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## REVIEW ARTICLE

# Neuropsychomotor developmental delay: conceptual map, term definitions, uses and limitations

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### KEYWORDS

Child development;  
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### Abstract

**Objective:** To retrieve the origin of the term neuropsychomotor developmental delay” (NPMD), its conceptual evolution over time, and to build a conceptual map based on literature review.

**Data source:** A literature search was performed in the SciELO Brazil, Web of Science, Science Direct, OneFile (GALE), Pubmed (Medline), Wiley Online, and Springer databases, from January of 1940 to January of 2013, using the following keywords: NPMD delay, NPMD retardation, developmental delay, and global developmental delay. A total of 71 articles were selected, which were used to build the conceptual map of the term.

**Data synthesis:** Of the 71 references, 55 were international and 16 national. The terms developmental delay and global developmental delay were the most frequently used in the international literature and, in Brazil, delayed NPMD was the most often used. The term developmental delay emerged in the mid 1940s, gaining momentum in the 1990s. In Brazil, the term delayed NPMD started to be used in the 1980s, and has been frequently cited and published in the literature. Delayed development was a characteristic of 13 morbidities described in 23 references. Regarding the type of use, 19 references were found, with seven forms of use. Among the references, 34 had definitions of the term, and 16 different concepts were identified.

**Conclusions:** Developmental delay is addressed in the international and national literature under different names, various applications, and heterogeneous concepts. Internationally, ways to improve communication between professionals have been indicated, with standardized definition of the term and use in very specific situations up to the fifth year of life, which was not found in Brazilian publications.

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**PALAVRAS-CHAVE**

Desenvolvimento infantil;  
Transtornos globais do desenvolvimento infantil

**Atraso do desenvolvimento neuropsicomotor: mapa conceitual, definições, usos e limitações do termo****Resumo**

**Objetivo:** Resgatar a origem do termo *atraso do desenvolvimento neuropsicomotor (DNPM)*, sua evolução conceitual ao longo do tempo e construir mapa conceitual do termo com base em busca bibliográfica.

**Fontes de dados:** Foi realizada busca nas bases de dados eletrônicas do Portal da Capes, que incluem Scielo Brazil, Web of Science, Science Direct, OneFile (GALE), Pubmed (Medline), Wiley Online e Springer, referente a Janeiro/1940-Janeiro/2013. Palavras-chave: *atraso e retardo do DNPM, developmental delay e global developmental delay*. Foram selecionados 71 artigos e construído o mapa conceitual do termo.

**Síntese de dados:** Das 71 referências, 55 eram internacionais e 16 nacionais. Os termos mais encontrados foram *global developmental delay e developmental delay* na literatura internacional e *retardo e atraso do DNPM* no Brasil. Internacionalmente, o termo surgiu em meados da década de 40 ganhando força nos anos 90. No Brasil, o termo começou a ser usado na década de 80 e vem sendo frequentemente citado na literatura. O atraso é citado em 23 trabalhos como característica presente em 13 tipos de condições clínicas. Com relação ao uso, foram encontrados 19 estudos, com sete situações de uso. Dentre os artigos revisados, 34 deles apresentaram definições, sendo identificados 16 conceitos diferentes.

**Conclusões:** O atraso do desenvolvimento é abordado na literatura internacional e nacional sob diversos nomes, diferentes aplicações e conceitos heterogêneos. Internacionalmente, apontam-se caminhos para melhorar a comunicação entre profissionais, com definição padronizada do termo e uso em situações específicas até o quinto ano de vida, o que não foi encontrado nas publicações nacionais.

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**Introduction**

*Arthur was born at a gestational age of 32 weeks, weighing 2,100 grams. At six months of life, his pediatrician referred him to physical therapy due to neuropsychomotor developmental delay (NPMD), because, according to his mother, "he could not support his head and had no tonus." The mother was told that she shouldn't worry, as it was nothing serious and, in fact, Arthur showed fast motor progress and was discharged from care. Currently, Arthur is 7 years old and has difficulty using cutlery, tying shoes, and does not perform personal hygiene tasks on his own. He cannot play ball, but loves video games. According to his mother, Arthur is a quiet child who walks, talks, sees, hears, and understands what is said to him normally, but has little initiative, is very dependent, and has difficulty in adapting to new environments and people. In school, according to the teacher, he is a shy child, but interacts with colleagues and participates in all activities requiring minimal assistance. He is learning to read and write, but is slower than peers and is inattentive. The parents are confused because the child persists with the diagnosis of NPMD, which does not qualify him to receive specialized support.*

It is estimated that 200 million children worldwide, younger than five years of age, are at risk of not reaching their full development.<sup>1</sup> The prevalence of developmental delay is largely unknown, but data from the World Health Organization (WHO) indicate that 10% of the population of any country consists of individuals with some type of disability, with a rate of 4.5% among those younger than five years of age.<sup>1</sup>

In Brazil,<sup>2</sup> there has been a decrease in the prevalence of children with developmental delay, which is justified by the advances in neonatal care, the expansion of health care coverage for the child in the first year of life that occurred in recent decades in hospitals located in large cities and in the countryside, and the increase in the socioeconomic status of the population. However, these same factors have led to a paradoxical situation, as the higher survival of at-risk infants, especially the premature, is associated with increased morbidity, such as neurodevelopmental sequelae, generating new demands for pediatricians and other health professionals.

Developmental delay is associated with several childhood conditions, from conception, pregnancy, and childbirth, due to adverse factors such as malnutrition, neurological diseases such as chronic childhood encephalopathy (cerebral palsy), and genetic factors, such as Down syndrome. The delay may also be a transient condition, which does not allow defining what the child development outcome will be and, thus, requires follow up with periodic evaluations. It can also be observed that it is not uncommon to find the term used as a diagnosis, as in the case of Arthur, without a more objective definition of what is happening with the child.

Although the term developmental delay is widely used in the area of child health, and is often employed clinically and mentioned in the literature, it is worth mentioning, as discussed by Aircadi<sup>3</sup> in 1998, that the term does not appear as a chapter title or in the table of contents of most books on child neurology, or in the International Classification of

Diseases - 10<sup>th</sup> Revision (ICD-10) and the Diagnostic and Statistical Manual of Mental Disorders - fourth Edition (DSM-IV).

Nevertheless, what does the term developmental delay mean? According to the Dictionary of Developmental Disabilities Terminology,<sup>4</sup> developmental delay is a condition in which the child is not developing and/or does not reach skills in accordance with the sequence of predetermined stages. However, this definition is not consensual and the lack of concept standardization has generated disagreement among professionals, leading to very different usage scenarios and a multitude of terms (e.g., developmental delay, neuropsychomotor developmental delay, mental retardation, delayed neuropsychomotor development, delayed global development), which do not seem to have the same meaning, although they are often used in a similar manner.<sup>3,5,6</sup>

In fact, it is a term that has baffled professionals and especially parents, as the term delay gives the idea of retardation, something that will take time to occur, or that development is slow, but the child will reach his/her final destination, i.e., that the problem is temporary and the prognosis is favorable.<sup>7-9</sup> That does not always occur, as in the case of Arthur. The term has been used over the years in a generic way, not functioning as a communication tool, bringing dissatisfaction to parents, as they do not know what type of problem their child has, and causing frustration at school, because without a specific diagnosis, the child is not eligible to receive specialized educational support or assistance by the health team.

Thus, the term appears to be a byproduct of conceptual and methodological difficulties in reliably defining and measuring the skills of young children, as it can be applied indiscriminately to both a child with mild delay and one with severe impairment. An infant, for instance, who shows

such delay in fine motor and language skills can receive the same label as an infant with severe motor and cognitive delay, i.e., they will be treated as if they have a homogeneous entity, both in terms of cause and prognosis.<sup>7,8</sup>

In practice, the physician does not always have appropriate tools, which includes valid and reliable development tests, or the support of an interdisciplinary team to assist in the diagnosis. Moreover, assessing developmental delay requires the capacity to recognize that development pathways are invariably individualized, with variations within what can be accepted as normal and abnormal,<sup>10,11</sup> which implies the need for more prolonged contact to identify the context of the child's life.

Considering the frequent use and conceptual misperceptions related to the use of the term developmental delay, the objective of this study was to seek information through a literature search on the term NPMD delay, aiming to recover its conceptual origin and evolution over time, as documented in scientific articles. To organize such information, a conceptual map was constructed to provide an insight into the complexity of this terminology use.

## Method

The authors initially conducted a search on the subject at CAPES Portal using the term *atraso do desenvolvimento* (developmental delay), aiming to identify the databases that index articles on the subject. The most frequent databases were: SciELO Brazil, Web of Science, Science Direct, OneFile (GALE), Pubmed (MEDLINE), Wiley Online, and Springer. Next, searches were performed with specific terms for each database as described in Table 1. Searches and coding of data were performed by the first author.

**Table 1** Electronic databases with the terms used and number of documents found.

| Databases            | Terms used                                                                                                                                                                                                                                                       | Number of documents found |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Scielo Brazil        | atraso do desenvolvimento; atraso do desenvolvimento neuropsicomotor; retardo do desenvolvimento neuropsicomotor, atraso do desenvolvimento global; retardo mental                                                                                               | 498                       |
| Web of Science       | developmental delay* AND child; global developmental delay*; neuropsychomotor developmental delay*; neuropsychomotor developmental retardation*; mental retardation* AND child; neurodevelopmental disabilities* AND child; developmental disorder* AND child*   | 7,545                     |
| Science Direct       | developmental delay AND child; global developmental delay; neuropsychomotor developmental delay; neuropsychomotor developmental retardation; mental retardation AND child; neurodevelopmental disabilities AND child; developmental disorder AND child           | 3,672                     |
| Pubmed (MEDLINE)     | developmental delay child; global developmental delay; neuropsychomotor developmental delay; neuropsychomotor developmental retardation; mental retardation child; neurodevelopmental disabilities child; developmental disorder child                           | 8,974                     |
| Wiley Online Library | developmental delay AND child; global developmental delay AND child; neuropsychomotor developmental delay; neuropsychomotor developmental retardation; mental retardation AND child; neurodevelopmental disabilities AND child; developmental disorder AND child | 3,662                     |
| Springer             | developmental delay; global developmental delay; neuropsychomotor developmental delay; neuropsychomotor developmental retardation; mental retardation; neurodevelopmental disabilities; developmental disorder                                                   | 4,505                     |
| OneFile (GALE)       | children with developmental delays; global developmental delay; neuropsychomotor developmental delay; neuropsychomotor developmental retardation; mental retardation AND children's; neurodevelopmental disabilities; developmental disorders                    | 675                       |
| Total                |                                                                                                                                                                                                                                                                  | 29,531                    |

With the objective of retrieving the origin of the term, the search strategy did not have a time limit, including from the earliest records on the subject, published in 1940, until January of 2013, resulting in 29,531 documents. Aiming to focus on more specific terms, the “filter results by topic” resource was used in each database. Through the filter, it was observed that, of the keywords used, the terms global developmental delay and developmental delay in the international literature and *atraso do desenvolvimento*, *atraso do DNPM*, and *retardo do DNPM* in national databases were the most suitable to encompass and find as many articles as possible related to the proposed objective.

Therefore, after using the filter for these terms, 3,679 studies were selected. Subsequently, the titles and abstracts of the located articles were screened to eliminate those not related to the proposed topic. To select studies that would be read in full, as illustrated in Figure 1, the following inclusion and exclusion criteria were applied until the final sample was reached:

#### Inclusion criteria:

- Articles published in English and Portuguese; original articles, review articles, and special articles (theoretical);
- Articles that used the terms developmental delay and global developmental delay in the international literature and *atraso do DNPM* and *retardo do DNPM* in the national literature, which included at least one of the three topics below:
  - Population - description or indication of the type of disorder or population included in the term;
  - Use - description of the situation or criteria used to employ the term;

- Definition - presentation of definition or concept, explaining the meaning of the term.

**Exclusion criteria:** topics that were not related to the keywords used, studies that only mentioned the term without any information, case reports, reviews, letters to the editor, testimonials, interviews, points of view, editorials, minutes of conferences, and comments of newspapers. Books and book chapters were excluded due to the difficulty in locating both the records and the material in its entirety, electronically, especially older publications.

The selected articles were read in full for detailed data extraction, which were organized into three tables, according to the type of information obtained: the first addresses the population to which the term was applied (Table 2), the second describes how the term was used (Table 3), and the last, the term definitions (Table 4). Each table included information about the title, author and year, type of article, country, term used, and specific information about the term. In order to encompass the largest amount of information on the term use, while considering a historical perspective, it was decided not to assess the methodological quality of the articles; however, all studies met the inclusion and exclusion criteria for this review. The reference lists of the articles were assessed in an attempt to locate sources of information and theoretical data that gave rise to the term definitions and uses employed in the articles.

After the coding and analysis of the articles, a conceptual map was constructed, according to the specifications of Novak,<sup>12</sup> the creator of this tool. The conceptual map is considered a knowledge-structuring tool. It can be understood as a visual representation used to share meanings, and relies heavily on the meaningful learning theory of David Ausubel,<sup>13</sup> which proposes that human beings organize their knowledge through the hierarchization of concepts.

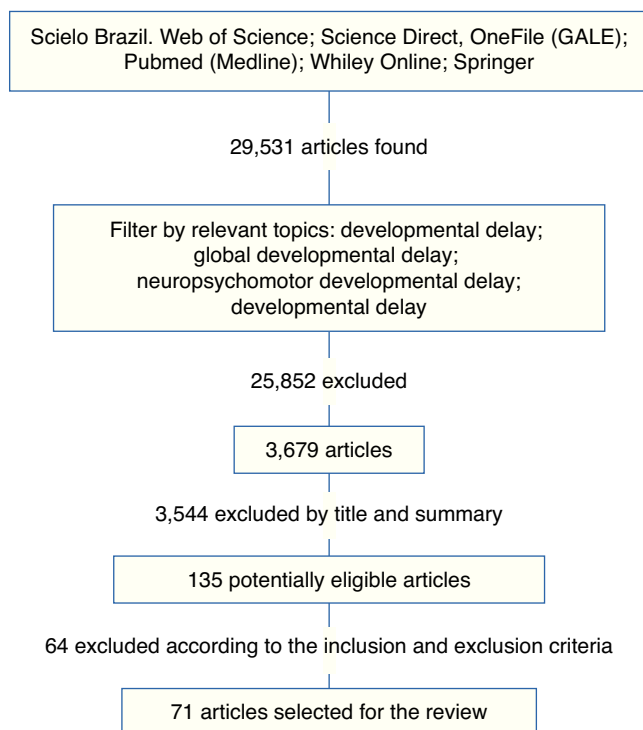
There are several types of maps, which can be used in different situations, according to the specific purpose. The conceptual map used in this review is the system type, which organizes the information in a format similar to a flow chart and shows the various associations between the concepts. The CmapTools software was used to create the conceptual map.<sup>14</sup>

## Results

Of the 71 articles selected for the review, 55 (77.5%) were international and 16 were national publications (22.5%). The terms global developmental delay and developmental delay were the most frequent in the international literature and emerged in the mid-1940s and 1960s, respectively, gaining strength in the 1990s. In Brazil, the terms *retardo do DNPM* and *atraso do DNPM* started to be used in the scientific area in the 1980s, but it was in the last decade that they started to be frequently mentioned in the literature.

### 1- Regarding the population to which the term was applied (Table 2)

As mentioned in 23 articles, 13 types of clinical conditions showed developmental delay as a characteristic. In the international literature, the first time the term was mentioned was



**Figure 1** Literature search steps.

**Table 2** Articles organized according to the population classified using the term neuropsychomotor developmental delay.

| Nº  | Title                                                                                                              | Author, year          | Type of article | Country        | Term                                 | Population                                                                                                              |
|-----|--------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|----------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1-  | Mental development of prematurely born children                                                                    | Benton, 1940          | Cross-sectional | United States  | Global developmental delay           | Preterm children                                                                                                        |
| 2-  | Impact of delayed development in premature infants on mother-infant interaction: a prospective investigation       | Minde et al, 1998     | Longitudinal    | Canada         | Developmental delay                  |                                                                                                                         |
| 3-  | Relation between very low birth weight and developmental delay among preschool children without disabilities       | Schendel et al, 1997  | Cross-sectional | United States  | Developmental delay                  |                                                                                                                         |
| 4-  | Developmental delay at 12 months in children born extremely preterm                                                | Lando et al, 2005     | Longitudinal    | United States  | Developmental delay                  |                                                                                                                         |
| 5-  | In pursuit of potential: a discussion of developmental delay, structuralization and one child's efforts at mastery | Socor, 1981           | Theoretical     | United States  | Developmental delay                  | Children with cerebral palsy                                                                                            |
| 6-  | Novelty responding and behavioral development in young, developmentally delayed children                           | Mundy et al, 1983     | Cross-sectional | United States  | Developmental delay                  | Children with chromosomal and congenital abnormalities, hydrocephalus, autism, alcoholic syndrome, and preterm children |
| 7-  | Preschool children with developmental delays: nursing intervention                                                 | Steele, 1998          | Descriptive     | United States  | Developmental delay                  |                                                                                                                         |
| 8-  | Benefits of early intervention for children with developmental disabilities                                        | Majnemer, 1998        | Theoretical     | Canada         | Global developmental delay           |                                                                                                                         |
| 9-  | Neurodevelopmental delay in small babies at term: a systematic review                                              | Arcangeli et al, 2012 | Review          | United Kingdom | Developmental delay                  |                                                                                                                         |
| 10- | Semiology of growth restriction: diagnostic script                                                                 | Marcondes, 1983       | Theoretical     | Brazil         | Neuropsychomotor developmental delay | Children with mental retardation                                                                                        |
| 11- | The etiology of developmental delay                                                                                | Aircardi, 1998        | Theoretical     | England        | Developmental delay                  |                                                                                                                         |
| 12- | Radiological findings in developmental delay                                                                       | Shaefer et al, 1998   | Theoretical     | United States  | Developmental delay                  |                                                                                                                         |
| 13- | Early experience and early intervention for children at risk for developmental delay and mental retardation        | Ramey et al, 1999     | Review          | United States  | Developmental delay                  |                                                                                                                         |

(Cont.)

**Table 2** Articles organized according to the population classified using the term neuropsychomotor developmental delay. (Cont.)

| Nº  | Title                                                                                                       | Author, year          | Type of article | Country        | Term                                 | Population                                                                    |
|-----|-------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|----------------|--------------------------------------|-------------------------------------------------------------------------------|
| 14- | Diagnostic evaluation of developmental delay/ mental retardation: an overview                               | Bataglia et al, 2003  | Review          | United States  | Developmental delay                  |                                                                               |
| 15- | Peer-related social interactions of developmentally delayed young children: development and characteristics | Guranilk et al, 1984  | Longitudinal    | United States  | Developmental delay                  | Children with chromosomal and congenital abnormalities and preterm children.  |
| 16- | Identifying patterns of developmental delays can help diagnose neurodevelopmental disorders                 | Tervo, 2006           | Theoretical     | United Kingdom | Global developmental delay           |                                                                               |
| 17- | Differences in the memory-based searching of delayed and normally developing young children                 | Deloache et al, 1987  | Cross-sectional | United States  | Developmental delay                  | Children with cerebral palsy, delayed language skills and preterm children    |
| 18- | Variability in adaptive behavior in children with developmental delay                                       | Bloom et al, 1994     | Cross-sectional | United States  | Developmental delay                  | Children with mental retardation and preterm children                         |
| 19- | The negative effects of positive reinforcement in teaching children with developmental delay                | Bierdeman et al, 1994 | Cross-sectional | Canada         | Developmental delay                  |                                                                               |
| 20- | Evaluation of neurodevelopmental delay in special-needs children at a university subnormal vision service   | Sampaio et al, 1999   | Cross-sectional | Brazil         | Neuropsychomotor developmental delay | Children with sensory impairment                                              |
| 21- | Early rehabilitation service utilization patterns in young children with developmental delays               | Majnemer et al, 2002  | Longitudinal    | Canada         | Global developmental delay           | Children with global delay, with motor delay, with language delay and autism. |
| 22- | Global developmental delay and its relationship to cognitive                                                | Grether, 2007         | Theoretical     | United States  | Global developmental delay           | Children with mental retardation, delayed motor development                   |
| 23- | Does race influence age of diagnosis for children with developmental delay?                                 | Mann et al, 2008      | Longitudinal    | United States  | Developmental delay                  | Children with cerebral palsy, with language delay and sensory impairment      |



**Table 3** Articles organized according to the use of the term neuropsychomotor developmental delay.

| Nº  | Title                                                                                                             | Author, year         | Type of article | Country       | Term                                 | Term use                                                                                                                                                                   |
|-----|-------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|---------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-  | The changing picture of cerebral dysfunction in early childhood                                                   | Solomons et al, 1963 | Longitudinal    | United States | Developmental delay                  | Children who do not exhibit typical development without obvious neurological signs that may indicate cerebral palsy<br><br>Children with low scores at developmental tests |
| 2-  | The status at two years of low-birth-weight infants born in 1974 with birth weights of less than 1,001 gm         | Pape et al, 1978     | Longitudinal    | Canada        | Developmental delay                  |                                                                                                                                                                            |
| 3-  | Relation between very low birth weight and developmental delay among preschool children without disabilities      | Schendel et al, 1997 | Cross-sectional | United States | Developmental delay                  |                                                                                                                                                                            |
| 4-  | Screening tests and standardized assessments used to identify and characterize developmental delays               | Rosenbaum, 1998      | Theoretical     | Canada        | Developmental delay                  |                                                                                                                                                                            |
| 5-  | Effects of testing context on ball skill performance in 5 year old children with or without developmental delay   | Doty et al, 1999     | Cross-sectional | United States | Developmental delay                  |                                                                                                                                                                            |
| 6-  | Etiologic evaluation in 247 children with global developmental delay at Istanbul Turkey                           | Ozmen et al, 2005    | Cross-sectional | Turkey        | Global Developmental delay           | To diagnose children with developmental delay and avoid labeling them                                                                                                      |
| 7-  | Assessment of the neuropsychomotor development of children living in the outskirts of Porto Alegre                | Saccani et al, 2007  | Cross-sectional | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                            |
| 8-  | Risk factors for suspected neuropsychomotor developmental delay at 12 months of age                               | Halpern et al, 2000  | Cross-sectional | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                            |
| 9-  | Natural history of suspected developmental delay between 12 and 24 months of age in the 2004 Pelotas birth cohort | Moura et al, 2010    | Longitudinal    | Brazil        | Global developmental delay           |                                                                                                                                                                            |
| 10- | Epidemiology in child neurology: a study of the most common diagnoses                                             | Lefèvre et al, 1982  | Descriptive     | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                            |
| 11- | Diagnosis of developmental delay: the geneticists approach                                                        | Lunt, 1994           | Theoretical     | England       | Developmental delay                  |                                                                                                                                                                            |
| 12- | Evaluation and management of children with low school achievement and attention deficit disorder                  | Araújo, 2002         | Review          | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                            |

(Cont.)

**Table 3** Articles organized according to the use of the term neuropsychomotor developmental delay. (Cont.)

| Nº  | Title                                                                                                                            | Author, year          | Type of article | Country       | Term                                         | Term use                                                                                                                                   |
|-----|----------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|---------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 13- | Global developmental delay and its relationship to cognitive                                                                     | Grether, 2007         | Theoretical     | United States | Global developmental delay                   | To diagnose children with developmental delay and avoid labeling them                                                                      |
| 14- | Acquisition of functional skills in the mobility area in children attending an early stimulation program                         | Hallal et al, 2008    | Cross-sectional | Brazil        | Neuropsychomotor developmental delay         |                                                                                                                                            |
| 15- | The infant or young child with developmental delay                                                                               | First et al, 1994     | Review          | United States | Developmental delay                          | In children who do not have the motor milestones expected for their chronological age                                                      |
| 16- | Classification of developmental delays                                                                                           | Petersen et al, 1998  | Theoretical     | United States | Developmental delay; psychomotor retardation | To identify children who have as the chief complaint the delay in meeting the developmental milestones in one or more areas of development |
| 17- | Diagnostic evaluation of developmental delay/mental retardation: an overview                                                     | Bataglia et al, 2003  | Review          | United States | Developmental delay                          | Children younger than 5 years of age with suspected mental retardation                                                                     |
| 18- | Clinical genetic evaluation of the child with mental retardation or developmental delays                                         | Moeschler et al, 2006 | Theoretical     | Canada        | Developmental delay                          |                                                                                                                                            |
| 19- | "Is My Child Normal?": Not all developmental problems are obvious. How to trust your instincts and tell if your child needs help | Costello et al, 2003  | Theoretical     | United States | Developmental delay                          | Children that show a peculiar variation of motor milestones when compared to the average child                                             |

to refer to preterm children and those with mental retardation. Subsequently, other conditions that included developmental delay were encompassed, such as cerebral palsy, autism, chromosomal abnormalities, and congenital abnormalities. In the late 1990s, it was expanded to the population of children who had no defined underlying pathology, but who had some kind of developmental delay as a characteristic.

In Brazil, the first time the term was mentioned, it also referred to children with mental retardation and, subsequently, to children with sensory impairments.

### Regarding use of the term (Table 3)

A total of 19 articles were found, which showed seven types of situations to which the term was applied. Internationally, it started to be used for children with neurological disorders that had atypical development or for children who did

not reach the motor development milestones expected for their chronological age. Subsequently, the concept of the delay was operationalized by means of norm-referenced tests for development. At the end of the 1990s, the term started to be used in children younger than five years, pending definitive diagnosis, as well as with diagnosis, albeit with no specific criteria.

In Brazil, the term started to be used in the 1980s as a diagnosis for children with mental retardation and, from the 1990s on, for any child that showed some type of developmental delay. Only more recently the term has been used for children with low scores on norm-referenced tests.

### Regarding definition of the term (Table 4)

Thirty-four articles included definitions, in which 16 different concepts were identified. In the international litera-



**Table 4** Articles organized according to the definition used for the term neuropsychomotor developmental delay.

| Nº  | Title                                                                                                                  | Author, year          | Type of article | Country       | Term                                 | Definition                                                                                                      |
|-----|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|---------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| 1-  | Child developmental delay and socio-economic disadvantage in Australia: a longitudinal study                           | Najman et al, 1992    | Longitudinal    | Australia     | Developmental delay                  | Delay in language development, cognition, motor skills, and social skills within a particular culture           |
| 2-  | Electrocochleography in children: study of 2,336 cases                                                                 | Ramos et al, 1992     | Cross-sectional | Brazil        | Neuropsychomotor developmental delay | A combination of microcephaly; phonal abnormalities with atypical brain development                             |
| 3-  | Pediatric assessment of the child with developmental delay                                                             | Levy et al, 1993      | Cross-sectional | United States | Developmental delay                  | Delay in two or more areas of child development with a standard deviation below the mean on developmental tests |
| 4-  | Diagnostic yield of the neurologic assessment of the developmentally delayed child                                     | Majnemer et al, 1995  | Longitudinal    | Canada        | Global developmental delay           |                                                                                                                 |
| 5-  | The evaluation of the child with a global developmental delay                                                          | Shevell, 1998         | Theoretical     | Canada        | Global developmental delay           |                                                                                                                 |
| 6-  | Etiologic yield of subspecialists' evaluation of young children with global developmental delay                        | Shevell, 2000         | Cross-sectional | Canada        | Global developmental delay           |                                                                                                                 |
| 7-  | Practice parameter: evaluation of the child with global developmental delay                                            | Shevell et al, 2003   | Review          | Canada        | Global developmental delay           |                                                                                                                 |
| 8-  | Developmental and functional outcomes in children with global developmental delay or developmental language impairment | Shevell et al, 2005   | Longitudinal    | Canada        | Global developmental delay           |                                                                                                                 |
| 9-  | Office evaluation of the child with developmental delay                                                                | Shevell, 2006         | Theoretical     | Canada        | Global developmental delay           |                                                                                                                 |
| 10- | Analysis of clinical features predicting etiologic yield in the assessment of global developmental delay               | Srour et al, 2006     | Longitudinal    | Canada        | Global developmental delay           |                                                                                                                 |
| 11- | Investigation of global developmental delay                                                                            | Mc Donald et al, 2006 | Review          | England       | Global developmental delay           |                                                                                                                 |
| 12- | Global developmental delay and its relationship to cognitive skills                                                    | Grether, 2007         | Theoretical     | United States | Global developmental delay           |                                                                                                                 |
| 13- | Global developmental delay and its relationship to cognitive skills.                                                   | Riou et al, 2008      | Longitudinal    | Canada        | Global developmental delay           | Delay in two or more areas of child development with a standard deviation below the mean on developmental tests |

(Cont.)

**Table 4** Articles organized according to the definition used for the term neuropsychomotor developmental delay. (Cont.)

| Nº  | Title                                                                                               | Author, year          | Type of article | Country       | Term                                 | Definition                                                                                                                                                                                                                             |
|-----|-----------------------------------------------------------------------------------------------------|-----------------------|-----------------|---------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14- | Investigation of developmental delay                                                                | Newton et al, 1995    | Theoretical     | England       | Developmental delay                  | The child reaches the developmental milestones, but significantly more slowly than the average for other children, and may have future learning difficulties                                                                           |
| 15- | A preliminary study of creative music therapy in the treatment of children with developmental delay | Aldridge et al, 1995  | Experimental    | Germany       | Developmental delay                  | A consequence of several physical, mental, and social difficulties                                                                                                                                                                     |
| 16- | Early intervention for young children with developmental delay: the Portage approach                | Cameron, 1997         | Review          | United States | Global developmental delay           | The result of several biological and environmental risk factors                                                                                                                                                                        |
| 17- | Study of primitive reflexes in normal preterm newborns in the first year of life                    | Olhweiler et al, 2005 | Cross-sectional | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                                                                                        |
| 18- | Choice of medical investigations for developmental delay: a questionnaire survey                    | Gringras, 1998        | Cross-sectional | United States | Developmental delay                  | A heterogeneous group of conditions resulting from the consequences of genetic, infectious, and chromosomal processes, and several other processes                                                                                     |
| 19- | Genetics and developmental delay                                                                    | Mac Millan, 1998      | Theoretical     | United States | Developmental delay                  |                                                                                                                                                                                                                                        |
| 20- | Motor profile in school children with learning difficulties                                         | Rosa-Neto et al, 2005 | Cross-sectional | Brazil        | Neuropsychomotor developmental delay | A symptom that something is not as expected                                                                                                                                                                                            |
| 21- | Early intervention in developmental delay                                                           | Kaur et al, 2006      | Cross-sectional | India         | Developmental delay                  | The physical, cognitive, language, social, or emotional delay, or a condition prone to delay of development                                                                                                                            |
| 22- | Determinants of developmental delay in infants aged 12 months                                       | Slykerman et al, 2007 | Longitudinal    | New Zealand   | Developmental delay                  | The delay of motor milestones that may not necessarily be related to cognitive impairment, but rather to hypotonia or poor motor coordination, albeit without neurological signs, which does not justify a diagnosis of cerebral palsy |
| 23- | Assessment of the neuropsychomotor development of children living in the outskirts of Porto Alegre  | Saccani et al, 2007   | Cross-sectional | Brazil        | Neuropsychomotor developmental delay | A childhood development syndrome                                                                                                                                                                                                       |

(Cont.)

**Table 4** Articles organized according to the definition used for the term neuropsychomotor developmental delay. (*Cont.*)

| Nº  | Title                                                                                                                                 | Author, year         | Type of article | Country       | Term                                 | Definition                                                                                                                                                                            |
|-----|---------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|---------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24- | Characterization of motor performance in schoolchildren with attention deficit disorder and hyperactivity disorder                    | Toniolo et al, 2009  | Cross-sectional | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                                       |
| 25- | Developmental delay syndromes: psychometric testing before and after chiropractic treatment of 157 children                           | Cuthbert et al, 2009 | Cross-sectional | United States | Developmental delay                  |                                                                                                                                                                                       |
| 26- | Global developmental delay and mental retardation or intellectual disability: conceptualization, evaluation, and etiology             | Shevell, 2008        | Theoretical     | Canada        | Global developmental delay           | A disorder or a dysfunction of childhood development                                                                                                                                  |
| 27- | Difficulties and facilities experienced by families in the care of children with cerebral palsy                                       | Dantas et al, 2012   | Descriptive     | Brazil        | Neuropsychomotor developmental delay |                                                                                                                                                                                       |
| 28- | Global developmental delay - globally helpful?                                                                                        | Willians, 2010       | Theoretical     | United States | Global developmental delay           | Delay in two or more fields of development considered significant                                                                                                                     |
| 29- | Present conceptualization of early childhood neurodevelopmental disabilities                                                          | Shevell, 2010        | Theoretical     | Canada        | Global developmental delay           | when a discrepancy of 25% or more of the expected rate or a difference 1.5 to 2 standard deviations from the norm occurs in one or more areas of development in norm-referenced tests |
| 30- | Developmental delay: timely identification and assessment                                                                             | Pool et al, 2010     | Review          | United States | Developmental delay                  |                                                                                                                                                                                       |
| 31- | Evaluation of children with global developmental delay: A prospective study at Sultan Qaboos University Hospital, Oman                | Kou et al, 2012      | Cross-sectional | Saudi Arabia  | Global developmental delay           |                                                                                                                                                                                       |
| 32- | Characterization of the diagnostic profile and flow of a speech-language pathology service in child language within a public hospital | Mandrá et al, 2011   | Cross-sectional | Brazil        | Neuropsychomotor developmental delay | A comorbidity of child development                                                                                                                                                    |
| 33- | Profile of special needs patients at a pediatric dentistry clinic                                                                     | Menezes et al, 2011  | Cross-sectional | Brazil        | Neuropsychomotor developmental delay | A type of special needs in child development                                                                                                                                          |
| 34- | Monitoring of child development carried out in Brazil                                                                                 | Zeppone et al, 2012  | Review          | Brazil        | Neuropsychomotor developmental delay | Progressive non-acquisition of motor and psychocognitive skills that progresses in the cephalocaudal and proximal-distal direction                                                    |

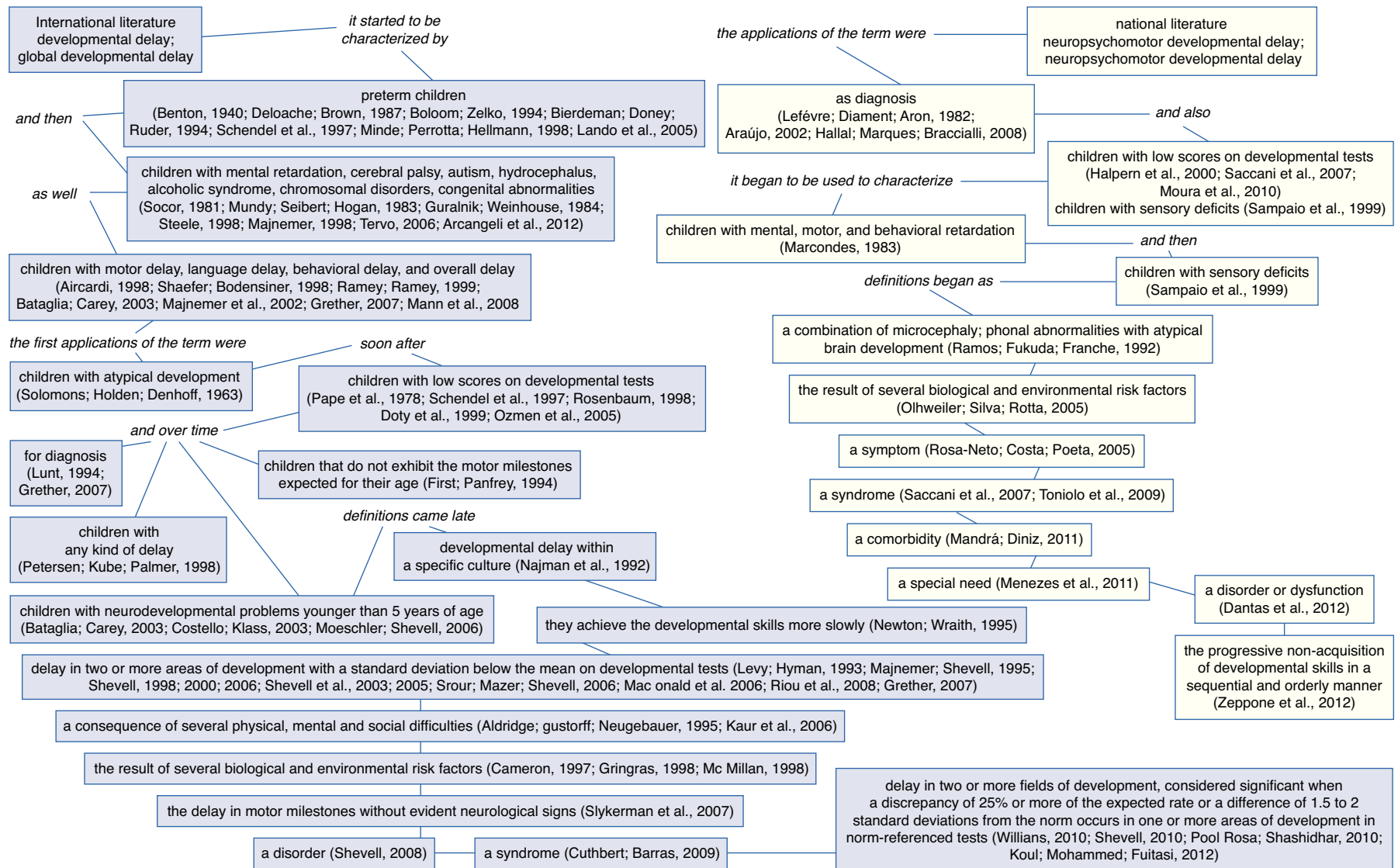


Figure 2 Conceptual map of the term neuropsychomotor developmental delay.

ture, the term definitions started to appear in the 1990s, and the concept initially referred to a slower development than other children from the same culture; such delayed development was attributed to a heterogeneous group of biological and environmental factors.

Since 2000, other term definitions emerged based on the motor milestones of development, which could be justified by hypotonia or poor motor coordination without specific cause, and the delay should be quantified by applying the norm-referenced tests. Recently, the term was conceptualized by the American Academy of Neurology and the Child Neurology Committee<sup>11</sup> as a delay in two or more areas of development, considered significant when a discrepancy of 25% or more of the expected rate occurs, or a difference of 1.5-2.0 standard deviations from the norm in one or more areas of development in norm-referenced tests.

In Brazil, in the early 1990s, the term was conceptualized as a combination of microcephaly, with phonal abnormalities and atypical brain development. Over the last decade, it received several meanings, as a symptom, syndrome, disorder, comorbidity, and even as a special need. The most recent Brazilian article defines the term as the progressive non-acquisition of motor and psychocognitive skills in an orderly and sequential manner, which progresses in the cephalocaudal direction, and from the proximal to the distal.

Based on the analysis of tables and information obtained from the articles, the conceptual map was constructed (Fig. 2), showing the origin of the terms related to developmental delay and evolution over time.

## Discussion

The present review shows that, in the international literature, the terms related to the NPMD delay started to be used in studies on cognitive development of preterm children. The oldest study identified, by Benton<sup>15</sup> in 1940, used the Stanford-Binet intelligence test to characterize developmental delay in children born prematurely. According to the author, although preterm children were not intellectually inferior, they suffered from anxiety, nervousness, and fatigue, resulting in distraction and poor concentration. Thus, it can be observed that, in the scientific literature, the early works on developmental delay used cognitive tests,<sup>16</sup> soon followed by the extensive work of Gesell,<sup>17</sup> who created the first scale of developmental milestones by age range in 1940 and gave rise to further studies that sought to characterize developmental delay in several populations.

Gesell's studies were disseminated worldwide, inspiring the creation of several currently used development tests and influencing the use of the term developmental delay, thus one of the most frequent use scenarios found in this study was the operationalization of the term through developmental tests.<sup>18-22</sup> For instance, in one of the first references located, in 1978 Pape and colleagues<sup>19</sup> adopted as criteria for developmental delay in infants the development index below that expected for age assessed according to first version of the Bayley Scales of Infant Development,<sup>23</sup> a test based on the work of Gesell.

Nevertheless, although the term developmental delay has emerged from the neuromaturational perspective<sup>17</sup> and

has been widely used in the area of child health, there is no term consensus regarding both the population to which it is applied (Table 2)<sup>15,24</sup> and the term use (Table 3).<sup>25,26</sup> In both situations, the term is mentioned in a generalized and excessively encompassing manner; this range of possibilities can be justified by the most widely used method to identify children with delay: developmental screening.<sup>18-22</sup>

In fact, developmental screening is the best option to screen children with developmental problems, as it is a fast procedure suitable for application to large populations of children of several age groups.<sup>27</sup> However, some reviewed studies<sup>5,28,29</sup> mention that *ad hoc* assessments of development in children younger than five years of age are unreliable to establish a definitive diagnosis, suggesting that the term developmental delay should be used as a temporary diagnosis.

One problem is that this use, even when it is temporary, gives the impression of a relatively benign condition that is resolved over time. However, the studies reviewed<sup>30-32</sup> on the outcome of children that had developmental delay in the first years of life show persistent developmental difficulties. Newton and Wraith<sup>33</sup> stated that most children younger than 5 years of age with developmental delay will have some type of learning disability at school age, and thus, it is important to attain a correct diagnosis.

Some authors<sup>29,34</sup> suggest that, considering these remaining problems, development monitoring in this population would be beneficial. Such an approach would involve periodic reassessments at key points of development, with the aim not only to identify problems as they arise, with referral to early intervention, but also to assist the achievement of a definitive diagnosis.<sup>27,35</sup>

Another aspect identified in this review refers to the term definitions (Table 4), which only started to emerge in the mid-1990s, but in a quite heterogeneous manner. This need to better define the concept may have been caused by a lack of standardization, which became unsustainable with the significant increase in publications from this period onward.

Some authors started to conceptualize the term based on the results of their studies, such as Najman et al<sup>36</sup> in 1992, when they studied the development of Australian children from the perspective of socioeconomic inequality, considered a national problem in the country, and found a higher prevalence of developmental delay in children who had mothers with low educational and socioeconomic levels. Based on this finding, the authors conceptualized the delay as the result of biological and environmental factors within a specific culture. That is, different factors interacting with the child's development, influencing the acquisition of motor, cognitive, language, and social skills.

In the last decade, international publications have shown more standardized definitions, consistent with the scientific advances in the area. The most recent concept that was suggested by the medical community<sup>10,37,38</sup> was operationally defined by the American Academy of Neurology and the Child Neurology Committee.<sup>10</sup> The definition, as mentioned before, encourages the use of validated tests, with norms and reference criteria to support the reliable measurement of relevant clinical data that can confirm the developmental delay.<sup>10</sup>

The Committee also suggests tests that can be used for each domain - motor domain: Alberta Infant Motor Scale; Peabody Developmental Motor Scale; Bruininks-Oseretsky Test of Motor Proficiency; phonol/language domain: Language-Peabody Picture Vocabulary Test; Expressive One Word Vocabulary Test; Clinical Linguistic Auditory Milestone Scale; Clinical Evaluation of Language Fundamentals; behavioral domain: Vineland Adaptive Behavior Scales, Pediatric Evaluation of Disability Inventory, Wee Functional Independence Measure; and for multiple domains: Batelle Developmental Inventory.<sup>10</sup>

As for the definitions in Brazil, over the decades little conceptual evolution can be observed, but many meanings.<sup>39-45</sup> The implicit concept in the term also follows the neuromaturational perspective;<sup>17</sup> however, it does not have quantitative parameters as found in other countries.<sup>10</sup> That is, the Brazilian definitions do not encourage the use of tools for development assessment, which is justified by the small number of child development tests that have been validated and standardized for the Brazilian population.

In fact, in Brazil, the use of the term in scientific publications began more recently,<sup>46</sup> in 1982, than in the international literature<sup>15</sup> and very specific names, uses, and definitions were found in the literature. Starting with the terminology, in Brazil the first mention found was NPMD retardation,<sup>47</sup> with the addition of the word psychomotor, which is not used in the international literature. This term originated in the mid-1950s, used by the neurologist Lefèvre<sup>48</sup> in his habilitation thesis (1950), in which he argued that, for the child to develop neuropsychomotor skills, he/she needs both neural growth and maturation, and psychological and motor aspects. In his thesis, Lefèvre presents the first scale for neuromotor assessment for Brazilian children, based on the works of Ozeretski (1936)<sup>49</sup> and the psychiatrist Ajuriaguerra (1948),<sup>50</sup> where, possibly, the term psychomotor came from.

The closest term to NPMD retardation, found in the reviewed works written in the English language, was psychomotor retardation, used by Fenichel (quoting Petersen, Kube, Palmer, 1998),<sup>5</sup> to refer to "children with mild mental retardation and motor delay, caused by mild hypotonia or poor motor coordination rather than low cognitive function." It is noteworthy that the term psychomotor is used only in Brazil. As the work of Lefèvre was very influential, it possibly determined the future use of the term.

In the first Brazilian scientific publications, the term NPMD delay was used as a diagnostic term to refer children to with cognitive impairment and mild motor delay, widely used by neurologists in Brazil. For instance, in 1982, Lefèvre and Diamant,<sup>46</sup> in a study performed with the objective of mapping the most common diagnoses in child neurology in Brazil, found that among the 16 most frequent diagnoses, NPMD delay was the third most common. Shortly thereafter, this term became known as delayed NPMD, described by Marcondes,<sup>51</sup> but keeping the same emphasis on the use, as a way to soften the terminology, since the term retardation was associated with children with severe impairment.

The conceptual map (Fig. 2) shows that there are several definitions, and that the international literature, in addition to showing a richer repertoire, is more concerned with the standardization of the term definition and the incen-

tive to research the cause of the delay, investing, in more recent studies, in specific diagnostic tests.<sup>52</sup> This is not observed in Brazil, as in addition to the fact that the literature on the topic is recent, it is also scarce, with very specific definitions and studies more focused on the risk factors for the delay.

In short, it is observed that the developmental delay is discussed in the international and national literature under different names, and has different applications and heterogeneous concepts. However, studies call attention to a fact in common, that *something is not going well* with the child, as he/she does not follow the expected sequence of important acquisitions for development. Internationally, an investment in definition standardization has been observed, which was not seen in national publications.<sup>10,11</sup> In other countries, the recommendation is to use the term in children younger than five years of age with developmental abnormalities, always identified by standardized tests,<sup>5,28,29</sup> and to employ periodic reviews with the aid of additional tests during the first years of life, in an attempt to find the cause of the delay and establish the final diagnosis.<sup>29,53</sup>

## Conclusion

A more precise definition of NPMD delay is essential for adequate care provision. However, the use of this term has generated difficulties in direct clinical decisions on the levels of assessment, intervention, and definition of prognosis of small children. Internationally, methods to improve communication between professionals, with standardized definition of the term and its use in very specific situations, have been proposed.

In Brazil, it is necessary to invest in both the standardization of the term, as well as in well-documented follow-up programs of children with suspected delay. The monitoring of development is a process that can help professionals and parents to understand what happens to the child, up to the establishment of the final diagnosis, as the term NPMD delay is more appropriately used as a temporary diagnosis.

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## Conflicts of interest

The authors declare no conflicts of interest.

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