Research Articles

Cognitive and Language Development in Preschoolers Is Related to Maternal Cognitive Performance: A Study of Young Mothers in an Urban Area of a City in Southern Brazil

Fernanda Teixeira Coelho[1], Jéssica Puchalski Trettim[1], Rochele Dias Castelli[1],

Mariana Carret Soares[1], Natália da Costa Dias[1], Graciela Coelho do Espírito Santo[1],

Denise Müller Böhm[1], Daniele Behling de Mello[1], Carolina Coelho Scholl[1],

Bárbara Borges Rubin[1], Mariana Bonati de Matos[1], Ricardo Tavares Pinheiro[1],

Luciana de Avila Quevedo*[1]

[1] Postgraduate Program in Health and Behavior, Catholic University of Pelotas, Pelotas, Brazil.

Abstract

To evaluate the relationship between maternal cognitive performance and language and cognitive development of children between 24 and 36 months old of mothers who became pregnant in adolescence, in the city of Pelotas, Southern Brazil. This is a cross-sectional study nested in a cohort study with adolescent mothers who received prenatal care in the city's public health system. To assess maternal cognitive performance, the Montreal Cognitive Assessment (MoCA) was used and Bayley Scales of Infant Development III (BSID-III) are used to assess children's language and cognition development. Data were analyzed using SPSS (Version 22.0) software. Pearson correlation, t-test, ANOVA and linear regression were performed. We evaluated 496 mother-child dyads. In the adjusted analysis, we found that children's language remained associated with maternal cognitive performance (p = .027, CI [0.0, 0.6]) and child's gender (p < .001, CI [−7.2, −2.4]). Besides that children cognitive development remained associated with maternal cognitive performance (p = .008, CI [0.1, 0.6]) and child's gender (p = .030, CI [−4.5, −0.2]). Our results suggest that poor maternal cognitive performance is associated with lower levels of children's language and cognitive development. The results contributing to early identification and intervention in children of mothers with poor cognitive performance at higher risk of negative developmental outcomes.

Keywords: maternal cognitive performance, child development, language development, cognitive development, preschoolers
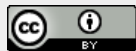
Child development is a process that occurs since the intrauterine period through the interaction of genetic, biological and environmental factors. It involves aspects such as physical growth, neurological maturation and

acquisition of abilities such as behavior and sensory-motor, language, cognitive, affective and social spheres of the child (Gallahue & Ozmun, 2003; Halpern & Figueiras, 2004).

In this context, the first years play an important role in child development as it is a period of brain neurophysiological events and early experiences are decisive for brain structure and, consequently, the abilities of the adult (Grantham-McGregor et al., 2007; Hackman & Farah, 2009).

The literature points out that the developmental delays are associated with different adverse conditions not only during early childhood, but from conception, pregnancy and childbirth (Dornelas, Duarte, & Magalhães, 2015). It is estimated that approximately 200 million children worldwide under the age of five year are at risk of not reaching their full development. Furthermore, 10% of the population of any country is made up of individuals with some type of delay, with a rate of 4.5% amongst children under five years old (Figueiras, de Souza, Rios, & Benguigui, 2005). In Pelotas, Southern Brazil, in a birth cohort, 34% of children at 12 months of age had suspected neuropsychomotor developmental delay (Halpern, Giugliani, Victora, Barros, & Horta, 2000).

Language difficulties and cognitive delays may compromise comprehension, verbal expression, thinking, action and interfere in the child's communication with the environment. They are usually predictors of learning and behavioral disorders, whose problems can persist until adulthood without an appropriate intervention (Schonhaut, Maggiolo, Herrera, Acevedo, & García, 2008; Young et al., 2002).

Frequently, children are exposed to multiple and cumulative risks. Development is increasingly compromised as risks overlap. Among the environmental factors, studies show that low maternal educational level and lower economic conditions are associated with poor language and cognition development (Mollborn & Dennis, 2012; Silva et al., 2011). There is evidence that the child's gender, prematurity, low birth weight and breastfeeding may be associated with developmental delays (Nishimura, Takei, Tsuchiya, Asano, & Mori, 2016; Sidhu, Malhi, & Jerath, 2010).

Also, it is known that adolescent mothers may find it more difficulty to provide child care and a quality affective exchange, because they tend to be less sensitive and less responsive and interact with their children, and so will may take to negative outcomes in child development (Pires et al., 2019).

Regarding to maternal characteristics that may influence the child development, there is evidence about an intergenerational transmission of cognitive abilities (Anger & Heineck, 2010). Bridgett et al. (2011) found that the executive function of mothers, that is, the behaviors that allow them to intentionally interact in the world and involve the formulation of an action plan based on previous experiences and demands of the current environment, was related to the same capacity in their children at 4, 8 and 10 months old. Nevertheless, other cognitive abilities have not been investigated.

As maternal executive function was related to the child development, it is believed that the same may occur with cognitive capacity in a global way. People with some cognitive impairment have episodic memory and other skills such as attention, language, orientation in time and space, recognition of environments and people, and organization and planning of thoughts and actions impaired (Radanovic, Stella, & Forlenza, 2015). Thus, it is possible that maternal cognitive performance may be related to the cognitive and language development of children, not only genetically but also regard to the quality of stimulation in the environment in which the child is placed.

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Considering that delays in the development of language and cognition in the early years of child's life can cause significant harm to children and their families, it is essential to identify children at higher risk as early as possible, minimizing the impact of these problems on the child's life. Thus, this study aimed to evaluate the relationship between maternal cognitive performance and language and cognitive development of children between 24 and 36 months old of adolescent mothers, in the city of Pelotas, Southern Brazil. We hypothesized that mothers with lower cognitive performance would have children with lower scores on language and cognitive development assessment (worse development), when compared to mothers with higher cognitive performance.
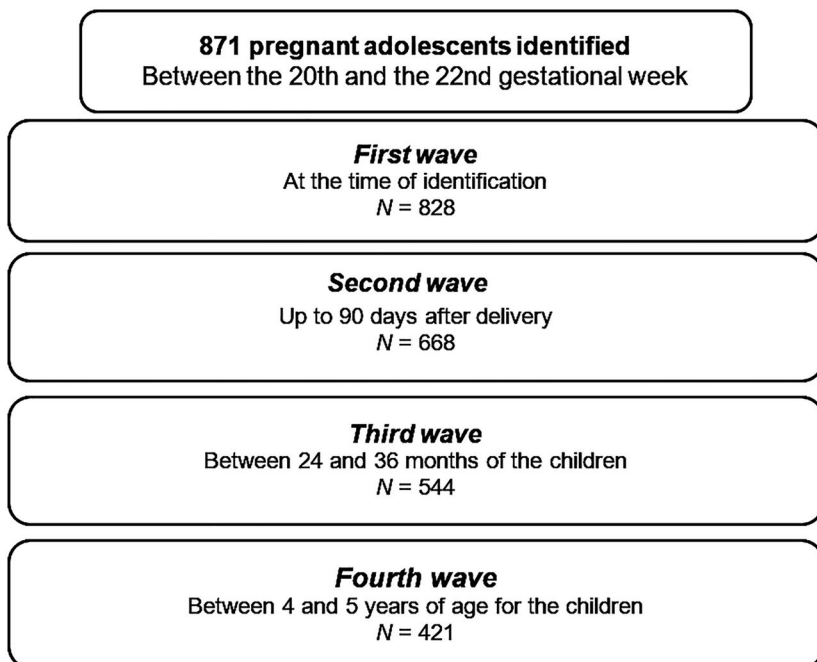
Method

This is a cross-sectional study nested in a cohort study on maternal mental health and child development. Between October 2009 and March 2011, for the baseline datas, all pregnant adolescents aged 10–19 years who received prenatal care from the public health system in Pelotas (southern Brazil) were invited to participate in the original study. Pregnant adolescents who showed an inability to answer and/or understand the instruments and who did not live in urban areas were excluded.

This study was conducted in different waves: In the first wave, pregnant teenagers were evaluated between the 20th and 22nd gestational week Subsequently, after the birth of the children, the mothers were reevaluated up to 90 days after delivery (second wave), then the mother-child dyads were evaluated between 24 and 36 months of the children (third wave). The last evaluation also known as fourth wave was realized when these children were between 4 and 5 years old (Figure 1).

Figure 1

Flowchart

871 pregnant adolescents identified
Between the 20th and the 22nd gestational week

First wave
At the time of identification
N = 828

Second wave
Up to 90 days after delivery
N = 668

Third wave
Between 24 and 36 months of the children
N = 544

Fourth wave
Between 4 and 5 years of age for the children
N = 421

Of the initial 871 pregnant adolescents eligible for study inclusion, 43 (4.94%) refused to participate, resulting in 828 participants in the first step of the study. For the present study, a subsample of 496 mother–child dyads (childs between 24 and 36 months old children and their respective mothers) were evaluated.

To evaluate the maternal cognitive performance was used the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005). This is a cognitive screening instrument that measures eight cognitive domains divided into twelve items. The instrument creates a total score that can vary from 0 to 30 points (higher scores indicating better function), from the sum of the score of each item evaluated. The cognitive domains investigated are: short-term memory; visuospatial abilities; executive function; attention, concentration and, working memory; language and verbal fluency; orientation to time; orientation to space. According to the author's recommendations, as a way to correct the effects of schooling on cognitive performance, an additional point is given to individuals with 12 years or less of schooling. The scores were analyzes continuous, since there are no studies that determine the cutoff point for the Brazilian population of pregnant women or adult women.

The children were assessed using the language and cognitive scales of the Bayley Scales of Infant Development III (Bayley-III; Bayley, 2006), which assesses the development of children from 0 to 42 months of age. The language scale is composed of items related to receptive and expressive communication. The Bayley-III Receptive Communication subtest begins with items that assess auditory acuity, including the ability to respond to the sound of a person's voice, to respond and to discriminate between sounds in the environment, and to localize sound, identify words and respond to requests. The Expressive Communication subtest includes items that assess the young infant's ability to vocalize, like the use of words. The evaluator, at the moment of the test, makes the child's raw score in each subscale (receptive and expressive). Then, according to the instrument's application and correction manual, to obtain the composite score, the sum of the raw scores of the two subscales must be used, thus determining language development. The items on the Cognitive Scale include sensorimotor development, exploration and manipulation, object relatedness, concept formation, memory and other cognitive abilities. The Bayley Scale III has not cutoff values for the Brazilian population. Thus, for methodological purposes related to statistical power, we used the composite score total of the subscales as the outcome, being that lower scores indicate worse developmental outcomes. Bayley III scores are converted to scores weighted according to the child's age.

We assessed socioeconomic class using the Brazilian Association of Research Companies criteria (Brazilian Association of Research Companies, 2013). This classification is based on the accumulated material assets of the family and in the education level of the head of the family. It classifies individuals into five classes (A, B, C, D and E), in which class A is the highest socioeconomic status and E is the lowest socioeconomic status. For this study, classes A and B were grouped up, as were classes D and E.

In addition, the mothers filled out a questionnaire about their education in years of study (from 0 to 3 years / from 4 to 7 years / from 8 to 10 years / 11 years or more), age and marital status (mother live with partner—no / yes). Mothers still answered about, child sex (male / female), prematurity (less than 37 weeks—no / yes), birth weight (less than 2.500 kg—no / yes), type of childbirth (cesarean / normal birth), breastfeeding (no / yes), daycare attendance (no / yes) and primary caregiver (mother / others).

The data were analyzed in the statistics program SPSS (Version 22.0) for Windows. Univariate analysis was performed to verify sample characteristics, through absolute and relative frequencies, mean and standard

deviation. The *t*-test and ANOVA were used in the comparison between means and Pearson test was used in the correlation. All variables with *p*-value < .20 in the raw analysis were included in the adjusted analysis. A linear regression analysis was performed and adjusted to covariates, following a hierarchical conceptual model (Victora, Huttly, Fuchs, & Olinto, 1997), in which the covariates were included at three different levels. In the first level, we included the maternal sociodemographic variables (economic class, maternal age and mother living with partner). Second level, the variables related to the child and (child's gender, prematurity, low birth weight, type of childbirth, breastfeeding, attends daycare centers and main caregiver). Third level, the predictor of interest (maternal cognitive performance). After the adjusted analysis, the statistical significance was consistently evaluated using the level of 0.05 (two-tailed) as indicative of statistical significance. In addition, effect sizes were calculated using Cohen's *d*, η^2 and R^2, according to the type of variables.

The present study was approved by the Ethics Committee of the Catholic University of Pelotas (protocol 2011/19). Participants were informed about the research aims and agreed to participate by providing their free and informed consent for the anonymous publication of the results. Mothers also signed the consent form for their children, which gave them permission to participate. Children and mothers who were identified with a delayed child development and/or mental disorder were referred to the public health system at the location next to their homes.

Results

Of the 544 mother–child dyads evaluated in the third wave of the study, 496 children completed the assessment of cognitive development and 491 completed the assessment of language. Table 1 shows sample's distribution and the association between maternal and child variables with language and cognition development between 24 and 36 months.

In bivariate analysis, lower means in language development was associated with male sex (*p* < .001) and showed a positive correlation with maternal cognitive performance (*p* = .009). Regarding cognitive development, lower means in this domain showed a positive correlation with maternal cognitive performance (*p* = .004).

In addition, we seek to determine whether there are specific aspects of maternal cognitive skills that may be particularly important for children's cognitive and language development. We found that the mothers' domain of language and verbal fluency had the highest correlation coefficient (*r* = .135), with the development of their children's language (*p* = .003) (data not shown).

Figure 2 shows two scatterplots that illustrate the association between maternal cognitive performance and the child's language development and the association between maternal cognitive performance and the child's cognitive development.

Table 1

Sample's Distribution and the Association Between Maternal and Child Variables With Language and Cognitive Development Between 24 and 36 Months, Pelotas, Southern Brazil

Variable	M (SD)	N (%)	Language development M (SD)	r	p	Effect size	Cognitive development M (SD)	r	p	Effect size
Economic class (ABEP) (N = 473)[a]					.111[b]	0.006[c]			.193[b]	0.006[c]
A+B		75 (15.9)	101.1 (13.8)				94.6 (8.8)			
C		334 (70.6)	99.7 (14.1)				92.2 (12.8)			
D+E		64 (13.5)	97.4 (10.4)				92.1 (9.6)			
Maternal age (N = 492)[a]	20.2 (1.6)			.021	.683	0.000[d]		.079	.082	0.006[d]
Mother live with partner (N = 492)[a]					.193	−0.118[e]			.646	0.043[e]
No		224 (45.5)	98.7 (13.5)				92.8 (10.8)			
Yes		268 (54.5)	100.3 (13.6)				92.3 (12.5)			
Child's gender (N = 495)[a]					< .001	0.352[e]			.053	0.180[e]
Female		249 (50.3)	101.8 (13.8)				93.6 (10.7)			
Male		246 (49.7)	97.1 (12.9)				91.5 (12.6)			
Prematurity (< 37 weeks) (N = 495)[a]					.435	0.102[e]			.233	0.158[e]
No		423 (85.5)	99.7 (13.5)				92.8 (11.8)			
Yes		72 (14.5)	98.3 (13.9)				91.0 (10.9)			
Low birth weight (< 2.500 kg) (N = 433)[a]					.463	−0.118[e]			.535	−0.100[e]
No		387 (89.4)	98.7 (13.4)				91.8 (11.9)			
Yes		46 (10.6)	100.3 (13.8)				92.9 (9.9)			
Type of childbirth (N = 442)[a]					.384	0.089[e]			.465	0.069[e]
Cesarean		213 (49.3)	99.5 (13.3)				92.3 (10.7)			
Normal birth		229 (50.7)	98.3 (13.5)				91.5 (12.5)			
Breastfeeds (N = 493)[a]					.423	−0.089[e]			.595	−0.074[e]
No		414 (84.0)	99.3 (14.0)				92.4 (12.1)			
Yes		79 (16.0)	100.4 (10.5)				93.2 (9.3)			
Attend daycare centers (N = 493)[a]					.217	−0.138[e]			.376	−0.094[e]
No		387 (78.5)	99.1 (13.4)				92.3 (11.7)			
Yes		106 (21.5)	101.0 (14.1)				93.4 (11.8)			
Main caregiver (N = 474)[a]					.719	−0.045[e]			.934	0.008[e]
Mother		393 (82.9)	99.6 (13.7)				92.6 (11.7)			
Others		81 (17.1)	100.2 (12.7)				92.5 (12.0)			
Maternal cognitive performance (N = 489)[a]	20.1 (4.5)			.119	.009	0.014[d]		.129	.004	0.017[d]
Total		496 (100.0)	99.5 (13.6)				92.6 (11.7)			

Note. ABEP = Associação Brasileira de Empresas de Pesquisa [Brazilian Association of Research Companies].

[a]Variable with missing data. [b]Linearity *p*-value. [c]η^2. [d]R^2. [e]Cohen's *d*.

Figure 2

Correlation Between Maternal Cognitive Performance and Child Development Between 24 and 36 Months Old
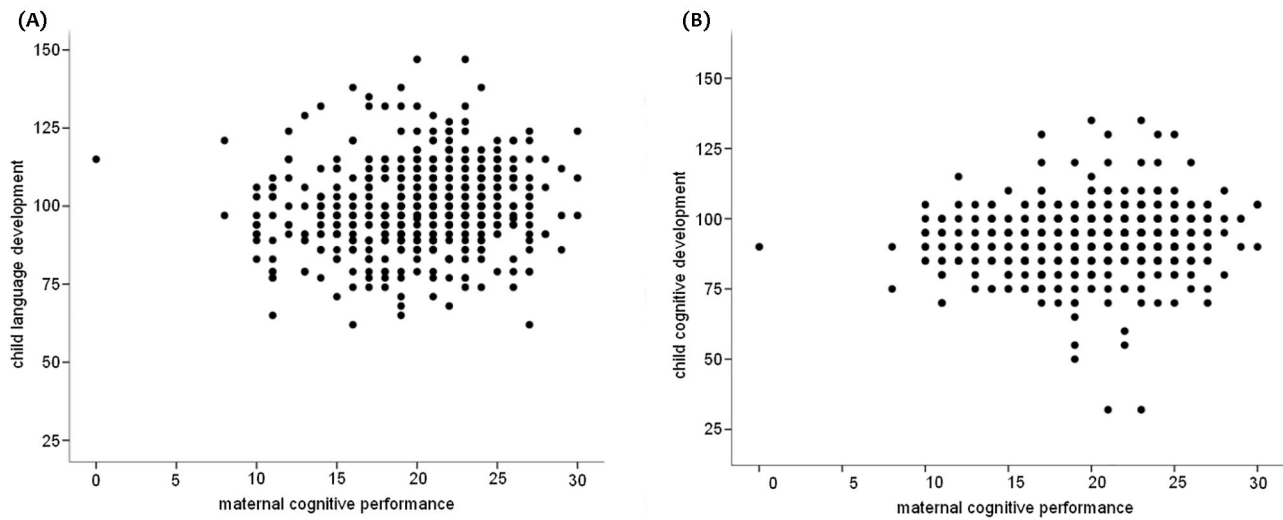

Table 2 presents raw and adjusted analysis by linear regression of language domain, according to hierarchical levels. The variables economic class, mother live with partner, child's gender and maternal cognitive perform-ance were used in the multivariate analysis because these variables had $p < .20$.

Table 2

Raw and Adjusted Analysis by Linear Regression of Language Domain According to Hierarchical Levels, Pelotas, Southern Brazil

	Language domain					
	Raw analysis			**Adjusted analysis**		
Variable	**B**	**CI 95%**	**p**	**B**	**CI 95%**	**p**
1st level						
Economic Class (A+B[a])	−1.8	[−4.1, 0.4]	.110	−1.1	[−3.4, 1.2]	.332
Maternal age[b]	0.2	[−0.6, 0.9]	.638	-	-	-
Mother live with partner (Yes[a])	−1.6	[−4.0, 0.8]	.193	−1.4	[−3.8, 1.1]	.265
2nd level						
Child's gender (Female[a])	−4.8	[−7.1, −2.4]	< .001	−4.8	[−7.2, −2.4]	< .001
Prematurity (No[a])[b]	−1.4	[−4.8, 2.1]	.435	-	-	-
Low birth weight (No[a])[b]	1.5	[−2.6, 5.6]	.463	-	-	-
Type of childbirth (Normal birth[a])[b]	1.1	[−1.4, 3.7]	.384	-	-	-
Breastfeeds (Yes[a])[b]	−1.1	[−4.4, 2.2]	.507	-	-	-
Attend daycare centers (Yes[a])[b]	−1.8	[−4.8, 1.1]	.217	-	-	-
Main caregiver (Mother[a])[b]	0.6	[−2.6, 3.8]	.719	-	-	-
3rd level						
Maternal cognitive performance	0.4	[0.1, 0.6]	.009	0.3	[0.0, 0.6]	.027

[a]Reference category. [b]Variable not included in the adjusted analysis because in raw analysis had $p > .20$.

After adjusting for covariates, the result for the scale of language remained associated with child's gender (*p* < .001) and maternal cognitive performance (*p* = .027). The male children had an overall average −4.8 points (CI [−7.2, −2.4]) less than children female. Moreover, we found that with every 1 point decrease in maternal cognitive performance, there was a 0.3 point (CI [0.0, 0.6]) decrease in children's language development. The total variance explained by the model was 0.041 (R^2 adjusted).

Table 3 presents raw and adjusted analysis by linear regression of cognitive domain according to hierarchical levels. The variables economic class, maternal age, child's gender and maternal cognitive performance were used in the multivariate analysis because these variables had *p* < .20.

Table 3

Raw and Adjusted Analysis by Linear Regression of Cognitive Domain According to Hierarchical Levels, Pelotas, Southern Brazil

| | Cognitive domain | | | | | |
| | Raw analysis | | | Adjusted analysis | | |
Variable	***B***	**CI 95%**	***p***	***B***	**CI 95%**	***p***
1st level						
Economic Class (A+B[a])	−1.3	[−3.3, 0.7]	.193	−0.7	[−2.7, 1.4]	.517
Maternal age	0.6	[−0.1, 1.2]	.082	0.4	[−0.3, 1.1]	.226
Mother live with partner (Yes[a])[b]	0.5	[−1.6, 2.6]	.646	-	-	-
2nd level						
Child's gender (Female[a])	−2.0	[−4.1, 0.0]	.053	−2.4	[−4.5, −0.2]	.030
Prematurity (No[a])[b]	−1.8	[−4.7, 1.1]	.233	-	-	-
Low birth weight (No[a])[b]	1.1	[−2.4, 4.7]	.535	-	-	-
Type of childbirth (Normal birth[a])[b]	0.8	[−1.4, 3.0]	.465	-	-	-
Breastfeeds (Yes[a])[b]	−0.8	[−3.6, 2.1]	.595	-	-	-
Attend daycare centers (Yes[a])[b]	−1.1	[−3.6, 1.4]	.376	-	-	-
Main caregiver (Mother[a])[b]	−0.1	[−2.9, 2.7]	.934	-	-	-
3rd level						
Maternal cognitive performance	0.3	[0.1, 0.6]	.004	0.3	[0.1, 0.6]	.008

[a]Reference category. [b]Variable not included in the adjusted analysis because in raw analysis had *p* > .20.

After adjusting for covariates, the result for the scale of cognitive remained associated with child's gender (*p* = .030) and maternal cognitive performance (*p* = .008). The male children had an overall average −2.4 points (CI [−4.5, −0.2]) less than female children. Moreover, we found that with every 1 point decrease in maternal cognitive performance, there was a 0.3 point (CI [0.1, 0.6]) decrease in children's cognitive development. The total variance explained by the model was 0.024 (R^2 adjusted).

Discussion

This study aimed to evaluate the association between maternal cognitive performance and cognitive and language development in children aged between 24 and 36 months old and we found that children of adolescent mothers with less cognitive performance had lower language and cognitive development scores, even after controlling for covariates. The potential for child development is genetically determined; however, however

environmental variables can modulate how much of this potential will be expressed. In this context, the higher brain functions, such as language and cognition, the most vulnerable to environmental influence (Schonhaut et al., 2008). Maternal behavior, affection, and cognition are known to form distinct patterns that affect the child's outcomes (Unternaehrer et al., 2019). Thus, some studies suggest that cognitive abilities are transmitted from mothers to children through gene inheritance or parent's better cognitive ability could predict a positive effect on their children's better health and education, resulting in higher cognitive abilities (Bridgett et al., 2011; Cuevas et al., 2014). Utilizing the data from the German Socio-Economic Panel Study, Anger and Heineck (2010) provide evidence on the intergenerational transmission of cognitive abilities. Their estimates suggest that individual's cognitive skills are positively related to the same abilities of their parents.

Among the cognitive skills that can be transmitted from mother to child, the heritability of executive functions has been investigated. Bridgett et al. (2011) and (Cuevas et al., 2014) found that mother's executive functions were associated with the same ability in children at different ages. Maternal executive functions have been associated with a range of care behaviors that are likely to pertain to intergenerational transmission of a wide variety of individual attributes. Nevertheless, other cognitive and language skills have not been investigated.

In our study, language and verbal fluency of mothers were particularly important to language development of children. Verbal fluency is a language skill that belongs to the overall construct of cognitive performance and that appears to be associated with the development of children's language. Anger and Heineck (2010) found that mother's verbal fluency is an important determinant of the same ability in the child. Similarly, another study found that mothers with higher verbal abilities when children were 8 months old had children with higher verbal skills at age 36 months. The authors find that the relationship between maternal and child verbal abilities operates indirectly through maternal responsiveness (Prime, Wade, & Gonzalez, 2020). Therefore, we believe that this result can be explained by the genetic interaction or the better quality of child development stimulation which occurs as a result of better maternal cognitive performance.

Regarding gender, we found that male children had lower scores on language and cognition than female children. These results are in accordance with the literature, as it has been shown that worse development is more prevalent in male children (Ali, Mahmud, Khan, & Ali, 2013; Kaplan et al., 2014; McManus & Poehlmann, 2012; Sylva, Stein, Leach, Barnes, & Malmberg, 2011). Boys have been found to typically understand and produce language at a slower rate than girls in the first 30 months of life (Bouchard, Trudeau, Sutton, Boudreault, & Deneault, 2009; Reilly et al., 2009). However, it is still unclear whether these findings are due to the biological factor or whether environmental risk factors have a more detrimental effect on boys as they are more vulnerable to environmental risk factors than girls (Zambrana, Ystrom, & Pons, 2012). As for cognitive development, Sylva et al. (2011) found that boys also had lower scores on cognitive scale results when compared to girls.

The socialization factors, such as parental expectations about gender roles and parent's and children's gender specific behavior, are indicated an important factor in gender differences (Barbu et al., 2015). The role of the environment and its social factors in differences between genders in development becomes even more evident with the result of a metanalysis (Umek & Fekonja-Peklaj, 2017). The authors found that as the child's age increased, the difference in language development between boys and girls also increased. From this we may think that the longer the exposure to social factors, higher their impact on children's development.

Regarding the sample consisted of women who became pregnant in adolescence, it is known that teenage mothers tend to exhibit less sensitive, more intrusive and hostile interactive behaviors and less often engage

in synchronous interactions with their children (Lee, 2009; Madigan, Moran, & Pederson, 2006). This can lead to negative outcomes in the development of children, as show in some studies where children born to young mothers are prone to have a poor performance in cognitive and language tests (Ali et al., 2013; Kaplan et al., 2014; McManus & Poehlmann, 2012).

The findings of our study should be interpreted in the light of its limitations. As any cross-sectional study, causality could not be assessed. Furthermore, although this is an important data for the population of young mothers, we must be cautious when generalizing the findings because this is a specific group of teenage girls who live in the urban area. Still, despite the association found between maternal cognitive performance and children's cognitive and language development, their effect sizes were small. Therefore, the results should be interpreted with caution. For future studies we suggest that the samples include mothers of different ages and residents of urban and rural areas. As strengths, we can highlight that our sample composed at-risk women who became pregnant during adolescence and the instrument used to assess children's cognitive and language development is considered the gold standard in the evaluation of children at this age and was applied by trained psychologists.

Concluding, maternal cognitive performance was associated with language and cognitive development of children of adolescent mothers, aged 24 to 36 months, suggesting that lower cognitive performance of mothers is a contributing factor to worse child development. Considering that developmental delays may become predictors of behavioral problems and early onset disorders, it is essential that as soon as possible children at higher risk can be identified so they can intervene in child development through a preventive approach, so the impact on children and families can be minimized. We suggest, as an intervention approach, that women who become pregnant in adolescence and who have cognitive difficulties are identified so their children can be stimulated early on cognitive and language development. This stimulation can be done through public services, with brief home visiting protocols in which stimulation can be performed with materials accessible and adaptable to each family and cultural context.

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Competing Interests

The authors have declared that no competing interests exist.

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