Middle Childhood Adverse Psychomotor Outcomes from Malaria in Pregnancy: A Study using the Denver Developmental Screening Test-II

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Abstract

Objective: to evaluate changes in the development of premature children aged 5 to 6 years, born to mothers with malaria during pregnancy and to compare them to a control group of premature children born to mothers who did not have malaria during pregnancy. Methods: cross-sectional and analytical study. The Denver test-II was applied to 20 children in the study group and 20 children in the control group. Results: in the group of premature children of mothers with malaria during pregnancy, the vast majority showed abnormal performance with more significant changes in the activities of the language sector

"define seven words", "say two compound words", "understand four prepositions" and "account five blocks", "knows three adjectives". In the fine-adaptive motor sector, the activities "draw people with six parts", "copy disassembled square", "copy +" and in the gross motor sector "swing your foot for six seconds", "swing your foot for five seconds", "swing the foot for four seconds", "rocks the foot for three seconds", were the most important developmental changes. In the control group, the performance of suspected delay or possible abnormality was more concentrated in the gross motor sector. Conclusions: children from 5 to 6 years of age, born prematurely to mothers with malaria during pregnancy, 80% had suspected abnormal performance, a result much higher than the group of children born prematurely to mothers without malaria. These results strongly suggest that malaria disease during pregnancy alters fetal development, producing developmental sequelae that can be detected even at 5 to 6 years of age. In addition, the results support the use of the Denver test-II as a simple screening method for the assessment of delays in child development, covering broad motor coordination (coarse), fine motor coordination (adaptive), language and personal-social adaptation. This test has been used to identify children who are at risk of developing problems and to monitor the child longitudinally.

Keywords: Developmental changes; Prematurity; Denver test-II; Malaria; Gestation.

I. INTRODUCTION

According to the malaria therapeutic manual of the Ministry of Health of Brazil, in the Brazilian Amazon, infectious diseases, such as malaria, lead to serious complications for the mother-child binomial [1]. Brazil is responsible for one third of the reported cases of malaria. About 40% of the population in more than 90 countries live with the risk of contagious malaria. The occurrence of malaria during pregnancy is common in endemic areas, in the states of Rondônia, Pará, Mato Grosso, Acre and Amazonas, and is an important cause of maternal and fetal morbidity and mortality [2; 3], a fact confirmed by Amado Neto, Henriques [4].

Immune depression of the humoral component in pregnancy associated with other factors (iron deficiency anemia, deficiency of prenatal services, etc.) is related to the increase in clinical manifestations and severity of the disease, as well as the effects on the fetus [5; 6]. As described in the high-risk pregnancy technical manual of the Ministry of Health of Brazil [7], malaria in pregnancy can lead to abortion, prematurity, low weight, megaloblastic anemia, perinatal and maternal mortality. Complications are more important in primigravidae, cases with exacerbated clinical symptoms and elevated parasitemia, especially malaria caused by *Plasmodíum falciparum*, as described in the high-risk pregnancy technical manual of the Ministry of Health of Brazil.

Duffy, Fried [8] in their work "Malaria in pregnancy" consider that the risk of developing severe or complicated malaria is three times higher among pregnant women, especially if they are primigravidae and / or those coming from areas with hyperendemic or unstable transmission. For the Brazilian Ministry of Health's Malaria Epidemiological Surveillance Information System [9], indigenous women from holoememic areas acquire a considerable degree of partial immunity against malaria. At the beginning of pregnancy, however, their immunity level is reduced, the effect being more pronounced in primiparous than in multiparous women. Severe forms of the disease are more frequent in individuals not exposed to

infection or coming from areas that are not infected, in addition to being associated with the virulence of the parasite strain.

Simões study [5] found the highest incidence of pregnant women who became infected with *Plamodium vivax* in the first trimester of pregnancy. Espinosa [10] in studying patients from the Institute of Tropical Medicine of Amazonas with malaria during pregnancy and Singh, Mehra, Srivastava [11] in a survey "Malaria during pregnancy and infancy, in an area of intense malaria transmission in central India", found results similar to that of Simões carried out in Rondônia [5]. Moorman, Sullivan, Rochford et al [12] in "Retraso del intrauterino crecimiento as a result of malaria" confirm that in places of high endemicity, infection in advanced stage of pregnancy is associated with intrauterine growth restriction and low weight to born.

In the study by Simões [5] it was observed that children born to mothers who contracted malaria during pregnancy, had complications during delivery, such as fetal distress, meconium aspiration, cerebral anoxia, obtained rates of 52.95%, 42.85%, 52.63% in the years 2001, 2002 and 2003, respectively. One must always consider the importance of associating factors such as postnatal complications, Apgar score below seven in the 5th minute, numbers of complications and / or neonatal complications, such as asphyxia, cyanosis, pallor, severe jaundice, seizures, infections, use of oxygen therapy, blood transfusion and the need for phototherapy, suction problems, which contribute to a deficit in the development of these preterm newborns [13]. In the study by Simões [5] and Simões, Tomaz [6], the children studied presented complications shortly after delivery, such as respiratory distress, infant respiratory distress syndrome, jaundice, anemia, pneumonia and changes in the DNPM.

The risks for delay in the DNPM are associated with several factors classified as biological, social and environmental. The sum of several risk factors increases the likelihood of impaired child development [14]. In order to detect changes in neuro-sensory-motor development early, several instruments have been used to assess development in the first year of life [15]. In this period, motor development presents an accelerated pace of changes that culminate in mobility functions, with the acquisition of crawling and independent walking, respectively at 9 and 12 months of age, as concluded by Mancini, Teixeira, Araújo et al [16] in study of the development of motor function at 8 and 12 months of age in children born preterm and at term.

Children living in developing countries are exposed to several risks, including that of having a high prevalence of diseases that interfere with neuropsychomotor development (DNPM), that of being born from unfavorable and / or incomplete pregnancies and that of living in conditions adverse socioeconomic conditions. Pilz, Schermann [17] in their study of biological and environmental determinants of neuropsychomotor development in a sample of children from Canoas in Rio Grande do Sul, state that such a chain of negative events makes these children more likely to have delays in their potential growth and development.

In the study of prematurity, risk and developmental protection mechanism, Linhares [18] demonstrates that in the broad set of risk factors in childhood, the birth of preterm newborns (gestational age below 37 weeks) influencing development has been highlighted and child learning. The impact of biological, psychosocial (individual and family) and environmental factors on child development has been

the subject of numerous studies in recent decades, such as the study on risk factors for suspected delayed neuropsychomotor development by Halpern et al [19].

It is the biological or environmental conditions that increase the likelihood of deficits in the child's neuropsychomotor development. Miranda, Reseque, Figueiras [20] when studying children and adolescents with developmental problems in the pediatric outpatient clinic, claim that among the biological risk factors (prenatal, perinatal, postnatal) malaria was detected during pregnancy, complicating with prematurity, low birth weight.

Simões [5] observed in his study the prevalence of delayed learning development, delayed motor development and delayed neuropsychomotor development. In a broader study on risk factors for developmental changes, Simões [5] observed a higher incidence of premature children associated with chronic childhood encephalopathy, children with delayed motor development, delayed neuropsychomotor development, delayed learning development, myelomeningocele and Down syndrome. Meanwhile, authors such as Gristão, Martins [21] considering the adverse conditions in the lives of children with developmental delay, separate the so-called established risks from biological ones, referring to defined medical disorders, such as innate metabolism errors, congenital malformations, Down's Syndrome and other genetic syndromes.

For Simões [5] and Simões, Tomaz [6] knowledge of morbidity and mortality is essential to guide important decisions related to perinatal care, parental counseling and the forecast of the need for health services. The precise obstetric estimate of gestational age (based on the date of the last menstrual period and early clinical, laboratory and ultrasound examination of the pregnant woman) seems to be better than birth weight to assess the evolution of preterm infants. On this topic, Goulart [22] in his work assisting preterm newborns comes to the conclusion that it is still difficult to obtain accurate information about gestational age, and most survival statistics are related to birth weight.

Several studies show that the survival of extremely low birth weight preterm infants (BPH) is a reality that needs to be improved. Msall, Tremont [23] published a study showing results with groups of very low birth weight newborns (RNMBP), from 1,001 to 1,500 g, who had a survival rate of 93%, newborns weighing between 751 and 1. 000 g with 85%, and among NBs from 501 to 750 g, 50% survived. These authors make a warning. Surviving RNMBP have cerebral palsy (CP) in about 5 to 15% of cases, and 25 to 50% exhibit minor motor impairments; they may also have cognitive, behavioral deficits and disorders at school.

Inder, Volpe [24] observed long-term attention deficits, hyperactivity and psychiatric disorders in adolescence in 25 to 30% of patients. Other researchers presented the results of their work, such as Halpern et al [19]; Carter [25]; Wedge [26]; Spallici, Chiea, Zugaib et al [27]. These same authors demonstrated the significance of birth weight in motor development. Silva, Ceu, Silva [28] conducted a study using a sensorimotor stimulation protocol applied to premature infants with delayed DNPM.

The aim of this study was to evaluate possible changes in the neuropsychomotor development of children aged 5 to 6 years, born prematurely to mothers with malaria during gestation, in Porto Velho, Rondônia, Brazilian Amazon and to compare them to a control group of children premature infants born to mothers who did not have malaria during pregnancy using the Denver Test-II as a screening instrument.

II. METHODS

This is an epidemiological cross-sectional analytical study of 20 children aged 5 to 6 years old, born from premature births, mothers who had malaria during pregnancy, users of the Brazilian Unified Health System - SUS, followed up in a Polyclinic, Service of State Reference for Medical Specialties, in Porto Velho - Rondônia, Brazilian Amazon and in 20 children born prematurely to a mother without malaria.

Sample Features

Of the total of 62 children born prematurely to mothers who had malaria during the gestational period over a period of approximately 3 years, the sample consisted of 20 children aged 5 to 6 years. The Denver II test was applied to these children in the sample. The same test was applied to a control group of 20 (twenty) children, born prematurely to mothers who did not have malaria during pregnancy, called according to Vieira [29] as a convenience sample.

Inclusion, Exclusion Criteria and Ethical Aspects

Inclusion criteria were children born of premature births to mothers with malaria during pregnancy and who were 5 to 6 years old at the time of application of the Denver II Test and a control group of premature children whose mothers did not have malaria during pregnancy and that they were 5 to 6 years old and that the mothers accepted to participate in the research. There is no exclusion because all mothers, after signing the Free and Informed Consent Form, agreed to participate in the research. The study is based on what advocates resolution 196/96 of the National Health Council of Brazil, which establishes rules for conducting research involving human beings, pointing out the four basic references of bioethics: autonomy, non-maleficence, beneficence and justice, which aims to guarantee the rights and duties, with respect to the scientific community, to the subjects of research and study. The execution of the research was authorized by the Directorate General of HBAP; the research project was approved by the Ethics and Research Committee and a free and informed consent form was requested from the mothers to participate in the research.

Data Collection and Procedures

The Denver II Test was applied to premature children aged 5 to 6 years old, born to mothers with malaria during pregnancy and to a control group of premature children whose mothers did not present malaria during pregnancy, who are being followed up at POC. When applying the Denver II Test in children, the post-conception age was considered and not the corrected age, as it is a more sensitive indicator of abnormality, since in premature infants there is a difference in the results if the corrected or chronological age is used according to authors Silva, Ceu, Silva [28].

The screening test that was applied was that of Denver II, translated into Portuguese, which is used in children from fifteen days of age to six years of age, which aims at the early detection of any possible deviation in the DNPM and being used to monitor the development of all children, whether at risk or not. The test consists of 125 items, which are divided into four groups: a) Personal-social: aspects of the child's socialization inside and outside the family environment; b) Adaptive motor: eye-hand coordination,

manipulation of small objects; c) Language: sound production, ability to recognize, understand and use language and d) Gross motor: body motor control, sitting, walking, jumping and all other movements performed by the broad musculature.

The 26/125 items referring to the assessment of children aged 5 to 6.1 years were used, five from the personal-social domain / sector, seven from the fine-adaptive motor domain / sector, eight from the language domain / sector and six of the gross motor domain / sector:

• Domain / personal-social sector: “put on a t-shirt”, “wear without help”, “play cards”, “brush my teeth without help”, “prepare food”.

• Domain / Thin motor sector - adaptive “copy circles”, “draw people with 3 parts”, “copy cross”, “take longer line”, “copy square with help”, “draw person with six parts”, “copy square without help”.

• Domain / Language sector: “understandable speech”, “understands four prepositions”, “names four colors”, “defines five words”, “knows three adjectives”, “counts five blocks”, “says two compound words”, “defines seven words".

• Domain / Large motor sector: “jumps with one leg”, “rocks your foot for three seconds”, “rocks your foot for four seconds”, “rocks your foot for five seconds”, “toe-toe”, “swing your foot for six seconds”.

Children were assessed individually in groups of five children, depending on the result of the first assessment, the children who obtained a result as "questionable" or "abnormal", was / were reassessed one by two weeks after.

In the application of the Denver II Test, a line was designated as the age line that intercepted all the tests that should be performed by the child. Age was calculated using the difference between the date of the exam and the date of birth. Decimal age in years was used.

Each item or test was represented by a rectangle whose left limit corresponded to the 25th percentile (p25), that is, the age at which 25% of children in Denver, Colorado, United States, took that test and the right, the p90, that is, the age at which 90% of children were successful in that test. The Denver II: a major revision and restandardization of the Denver developmental screening test, authored by Frankenburg, Dodds, Archer, et al [30] was the benchmark where p90 was the cutoff point used in the Denver II Test for define: (1) delay - when the child failed an item or test, which was completely to the left of the age line, that is, in addition to the p90; (2) caution or attention - when the child failed a test that was intercepted by the age line between p75 and p90 (inclusive); (3) passes - when the child successfully performed the test.

The performance classification was made according to the number of failures (delay and caution) and this was considered as: (1) abnormal - when the evaluated child had two or more delays regardless of the area or sector; (2) questionable - when the evaluated child presented only one delay or two or more cautions; (3) normal - when the evaluated child had no delay and at most caution. The results obtained: normal, caution or delay were grouped into normal (normal) and delay (caution and / or delay), according to Frankenburg, Dodds, Archer et al [31].

Data analysis

The collected data were compiled into spreadsheets using the CALC Program of the Br Office, to proceed with the descriptive analysis of the data, presenting them in the form of tables. For statistical analysis, the Statistical Package for the Social Sciences (SPSS) 13.0 for Windows (SPSS Inc., Chicago,

United States) programs was used. The statistical methodology adopted was: tabular presentation standards - IBGE, graphical representation, trend measures central and dispersion, non-parametric statistics (chi-square test).

III. RESULTS

The Denver II Test was applied to 40 premature children aged 5 to 6 years, born in 2013/2014 year at HBAP and assisted by POC, with 20 (twenty) premature children of mothers with malaria during pregnancy, where the vast majority obtained abnormal performance, that is, 80% of the children presented abnormal performance and 20% performed with caution. In the control group of 20 (twenty) premature children born to mothers who did not have malaria during pregnancy, the majority had an abnormal performance in 45%. In the control group, 45% of the children showed abnormal performance and 45% were cautious. (Table 1).

Table 1 - Distribution of the performance evaluation of premature children born to mothers with malaria during pregnancy and to mothers without malaria during pregnancy, using the Denver II Test, according to gender, who were born in the years 2013/2014 at HBAP, in Porto Velho - RO.

	Premature children born to mothers with malaria during pregnancy				Premature children born to mothers without malaria during pregnancy			
	Female		Male		Female		Male	
Teste de Denver II	N	%	N	%	N	%	N	%
Abnormal	8	40.00	8	40.00	4	20.00	5	25.00
Normal					2	10.00		
Caution	2	10.00	2	10.00	4	20.00	5	25.00
	0.25*				0.25*			

*P-Value of the non-parametric Chi-square test.

Source: POC. Search result.

The performance of premature children born to mothers with malaria during pregnancy showed statistically significant differences in the four domains evaluated. In the Personal-Social Domain / Sector in the item "prepares food" 10 (50%) children obtained results of caution and 10 (50%) of delay, in the item "brush your teeth without help" 15 (75%) were cautious and 5 (25%) children were late, in the item “playing cards” 5 (25%) children were cautious and 15 (75%) children were late, in the item “clothes without help” 12 (60%) were cautious and 8 (40%) were late and in the item “put on a shirt” 12 (60%) were cautious and 8 (40.00%) were late. (Table 2).

In the performance of the Adaptive Fine Motor Domain / Sector, the following findings were found: item “square copy” 9 (45%) children were normal, 2 (10%) cautious and 9 (45%) delayed, in the item “draws people with six parts ”5 (25%) children showed normal and 12 (60%) delayed, in the item“ copied square disassembled ”5 (25%) children showed normal and 12 (60%) delayed, in the item“ take a longer line ”13 (65%) children showed normal and 6 (30%) delayed, in the item“ copy + ”9 (45%) children showed normal and 11 (55%) showed delay, in the item“ draws people with three parts ”9 (45%) children showed normal and 9 (45%) showed delay, in the item “copy circle” 11 (55%) children showed normal and 9 (45%) delayed. (Table 2).

The performance of premature children born to mothers with malaria during pregnancy in the Domain / Language Sector presented in the item “define seven words” 9 (45%) children were cautious and 10 (50%) children were delayed, in the item “says 2 compound words ”8 (40%) children were cautious and 10 (50%) were late, in the item“ count five blocks ”10 (50%) children were cautious and 10 (50%) were late, the item“ knows three adjectives ”9 (45%) children were cautious and 11 (55%) were late, in the item “define five words” 7 (35%) children were cautious and 9 (45%) children were late, in the item “names four colors” 9 (45%) children were cautious and 9 (45%) children were late, in the item “understands four prepositions” 10 (50%) children were cautious and 10 (50%) were late, in the item “everything talks understandable” 10 (50 %) children were cautious and 7 (35%) delayed. (Table 2).

In the Gross Motor Domain / Sector the following results were found. In the item “rocks the foot for six seconds” 15 (75%) children were delayed, in the item “rocked the foot for five seconds” 14 (70%) children were delayed, the same value was found in the item “rocks the foot by four seconds ”, in the item“ rocks the foot for three seconds ”5 (25%) children presented normal and 10 (50%) delayed, in the item“ toe-toe walking ”9 (45%) children presented normal and 9 (45 %) delay and in the item “jump with one foot” 7 (35%) children were normal and 9 (45%) delayed. (Table 2).

Table 2 - Performance of premature children born to mothers with malaria during pregnancy in the four sectors of the Denver II Test, which were born in 2013/2014 at HBAP, in Porto Velho - RO.

	NORMAL		CAUTION		DELAY	
Personal-Social	N	%	N	%	N	%
Prepares food	0	0.00	10	50.00	10	50.00
Brush teeth without help	0	0.00	15	75.00	5	25.00
Play Cards	0	0.00	5	25.00	15	75.00
Vest without help	0	0,00	12	60.00	8	40.00
Put on a shirt	0	0.00	12	60.00	8	40.00
Fine Motor - Adaptive Copy						
Copy " Square "	9	45.00	2	10.00	9	45.00
Draw people with 6 parts	5	25.00	3	15.00	12	60.00
Copy disassembled Square	5	25.00	3	15.00	12	60.00

Take a longer line	13	65.00	1	5.00	6	30.00
Copy +	9	45.00	0	0.00	11	55.00
Draw people with 3 parts	9	45.00	2	10.00	9	45.00
Copy Circle	11	55.00	0	0.00	9	45.00
Language						
Defines 7 words	1	5.00	9	45.00	10	50,00
Says 2 compound words	2	10.00	8	40.00	10	50.00
Account 5 blocks	0	0,00	10	50.00	10	50.00
Knows 3 adjectives	0	0,00	9	45.00	11	55.00
Defines 5 words	4	20.00	7	35.00	9	45.00
Name 4 colors	2	10.00	9	45.00	9	45.00
Understands 4 prepositions	0	0,00	10	50.00	10	50.00
Speak everything understandable	3	15.00	10	50.00	7	35.00
Thick Motor						
Balance the foot for 6s	2	10.00	3	15.00	15	75.00
Toe-toe walking	9	45.00	2	10.00	9	45.00
Balance the foot for 5s	2	10.00	4	20.00	14	70.00
Balance the foot for 4s	3	15.00	3	15.00	14	70.00
Balance the foot for 3s	5	25.00	5	25.00	10	50.00
Skip with 1 foot	7	35.00	4	20.00	9	45.00

Source: POC / 2013-2014. Search result.

The performance of premature children born to mothers without malaria during pregnancy showed the following domains or sectors evaluated: in the Personal-Social Domain in the item "prepare food" 50% with caution and 50% with delay, in the item "brush your teeth without help" 12 (60%) were cautious and 3 (25%) children were late, in the item “playing cards” 11 (55%) children were late, in the item “clothes without help” 13 (65%) children were cautious and 4 (20 %) delay, in the item “put on a shirt” 14 (70%) children were cautious. (Table 3).

In the Fine-Adaptive Motor Domain item “copy square without help” 10 (50%) children were cautious and 9 (45%) children were late, in the item “draw people with 6 parts” 10 (50%) children were cautious and 9 (45%) were late, the same values were found in the item “draw people with six parts”, in the item “copy square with help” 10 (50%) children were normal, 5 (25%) cautious and 5 (25%) children were late, in the item “take a longer line” 10 (50%) children were cautious and 7 (35%) normal, in the item “copy +” 10 (50%) children were normal and 5 (25%) cautious , in the item “draws people with 3 parts” 8 (40%) showed normal, 6 (30%) caution and 6 (30%) delayed, in the item “copia cirulo” 10 (50%) children showed normal and 5 (25 %) presented caution and delay respectively. (Table 3).

In the Language Domain item “define 7 words” 8 (40%) children have normal and 10 (50%) were cautious, in the item “says 2 compound words” 13 (65%) were cautious, in the item “count 5 blocks” 15 (75%) children presented normal, in the item "knows 3 adjectives" 11 (55%) children presented normal and 7 (35%) caution, in the item "define 5 words" 15 (75%) children presented normal, the same values evaluated in the item “names 4 colors”, in the items “understands 4 prepositions” and “speaks everything understandable” 8 (40%) children were normal and 11 (55%) were cautious.

In the Motor Gross Domain, the results presented were as follows: item “rocks the foot for 6 seconds” 13 (65%) children were delayed and 5 (25%) caution, in the item “rocks the foot for 5 seconds” 10 (50%) children were late and 6 (30%) cautious, in the item “swing your foot for 4 seconds” 9 (45%) children were late and 6 (30%) cautious, in the item “swing your foot for 3 seconds” 8 (40%) were late and 6 (30%) cautious, in the item “toe-heel walking” 11 (55%) children were late and 5 (25%) cautious, in the item “jumps with one leg” 16 (80%) children were late.

Table 3 - Performance of premature children born to mothers without malaria during pregnancy in the four sectors of the Denver II Test, who were born in the years 2013/2014 at HBAP, in Porto Velho - RO

	NORMAL		CAUTION		DELAY	
Personal-Social	N	%	N	%	N	%
Prepares food	0	0.00	10	50.00	10	50.00
Brush the teeth without help	3	15.00	12	60.00	5	25.00
Play Cards	5	25.00	4	20.00	11	55.00
Vest without help	3	15.00	13	65.00	4	20.00
Put on a t-shirt	3	15.00	14	70.00	3	15.00
Motor Fino – Adaptativo						
Copy "Square" without help	1	5.00	10	50.00	9	45.00
Draw people with 6 parts	1	5.00	10	50.00	9	45.00
Copy "Square" with help	10	50.00	5	25.00	5	25.00
Take a longer line	7	35.00	10	50.00	3	15.00
Copy +	10	50.00	5	25.00	5	25.00
Draw people with 3 parts	8	40.00	6	30.00	6	30.00
Copy "Circle"	10	50.00	5	25.00	5	25.00
Language						
Defines 7 words	8	40.00	10	50.00	2	10.00
Says 2 compound words	5	25.00	13	65.00	2	10.00
Account 5 blocks	15	75.00	3	15.00	2	10.00
Meet 3 adjectives	11	55.00	7	35.00	2	10.00
Defines 5 words	15	75.00	3	15.00	2	10.00
Name 4 colors	15	75.00	3	15.00	2	10.00

Understands 4 prepositions	8	40.00	11	55.00	1	5.00
Speak everything understandable	8	40.00	11	55.00	1	5.00
Thick Motor						
Balance the foot for 6s	2	10.00	5	25.00	13	65.00
Toe-toe walking	4	20.00	5	25.00	11	55.00
Balance the foot for 5s	4	20.00	5	25.00	10	50.00
Balance the foot for 4s	5	25.00	6	30.00	9	45.00
Balance the foot for3s	6	35.00	6	35.00	8	40.00
Jump with one leg only	3	15.00	1	5.00	16	80.00

Source: POC / 2013-2014. Search result.

IV. DISCUSSION

4.1 Application of the Denver II Test to Premature Mothers with Malaria in Pregnancy

The Denver II test according to Pena [32] is the most suitable instrument to perform an early assessment of neuropsychomotor development in low birth weight preterm newborns. This same author argues that the Denver II Test is more for the purpose of screening and not to diagnose developmental abnormalities and that it can be applied to children from 15 days to 6 years of age. For Caon, Ries [33] the Denver II Test should be used to identify children who are at risk of developing problems and to monitor the child longitudinally. They confirmed their understanding with the study of screening motor development in the first two of life.

In our study, we did not seek to assess children as to gender. In other studies such as the "Development of children attended at the pediatric hospital of the federal university of Rio Grande do Norte in the first year of life through the Denver II", Cunha [26] and Rezende, Costa, Pontes [34] where no relationship was found between genders. However, other studies have shown different results such as the "Turkish children's performance on Denver II: effect of sex and mother's education" by Durmazlar, Ozturk, Ural, et al [35].

Premature children born to mothers with malaria showed suspicion of delay or abnormality in 50% of children and 50% were cautious in the personal-social domain / sector in the item "prepares food" in agreement with other studies such as (93). In "brush your teeth without help" 75% of the children were cautious and 25% late, the item "playing cards" is quite significant with 75% of the children with delay or abnormality, "wear without help" 60% were cautious and 40% delay, and in the item "put a shirt on" 60% were cautious and 40% late. These findings are in agreement with Souza et al [36] who reports that the activity "prepares food" is important to stimulate and develop skills to meet basic needs such as eating and drinking, in addition to learning the use of utensils such as glass, spoon, plate , providing the incorporation

of healthy practices of body hygiene, food, and mainly stimulating motor coordination. Simões [5] in a research at the same health unit found a delay in 42.11% of children in the activity "prepares food", 15.79 in the activity "brush your teeth without help", 68.42 in the activity "play cards". Similar results to those found in the current research.

The performance of premature children born to mothers with malaria during pregnancy in the Language Domain / Sector showed a 50% delay in the items "define seven words", "says 2 compound words", "counts five blocks" and "understands four prepositions". In the item "knows three adjectives" 55% of the children were late, in the items "define five words" and "name four colors", 45% of the children were late. These results differ from those found by Simões [5]. In Simões' survey, 36.84% of delay was found in “define 7 words”, “count 5 blocks”, “know 3 adjectives”, “define 5 words” and “understand 4 prepositions”, 42.11% delay in “Says 2 compound words” and “names 4 colors”. In the item “says everything understandable”, 47.37% of children with delay or abnormality were found.

In the performance of the Adaptive Fine Motor Domain / Sector, 45% of children in the item “square copy” were late and 60% were late in the items “draws people with six parts” and “copied square disassembled” In the item “copy +” 55% of children were late. Simões [5] also found inferior results in the activities “copy square” and “copy square disassembled” with 31.58% of children showing delay.

The children showed significant delay in the item "shakes their feet for six seconds" with 75% of children with abnormality or delay, 70% in the item "shakes their feet for five seconds", 70% in the item "shakes their feet for four seconds" and a 50% delay in the item “balance your foot for three seconds”. In the gross motor domain, Simões's work [5] also diverges mainly in the activities of "swing your foot for six seconds", "swing your foot for four seconds" and "swing your foot for three seconds".

In personal-social and language skills, as in other areas of development, children depend on the opportunities offered by the environment to fully develop their genetic heritage. Shore [37], when studying the new views on brain development, states that the development of personal-social skills is a product of its interaction with the environment, constituting the so-called interactionism. When evaluating language and personal-social skills through the Denver II Test in early childhood education institutions, Rezende, Beteli, Santos [38] concluded that in the personal-social area, the achievement of the child's independence is valued in order to carry out daily tasks and important, for example, how to wash your hands, eat and brush your teeth.

In the current study, it was found that the area of language was severely impaired, with a higher occurrence of “delays” and “cautions”, similar to other studies. The studies by Rezende, Costa, Pontes “Screening for neuropsychomotor development in early childhood education institutions according to the Denver II Test [34] and “Evaluation of the performance of a group of children assisted in daycare centers using the Denver II Screening Test” designed by de Souza, Siqueira [39] corroborate our findings.

The study “Motor skills of children from 0 to 3 years old who attend daycare centers, according to the Denver II Developmental Screening Test by the authors Rezende et al [40] and“ Prevalence of idiopathic speech and language disorders in children of one to eleven years of age ”by Andrade [41], both devolved with children in daycare centers also highlight the persistence of deficiencies in the area of language and in the personal-social domain, which are accentuated from the age of three deity. This

situation is justified according to these same authors, due to the neurophysiological immaturity for the acquisition and mastery of language and the social stimuli, essential for linguistic patterns to develop.

Moraes et al [42] clarify that as a child is very dependent on others for the development of this skill, it would be important to advise parents on the need to monitor their child's activities and use strategies that encourage their verbalization, how to speak slowly and articulate, sing songs, read children's stories, among others. For Biscegli et al [43] in the persistence of "risk" tests, the possibility of referring the child to specialized professionals (speech therapist, psychologist, otorhinolaryngologist, among others) should be evaluated. Moraes et al [42] corroborate advising that it should be referred to health professionals from different specializations in order to identify other factors related to this insufficient performance, such as, for example, hearing deficits or emotional problems.

4.2 Application of the Denver II Test to Premature Mothers without Malaria in Pregnancy

The performance of premature children born to mothers without malaria during pregnancy in the personal-social domain showed in the activity "prepares food" 50% of children with delay, "brush their teeth without help" 60% with caution, "play cards" 55% delay , "Wears without help" 65% children were cautious and "put on a shirt" 70% cautious. Regarding the personal-social domain or sector, Simões [5] and Simões, Tomaz [6] found similar results. In the activity "preparing food" 42.11% were late and 57.89% cautious, in the activities "brushing your teeth without help" 73.68% of the children were cautious, "playing cards" 57.89% late, "dressing without help "73.68% caution and," put on a shirt "73.68% caution.

In the activity "copy square without help" 50% of the children were cautious and 45% delayed, "draws people with 6 parts" 50% cautious and 45% delayed, "draws people with six parts", 50% cautious and 45% delayed, "Take a longer line" 50% caution. Similar values were found by Simões [5], Simões, Tomaz [6] where in the activity "copy square without help" 57.89% were cautious and 42.11 delayed, "draws people with 6 parts" 52.63% cautious and 47.37% delay, "take a longer line" 57.89% were cautious. In the activity "define 7 words" 50% of the children evaluated were cautious, "says 2 compound words" 65% cautious, "understands 4 prepositions" and "says everything understandable" 55% were cautious. Simões [5] found results in agreement: in the activity "define 7 words" 57.89% of the children evaluated were cautious, "says 2 compound words" 63.16% cautious, "understands 4 prepositions" and "speaks everything understandable" 57,89% caution.

In the "swing your foot for 6 seconds" activity 65% of the children evaluated were delayed, "swing their foot for 5 seconds" 50% were delayed, "toe-toe walking" 55% were delayed and "jumped with one leg" 80 % delay or abnormality. These results are not in agreement with those found with Simões [5].

Several studies on assessing the development of premature children using the Denver II Test, however, according to Halpern, Barros, Horta [44], the Denver Test is a screening test, where the developmental delay found must be confirmed through tests specific tests performed through systematic follow-up, especially in premature children who are more susceptible to greater changes.

The most important references on the Denver II Test are exactly the works Denver II Technical Manual, by Frankenburg, Dodds, Archer [45], DENVER II: training manual by Frankenburg, Dodds,

Archer et al [31] and The Denver II: a major revision and restandardization of the Denver developmental screening test, by Frankenburg, Dodds, Archer et al [30].

The Denver II Test should be used to identify children who are vulnerable to delayed neuropsychomotor development and to monitor it longitudinally. The Denver II test was used in important studies, such as Brêtas, Silva, Silva [46]; Beteli [47]; Bateli [48]; Moraes et al (42); Magalhães et al [49].

With regard to the personal-social domain / sector, Halpern, Barros, Horta [44] question the neuropsychomotor development from the differentials according to birth weight. Caon, Ries [33] found different development in children in the first two years of life. Drachler [50] measuring child development in epidemiological studies identified the underlying difficulties of the children studied, while Barros [51] points out that activities in this sector are risk factors for delayed neuropsychomotor development.

As for language development, Lordelo [52] reports that, as a cognitive and communicative function, language presents its stimulated aspects in social relationships and the way the child interacts with his environment and the quality of the information he receives are important factors for this domain. This study corroborates the publication "Infection an preterm birth: epidemiological and biochemical linkage" [53]; "Language and social skills of children aged 0 to 3 years cared for in daycare centers" [54]; "Language acquisition: considerations from the perspective of social interaction" [55].

Manoel [56] in relation to the fine-adaptive motor sector, reports that the development of the motor depends on a set of factors that involve the task, the environment and the organism. It also states that some stimuli can facilitate the acquisition of these skills (fine motor), however the biological factors (prematurity) can, with greater influence, limit their development. Souza, Gomes, Cambraia et al [57] found suspicion of delay in the area of motor skills, in the motor-fine domain in children, where some revealed the occurrence of prematurity and other gestational complications (arterial hypertension, premature rupture of membranes and infection). Caon, Ries [33] found children who had a suspicion of delay in the area of fine motor skills, however, some also with questionable development in gross motor skills.

The research "Early Delay in Motor Development" by Benner [58] states that normal variations are more typical in the context of gross motor development and that it is less affected by environmental factors, being strongly conditioned by family characteristics, which corroborates the findings of this research. Studies by Rugolo [59], Murphy, Such-Neibar [60], Morton [61] report that around 30% of premature children develop with severe motor damage and are frequently diagnosed as brain paralyzed and that the rates neuromotor disorders can reach 50% in premature children of very low weight and extremely low weight.

By analogy, the study sought confirmation with important studies already carried out. Among them, the authors [56]; [62]; [63]; [64]; [65]; [66]; [67].

4.3 Main Differences Found

In Table 1 we present the main differences that we observed in the application of the Denver II Test in premature children born to mothers with malaria during pregnancy and in children whose mothers did not present malaria during pregnancy.

Table 1 - Main differences observed in the Denver II Test in premature children born to mothers with malaria during pregnancy and in premature children born to mothers without malaria during pregnancy.

Sector	Premature children of mothers with malaria during pregnancy	Premature children of mothers without malaria during pregnancy
Personal-social	↑↓ "prepares food" ↑ "brush your teeth without help" ↓ "play cards" ↑ "wear without help" ↑ "put on t-shirt"	↑↓ "prepares food" ↑ "brush your teeth without help" ↓ "play cards" ↑ "wear without help" ↑ "put on t-shirt"
Fine-adaptive engine	↓ "copy square without help" ↓ "draw people with 6 parts" ↓ "copy unmounted square" ↓ "copy +" ↓ "draws a person with 3 parts" ↓ "copy circle"	↑ "copy square without help" ↑ "draw people with 6 parts" ↑ "take a longer line"
Language	↓ "define 7 words" ↓ "says 2 compound words" ↑↓ "count five blocks" ↓ "knows 3 adjectives" ↓ "define 5 words" ↓↑ "name 4 colors" ↓↑ "understands 4 prepositions" ↑ "speak everything understandable"	↑ "define 7 words" ↑ "says 2 compound words" ↑ "knows 3 adjectives" ↑ "speak everything understandable"
Thick motor	↓ "swing the foot for 6s" ↓ "swing the foot for 5s" ↓ "swing the foot for 4s" ↓ "swing the foot for 3s"	↓ "swing the foot for 6s" ↓ "swing the foot for 5s" ↓"swing the foot for 4s" ↓ "swing the foot for 3s"

↓ “jump with one foot” ↓ “jump with one foot”

Note: Summary of items that have statistically significant differences. Where ↑ indicates a higher percentage of caution and ↓ a higher percentage of delay in the children in this study.

V. CONCLUSIONS

Malaria infection during pregnancy in Rondônia, the Brazilian Amazon, led to the occurrence of premature births with results superior to those seen in the Brazilian literature. Of the children aged 5 to 6 years old, born prematurely to mothers with malaria during pregnancy, 80% showed abnormal performance, a result much higher than the group of children born prematurely to mothers without malaria. In the control group, 45% of the children showed abnormal performance and 45% were cautious.

The Denver II Test contributed to the detection of developmental changes and probable delay or abnormality in the language sector, fine-adaptive motor and large motor. The most significant changes in the performance of the activities of the domain or language sector were "define seven words", "says 2 compound words", "understands four prepositions" and "counts five blocks" with 50% abnormality, "knows three adjectives" with 55% delay or abnormality. In the fine-adaptive motor sector, the activities evaluated that showed changes suspected of delay or abnormality greater than 50% were, “draws people with six parts”, “copied square disassembled”, “copied +”. In the gross motor sector, suspicions of developmental changes of more than 50% were found in the activities "swing your foot for six seconds", "swing your foot for five seconds", "swing your foot for four seconds", "swing your foot for three seconds”. In the control group, the performance of suspected delay or abnormality was more concentrated in the gross motor sector.

Early diagnosis of developmental changes in children born prematurely to mothers with malaria during pregnancy or children born prematurely to mothers who did not contract malaria during pregnancy is important for possible therapeutic interventions and stimulations, in order to alleviate or prevent complications, and thus be able to improve the quality of life of these children. The early identification of changes in development is a complex task for health professionals working in primary care [5]. It was demonstrated that early diagnosis allows early intervention, thus reducing the sequelae of these children. When screening for abnormality or delay and risk to the development of these children, it facilitates early intervention. Performing screening to detect abnormalities and risks for development facilitates therapeutic intervention.

The use of the Denver II Test is recommended as it is a simple method for the assessment of children aged one month to six years old, and aims to detect delays in child development, covering the following functions: extensive motor coordination (coarse), fine motor coordination (adaptive), language and personal-social adaptation. This test has been used to identify children who are at risk of developing problems and to monitor the child longitudinally. The evaluation of the four sectors of this Screening Test is justified because motor behavior is associated with the maturation of the nervous system, corresponding to the control of motor acquisitions. Language behavior encompasses the perceptions of sounds, images and their responses, while adaptive behavior comprises the child's reaction to objects and situations.

Personal-social conduct, on the other hand, corresponds to the assessment of behavior in the face of cultural stimuli.

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