschool age (15, 16). In addition to school success, EFs are skills essential for mental and physical health (14). Thus, the timely assessment of EF at preschool age is of paramount importance for preventing and ameliorating the potential problems originating from the deficits in EFs. This is especially important for preschool children born preterm as they might be at greater risk of having deficits in EFs.

For the purposes of this study, we used a conceptualization of EF postulated by Gioia et al. and used their instrument Behavior Rating Inventory of Executive Function- Preschool version (BRIEF-P) for the purpose of this study (17). BRIEF-P was chosen as it is ecologically valid instrument and assesses EFs from everyday perspective. It consists of five clinical scales: 1. Inhibit- ability to control impulses and behavior assesses the ability to stop and modulate own behavior at the proper time; 2. Shift- ability to move freely from one situation or activity to another as the situation demands, makes transitions and solves problems flexibly; 3. Emotional Control- ability to modulate emotional responses appropriately to situational demand or context; 4. Working memory- ability to hold information in mind for the purpose of completing a task, stays with an activity; and 5. Plan/organize- ability to anticipate future events or consequences, uses goals or instructions to guide behavior in context. As the current studies are limited regarding the effects of preterm birth on EFs development, we wanted to examine how preterm birth affects different aspects of EFs.

The goal of the present study was to examine the EFs in preschool children born preterm.

Specific objectives were:

1. to compare EFs in preterm born children with normative sample;
2. to determine the occurrence of clinically significant deficits in EFs in children born preterm;
3. to determine correlations between birth weights, gestational week and BRIEF-P clinical scales; and
4. to examine whether there were differences in EF clinical scales in relation to the child's gender.

To the authors' best knowledge, this is the first study in Bosnia and Herzegovina that examined EFs in preterm born children.

2- MATERIALS AND METHODS

2-1. Participants

Total of 39 mothers of preterm born children filled the Bosnian translation of the BRIEF-P, parent version, for 40 children (one mother had twins). The mean age of mothers at the time they gave birth to children was 29.1 years (SD- 4 years). In relation to the educational status of the mothers, 21 of them had finished high school and 18 had finished a faculty. At the time of filling the BRIEF-P, children were between 5 and 6 years of age (mean age: 5.6 years, standard deviation [SD]: 0.36). There were 21 boys and 19 girls in the sample, and there were no statistically significant differences in the mean age of boys and girls (p=0.19). All children were born preterm ($\leq$ 36 weeks gestation), range of gestation: 27 weeks- 36 weeks, mean gestational was 32.9 weeks (SD: 2.8). The birth weights of children ranged from 900gr to 3,000gr mean weight at birth was 2,200gr and SD was 500gr. According to the medical records, all children were free of any neurologic condition such as cerebral palsy, epilepsy, etc.

2-2. Procedure

We translated BRIEF-P into the Bosnian language. A person who was unaware of the English version translated the Bosnian version back to English. After some ambiguities were corrected, the publisher approved the Bosnian translation of the instrument. Mothers of preschool children, born preterm, aged 5-6 years, were asked to fill the BRIEF-P questionnaire at a regular medical checkup at two local health centers in Canton Sarajevo, Bosnia and Herzegovina. Total of 50 questionnaires were distributed, 46 were returned and 40 questionnaires had complete data necessary for the analysis. Parents respond to items describing child's behavior on a 3-point scale, on which they indicate whether the certain behavior has never been a problem, sometimes been a problem or often has been a problem. The participation in the study was voluntary and anonymity of data was guaranteed. The study was approved by the Ethical Committee of the Health Center of Sarajevo Canton, Bosnia and Herzegovina.

2-3. Instrument

The Behavior Rating Inventory of Executive Function- Preschool version (BRIEF-P) is a valid and reliable instrument for the assessment of executive functions in the home and preschool environments (17). It is designed for preschool children aged 2 years through 6 years, including children with various developmental disabilities such as children with learning disabilities, attention disorders, traumatic brain injuries etc. BRIEF-P consists of 63 items that measure different aspects (clinical scales) of EF: Inhibit, Shift, Emotional Control, Working Memory and Plan/Organize. These five clinical scales yield three indexes: Inhibitory Self-Control Index, Flexibility index, and Emergent Metacognition Index. The overall composite index is the Global Executive Index. In this study we used five

clinical scales of BRIEF-P as the dependent measures. BRIEF-P has two versions, parent version and teacher version. Internal consistency, Cronbach's alpha, is high for both versions, ranging from 0.80 to 0.97. In this study, Cronbach's alpha was 0.96 indicating excellent internal consistency. For the parent version, test-retest correlation was significant ranging from 0.78 to 0.90. For the purposes of this study we used parent version of the BRIEF-P. More information about the psychometric properties of the instrument can be found in the BRIEF-P professional manual.

2-4. Statistical analysis

Descriptive data scores were presented for all five clinical scales. We converted raw scores to T-scores according to the Manual conversion tables, adjusted for the child's gender. The T scores were not adjusted for the age as all children were in the same age category. According to the BRIEF-P manual, scores above 65 (1.5 SD above the mean) are considered clinically significant. Frequency of clinically significant results for each scale was reported. Correlations between gestational week, birth weight and clinical scales were presented. Lastly, we compared mean scores of boys and girls on EF clinical scales.

3- RESULTS

Descriptive results for the five BRIEF-P scales are presented in **Table.1**; along with a comparison with normative sample.

Table-1: Mean T scores of preschool children born preterm on the BRIEF-P clinical scales in comparison with normative sample

Scale	BRIEF-P T score (SD)	One sample t-test	P-value	Cohen's d (effect size)
Inhibit	52.3 (11.1)	1.3	.200	0.22
Shift	53.7 (11.2)	2.1	.040	0.35
Emotional Control	55.4 (10.9)	3.2	.003	0.52
Working Memory	57.0 (13.4)	3.3	.002	0.59
Plan/Organize	52.6 (12.6)	1.3	.200	0.23

Note. Normative sample consisted of 460 parents; the mean score of normative sample is 50 with SD = 10; BRIEF-P: Behavior Rating Inventory of Executive Function- Preschool version.

It can be seen from **Table.1** that statistically significant differences between preschool children born preterm and normative sample on BRIEF-P were for the scales Shift, Emotional Control and Working Memory. However, if Bonferroni correction was applied (due to multiple comparisons), then the clinical scale Shift would not be statistically significant (as the statistical significance limit would be set to .01 [Bonferroni correction: 0.05 (5%)]). Thus, these results regarding the scale Shift need to be interpreted cautiously, having in mind both statistical error 1 and error 2 in minds. Cohen's d as a measure of an effect size provides additional information into the nature of this relationship and it can be concluded that Emotional Control and Working Memory were the areas of weakest performance for preschool children born preterm. Next we wanted to find out how many of preschool children born preterm had clinically significant scores above 65 (above 1.5 SD above the mean). These results are presented in **Table.2**.

Table-2: The frequency of clinically significant deficits in EF in preschool children born preterm

Scale	No deficits in EF Number (%)	Deficits in EF Number (%)
Inhibit	33 (82.5)	7 (17.5)
Shift	33 (82.5)	7 (17.5)
Emotional Control	31 (77.5)	9 (22.5)
Working Memory	31 (77.5)	9 (22.5)
Plan/Organize	33 (82.5)	7 (17.5)

EF: executive function.

From the **Table.2** we can see that between 17.5% and 22.5% of preschool children born preterm have clinically significant deficits in EF. Next we present the correlations between birth weights, gestational week and BRIEF-P clinical scales. These results are presented in **Table.3**.

Table-3: The correlations between birth weights, gestational week and BRIEF-P

Measure	1	2	3	4	5	6	7
1. Gestational week	--						
2. Birth weight	.52**	--					
3. Inhibit	-.22	.15	--				
4. Shift	-.36*	.09	.91**	--			
5. Emotional control	-.30	-.23	.79**	.81**	--		
6. Working memory	-.05	.28	.93**	.83**	.70**	--	
7. Plan/organize	-.02	.29	.89**	.78**	.70**	.94**	--

Note. *p<0.05; **p<0.01; BRIEF-P: Behavior Rating Inventory of Executive Function- Preschool version.

As expected, there was a statistically significant positive correlation between gestational week and birth weight. Gestational week was only significantly correlated with the EF scale Shift (p<0.05). Birth weight was not statistically significantly related with any EF scales. On the other hand, all EF scales were significantly correlated with each other (p<0.01). Lastly, we wanted to examine whether there were differences in mean scores of EF measured between boys and girls. The results are shown in **Table.4**.

Table-4: Gender differences for EF scales between boys and girls

Scale	Boys Mean (SD)	Girls Mean (SD)	t (df=38)
Inhibit	52.8 (10.8)	51.7 (11.7)	0.32
Shift	55.2 (9.5)	52.1 (12.9)	0.87
Emotional Control	59.3 (10.8)	51.2 (9.4)	2.5*
Working Memory	57.2 (14.0)	56.8 (13.1)	0.09
Plan/organize	54.1 (14.8)	50.9 (9.7)	0.80

Note. *p=0.017; df: degrees of freedom; SD: standard deviation.

As can be seen from **Table.4**, the only significant difference between boys and girls was on the scale Emotional Control. Again, this result needs to be interpreted cautiously as there might be the risk of committing Type 1 error, as we had multiple comparisons. Thus, we calculated a Cohen's d as a measure of an effect size and it was 0.68. Given the size of the effect, it is very likely that there are real differences between boys and girls on the scale of Emotional Control.

4- DISCUSSION

The goal of this study was to examine EFs in preschool children born preterm in Canton Sarajevo. The results of this study showed that the mean values of EF scores for preschool children born preterm were all in the typical range. However, statistically significant differences between this sample and normative sample were for the scales of Emotional Control and Working Memory. This finding regarding the Emotional Control is in line with earlier studies. For example, Clark and colleagues have found that children born at younger gestational age have poorer self-regulation skills across multiple contexts including parental reports of child behavior at home (18). Another study also found that children born preterm had poor emotional and behavioral adjustment and poor emotion regulation (19).

As for the working memory, the results are still inconclusive, as some studies have found differences between preterm born children and full term born children and some have not find these differences. For example, one study has shown that school-aged children born preterm have deficits in working memory (20). Our study expands these findings to preschool children as well. Yet another study has found preterm born children to have poorer performance than full term children in all EF domains (21). On the other hand, a study by Murner-Lavanchy and colleagues has shown that there were no differences in visuospatial working memory in the two groups of children (22). It is important to note that BRIEF scale of working memory has a very good discriminatory validity. For example BRIEF working memory scale best classified children with mild and moderate intellectual disability (23). As for the frequency of EF deficits, defined as 1.5 standard deviations above the normative mean scores, there were 7 children or 17.5% who had clinically significant deficits in the EF domains of shift, inhibit and plan/organize. For the scales of emotional control and working memory, there were 9 children or 22.5% who had deficits in these domains. This prevalence of EF deficits is high and these results need to be confirmed or refuted in subsequent studies. As for the relationship between gestational age and EF clinical scales, the only statistically significant correlation was between gestation age and Shift. This finding was in contrast to our expectations and to current literature (19), as we expected gestational age to be significantly correlated with all EF clinical scales in the way that lower gestational age is related to poorer EF outcomes. One possible explanation of this lack of relationship is that the sample was too small to reveal significant correlations.

Another likely explanation is that this sample did not contain very preterm children (<27 gestational weeks) so these correlational trends could not be detected. As for the intercorrelations between the BRIEF-P clinical scales, we assumed that they will be significantly correlated. This assumption was confirmed and these findings are in line with BRIEF-P manual (17). In terms of gender differences, the significant mean differences were only found for the domain of Emotional Control scale, while in the other EF domains there were no statistically significant differences between boys and girls.

On the Emotional Control scale, boys had poorer scores than the girls. It is well established that boys and girls have different emotional development trajectory. Girls engage in more prosocial interactions, are more likely to express their emotions and receive many emotional provisions in their friendships, while the boys receive fewer emotional provisions in their friendships (24). Let us mention couple of limitations of this study. First of all, the sample was too small to generalize these results beyond the sample. However, these results should be viewed as

exploratory and serve as a basis for future research. Another limitation deals with the instrument used. Parents were not trained to fill the BRIEF-P scale so there might be some error on that part. For example, same behavior can be perceived as problematic by some parents and non-problematic by others. This issue follows all the studies involving rating scales. We tried to limit this issue by informing parents on how to fill the questionnaires. Lastly, we did not have information on the educational status of children, whether they attend regular kindergartens, special kindergartens, do they have speech and/or occupational therapy. Earlier studies have also revealed deficits in EF in children born preterm (25). This study confirmed the presence of EF deficits in preterm born preschool children. Given the fact that EF is very susceptible to training, the intervention aimed at improving EFs should start as soon as possible. Numerous studies have shown that EF can be trained. Some of these programs such as Tools of the Mind improve preschoolers EF at a minimum expense for the teachers (26).

5- CONCLUSION

Preterm born children have an increased risk for executive functions deficits. BRIEF-P can provide us with valuable, ecologically valid, information about the child's EF. This can further serve as the basis for making the individualized educational programs aimed at improving EF. Pediatricians, psychologists and early education specialists should work together in identifying the potential EF problems in preterm born preschool children and in making the programs for ameliorating EF deficits.

6- CONFLICT OF INTEREST: None.

7- ACKNOWLEDGMENT

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