

**Influence of high weight on motor development in infants: an integrative review****Influência do peso elevado no desenvolvimento motor de lactentes: uma revisão integrativa****Influencia del peso elevado en el desarrollo motor de lactantes: una revisión integrativa****Recebido: 19/08/2019****Aprovado: 18/06/2020****Publicado: 07/10/2020****Carolina Fioroni Ribeiro da Silva<sup>1</sup>****Roberta Jéssica Silva Pires<sup>2</sup>****Igor de Oliveira Loss<sup>3</sup>****Elaine Leonezi Guimarães<sup>4</sup>**

This is an integrative review considering the period between the years of 2007 to 2019, aim the knowledge of publications about the influence of overweight or obesity on the motor development of infants. The databases considered were: PubMed, Medical Subject Headings, LILACS, MEDLINE, Biblioteca Cochrane, PEDro and Science Direct and the descriptors: " obesity ", " overweight ", " motor development " and "infants" . From an initial search of 210 articles, four articles were considered. Studies have shown that having a high weight/age ratio appears to be a risk factor for delayed infant and cognitive development. It is important to monitor the development of the infant with high weight, guide and intervene in order to minimize and prevent changes, taking care that they do not extend and harm the child in school age, and adulthood. The need for further studies on the subject proved to be urgent.

**Descriptors:** Obesity; Overweight; Child development; Infant.

Esta é uma revisão integrativa considerando o período de 2007 a 2019, com o objetivo de conhecer as publicações acerca da influência do sobrepeso ou obesidade no desenvolvimento motor de lactentes. As bases de dados consideradas foram: PubMed, Medical Subject Headings, LILACS, MEDLINE, Biblioteca Cochrane, PEDro e Science Direct e os descritores: "obesidade", "sobrepeso", "desenvolvimento motor" e "lactentes". De uma busca inicial de 210 artigos foram considerados quatro artigos. Os estudos demonstraram que o peso elevado para a idade parece ser um fator de risco para atraso no desenvolvimento motor e cognitivo do lactente. É importante acompanhar o desenvolvimento do lactente com peso elevado, orientar e intervir de maneira a minimizar e prevenir alterações, cuidando para que estas não se estendam e prejudiquem a criança na idade escolar, e, idade adulta. A necessidade de mais estudos na temática se mostrou premente.

**Descritores:** Obesidade; Sobrepeso; Desenvolvimento infantil; Lactente.

Esta es una revisión integrativa que considera el período comprendido entre 2007 y 2019, con el objetivo de conocer las publicaciones acerca de la influencia del sobrepeso o la obesidad en el desarrollo motor de lactantes. Las bases de datos consideradas fueron: PubMed, Medical Subject Headings, LILACS, MEDLINE, Biblioteca Cochrane, PEDro y Science Direct y los descriptores: "obesidad", "sobrepeso", "desarrollo motor" y "lactantes". A partir de una búsqueda inicial de 210 artículos, se consideraron cuatro artículos. Los estudios mostraron que el peso elevado para la edad parece ser un factor de riesgo para el retraso del desarrollo motor y cognitivo de los lactantes. Es importante seguir el desarrollo del lactante con un peso elevado, orientar e intervenir para minimizar y prevenir los cambios, cuidando que no se extiendan y dañen al niño en la edad escolar y en la edad adulta. La necesidad de más estudios acerca del tema ha demostrado ser urgente.

**Descriptores:** Obesidad; Sobrepeso; Desarrollo infantil; Lactante.

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## INTRODUCTION

**H**igh birth weight seems to be associated with the development of obesity and overweight in childhood and adolescence<sup>1,2</sup>, presenting a multifactorial character, related to environmental and biological aspects<sup>3</sup>.

The prevalence of childhood obesity has increased worldwide, and is associated with risk factors for cardiovascular, orthopedic, psychosocial and metabolic disorders, which in the long term increase mortality<sup>1,4,5</sup>. About 50% of obese children at six months of age, and 80% of obese children at five years of age, will remain obese. In addition, scientific evidence has revealed pathological processes (atherosclerosis and arterial hypertension) related to obesity, present since childhood, a period in which eating and physical activity habits are formed<sup>6</sup>.

Simultaneously with anthropometric growth, from birth the child begins to develop their motor skills. Motor development, in turn, is characterized by the acquisition of motor skills such as: moving around the environment in various ways (walking, running and jumping), and manipulating several objects and instruments (catching a ball, throwing a stone, kicking), skills that enable the child to have a wide domain of their body in different postures (static and dynamic). This process occurs in a dynamic way, and it is different from one individual to another, with specific characteristics (organic, psychological, motivational and among others). Among these characteristics is the ability to manage movement and balance of one's own body weight<sup>7-9</sup>.

In Brazil, data relating to childhood obesity and the child's motor development are still limited to specific age groups (children or adolescents separately) and, not always with representative samples of the entire child population, especially preschoolers<sup>9</sup>.

Thus, given the possibility of obesity and/or overweight influencing the child's motor development, this study aims to get acquainted with publications about the influence of overweight or obesity on the motor development of infants.

## METHOD

This is an integrative literature review, which seeks to synthesize results obtained in research on the theme in a systematic, orderly and comprehensive manner, providing broader information on the subject<sup>10</sup>.

The search strategy used included searches in the electronic databases: National Library of Medicine (PubMed), Medical Subject Headings, Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), Medical Literature Analysis and Retrieval System Online (MEDLINE), Biblioteca Cochrane, PEDro and Science Direct. The descriptors were chosen according to the HSD (Health Sciences Descriptors), "obesity", "overweight", "motor development" and "infants" were used; and according to MSH (Medical Subject Headings), "obesity", "overweight", "motor development" and "infant" were used.

The selection of articles after searching the databases considered those published in English, Spanish and Portuguese, from 2007 to 2019, and in indexed journals with an impact factor (JCR) greater than or equal to one. Editorials, letters to editor, book chapter reviews, duplicate articles in different databases, articles with discrepancy between title and abstract and/or the overall content of the article were excluded.

The selection process of articles was carried out by two people, who worked independently and blindly, guided by a third participant, and with critical analysis by a fourth researcher.

The Cochrane Collaboration<sup>11</sup> model was followed as the basis, in which the researchers selected the articles by means of titles and abstracts, excluding those that did not meet the inclusion criteria, which showed no association with descriptors defined for the search, and duplicates. Then the articles were read in full, in case of disagreement, the researchers read and discussed the articles together, and determined the selection.

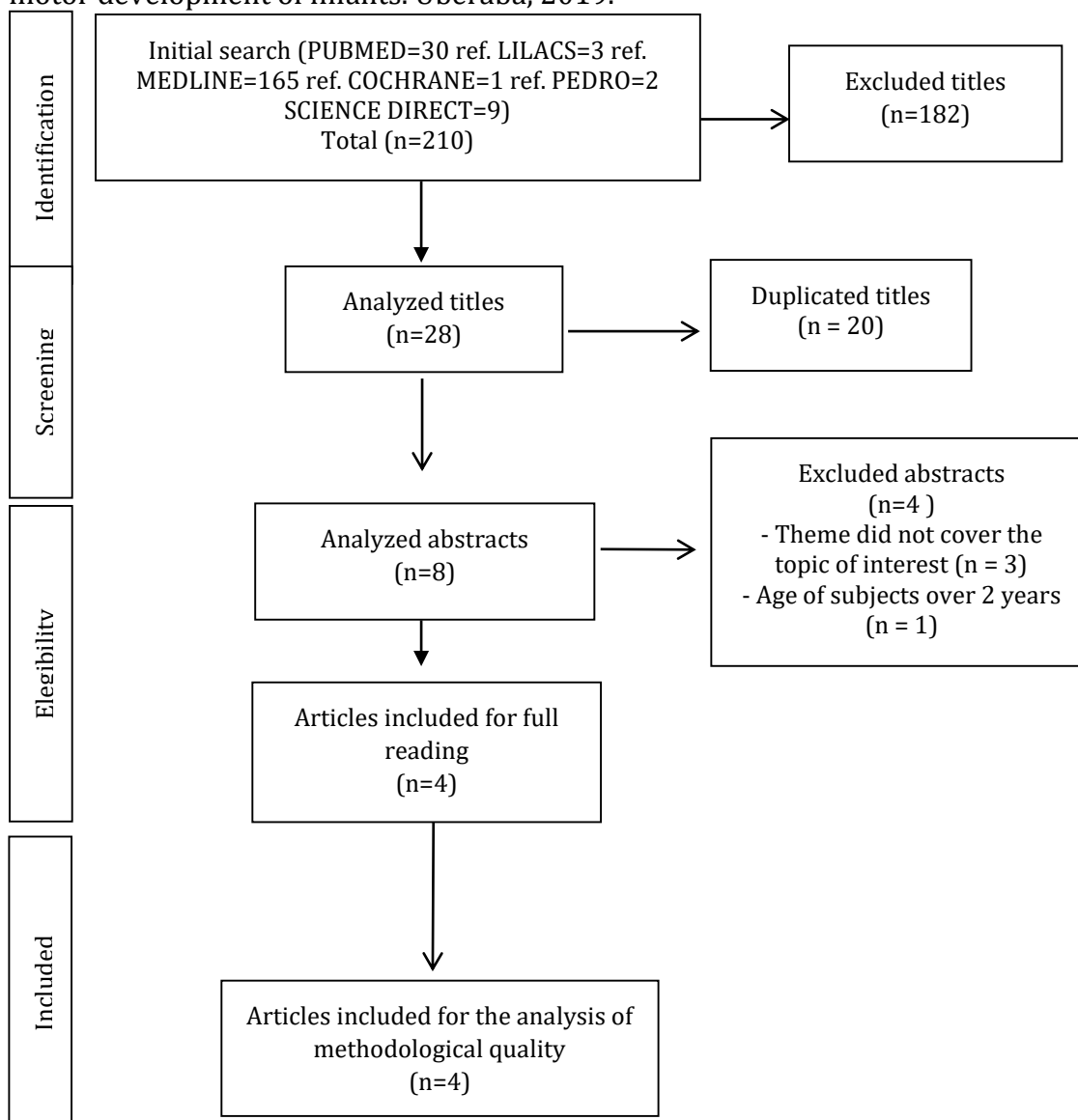
To assess reliability among researchers, the Kappa index was used, obtaining the value one, indicating strong reliability.

## RESULTS

Figure 1 shows the search and selection process for the studies considered for this review. Initially, 210 articles were found, but 182 of these could not be included in the study after reading the titles. Of the remaining 28 studies, 20 were excluded because they had duplicate titles, and four were excluded after reading the abstracts. There were then only four articles that met all the pre-established criteria.

In turn, Table 1 shows the characterization of the articles considering: authors/year of publication, title, participants/analyzes, results, country, journal and impact factor of the journal.

**Figure 1.** Search and selection of the included studies about the Influence of high weight in the motor development of infants. Uberaba, 2019.



**Table 1.** Selected studies on the influence of high weight on the motor development of infants. Uberaba, 2019.

Author	Title	Type of Study	Participants/ Analysis	Results	Country	Journal/ Impact Factor
BOVE <i>et al.</i> (2012) <sup>12</sup>	Stunting, overweight and child development impairment go hand in hand as key problems of early infancy: Uruguayan case	Cross-sectional study	2,069 children under 5 years of age participated (mean age in months = $28.4 \pm 17.1$ months). Anthropometric, socioeconomic, demographic and child health data were evaluated. Motor, social and emotional domains were measured through an interview (Catholic Chile University questionnaire) applied to the children's guardians. To assess the relationship between variables, multiple logistic regression analyzes were used.	Excess weight impairs children's neuropsychomotor development. It showed a positive association between weight and development.	Uruguay	Revista Early Human Development 2,26
CAMARGOS <i>et al.</i> (2016) <sup>13</sup>	Overweight and obese infants present lower cognitive and motor development scores than normal-weight peers	Cross-sectional study	56 infants participated with ages between 6 to 24 months (28 in the overweight/obese group and 28 in the normal weight group). All were assessed using the Bayley-III scale motor. Independent t test was used to compare groups, and Spearman correlation to test the association between anthropometric parameters with cognitive and motor scores.	Lower motor and cognitive scores in overweight/obese infants, being: cognitive ( $p = 0.03$ ); motor $p = 0.04$ ).	Brazil	Revista Research in Developmental Disabilities 1,50

CAMARGOS <i>et al.</i> (2017) <sup>14</sup>	Association between obesity-related biomarkers and cognitive and motor development in infants	Cross-sectional study	Fifty infants with ages between 6 to 24 months participated (25 in the overweight/obesity group and 25 in the normal weight group). Using the ELISA method, plasma levels of leptin, adiponectin, resistin, soluble tumor necrosis factor 1 and 2 receptors (sTNFR1 and sTNFR2), chemokines, brain-derived neurotrophic factor (BDNF), serum cortisol and redox status were measured. Motor and cognitive development was assessed using the Bayley-III scale. Multiple linear regression models were performed to verify the association between the selected biomarkers and motor and cognitive development.	It was found that obesity-related biomarkers are associated with infant motor development in the first years of life. A significant association was found between the plasma levels of sTNFR1, which explained 24% of the variability of the compound motor scores ( $p = 0.003$ ). And, the plasma levels of leptin and sTNFR1 together, explained 37% of the variability of the cognitive composite scores ( $p = 0.001$ ).	Brazil	Behavioural Brain Research  3,48
DINKEL <i>et al.</i> (2017) <sup>15</sup>	Postural control strategies differ in normal weight and overweight infants	Cross-sectional study	29 infants participated (19 with adequate weight, and 10 with overweight). The child's length and weight were measured at 3 months of age (visit 1). The infant's center of pressure (COP) was measured on a force platform at the beginning of the session (visit 2) and one month after the start of follow-up (visit 3).	Overweight infants showed more oscillations and an excessively flexible strategy to control sitting posture, compared to infants with adequate weight.	United States	Revista Gait & Posture  2,27

## DISCUSSION

In the first study<sup>12</sup> identified, there was damage to excess weight in neuropsychomotor development, obtaining a positive association between weight and developmental delay. It was also considered the importance of other risk factors such as psychological, social and nutritional disorders, to be evaluated simultaneously with the neuropsychomotor development of infants, since these factors demonstrate short and long-term repercussions on health, learning and socialization. In this study, anthropometric, socioeconomic, demographic data, child health data, as well as motor, social and emotional domains were considered, using the Catholic Chile University questionnaire, answered by those responsible for infants<sup>12</sup>.

Using the Bayley-III scale, the gold standard to assess neuropsychomotor development, there was a significant difference in the score achieved by overweight or obese infants, in the motor and cognitive domains, compared to infants with appropriate weight for their age, indicating that weight high for age can be a risk factor for delayed neuropsychomotor development<sup>13</sup>.

In 2017, a study found harmful effects of the levels of biomarkers of obesity and overweight, such as TNFR1 and Leptin, on neuropsychomotor development, more precisely in the motor and cognitive domains<sup>14</sup>. In this study, plasma levels of leptin, adiponectin, resistin, soluble tumor necrosis factor 1 and 2 receptors (sTNFR1 and sTNFR2), chemokines, brain-derived neurotrophic factor (BDNF), serum cortisol and redox status, and, thus, the association with the motor and cognitive scores achieved by the infant in the evaluation using the Bayley-III Scale was also observed<sup>14</sup>. The results indicated a significant association between the plasma levels of sTNFR1, which explained 24% of the variability of the compound motor scores ( $p = 0.003$ ). And, the plasma levels of leptin and sTNFR1 together, explained 37% of the variability of the cognitive compound scores ( $p = 0.001$ ). This result indicates the possible negative influence of overweight/obesity on children's motor development in the first years of life<sup>14</sup>.

Regarding the acquisition of independent sitting posture, assessed by means of the infant's center of pressure (COP), using a force platform, it was found that overweight/obese infants presented more oscillations and different strategies to remain in the sitting posture than infants with appropriate weight for their age, although there are different strategies to maintain posture, there was no significant difference between groups<sup>15</sup>.

In general, the selected studies demonstrated that overweight/obese infants had lower motor performance compared to infants with appropriate weight for their age. Thus, such studies consider overweight/obesity as a risk factor for neuropsychomotor development<sup>12-15</sup>. In addition, two studies<sup>13,14</sup> showed evident delay in the cognitive and motor domains.

There were few studies found relating motor development to overweight or obesity, in the age group from zero to two years, that is, in early childhood, a period considered to be the most neuroplasticity of the central nervous system<sup>16</sup>.

The selected articles<sup>12-15</sup> indicated that excess body weight is associated with difficulty in the acquisition of motor skills, as well as delayed motor and cognitive development, which can also cause impairments in the development of skills at school age<sup>12,17</sup>.

A cross-sectional study<sup>18</sup> carried out with children under 5 years of age, therefore, including infants, showed that obese or overweight children have significantly delayed motor development. In turn, it is important to have a simultaneous assessment: of motor development, of psychological, social and nutritional aspects, since these factors have a short and long term impact on health, learning and socialization, corroborating with other studies<sup>12,17, 18</sup>.

Adjusted for the variables of confusion, age, gender, socioeconomic status, maternal education and exclusive breastfeeding, it was observed that overweight and/or obese infants are more likely to have delayed motor and cognitive development. A lower score was observed in the motor (thick and thin) and cognitive domains, with a significant difference in the motor development domain. In the cognitive domain, infants in the obese and overweight group also obtained lower scores, however, there was a weak correlation, indicating the need for further studies to better assess cognitive development<sup>13</sup>.

Comparing motor development with the levels of plasma concentration of leptin, adiponectin, resistin, soluble receptors for tumor necrosis factor 1 and 2 (sTNFR1 and sTNFR2), brain-derived neurotrophic factor (BDNF) and serum cortisol concentrations, in infants with overweight/obesity and eutrophic, the presence of neuroendocrine-inflammatory changes was found only in infants with overweight/obesity<sup>14</sup>, as well as changes in motor development<sup>12,13</sup>.

There was a significant association between the plasma concentrations of leptin, a hormone synthesized by adipocytes, with an adjuvant function in the hunger inhibition process via hypothalamus<sup>17</sup>, and sTNFR1, with the cognitive compound score ( $p = 0.001$ ) only in overweight/obese infants. Thus, children in the overweight/obesity group had lower scores for motor development ( $p = 0.04$ ) and cognitive ( $p = 0.03$ )<sup>14</sup>.

Evidence regarding the acquisition of sitting points out that overweight/obese infants can acquire the sitting posture at the same time as infants with adequate weight. However, overweight/obese infants showed excessive strategies to control the sitting posture, and, with

many oscillations. Thus, high weight can impair the exploration of the environment, as well as the maintenance of sitting posture, requiring greater energy expenditure to acquire and maintain some postures during development<sup>9,15</sup>.

Despite scarce studies, the results are worrisome, since overweight/obesity in childhood is considered a public health problem. Estimates indicate increasing obesity in Brazil. In children between five and nine years old, it is estimated that one in three is already overweight<sup>14</sup>. Thus, it is not difficult to believe that this starts even before the age of five, compromising the infant's development.

The increased incidence of overweight/obesity in the last 30 years suggests an alarm to health, as this condition can influence not only the child's health in early childhood, but also in adolescence and adulthood<sup>17-19</sup>.

In an attempt to explain which risk factors may predispose overweight and obesity in childhood, some studies<sup>20,21</sup> show that obesity during pregnancy, caesarean section and the microbiota present in the intestine of infants are factors that can lead children to overweight/early obesity, aged 1 to 3 years. On the other hand, exclusive breastfeeding proves to be a protective factor against overweight/obesity in early childhood<sup>20</sup>.

In recent years, an increasing rate of overweight/obesity in preterm infants has been observed. The high weight occurs due to inadequate food, since, in order to reach the appropriate weight, families look for inadequate food supplements<sup>21</sup>.

Considering childhood obesity a public health problem that can negatively influence child development, in addition to other health problems for infants, preventive measures against obesity should be sought from early childhood, in order to avoid and/or minimize the consequent motor, cognitive, cardiovascular, metabolic and orthopedic disorders that may extend into adulthood<sup>19,20</sup>.

In the first year of life, the child is in a constant process of development, due to neuroplasticity. This period is considered excellent for the acquisition of motor skills, that is, the infant is able to receive, interpret and respond to intrinsic and extrinsic stimuli<sup>9</sup>. Thus, it is important to identify early, possible dysfunctions in the process of acquiring motor skills, as well as paying attention to all risk factors that may influence the process of neuropsychomotor development<sup>22-25</sup>, in order to intervene also early.

Programs to prevent and combat childhood obesity in early childhood, based on scientific evidence, must consider the context of life of each infant and their individual needs, and thus offer guidance on changes in family life habits, stimulate and value the practice of physical activity, and food adequacy.

## CONCLUSION

The high weight for age seems to impair the acquisition of motor skills of children in early childhood, causing delayed motor development.

In this sense, it is recommended to monitor the development of infants, seeking to detect the condition of overweight/obesity early, in order to start multidisciplinary intervention as soon as possible, to minimize and/or prevent changes, especially in the age group from zero to two years, a period considered optimal for neuropsychomotor development. And, thus, minimize the possible losses also at school age, and, consequently, at adulthood.

The dissemination of studies by means of scientific productions for the promotion of experiences allows to subsidize professionals in the elaboration and planning of multidisciplinary programs for the prevention and/or intervention of obesity and delayed development of the infant.

As limitations of the present study, there is a lack of specific studies, relating obesity and motor development of children from zero to two years of age. This limits the discussion, and consequently, the conclusions about the possible therapeutic inferences, justifying the need for more empirical studies on the subject.

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**CONTRIBUTIONS**

**Carolina Fioroni Ribeiro da Silva** and **Elaine Leonezi Guimarães** contributed to the conception, data collection and analysis, writing and revision. **Igor de Oliveira Loss** collaborated in writing and reviewing. **Roberta Jéssica Silva Pires** worked on obtaining data and analysis and writing.

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