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ORIGINAL ARTICLE

Assessment of neuropsychomotor development through the application of the Denver II scale in children monitored at a high-risk outpatient clinic

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Child development, Developmental disabilities, Congenital, hereditary, and neonatal diseases and abnormalities. Primary health care.

Abstract

Objectives: the study aims to evaluate the neuropsychomotor development of newborns and infants treated at an outpatient clinic, using the Denver II Developmental Screening Test. **Methods:** this is a cross-sectional, prospective study, carried out through the analysis of medical records and an electronic database, in which 100 patients, being followed up at a risk outpatient clinic in a tertiary hospital, underwent the Developmental Screening Test Denver II Revised ages zero to 6 years old will be assessed. The variables considered for the study will be: gestational age, birth weight, Apgar score, complications and diagnoses in the neonatal period. **Results:** the sample showed that 70 (89.7%) of the participants had a satisfactory result for the Denver test, 5 (6.4%) were classified as doubtful and 3 (3.8%) as problematic. That is, most infants were considered as children who did not present delays. While 100% of the problematic ones had a neurological pathology, this percentage was only 40% among the doubtful ones and 31.4% among those who had a satisfactory result for the Denver test. **Conclusion:** it was observed that there was a high number of children with satisfactory results for the Denver test, concluding that they had good indicators in the first years of life. This condition may be related to the follow-up that children and mothers receive through pediatric outpatient care specializing in preterm infants, since the main objective is to track risks and minimize the negative impact that factors may have on development.

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INTRODUCTION

Child development is a process that begins in the womb and involves several aspects, such as physical growth, neurological maturation, and the development of behavioral skills in the child's cognitive, social, and affective spheres. It enables the gradual increase in the individual's ability to perform increasingly complex functions through the influence of various factors, whether biological or external[1]. The early childhood phase, which extends from zero to five years of age, is decisive for the development of the individual, and this phase depends on genetic, socioeconomic, and environmental factors, as well as external stimuli in the form of daily tasks[2].

Biological factors are those related to pre-, peri-, and postnatal events, such as gestational age, birth weight, possible physical disabilities, the child's general health, and nutritional status. External factors are those related to the child's environment · There is also the possibility that both biological and external factors coexist, causing a cumulative effect that can be either positive or negative for development.

Pinto et al.[2] studied 150 children from São Paulo and observed that the greatest chance of developmental delay was related to the most disadvantaged segment of the population that accumulated several biological risk factors: they were poor, had more than three siblings, were born with low birth weight, had a gestational age of less than 37 weeks, and had received breast milk for less than three months or had not been breastfed at all[2,3].

Regarding external factors, the home environment has been highlighted as fundamental, since the quality and quantity of environmental stimuli present in the family context are indispensable for the overall development of children[4]. Among the methods of assessing child development in Brazil, the application of the Denver Developmental Screening Test (DDST), also known as the Denver test[5] stands out .

In 1990, it was updated and named the Denver Developmental Test-Revised (DDDT-R), better known as Denver II, and now contains 125 items covering motor, language, and psychosocial areas[6]. In 2007, a study conducted in Porto Alegre led to its standardization in Brazil[7]. Thus, it became the most widely used child development assessment test in Brazil[8].

The psychosocial area assesses 25 items, focusing on aspects of intra- and extra-familial socialization. Motor skills are subdivided into fine and gross motor skills, with 29 and 32 items assessed for each skill, respectively. Fine motor skills assess coordination and manipulation of small objects, while gross motor skills assess body motor control. Finally, language skills are analyzed, comprising 39 items focused on the ability to produce and recognize sounds[9].

The aforementioned items are arranged on an identification sheet, which contains a field for indicating the patient's age. A vertical line is drawn across the child's age range, indicating which actions should be performed. The vertical line contains the actions, which are contained in a rectangle divided into two portions: white and gray. The white portion indicates that 25 to 75% of the children will not yet be able to perform the task, while the gray portion indicates that 75 to 90% will be able to perform it[10].

Each item is scored based on observed behavior, as follows: "P" for passed; "F" for failed; "SO" for no opportunity; and "R" for refused. Subsequently, each item is classified as: advanced (passing an item completely to the right of the age line), normal (passing or failing an item between the 25-75% percentages), cautious (failing an item between the 75-90% percentages), or delayed (failing an item to the left of the age line)[11].

The Denver Test should not be used as a diagnostic tool, much less to assess intelligence and developmental quotients. However, it allows us to assess the current state of a child's maturational development[1].

The aim of this study was to evaluate the neuropsychomotor development of children being followed up at a high-risk outpatient clinic in a tertiary hospital through the analysis of the TTDD-R or Denver II Scale in medical records, highlighting the importance of early identification of developmental delays.

METHODS

This is a cross-sectional, analytical study, whose data were obtained from medical records, an electronic database and from the application of the Denver II scale by the authors of the article, during pediatric consultations with patients in a tertiary hospital.

The study included 78 children, aged between 0 and 5 years, treated at a pediatric outpatient clinic of a tertiary referral hospital in the interior of São Paulo, between January and June 2022. The variables collected were chronological age (converted to corrected age), gestational age at birth, birth weight, Apgar scores at 1 and 5 minutes, length of hospital stay (days), duration of oxygen therapy (days), occurrence of cardiorespiratory arrest, and presence of any neurological disease or disorder.

Neuropsychomotor development , the Revised Denver Developmental Test (Denver II Test) was used, which consists of 125 items divided into the areas of development: personal-social, fine-adaptive motor, language and gross motor.

The data were tabulated and analyzed using Excel and R software version 3.3.2 (R Core Team (2016). The values were presented as mean ± standard deviation for normal variables, median (interquartile range) for non-normal variables, and frequencies and percentages for categorical variables. To compare the groups classified according to the Denver II test, the ANOVA test was used for normal variables, the Kruskal-Wallis test for non-normal variables, and the Chi-Square test for categorical variables, considering in all cases a significance level of $\alpha = 5\%$. As a *post-hoc test* for the ANOVA, the Tukey test was used.

The project was submitted for evaluation and approved by the Ethics Committee, in accordance with CONEP Resolution

466/2012. The test was administered to children seen at the clinic during routine childcare. Furthermore, parents or guardians were asked to read and sign the Informed Consent Form (TCLE) for minors.

RESULTS

The observed sample is summarized in Table 1, which displays the TTDD-R results, taking into account chronological age, with a predominance of infants aged 17.5 to 23 months. It also took into account corrected age, gestational age at birth, birth weight, and Apgar score with a minimum of 5 in the first minute and 7 in the fifth minute. In addition, criteria such as longer hospital stay, prolonged duration of oxygen use, episodes of cardiorespiratory arrest, and neurological dysfunction—all factors that are associated with more equivocal or problematic results for the Denver test.

The sample showed that 70 (89.7%) of the participants presented satisfactory results on the Denver test, 5 (6.4%) were classified as doubtful, and 3 (3.8%) as problematic. In other words, most infants were considered children without delays, capable of performing tasks at a younger age than most children. However, they can still exercise a degree of caution, as they may present a doubtful factor in an isolated item. Therefore, items with satisfactory results are not considered for the purpose of interpreting the test as a whole.

Only a minority (3.8%) of the sample fell under "delay", which can be described when the child fails or refuses an item completely to the left of the age line, demonstrating that the child failed or refused an item that 90% of the children in the standardized sample were able to perform at an earlier age than the child being tested.

The average chronological age of the participants was approximately 23 ± 17 months, and the corrected age was approximately 10 ± 7 months. Gestational age at birth was approximately 7 months ± 18.5 days, and birth weight was 1447.6 ± 523.0 grams. Although the sample outcome showed a higher percentage of favorable results, prematurity is known to be a risk factor for delayed fine and gross motor development.

The median Apgar score at 1 minute was 7 (2) points, and at 5 minutes, 9 (1) points. 7.7% of participants suffered cardiorespiratory arrest overall. The mean length of hospital stay was approximately 2 ± 1 month, and the difference in time between individuals who had a problematic result and those who had a satisfactory result in the Denver test was considered significant (p=0.022). In the group considered problematic, the months of hospital stay were on average 3 ± 1.5, while in the satisfactory group, 2 ± 1.

The average oxygen therapy time was 24.1 ± 27.5 days for participants in general, and the differences between the problematic group and the others were considered significant (p<0.001). Among the problematic group, the average oxygen use was 86.0 ± 27.8 days, that is, 63 days more than the doubtful group (23.0 ± 19.3) and 64.4 days more than the satisfactory group (21.6 ± 25.0).

Finally, the differences in the occurrence of neurological pathology were also significant between the groups. While 100% of those with problematic results had neurological pathology, this percentage was only 40% among those with doubtful results and 31.4% among those with satisfactory results on the Denver test.

DISCUSSION

The present study found a prevalence of 3.8% of children with results considered problematic and elucidating some degree of delay, and, satisfactorily, 89.7% of children with adequate development for their age. These results, when

Table 1. General characteristics of the participants, and comparison between the groups according to the results of the Denver test.

Variable	General (n=78)	Denver Test Result			*P*-value
		Satisfactory (n=70)	Doubtful (n=5)	Problematic (n=3)	
Chronological age (days)	694.4 ± 523.3	685.0 ± 542.9	932.8 ± 257.1	517.3 ± 224.1	0.502
Corrected age (days)	297.0 ± 201.5	287.7 ± 200.0	652.0	322.0 ± 131.5	-
Gestational age at birth (days)	218.0 ± 18.5	219.0 ± 16.2	220.0 ± 38.8	193.3 ± 15.9	0.060
Weight (g)	1447.6 ± 523.0	1467.8 ± 518.8	1444.0 ± 665.1	981.7 ± 145.1	0.292
Apgar 1st minute	7 (2)	7 (2)	5 (2)	6 (2)	0.185
Apgar 5th minute	9 (1)	9 (1)	8 (2)	7 (2)	0.221
Length of hospital stay (days)	54.3 ± 32.7	52.4 ± 31.4	51.0 ± 24.6	105.0 ± 44.2	**0.022**[a]
Oxygen therapy time (days)	24.1 ± 27.5	21.6 ± 25.0	23.0 ± 19.3	86.0 ± 27.8	**<0.001**[a,b]
Cardiopulmonary arrest	6 (7.7%)	6 (8.6%)	0 (0.0%)	0 (0.0%)	0.690
Neurological pathology	27 (34.6%)	22 (31.4%)	2 (40.0%)	3 (100.0%)	**0.049**

Note: Values are presented as mean ± standard deviation for normal variables, median (interquartile deviation) for non-normal variables, and frequencies (percentages) for categorical variables. P-value refers to the ANOVA test for normal variables, Kruskal-Wallis test for non-normal variables, and Chi-Square test for categorical variables; in bold when significant (α=5%). Superscript letters refer to multiple comparisons of the Tukey test, where a: significant differences between the problematic and satisfactory groups; b: significant differences between the problematic and doubtful groups.

compared with existing literature, demonstrate a favorable outcome for the population sample evaluated. The study conducted in Paraisópolis, São Paulo, screened 35 children, and the result obtained was "at risk" for 28.6% of them[1]. A very similar result was found in a study conducted in Canoas, Rio Grande do Sul, with 197 children, which demonstrated that 27% of the study population had suspected developmental delay[12].

Current studies highlight the relationship between biological and environmental factors in child development, particularly pre-, peri-, and postnatal care. This allows for a comparison between psychological makeup, prematurity, hospital complications, and organic dysfunctions with motor characteristics and language acquisition[13].

This study considers organic, biological, and environmental factors. The Ministry of Health states that an at-risk newborn is any child who presents at least one of the following criteria: residence in a high-risk area; birth weight less than 2,500g; newborn born before 37 weeks of gestation; Apgar score <7; hospitalization or complication in the maternity ward or newborn care unit; need for special guidance upon discharge from the maternity ward; child of a teenage mother (<18 years of age); mother with low education (≤8 years of schooling); history of death of a child under 5 years of age in the family. Thus, it is observed that the studied sample encompasses at least four risk indicators: prematurity, low birth weight, Apgar score <7, and the need for hospitalization[14].

One of the biological factors most often cited as essential to child development is prematurity. It poses a relatively significant risk for delayed cognitive, language, and motor development, as well as being a marker and determinant of morbidity and mortality in infants. Therefore, it is common for many pediatric health services to have outpatient clinics specifically for prematurity[15].

According to Bortagarai, premature infants weighing less than two kilograms are five times more likely to have motor delays and develop autism spectrum disorder, which constitutes a psychological risk compounded by the environmental risks to which they are exposed: education level, family income, quality of family bonding and interaction, and maternal health. Both of these effects affect psychomotor development, which is exacerbated by prematurity. Hence the need to use developmental scores and scales to identify early signs that detect risks and difficulties based on organic dysfunctions and additional environmental factors[16].

According to the literature, in a sample of 87 infants with hearing loss, the main indicators were: neonatal ICU stay (65.52%), ototoxicity (48.28%), mechanical ventilation (39.66%), and hyperbilirubinemia (46.55%). A correlation between environmental and obstetric factors can be interpreted, with lack of prenatal care, gestational age, low birth weight, and inadequate nutrition predisposing to a greater risk of hearing loss, which indirectly interferes with language acquisition and development. Given these organic conditions and dysfunctions, preterm infants have a higher percentage of risk when compared to full-term infants[17].

Another bias suggests that prematurity acts as an additional risk factor, rather than the primary cause of developmental failure. According to Soares (2017), organic factors significantly interfere with language, motor, and social development, such as the presence of peri-intraventricular hemorrhage (PIVH) and bronchopulmonary dysplasia (BPD). This is in addition to gestational issues. These variables, complications of prematurity, culminate in the greatest and primary risk factor for child developmental delay, as assessed by the Denver test[18].

Thus, it was observed that a high number of children had satisfactory results on the Denver test, concluding that they presented good indicators in the first years of life. This adequate developmental condition in the first year of life for a large portion of the study sample may be related to the monitoring that children and mothers receive through outpatient pediatric care specializing in premature infants, since the main objective is to screen for risks and minimize the negative impact that these factors may have on development.

CONCLUSION

In the population evaluated by this study, there were criteria of the Denver test where the results obtained by the patients resemble those obtained in rich countries where the test is also applied, evidencing good neuropsychomotor development, meeting what was initially expected, due to risk factors associated with prematurity such as low birth weight, perinatal asphyxia, cardiorespiratory arrest, prolonged hospitalization time, prolonged oxygen therapy time, presence of neurological pathologies (seizure, intracranial hemorrhage, meningitis, hydrocephalus, periventricular leukomalacia) and repeated apneas.

However, we should not only consider the positive results and disregard the negative ones, especially if we take into account that this study was conducted with patients from a tertiary hospital that has a specialized outpatient clinic and broad access to infrastructure that, as a rule, is not accessible to the majority of the Brazilian population under the same conditions.

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