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ORIGINAL ARTICLE

# Influence of type of birth on child development: a comparison by Bayley- III Scale

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Open acess

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## Abstract

**Introduction:** Elective cesarean section is associated with several damages to the newborn's health, such as respiratory, gastrointestinal problems and diabetes that last throughout life. However, few studies discuss aspects related to psychological development.

**Objective:** To investigate the development of Brazilian children according to the type of birth and gestational age in the cognitive, language, motor, socio-emotional and adaptive behavior domains.

**Methods:** This is an exploratory and descriptive cross-sectional study conducted in the city of São Bernardo do Campo, São Paulo, Brazil, between June 2016 and March 2017. The final sample consisted of 263 children up to 42 months of age. For data collection were applied a socio demographic questionnaire and the Bayley-III Scale. The statistical analysis was based on both a North American reference sample and a local sample using the SPSS version 21, through Pearson's Chi-square statistical test and significance criteria $p < 0.05$.

**Results:** A significant difference ($p<0.005$) was observed, with a higher risk of problems in fine motor development and expressive language in children born at pre-term between 37- 39 weeks compared to those born at term between 39 - 41 weeks. Significant difference ($p<0.005$) was also observed in sensory processing and adaptive behavior, with greater impairment in children born via elective cesarean section compared to those born vaginally.

**Conclusion:** Despite its limitations and discrepancies, this research indicates potential impairments in the psychological development of children born at early term via elective cesarean.

**Keywords:** child development, cesarean section, normal birth, Bayley-III, prematurity.

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**Authors summary**

**Why was this study done?**
This study was part of the author's master's dissertation in the Postgraduate Program in Health Psychology of the Methodist University of São Paulo. The theme was selected due to the author's experience, throughout her clinical practice, of the increasing incidence of children born via elective cesarean section with problems in their psychological development.

**What did the researchers do and find?**
Through the application of a sociodemographic questionnaire and the Bayley-III Child Development Scale, 400 children between 15 days and 42 months and 15 days of age were evaluated at Centers for Early Childhood Education in the city of São Bernardo do Campo, São Paulo, Brazil, to investigate the relationship between birth and child development. A higher incidence of developmental delays was observed in children born via elective cesarean section compared to the ones born via vaginal delivery, as well as in those born pre-term, compared to those born at term.

**What do these findings mean?**
These findings imply the need to raise awareness about the choice of the mode of delivery, as elective cesarean section born children are exposed to iatrogenic prematurity and a greater risk of experiencing difficulties in their overall development, which may last throughout their lives.

## INTRODUCTION

In several countries around the world, cesarean section rates are significantly higher than those recommended by the World Health Organization (WHO) that states there is no justification for rates above 15%[1]. The national and international literature indicates significant damages to the newborn associated with elective cesarean (EC) sections, due to the prematurity associated with this surgical intervention, a fact aggravated by the inaccuracy in the calculation of gestational age (GA)[2].

Brazil is considered a country with one of the worst obstetric realities on the world stage. Although only 24% of women initially wanted surgical delivery, a rate of 52% of cesarean sections is reported, reaching 90% in private care, and about 50% were performed between the 37th and 38th gestational week. These data indicate the indiscriminate use of this procedure, generating negative consequences for both the mother and the newborn, even when performed after the 39th gestational week[3].

The literature shows that EC has a higher risk of morbidity[2,3], admission to the Neonatal Intensive Care Unit (NICU), hospitalization and respiratory complications[2]. Among the known long-term effects, there is a higher risk of immunological diseases, a higher occurrence of metabolic syndrome, asthma, dyslipidemia, cardiovascular disease, gastrointestinal problems, obesity[2] and a higher risk of hypertension in youth and adulthood[4].

Faced with this reality, in 2016, the Federal Council of Medicine (CFM-Conselho Federal de Medicina) vetoed to perform an EC before 39th gestational week, a frequent practice until then, guaranteeing the pregnant woman the right to choose the type of delivery[5]. However, this is usually imposed by the doctor, and the availability of information on the consequences of the route of delivery for the mother and baby is reliable[6]. Therefore, exploratory studies on the risks and benefits of EC that support the decision of pregnant women and the medical profession are urgent.

Despite the evidence regarding the impairment in physical health of newborns via EC, which may last until adulthood[2-4], there is a gap in the knowledge about the impact of the mode of delivery on psychological development. Child development is known to occur in an integrated manner, with physical, psychological and environmental aspects inseparable[7]. Therefore, since the type of delivery impacts physical aspects of child development, it is necessary to investigate other potential effects.

In the literature, there are few studies addressing other aspects of child development according to the type of delivery, some with inconsistent results[8]. However, they indicate an association between EC and delayed the neuropsychomotor development[9,10]. There is an even lower rate of locomotor, manipulative, visual, speech and language skills and personal autonomy compared to vaginal delivery[11].

The WHO encourages research to study mother-infant bonding, women's mental health, newborn well-being, breastfeeding, and psychological and social aspects related to the type of delivery[1]. The urgency of conducting studies that investigate the possible effects of elective cesarean section on child psychological development in the short, medium and long term, in the most diverse areas that compose it, motivated this work.

Thus, the aim of this study is to investigate the psychological development of children aged between 15 days and 42 months and 15 days, according the type of delivery and gestational age at birth.

## METHODS

### Study type and sample

This is a cross-sectional, exploratory and descriptive study, using quantitative variables, based on a non-probabilistic sample of convenience.

It was considered an initial population of 400 children aged between 15 days and 42 months and 15, who received care at the Early Childhood Education Centers (CEI- Centro de Educação Infantil) of the city of São Bernardo do Campo, São Paulo, Brazil.

Then, there were excluded children whose families did not sign the Informed Consent Form (ICF); infants clinically premature (before 37 weeks); with syndromes, malformations, presence of labor during the EC; emergency cesarean section and risk pregnancy. Nine babies aged between 15 days to 6 months and 15 days were also excluded due to the impossibility of performing the percentile calculation by age group with such small sampling.

The final sample consisted of 263 children, female (n = 122) and male (n = 141); vaginal route (n = 103) and EC (n = 160); born pre-term (370/7 - 386/7 weeks) (n = 104), at term (390/7 - 416/7 weeks) (n = 148) and post term (>420/7 weeks) (n = 11). Regarding ethnicity, most of the sample was white (48.3%) and mixed (37.6%). More than half of mothers completed high school (51.7%) and 37.7% had higher education. Regarding maternal age, 19.8% of mothers were between 21 and 25 years old; 24.7% between 26 and 30; 26.2% between 31 and 35; 20.9% between 36 and 40. Regarding family income, 62.8% belonged to the lower middle class.

### Instruments and procedures

Data collection was initiated after prior consent from the São Bernardo do Campo Department of Education and CEI leaders. The invitation to participate in the study included all children from the participating institutions, within the stipulated age range, being conducted within the school term. The guardians and/ or parents answered the instruments individually, lasting between 60 and 90 minutes.

Two instruments were used: Sociodemographic Questionnaire, which provided information regarding the independent variables (IVs) - route of delivery and gestational age at birth, since the literature associates EC with signs of prematurity[3] and the Bayley Child Development Scale[12] (Bayley III), from which the 11 dependent variables (DVs) were measured.

Bayley III assesses child development through direct observation and interaction with the child in relation to the DVs: cognitive (COG), expressive language (EL), receptive language (RL) domains, fine motor (FM) and gross motor (GM) skills. It also evaluates, through a questionnaire conducted with parents the adaptive behavior (AB) and socio emotional (SE) domains. The analysis provided by these domains made up 6 other DVs from this research: Global Adaptive Behavior (GAB), Practical (PRA), Conceptual (CON), Social (SO), SE and Sensory Processing (SP) Behaviors.

Although this scale has no standardization for the Brazilian population, it is commonly used in numerous national and international surveys based on US normative data. To minimize possible interference with the reliability of the data found, the English version of Bayley III was translated into Portuguese, which underwent three reviews and semantic analyzes by interdisciplinary teams composed of health professionals from the municipality of the Uberlândia Federal University, Minas Gerais, Brazil (UFU) and the Federal University of Pará, Brazil (UFPA), users of this instrument.

The scale application procedures were standardized through a training course, with 24 theoretical hours and 20 hours of supervised practice, ensuring uniformity of the test application procedures. We also compared data obtained from two normative data: North American and local obtained from the sample of this study. Despite the limitations of this type of analysis, it is an ethical and valid resource in the use of instruments that do not have local standardization for the population in question[13].

In the first analysis, the obtained gross score was converted into a weighted normative score - for the COG, EL, RL, FM and GM - and composite - for the GAB, CON, PRA, SE and SO - according to the table of conversion available in the scale manual[12]. Bayley III standardization for the local population was performed by means of the percentile calculation, which allowed the interpretation and comparison of the individual's results in the different domains evaluated, in addition to pointing out the individual's position in the normative sample.

For the percentile calculation, the statistical criterion of a standard deviation (SD) and normal distribution was considered. This criterion makes it possible to compare values from both different samples and within the sample itself, where approximately 68% of the values are within a range of one SD (negative and positive) from the mean.

### Statistical analysis

Nonparametric statistical analysis was performed using the Statistical Package for Social Sciences Version 21– SPSS. Pearson's chi-square statistical test was used, with significance criteria $p < 0.05$. Comparisons were made between the findings, looking for differences and similarities between the groups in each of the areas of psychological development - cognitive, motor, linguistic, social and emotional and adaptive behavior - considering the mode of delivery and GAB. The occurrence of each DV in gross numbers as well as its frequency in percent was raised.

### Ethical aspects

This study is aligned with the ethical aspects of the Declaration of Helsinki and was approved by the Research Ethics Committee (CEP-UMESP) under opinion number 1,339,889 in Platform Brazil. After approval, it was submitted to the Research Support Foundation of the State of São Paulo - FAPESP, which financed the research, together with CAPES. All participants previously signed the informed consent form.

## RESULTS

Comparisons based on US standardization showed a significant difference ($p<0.05$) in EL when considering the variable gestational age, and in AB skills when considering the mode of delivery. Also, in the comparisons made based on the standardization obtained from the local sample, a significant difference ($p<0.05$) was observed in the FM when considering the gestational age variable and in the SP when considering the mode of delivery. These results show signs of the association reported in the literature between EC and prematurity. Table 1 shows overall results.

**Table 1:** Comparison of the results of children participating in this study, by development domain, based on standardization performed with a sample of US children and a local sample (n = 263).

| Development domain rated | Variables | Sample local (p) | Sample north american (p) |
|---|---|---|---|
| Cognitive (COG) | Type of birth | 0.728 | 0.388 |
| | Gestational age | 0.673 | 0.896 |
| Receptive language (RL) | Type of birth | 0.083 | 0.313 |
| | Gestational age | 0.147 | 0.904 |
| Expressive language (EL) | Type of birth | 0.142 | 0.70 |
| | Gestational age | 0.118 | 0.023* |
| Gross motor (GM) | Type of birth | 0.719 | 0.382 |
| | Gestational age | 0.276 | 0.244 |
| Fine motor (FM) | Type of birth | 0.66 | 0.101 |
| | Gestational age | 0.001** | 0.443 |
| Socioemotional (SE) | Type of birth | 0.853 | 0.944 |
| | Gestational age | 0.669 | 0.341 |
| Sensory processing (SP) | Type of birth | 0.033* | 0.124 |
| | Gestational age | 0.465 | 0.99 |
| Adaptive behavior (GAC) Global adaptive behavior | Type of birth | 0.740 | 0.376 |
| | Gestational age | 0.132 | 0.122 |
| Adaptive behavior Conceptual | Type of birth | 0.637 | 0.018* |
| | Gestational age | 0.956 | 0.473 |
| Adaptive behavior Practical | Type of birth | 0.068 | 0.020* |
| | Gestational age | 0.316 | 0.539 |
| Adaptive behavior Social | Type of birth | 0.067 | 0.522 |
| | Gestational age | 0.307 | 0.352 |

Note: *p<0.05; **p<0.001

**Comparisons based on the standardization made from the sample itself**

Relate the frequency of incidence of poor outcomes in relation to sensory processing, it was observed that children born via EC are 3 times more likely to have delays in this area compared to those born vaginally, as indicated in Figure 1.

The results also showed that children born at an early term have a 1.2 times higher incidence of delays in their FM skills development than those born at term, as shown in Figure 2.

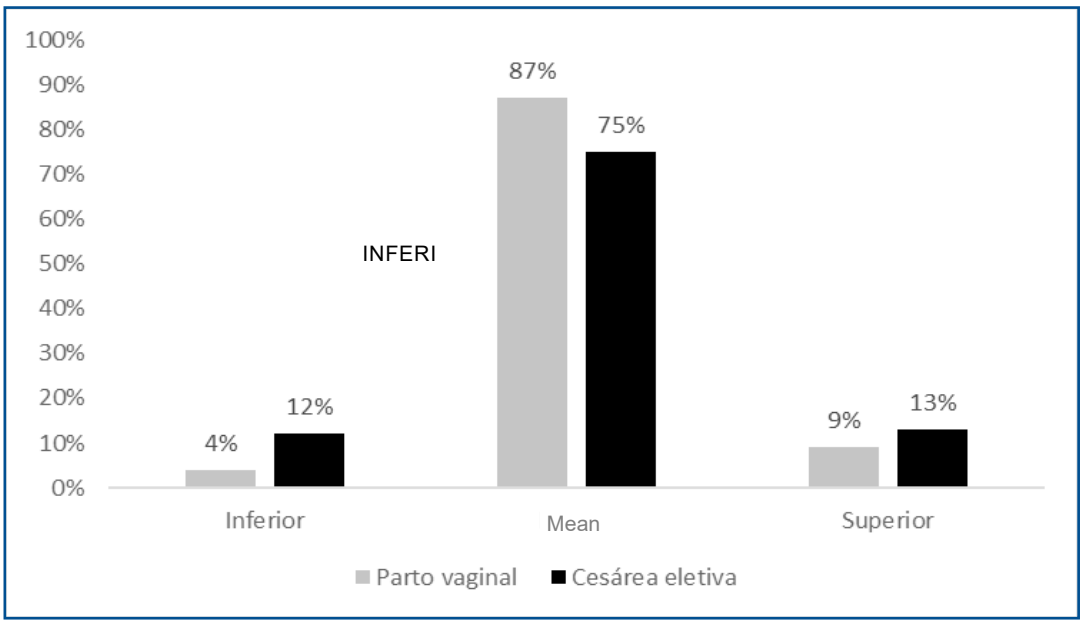


**Figure 1:** Sensory processing according to type of child birth: comparison between the reference sample and local sample.

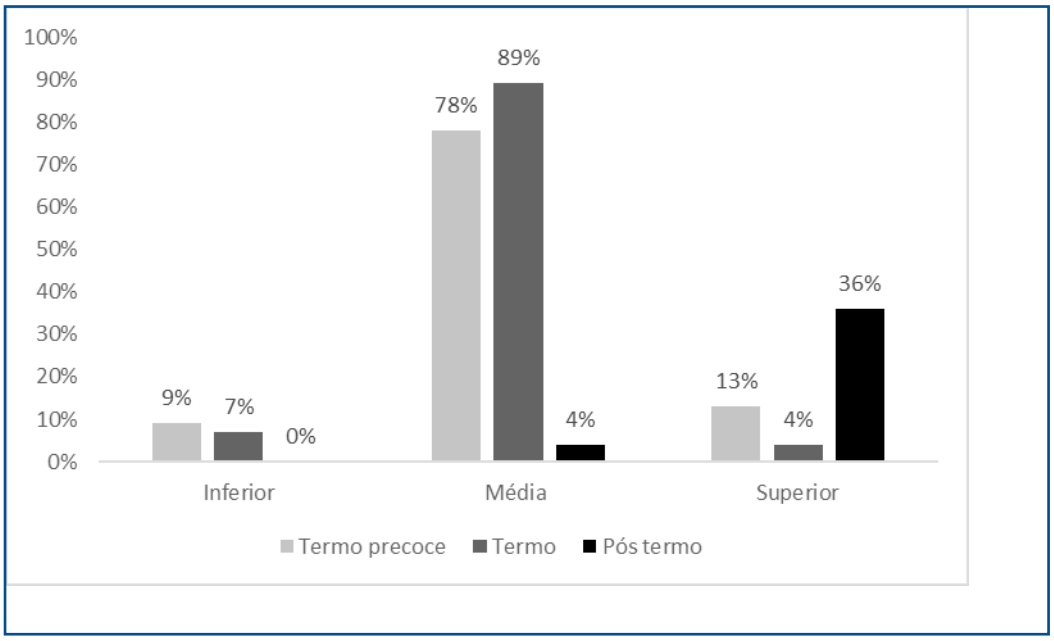


**Figure 2:** Fine motor development according to gestational age: comparison between the reference sample and local sample

**Comparisons based on North American standardization**

In the skills related to the adaptive behavior (AB), statistically significant differences ($p = 0.05$) were found in the composition of CON ($p = 0.020$) and PRA ($p = 0.018$) abilities in relation to the American sample, as shown in Figure 3. Children born via EC were 4 times more likely to have AB practical skills deficits, and 2.5 times more likely to have conceptual skills deficits.

However, when correlating the variable gestational age at birth with EL, from the North American normative data, a significant difference ($p < 0.05$) was observed in this area of development. Pre-term infants had a 2-fold higher risk of delayed EL than infants born at term, as illustrated in Figure 4.

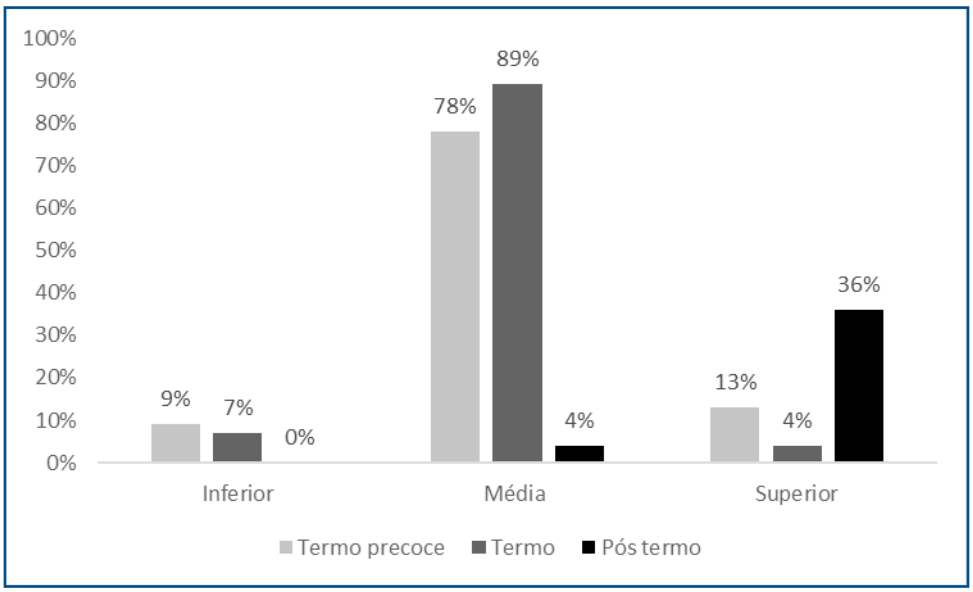


**Figure 3:** Adaptive Behavior by type of childbirth: Comparison between the reference sample and local Sample

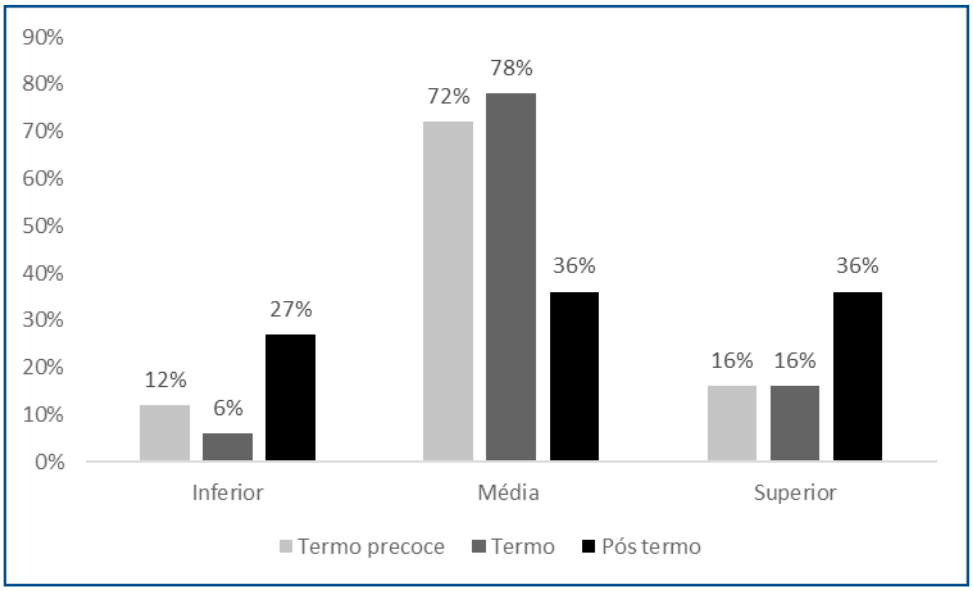


**Figure 4:** Expressive language development according to type of childbirth: comparison with North American sample

## DISCUSSION

In this study, a significant difference ($p < 0.005$) was found in the development of children assessed according to type of birth and gestational age at birth in some areas. Compared to the US population, children born via EC showed 2.5 and 4 times more damage in the CON and PRA subdomains, compared to those born vaginally. In comparison with the standardization performed from the sample itself, there was a 3 times higher incidence of SP damage among those born via EC.

Considering GAB, there were also differences in the comparison with each population. An incidence of 1.2 times higher of impairments in FM, compared to the standardization performed from the sample itself, among those children born at early term. Compared to the US standard, they also had a 2 times higher incidence of delayed development of EL. These results are important to help doctors and pregnant women on the choice of delivery, given the high rates of EC in the country[2,3].

However, this study has important limitations to consider. One is the choice of an instrument not validated for the Brazilian population. Bayley III was chosen because of the importance of using internationally standardized measures to ensure comparisons between different countries. This is an internationally recognized scale and widely used in scientific research around the world from standardized infant and young child scores in the United States[14].

Despite the standardization of the test application, it is known that cultural habits, among other factors, influence child development[7] and may interfere with the fidelity of results compared with different population, and caution is required. In the literature, there are studies that suggest safety in the use of the American norm in other populations[15], others, in turn, point out differences[16].

For this reason, we resorted to the standardization from the data of the sample itself, despite the limitations of this type of analysis[13]. Thus, it was guaranteed the

possibility of comparing the results found according to sociocultural differences that could influence the classification of the children.

This strategy made it possible to verify aspects of convergence and divergence when comparing the results with each of the established norms that would otherwise go unnoticed. The importance of standardization of the instrument is emphasized in subsequent studies from a representative sample of the national reality for a more reliable measurement.

Another important limitation of this study was the small sample size and its homogeneity, which, on one hand, minimizes some environmental variations that influence child development; on the other hand, it does not allow the generalization of the results. Studies covering a larger sample could consolidate, refute or broaden the results of this work, making them more susceptible to generalization.

Considering the limitations mentioned, the results of this study are in line with current evidence on the association reported in the literature between EC and prematurity, which point out GAB and type of birth as important risk factors for both child development and outcomes during the first years of life[2,3]. Thus, the form and moment of birth are part of the multiple determinants of child development, which partly depends on the genetic background and the affective, sensory and social experiences lived in early childhood.

### Type of Birth

Considering type of delivery, impairment in SP was observed in 12% of children born via EC in this study compared to the local sample. SP is a neurophysiological mechanism responsible for filtering, interpreting and organizing important stimuli received from the environment. It consists of an innate ability of the central nervous system that allows the child to emit appropriate behavior adapted to the environment[17].

The integrated non-functioning of sensory systems in the first months of life is known to affect motor development and planning, visual motor coordination, social interaction and learning, as well as emotional development and behavior[18]. The possible immaturity of cortical brain systems involved in SP[17], due to iatrogenic prematurity associated with EC, may be related to the higher incidence of SP impairment among those born via EC.

There are no studies in the literature investigating the association between sensory processing and EC, and there are few that do in relation to gestational age, considering term and early term births. Most compare premature and term infants[19]. A prospective study of 157 children at 12 months of age, late and term preterm infants, identified that late preterm infants constitute a risk group for sensory modulation disorder[20]. Given possible errors in the calculation of GA2, this may be the reality of some EC-born children.

A literature review pointed out the relationship between SP integrity and the learning process and behavioral responses of children, raising possible relationships with Attention Deficit Hyperactivity Disorder[21]. It is known that sensory systems support the subject's responses and adaptation to environmental requirements[18], with potential for interference in AB abilities, which was not found in the results of this research, compared to the local norm but was present compared to the North American sample.

SP alterations may make it difficult for the subject to adapt to the environment[17,18] and, thus, it would be expected to find this difference as a result of the comparison with the local sample. However, this hypothesis was not confirmed in the present research, and this difference occurred in comparison with the North American standard.

AB relates the child's ability to adapt to various demands of the daily life routine. It refers to the use of previous experience in solving new problems, which ensures cognitive improvement, development of autonomy, independence and communicative and social skills[12]. The CON variable involves communicative and pre-academic skills. There was a 2.5 times higher incidence of delayed subdomain CON among those children born via EC.

In the PRA variable, in turn, there was a 4 times higher incidence of damage in children born via EC compared to those born vaginally. This variable involves the verification of skills related to autonomy and independence[12].

A recent observational cross-sectional study with 400 dyads, using the Child Development Skills Assessment Scale II, investigated significant differences in competence development at 2 years of age between normal and EC births. Those born via EC were lower than expected in manipulative, visual, speech and language skills, and personal autonomy[11].

Another longitudinal study[22], conducted with 11134 children, searched the impact of the mode of delivery on child development. The Ages and Stages Questionnaire was applied to parents, and there was a higher risk of neurodevelopmental delay in EC-born children at 9 months of age, especially in the personal-social domains, which includes the self-help skills used by the child in their interactions with each other[22] and gross motor skills.

Although the previous mentioned studies[11,22] use different methods, both found impairments in EC-related AB skills, corroborating the findings of current study. However, the present study did not find, like previous ones, damage to gross or fine motor skills[11] associated with the type of delivery, but to GAB, with significant losses in premature infants. The multifaceted characteristic of the relationship between type of delivery and child development makes further population studies necessary to verify the consistency of the results[22].

The authors also raised possible psychological and biological mechanisms involved in the alterations found, including absence of labor and the higher frequency of postpartum complications, which may interfere in early mother-newborn[22] interaction and affect both the SP and AB[17,18]. It is important to consider that factors associated with EC limit and interfere in the newborn's first relations with the environment, both regarding the organic apparatus that the newborn disposes at birth[2] and the new environment that newborn faces.

Both factors associated with the conditions of women[11] and baby before, during and after delivery, as

well as biological and environmental aspects are certainly involved in the differences found in the psychological development of children born via EC. However, consistent studies, preferably longitudinal and multicenter, are necessary to obtain greater clarity of these events and their causes.

### Gestational age

Considering GAB, once again there was discrepancy in comparisons with US standards, and those derived from the sample itself. There are also few studies comparing the effects of gestational age, or the type of delivery, on the development of FM or EL.

A documentary study with a sample of 38.802 late preterm infants, pre-term and term, indicated adverse long-term neurodevelopmental outcomes and increased risk of language delay in the first two[23]. This data corroborates the results current study, which found a 2 times greater risk in the development of EL compared to the North American sample, which may be due to differences in language structure, as observed in other countries[23].

A national cross-sectional study assessed the influence of sociodemographic, obstetric and neonatal variables on neuropsychomotor development through the Developmental Surveillance Instrument, finding that cesarean section is associated with a higher occurrence of developmental delay[10]. However, it did not mention the gestational age from which it was found a 1.2 times higher incidence of impairments in FM development in children born at early term compared to those born at term in this study.

Even though the scientific literature on developmental aspects related to early term birth is scarce, there are indications that motor and language difficulties are two manifestations of vulnerabilities that underlie neurological development and are closely related[11]. Thus, it can be inferred that small differences in GI may interfere with the development of these skills.

Despite the fact that many babies born at an early term present a neonatal course without complications, when compared to those aged 39 to 41 weeks, their probability of suffering some type of morbidity in the short and long term is already proven to be higher[11,12]. The available publications suggest that they are at significant risk of presenting difficulties in their growth, as well as changes in neuropsychological, educational and behavioral aspects, contrary to what happens with those born at term[12].

Ignoring the influences of the birth type and gestational age on child development is to neglect preventive care and health promotion that can help to reduce developmental problems and other psychopathologies of childhood and adolescence. Identifying vulnerabilities early means reducing the risk of potential difficulties that could get worse over a lifetime. This study indicates that EC can be considered a sign of vulnerability in the child's history.

## CONCLUSION

Despite its limitations and discrepancies, this research indicates potential impairments in the psychological development of children born at early term via elective cesarean.

These findings not only encourage further studies to expand their results in other populations and explore the potential biological mechanisms involved, but also support the dialogue between pregnant women and physicians about the short, medium and long-term risks associated with elective cesarean. This allows a step towards primary prevention of child health.

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**Resumo**

**Introdução:** A cesárea eletiva está associada a diversos prejuízos à saúde do recém-nascido, como problemas respiratórios, gastrointestinais e diabetes, que perduram ao longo da vida. No entanto, poucos estudos discutem os aspectos relacionados ao desenvolvimento psicológico.

**Objetivo:** Investigar o desenvolvimento de crianças brasileiras segundo a via de parto e a idade gestacional nos domínios cognitivo, linguagem, motor, socioemocional e comportamento adaptativo.

**Método:** Trata-se de um estudo exploratório-descritivo, transversal, realizado no município de São Bernardo do Campo, entre junho de 2016 e março de 2017. A população foi composta por 400 crianças até 42 meses de idade. Para coleta de dados foram aplicados questionário sociodemográfico e Escala Bayley-III. Foi utilizada para análise estatística tanto a normatização oferecida pela Escala Bayley (norte-americana) quanto a normatização referente à amostra estudada, por meio do SPSS version 21, utilizando o teste estatístico do Qui-Quadrado de Pearson, critérios de significância $p<0,05$.

**Resultados:** Observou-se diferença significativa ($p<0,005$), com maior risco de problemas no desenvolvimento motor fino e na linguagem expressiva em crianças nascidas a termo precoce (37 a<39 semanas) quando comparadas às nascidas a termo (=39 a <41 semanas). Diferença significativa ($p<0,005$) também foi observada no processamento sensorial e comportamento adaptativo, com maior prejuízo observado nas crianças nascidas via CE em comparação às nascidas de parto vaginal.

**Conclusão:** Este estudo evidencia o aumento de riscos psicológicos em crianças nascidas via cesárea eletiva quando comparadas com as nascidas por parto vaginal nos aspectos relacionados ao processamento sensorial, motricidade fina, linguagem expressiva e emissão de comportamentos adaptativos.

**Palavras-chave:** desenvolvimento infantil; cesárea; parto normal; Bayley-III; prematuridade.