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Relationship between gender and psychomotor performance of children in Belém, Brazil

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Abstract *This study aimed to analyze the neuropsychomotor performance of children by implementing the Denver Developmental Screening Test-II (DDST-II). We evaluated a sample of 318 children aged 36 to 48 months. Results indicated that girls performed better in three of the four areas analyzed in the test: Personal-Social ($p < 0.001$), Fine Motor-adaptive ($p = 0.020$) and Language ($p = 0.028$). No significant difference was observed between genders in the Gross Motor skills area. Analyzing the performance of children in implementing the tasks expected in the test, we found significant differences in the following items: in the Personal–Social area, the worst-performing item was "Brushes teeth without help"; in the Fine Motor area, the worst-performing item was "shows the longest line"; in the Language area, the worst-performing items were "Knows two adjectives", "Knows four actions" and "Understands four prepositions"; and in the Gross Motor area, the worst-performing item was "Hops on one foot". The results suggest that socially-imposed standards, based on gender differences, may interfere with the neuropsychomotor behavior of children. Furthermore, knowing such development profile is crucial in the formulation of public policies and actions that can contribute to child development.*

Key words *Child development, Development evaluation, Gender differences*

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Introduction

Understanding the process of human development has been a worldwide concern, particularly among countries with low economic growth and high levels of social inequality. Studies in low- and middle-income countries emphasized the importance of intervention in the first years of life as a primary factor to improve the neurodevelopment of children[1]. The Neuropsychomotor Development (NPMD) is an essential parameter of evaluation in the early years of life, allowing researchers and professionals to detect early changes.

NPMD is associated with maturation of the central nervous system (CNS) and comprises four broad fields: Gross Motor, Fine Motor (Adaptive), Social and Linguistic. However, the skills that underpin each field come in sequence: the most straightforward skills serve as the basis for the most complex, and it is essential to understand and distinguish them. As the primitive reflexes are inhibited, the child acquires new skills within the four fields mentioned, reaching the developmental milestones. Each has its growth rate and is expected not to deviate drastically from the pattern observed for its age, among other established criteria[2].

The NPMD evaluation allows exploration of developmental milestones in children populations, ideally through standardized instruments. The early diagnosis of NPMD delay allows for timely therapeutic interventions, reducing the incidence of often permanent neurological complications. A study carried out in Curralinho, state of Minas Gerais, confirms the importance of this diagnosis through the Denver Development Screening Test-II (DDST-II) in routine childcare consultations, which can anticipate losses in patients and act preventively. It also states that the lack of qualified monitoring can lead to human and social harm, as well as financial loss to the municipality resulting from not intervening at an early stage in case of avoidable developmental delays[2].

Several tests and scales have been used to evaluate children's development in the country, most of them originated in other countries, such as the Bayle Scale[3] and the Alberta Scale[4]. However, some instruments standardized by Brazilian researchers, such as the Rosa Neto Scale[5] are also employed. The DDST-II, although not yet validated, has been widely used in research carried out in different Brazilian municipalities: Porto Alegre (RS)[6], Ribeirão Preto (SP)[7], São Carlos (SP)[8], São Paulo (SP)[9], Cuiabá (MT)[10], Belo Ipatinga (MG)[11], Belo Horizonte (MG)[12], among others, possibly because of its quick and easy applicability by technicians and researchers from many areas, provided they are adequately trained. It is worth noting that most of the studies were carried out in the Center-South region of the country, with only two in cities in the North of Brazil[13,14].

Building a solid foundation for healthy development in the early years of life is a prerequisite not only for individual well-being but also for the economic productivity of societies. Scientific evidence shows that adverse physical and social environments threaten human development and can generate long-term losses[15]. Knowing that development relies on biological and environmental factors, one should consider the types of stimuli that are provided to the child.

Studies have identified the consequences of the type of stimuli provided and expected social roles, giving children toys and proposing activities appropriate for each gender[16-21]. There is evidence that this type of directed stimulus may affect the performance of the NPMD's areas[22,23]. Research by Van Beek et al.[24] corroborates the relevance of the biology-environment binomial in children's NPMD (socioeconomic conditions, parental schooling, participation in social activities, among others).

Some environments in which NPMD has been studied are outpatient clinics[25], nursing homes[26], and schools[7,27]. In the latter, nurseries and pre-schools predominate because of their contextual importance in the first years of children's development[28,29]. According to Bronfenbrenner[30], school is the second most crucial microsystem for a child after the family, and thus its recognition as an essential research environment.

This work aimed to analyze the neuropsychomotor development of children enrolled in Child Education Units (UEI) of the public network of the municipality of Belém, in the North region of the country, based on their performance in DDST-II, and thus to establish a hypothesis of the relationship between these results and the gender variable of the child, as well as identify the items of the test in which these children obtained more failures.

Methods

This is an exploratory, cross-sectional study with a quantitative and descriptive approach. Data

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were collected in the UEIs of Belém linked to the municipality and with similar routines, with small working hours' variations. Some units have the structure and resources to carry out the activities correctly. However, many are improvised in rented houses with no room for games and gross motor activities. Evaluations were carried out in UEI's internal dependencies, usually in the cafeteria, or in another space that had tables and chairs that were suitable for children, following all the recommendations of the DDST-II manual.

The UEI were distributed in eight Administrative Districts (DA): Administrative District of Belém (DABEL), Guamá (DAGUA), Benguí (DABEN), Sacramenta (DASAC), Entroncamento (DAENT), Icoaraci (DAICO), District of Mosqueiro (DAMOS) and Outeiro (DAOUT). The first six DAs are located in the so-called Continental Belém (downtown and outskirts) and the last two in Insular Belém (Islands' region).

The sampling process was used by conglomerate, with a sample calculation error margin of 5% and confidence level of 95%. The UEIs studied were distributed according to the total number in each district, and to the number of children of the age group surveyed. The study comprised 19 UEIs that were selected in a universe of 35, as described in Table 1.

The database consisted of 318 children, after excluding one of them who did not perform all the items of the test. Both genders were selected, with ages between 36 and 48 months, without speech disturbances, sensory, auditory or visual changes and sequelae left by compromised CNS, as well as malformations, diagnosed osteoarticular pathologies or any other type of chronic, severe or debilitating diseases.

The subjects' characterization data were obtained with the Childhood Biopsychosocial Characteristics Questionnaire (CBCQ), produced especially for this study based on the literature on child development determinants. The questionnaire consisted of 48 questions, of which 19 were open-ended and 29 closed-ended, addressed to parents and distributed around the following thematic axes: (a) Identification of children and parents (19 questions); (b) Pre-, peri- and postnatal history (6 questions); (c) Socioeconomic and environmental conditions (20 questions).

A Spanish version of the DDST-II[31] adapted by the researchers, using kit materials accompanying the manual and others needed to perform the tasks (paper and pencil, table and child-sized chair) was adopted to obtain data on neuropsychomotor development.

Table 1. Distribution of Children and Child Educational Units by Administrative District of the Municipality of Belém, Brazil.

Administrative District (N = 8)	Number of UEI involved in the research (N = 19)	Number of participating children (N = 319)
DAGUA	3	89
DABEN	3	59
DASAC	2	23
DAENT	3	46
DAICO	3	38
DAMOS	3	39
DABEL	1	7
DAOUT	1	18

This research was authorized by the Municipal Education Secretariat (SEMEC) and approved by the Human Research Ethics Committee of Tropical Medicine Center (NMT/UFPA). The procedures used obeyed the recommendations of Resolution Nº 196/96 of the National Health Council and the National Research Ethics Committee in force at the time.

Once informed of the written authorization of SEMEC, the management of each UEI was invited to participate in the research. The researchers were asked to access their facilities, the children, and their families, prioritizing not to disrupt the routine of the institution or cause any discomfort.

The project was presented in the initial visits to the UEI, with preliminary contact with children, teachers and research environment. On this occasion, researchers met with teachers and parents of children to read and sign the Informed Consent Form. DDST-II was applied to children in the presence of their parents and, if impracticable, of teachers indicated by the institution. The duration of the researchers in the UEI varied according to the number of children selected and the availability of the institution to collect data, lasting on average one week for each institution. The test was applied individually for approximately 30 minutes. During the rest of the time, the researchers remained in the institution interacting with the children in other activities, aiming to introduce them in the environment and have a closer relationship with the children.

The researcher responsible applied DDST-II together with two previously trained research assistants, with a support team. Each child was

tested on the specific skills expected within its age range to verify slower or faster development rate. The performance of children in each item was evaluated and recorded, and their data are recorded in the Results Record Sheet. In this sheet, the term Pass (P) was recorded to indicate that the evaluated child had performed the requested task successfully or when its compliance had been reported by the mother or family member. Otherwise, Failed (F) was recorded.

The data collected were organized in a database using SPSS 20 software. A new database was prepared based on the nature of the data and the intended objective, which gathered information on each item evaluated and the percentage P or F. Descriptive and inferential statistics were generated. The Kolmogorov-Smirnov test was applied to verify the normality of the sample distribution; the t-test verified the differences between the means of failure by test areas (dependent variable), according to gender (independent variable); and the chi-square verified an association between the number of failures per item in relation to gender. All considered a significance level of 5% (p-value < 0.05).

Results

The sample distribution was considered normal (p-value < 0.001). Of the 318 children, 177 (56%) were boys and 141 (44%) girls, aged between 36 and 48 months, 87% were born at full term. Most families were low-income, with 31% receiving less than one minimum wage (MW), 65% receiving 1-3 MWs, and only 4% had an income above three MWs. Most of the mothers reported 12 years or more of study (40.4%) and performing some regular work (37.3%), while fathers had 9-11 years of schooling (29.8%), mostly performing some informal work (51.4%).

The t-test indicated a significant difference between the genders and the number of failures obtained by children in almost all the areas evaluated by DDST-II, except for the Gross Motor area. In all areas, higher averages were associated with females (Table 2) suggesting better performance of girls.

An attempt was also made to relate the results to other variables, besides the gender, among them mother schooling, father schooling, household income and situation at birth (term or preterm). None of them, however, showed a statistically significant association with the children's failures, so they were omitted from the final results.

A more detailed analysis showed that the rate of failure varied by gender. Table 3 shows the performance of children in each task by area of development evaluated and gender.

In absolute results, there were indications of inferior performance of boys in three of the four areas evaluated and also in most of the cited items (N=19). Girls performed worse than boys in the Gross Motor area items only.

In the Language Area, where both genders showed worse performances, with higher failure rates for boys, the items observed with the highest statistical differences were: "knows two adjectives", "knows four actions" and "understands four prepositions". In the Personal Social and Fine Motor areas, in which boys also had worse performance, the most failed items were "brushes teeth without help" and "indicates the longest line", respectively. In the Gross Motor area, the item with the greatest statistical difference was "hops on one foot".

Discussion

Performance by areas

The results show that girls obtained better performance in three of the areas surveyed (Social, Fine Motor, and Language), and only one area (Gross Motor) showed no statistically significant difference between genders. This data corroborates that found in a preschool study conducted in Cuiabá, pointing out that girls display superior performance in DDST[10]. Andrade and Negreiros[32] also found superior NPMD results in girls in the first two years of life, probably due to the faster myelination of girls' cerebral cortex. Such differentiation was also described using the Alberta Infant Motor Scale, with again a female superiority in the total score and percentile at 14 months[4], as boys showed a greater tendency in suspected developmental delays in areas such as motricity[33-35] and language[36].

However, some studies did not find significant relationships between gender and NPMD delay, in the Social and Language[7] areas and motor performance[37]. Other authors[38] also did not find significant differences comparing gender with overall results of the developmental test. Oliveira et al.[39] showed that boys have more developed global motor skills than girls. Only one study on locomotor performance and early childhood control of objects of premature children suggested impaired development of girls[40].

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Table 2. Performance of boys and girls by area assessed by the TTDD II (N = 318).

	Gender	n	Mean	Standard Deviation	t	p-value
Personal Social	Female	141	5.76	0.542	4.52	< 0.001*
	Male	177	5.41	0.842		
Fine Motor	Female	141	4.58	0.622	2.24	0.020*
	Male	177	4.41	0.718		
Language	Female	141	7.38	1.547	2.63	0.028*
	Male	177	6.87	1.887		
Gross Motor	Female	141	4.67	0.712	-0.20	0.586
	Male	177	4.68	0.639		
Total	Female	141	22.49	2.236	3.58	0.003
	Male	177	21.38	2.804		

Note: Level of significance = 5%.

Table 3. Children's performance (passed, failed) by gender in relation to area.

Area		Item	Did not complete task Failed (%)	Gender ♂♀	
				χ2	p-value
Personal Social	1.	Dresses without help	(♂ 0.6 and ♀ 1.4*)	0.612	0.434
	2.	Brushes teeth without help	(♂ 7.3* and ♀ 0.0)	10.7	0.001*
	3.	Washes hands	(♂ 8.5* and ♀ 3.5)	3.23	0.072
	4.	Names 1 friend	(♂ 25.4* and ♀ 8.5)	3.56	0.081
	5.	Wears shirt	(♂ 16.9* and ♀ 9.9)	3.24	0.072
	6.	Prepares simple snacks	(♂ 0.00 and ♀ 0.00)	-	-
Motor Fino	1.	Mimics vertical line	(♂ 13.6* and ♀ 7.8)	2.65	0.103
	2.	Eight-cube tower	(♂ 24.3* and ♀ 21.3)	0.38	0.534
	3.	Copies a circle	(♂ 13* and ♀ 8.5)	1.61	0.204
	4.	Copies a cross	(♂ 13* and ♀ 8.5)	1.61	0.204
	5.	Shows the longest line	(♂ 13.6* and ♀ 4.3)	0.90	0.013*
Linguagem	1.	Names 4 figures	(♂ 6.8* and ♀ 3.5)	1.62	0.103
	2.	Knows 2 actions	(♂ 6.8* and ♀ 3.5)	0.46	0.498
	3.	Knows 2 adjectives	(♂ 37.3* and ♀ 25.5)	4.97	0.026*
	4.	Names 1 color	(♂ 42.9* and ♀ 38.3)	0.69	0.405
	5.	Counts 1 block	(♂ 33.3* and ♀ 29.1)	0.65	0.417
	6.	Uses 3 objects	(♂ 40.7* and ♀ 33.3)	1.80	0.179
	7.	Knows 4 actions	(♂ 15.8* and ♀ 8.2)	3.88	0.049*
	8.	Speaks 100% clear	(♂ 11.9* and ♀ 9.9)	0.30	0.584
	9.	Understands 4 prepositions	(♂ 11.3* and ♀ 4.3)	5.18	0.023*
Motor Amplo	1.	Jumps	(♂ 1.1 and ♀ 2.8*)	1.23	0.266
	2.	Throws the ball top-down	(♂ 6.2* and ♀ 5.7)	0.41	0.840
	3.	Performs a large jump	(♂ 10.9* and ♀ 7.3)	1.15	0.283
	4.	Balances on one foot for 2 seconds	(♂ 1.8 and ♀ 5.7*)	2.45	0.117
	5.	Hops on one foot	(♂ 2.8 and ♀ 8.5*)	5.014	0.025*

Nota: ♀ = female; ♂ = male; Failed = Did not complete task required; * = Higher percentage of children who did not perform the requested task.

Thus, we find quite controversial research results. Authors differ in attempting to explain the differences in the performance of children of different genders. Such gaps may not be directly associated with the gender variable as an attribute of a biological nature, but to education

historically differentiated according to social expectations of gender and, therefore, the nature of the activities provided, such as games.

Thus, it is accepted that the social roles attributed to each gender differ from birth. Activities such as competition, physical contact and interdependence games requiring strength, endurance, and power, with the predominance of actions involving jumps and races, in larger spaces, are characteristics of boys' games, while girls are stimulated to activities of aesthetic or rhythmic nature, with finer and more controlled movements in smaller spaces[37]. Similar results were obtained for the 7 to 8-year-old age group, when there was a higher preference for toys with mobile components and motor activity in large spaces (for example, balls and cars); and among girls for more static games and more verbal than motor behavior, such as playing with dolls[17]. Thus, the personal and social expectations experienced by the child from birth could direct their behaviors according to the social roles expected for each gender and fit into gender stereotypes (attitudes, skills and personality traits considered appropriate for boys and girls according to the socio-cultural context)[41,42].

From the above, and considering that the DDST-II is a test built from the performance of tasks related to specific skills of each area that includes it, it can be suggested that the performance gaps shown here depict what can be observed in social life. If girls are more stimulated to perform predominantly fine motor and communication skills activities in generally more confined spaces, then it is understandable that they perform better than boys when assessed in these areas.

Percentage of failures per test items

We tried to identify items with more failures by gender in the four areas of the test. As shown in Table 3, the worst-performing items were similar between the two. For girls, the percentage of tasks not performed successfully was lower in Social Personal, Fine Motor, and Language, which assess skills related to fine motor coordination, interaction, and communication. In the Gross Motor area, which evaluates skills such as balance and overall motor coordination, both had a small but slightly higher percentage for girls.

One possible explanation for such diversity is that genders differ in their preferences in daily life. Girls seem to be more interested in social interactions and communication[43], while boys have a greater motor ability to run, jump and slide[39], which justifies the differentiated performance in the test. Gabbard[44] agrees with this data, stating that, in early childhood, boys tend to have a greater ability to run and jump, while girls have greater ease with fine motor skills and balance.

Such skills, or their absence thereof, are likely to be the fruits of stimuli present in children's daily lives. The influence of context and type of task has been discussed, and studies have shown that parents and socializing agents (teachers, caregivers, among others) often induce children to activities considered appropriate for each gender, supporting decisions, classifying toys and games, biological sexual characteristics[16,37].

In addition to differences between genders, the results show the significant number of items in which the children failed, evidencing the need to discuss the overall performance of children. It is worth noting that this study did not aim to analyze the socioeconomic variables impacting children's performance, but since the screening was carried out in the municipal public network of Belém, the studied population was characterized almost exclusively as low income. Thus, it was not possible to show, by statistical regression tests, a possible influence of the socioeconomic factors on the NPMD of the studied children.

Previous research carried out in the same institutions as this study reports that the selection of children for admission to the UEI would be due to the level of social vulnerability of their families, including socioeconomic factors (especially the income of customary caregivers). The author argues that the lack of basic sanitation or drinking water and the poor health conditions of the family and the immediate environment of the child would expose them to diseases, justifying the priority of public services to such a population. Thus, children's overall performance lower than expected for their age group could be directly related to the low socioeconomic level of their families (income, schooling, for example)[13].

The literature indicates that low socioeconomic levels have a direct association with the quality of neuropsychomotor development, pointing out that in addition to biological factors, environmental and socioeconomic conditions can determine NPMD[45] delay. Research seeking to assess the overall motor performance and motor and appendicular motor skills of infants in daycare setting found 30% of suspected cases of global motor delay in at least one of the evaluations performed. Such a result would be justified by the low level of environmental stimulation or the lack of opportunities for the development potential to be achieved[46]. Researchers evaluat-

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ed the impact of poverty on the development of a population of infants, describing that about 20% had a higher frequency of suspected delay in open communication and stemmed from families that belonged to the lower quartile of the socioeconomic level index. According to the authors, maternal and paternal unemployment reduced, respectively, the open communication and cognition scores of the children studied[36].

Unfavorable socioeconomic conditions have a unique impact when experienced in early childhood. Researchers identified a prevalence of 17% suspected delays in the Gross Motor area and its association with neonatal, family and daycare exposure factors in children up to three years old, assisted in public day care centers with disadvantages in children up to 24 months in Locomotion Skills. The risk of gross motor performance delay increased 2.81 times for children from households with monthly income up to R$ 700.00; while the risk of Locomotion Skills delay increased 4.63 times for children of parents with up to eight years of schooling[47]. Veleda et al.[48], using DDST-II, observed that children from households with a lower income, a low weight-for-age index and less than six prenatal care visits had a higher development risk.

Thus, we observe the close relationship between environment and child development, generating a cycle in which several risk factors feedback and have an impact. For example, parents with few years of study have fewer resources to promote the adequate development of their children. Unfavorable conditions are knowingly possibly associated with child development delays, preventing the achievement of maximum potential. To analyze the relationship between neuropsychomotor development and family environment, a study carried out in Belo Horizonte emphasizes that the stimulation by the environment was the variable with the most significant impact in the process, showing that the organization of the physical environment by the parents and their interaction with their children directly influences child development[49].

Some studies highlight that the introduction of children in UEI without adequate physical and professional training structure may put development at risk. Using inappropriate toys for the age group, small physical location, lack of pedagogical guidance and extra-family socialization, and low family socioeconomic conditions are factors that can adversely affect development[46]. A survey of children of different age groups found negative impacts on the development of children from the age of three when the proportion of students per caregivers increases in institutions[7]. In this study, however, it cannot be said that these aspects influenced the results found since they were not evaluated variables. Thus, it is suggested that these aspects be considered in future research with similar objectives, method, and population.

Besides, it is important to highlight that, even without analyses that allow the assertion that the performance of children evaluated in this study relied on the low socioeconomic level of their families, this is a relevant variable when addressing populations covered by public services, as is the case of this research. A more comprehensive and correlational analysis of the variables with a significant influence level on the developmental acquisitions in the researched population would require us to investigate the offered stimuli, the activities performed and other characteristics of the children's upbringing environment. Thus, the lack of information about their development contexts is characterized as a limitation of this study.

Final considerations

The analysis of the results allowed us to understand the essential aspects of the performance of boys and girls who attend the UEIs from their performance in a test that evaluates neuropsychomotor development. The differences show that girls performed better than boys, results that according to the literature may have relied more on the stimuli received in the environment than on biological differences.

We emphasize the importance of understanding the neuropsychomotor development in early childhood, in its various aspects, as this is the basis for the future acquisition of these children. Even when at risk, with the appropriate stimuli, deficiencies can be overcome, and development can occur satisfactorily. In short, the better the quality of the environmental stimulation available to the child, the better its development.

Finally, it is understood that preferences are built, and society tends to help young children follow a socially imposed standard of what it considers right or wrong, acceptable or unacceptable, and ends up opting for patterns of behavior that limit their growth. Thus, it is necessary to promote public policies aimed at guiding parents and educators who are the main stimulators in this first stage of life, so that they become aware of these differences and provide adequate stimuli to the development of all their children's skills.

Collaborations

M Lopes-Silva worked on the research, methods, design and final drafting of this paper. LIC Cavalcante worked on the design and final drafting. S Heumann and TVR Lima worked on the review, editing and final drafting.

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