

Breastfeeding Early in Life Is Associated with Better Athletic Performance in Childhood and Adolescence: A Systematic Review

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Abstract: Breastfeeding provides many short- and long-term benefits for both the child and the mother. However, little is known whether longer duration of exclusive breastfeeding early in life is associated with better athletic performance in childhood and adolescence. The present study aimed to investigate the association between breastfeeding and athletic performance. Methods: Three electronic databases (PUBMED, SCIENCE DIRECT, SCOPUS) were searched. The search and selection of articles followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Outcomes evaluated were breastfeeding duration and athletic performance parameters such as cardiorespiratory fitness, strength, flexibility, agility and speed. The results were double screened using predetermined criteria; extracted data and assessed the risk of bias; synthesized the evidence. Results: A total of 462 titles and abstracts were identified, and after full-text screening, seven articles were included. In five studies that exclusive breastfeeding was positively associated

with several components of physical fitness (cardiorespiratory fitness, strength, flexibility, balance, speed). Only two studies found no significant association between breastfeeding and the athletic performance. Conclusion: The data from this review provide evidence that longer duration of breastfeeding provided better athletic performance in childhood and adolescence. However, further studies are needed to understand the main mechanisms involved between the components of breast milk and athletic performance.

Keywords: Breastfeeding, Exclusive Breastfeeding, Physical Fitness, Athletic Performance, Sport, Children, Childhood Adolescents

1. Introduction

Breast milk is a source of nutrients and bioactive components, which provide several benefits. It is associated with a lower probability of infant morbidity and mortality and, in the long term, protects against overweight and type 2 diabetes mellitus [1-4].

Due to the numerous benefits of breast milk, the World Health Organization (WHO) recommends maintaining exclusive breastfeeding (EBF) for at least 6 months after birth, and breastfeeding can continue with adequate complementary feeding for 2 years after birth [5]. The practice of EBF for at least 6 months after birth, followed by breastfeeding complemented with other foods, may save the lives of more than 800,000 children and 20,000 women in the world annually [4].

Moreover, breastfeeding can influence physical fitness, defined as the ability to perform daily tasks with vigor and attention, without fatigue and with a lot of energy to enjoy leisure activities [6]. Physical fitness involves cardiorespiratory endurance, muscular endurance and muscle strength, flexibility, balance, agility and coordination [7].

A high level of physical fitness in childhood is considered essential for the maintenance of general health and well-being. This is due to the fact that it is related to adequate body composition, improved skeletal health, protection against cardiometabolic risk factors (e.g.: hypertension, dyslipidemia and obesity), improved mood, psychological health, academic performance, and quality of life [8, 6, 9].

Although there are several studies that point out the benefits of breastfeeding, studies investigating the association between breastfeeding and physical fitness are scarce. The guiding question of the research was the following: What is the association between breastfeeding and athletic performance?

Thus, considering that breastfeeding is a highly accessible, low-cost, public health preventive measure with great social impact and that can contribute to improving physical fitness, this systematic review aimed to evaluate the association between breastfeeding and athletic performance.

2. Method

2.1. Eligibility Criteria

This systematic review included randomized controlled clinical trials, double-blind, observational cohort, case-control, and cross-sectional studies published in English, between 2012 and 2022, available in full in electronic support online.

The studies included evaluated the relationship between breastfeeding and athletic performance, without any restrictions on gender, age or ethnicity. Animal-model research, review articles and articles that did not address the guiding questions were not included.

2.2. Search Strategy

The search strategy followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Metanalysis (PRISMA). Relevant studies were identified by searching the following electronic databases during June 2022: Pubmed, Science Direct, Scopus. We searched for papers that contained the term “Breastfeeding”, “physical fitness”, “athletic performance”. Search limiters included human subjects and studies published in English. These electronic searches were supplemented with a manual search of the citation lists of relevant articles. Two reviewers independently, screened all search results for their eligibility by examining titles and abstracts. There were no disagreements. The full texts of potentially relevant papers were then screened.

2.3. Quality Assessment

The methodological quality of the studies was evaluated using the ACROBAT-NRSI tool (“A Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies”), which assesses the methodological quality of cohort and case-control studies for systematic reviews. As it assesses the causal relationship, it can also be used in reviews evaluating etiology, which are classically answered using observational designs. The instrument assesses seven domains. The first three domains can be considered as pre-intervention domains, specific for observational studies. The other four domains are post-intervention and may also be, conceptually, potential biases in randomized clinical trials. For each domain, one of the following classifications is assigned in relation to the risk of bias: low risk of bias, moderate risk of bias, severe risk of bias, critical risk of bias, and no information to judge risk of bias.

2.4. Data Extraction

For the details of the studies, relevant information was collected, including: authors, year of publication, country, type of study, sample size and age, type and duration of breastfeeding (exclusive or not), physical tests to assess physical fitness and results of the association between breastfeeding and physical fitness.

3. Results

3.1. Search Results

A total of 462 articles were found by searching the databases PubMed (n = 60), Science Direct (n = 363), Scopus (n = 39). In the screening process, duplicate articles were removed and inclusion criteria were analyzed. Finally, seven articles were considered eligible for this systematic review

(Figure 1).

3.2. Study Type

Regarding the types of studies, five cross-sectional and two longitudinal studies were analyzed. Most of the records were carried out in European countries and only one was carried out in Latin America (Brazil) and one in Asia (Iran). An overview of the included studies is presented in Table 1.

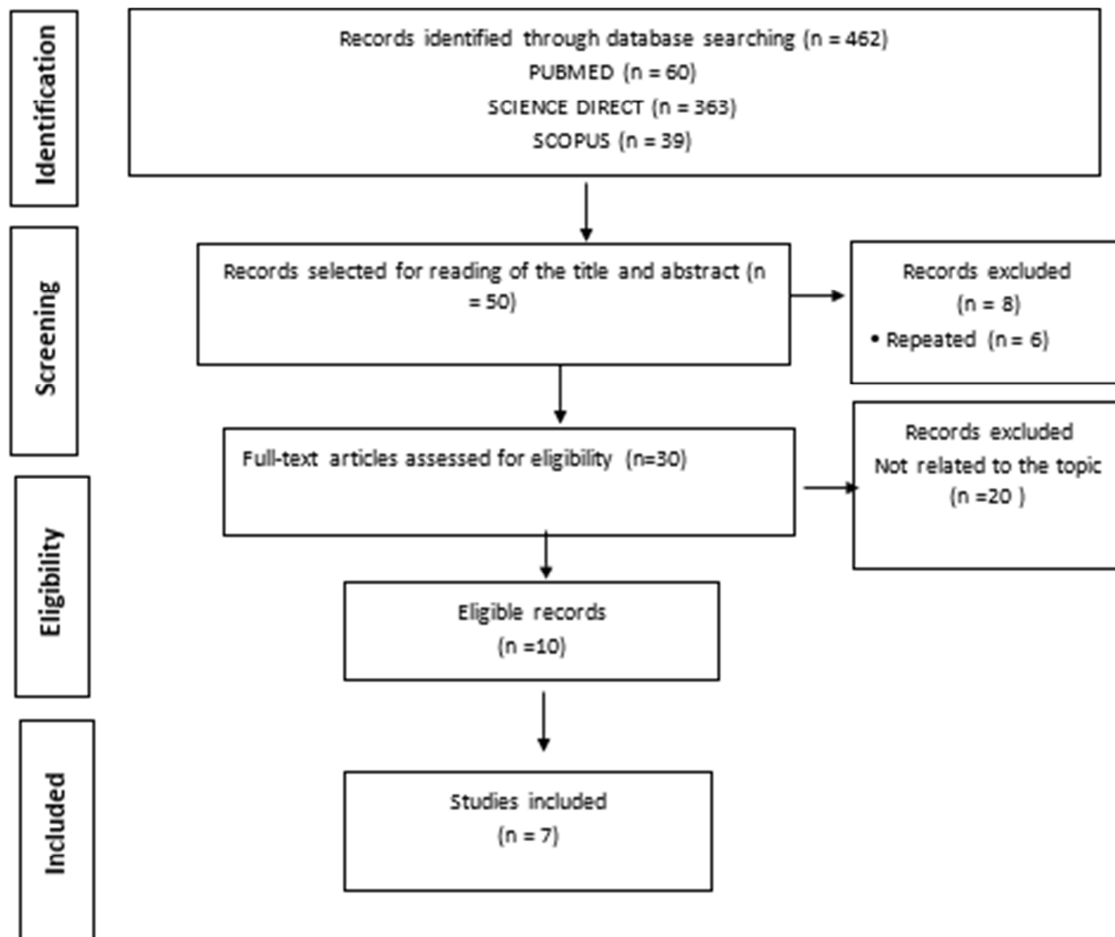


Figure 1. Flowchart of the methodological procedure to search of articles.

Table 1. Characteristics of the studies included in the review.

Study/country	Type of study	Sample/age	Breastfeeding	Physical test	Results
Béghin et al. (2022) Belgium, France, Germany, Sweden, Hungary, Austria, Greece, Italy, Spain.	Cross-sectional, multicenter study	n= 223tab Age=12.5-17.5 years	Exclusive breastfeeding (<3 month, ≥3- <6 months and ≥ 6 months)	Cardiorespiratory fitness- shuttle run (20m); Flexibility- back-saver sit-and-reach test; Muscle strength of the upper limbs-handgrip test, using a hand dynamometer; Explosive strength of the lower limbs-4 × 10 m shuttle run test.	The duration of breastfeeding had a positive influence on lower limb muscle strength.
Tambalis et al. (2019) Greece	Population study, longitudinal	n= 5125 Age=8-9 years	Exclusive breastfeeding (<1 month, 1-5 months and ≥ 6 months)	Cardiorespiratory fitness - shuttle run (20m); Explosive strength of lower body members - vertical jump (VJ) and long jump (SLJ); Explosive strength of the upper limbs - small ball throw (1 kg); Speed and agility-sprint of 30 m.	Exclusive breastfeeding ≥6 months favorably influenced the performance of the cardiorespiratory fitness test. Exclusive breastfeeding was favorably associated with all components of physical fitness.

Study/country	Type of study	Sample/age	Breastfeeding	Physical test	Results
Corridor-Corridor et al. (2019) Spain	Cross-sectional study	n= 233 Age= 14.76 years	No breastfeeding; breastfeeding (< 3 months, 3-5 months and ≥6 months)	Cardiorespiratory fitness-run of 20 meters; Lower limb strength-horizontal jump, Flexibility-sit and reach, sit 30 seconds limb strength-handgrip Agility (4 × 10)	Breastfeeding did not appear to be clearly associated with any of the physical fitness variables.
Zaqout et al. (2018) Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, Sweden	Cross-sectional study	n=2853 Age= 6 to 10 years	No breastfeeding Exclusive breastfeeding (1-3 months, 4-6 months, 7-12 months)	Cardiorespiratory fitness-20 mSRT progressive shuttle run test; Upper limb strength-handgrip test. Lower limb strength-Standing long jump test. Speed/Agility - 40m running test. Balance- Flamingo balance test; Flexibility - Sit and reach test.	Positive associations of exclusive breastfeeding with explosive lower body strength, flexibility and, in boys too, balance.
Silveira-Rodrigues et al., (2018) Brazil	Cross-sectional study	n=230 Age= 6 to 10 years	Exclusive breastfeeding (0-3 months, 4-6 months, ≥7 months); Formula	Cardiorespiratory fitness- Yo-Yo Test	Aerobic performance was not related to duration of breastfeeding
Vafa et al. (2016) Iran	retrospective cohort longitudinal	n=246 Age=7 to 8 years	Breastfeeding (≤6 months and >6 months); Formula feeding.	Cardiorespiratory fitness-treadmill exercise test	Breastfeeding for more than 6 months has positive effects on cardiorespiratory fitness
Labayen et al. (2012) Estonia and Sweden	Cross-sectional study	n= 1996 Age=9.5 to 15.5 years	Exclusive breastfeeding (< 3 months, 3-6 months and >6 months); Formula feeding	Cardiorespiratory fitness - maximal cycle ergometer test	Longer duration of breastfeeding was associated with greater cardiorespiratory fitness.

Source: authors, 2022.

3.3. Overview of Study Designs and Participants

Data were extracted from a total of 5125 participants (children and adolescents) aged between 6 and 17 years, both sexes. In order to assess the duration of exclusive breastfeeding, the authors used different stratifications by age group (<1 months, 1-5 months, ≥6 months, < 3 months, 0-3 months, 4-6 months, ≥6 months, 7- 12 months, ≥7 months) or never breastfed or who used formula feeding.

The physical tests that were used to assess physical fitness also varied. Three studies assessed only cardiorespiratory fitness and two studies used an exercise stress test, which is the gold standard for assessing aerobic capacity.

Of the seven articles included in this review, five studies stated that exclusive breastfeeding was positively associated with some of the components of physical fitness (strength, cardiorespiratory fitness, flexibility, balance, speed) and only in two studies there was no significant association between the parameters evaluated.

The multicentric research carried out by Béghin et al. [10] evaluated cardiorespiratory fitness, flexibility, upper and lower limb muscle strength, but the duration of breastfeeding was only associated with lower limb muscle strength. Zqout et al. [11] also found a positive association of exclusive breastfeeding with explosive strength of the lower limbs and better flexibility. In addition, boys who were breastfed had better balance than girls.

Tambalis et al. [12] observed that physical fitness tests were higher in children of both sexes who were exclusively breastfed for ≥ 6 months compared to those who were

exclusively breastfed for < 1 month. Moreover, the authors observed that 1-month increase in exclusive breastfeeding was associated with an increase in cardiorespiratory fitness test stage. Corroborating with these results, Vafa et al. [13] found a favorable association in cardiorespiratory fitness in children who were exclusively breastfed for ≥ 6 months.

Labayen et al. [14] compared the duration of exclusive breastfeeding with the use of formulas and found greater cardiorespiratory fitness in children and adolescents who were breastfed in childhood compared to those who were formula-fed.

In contrast with the five studies aforementioned, Silveira-Rodrigues et al. [15] found no association between duration of breastfeeding and cardiorespiratory fitness. There was no difference between those who were exclusively breastfed for the first six months of life and those who were not exclusively breastfed during this period. Likewise, Corredor-Corredor et al. [16] evaluated several parameters of physical fitness and found no association between breastfeeding and any of the physical fitness variables.

3.4. Methodological Quality of Studies

The assessment of the methodological quality of the studies included in this review was performed using the ACROBAT-NRSI tool (“A Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies”). The methodological quality assessment of the seven selected studies is presented in Table 2. Overall, the risk of bias was low or without information to judge the risk of bias for most items.

Table 2. Assessment of the methodological quality of studies.

Authors	Confounding	Selection of participants	Measurement of the intervention	Non-receipt of the assigned intervention	Losses	Measurement of outcomes	Selective reporting of outcomes
Béghin et al. (2022)	No information to judge risk of bias	Low risk	Low risk	Low risk	No information to judge risk of bias	Low risk	Low risk
Tambalis et al. (2019)	Low risk	No information to judge risk of bias	Low risk	Moderate risk	Low risk	Low risk	Low risk
Corridor-Corridor et al. (2019)	Low risk	Low risk	Low risk	Moderate risk	Low risk	Low risk	Low risk
Zaout et al. (2018)	Low risk	No information to judge risk of bias	Low risk	Low risk	Moderate risk	Low risk	Low risk
Silveira-Rodrigues et al., (2018)	Low risk	No information to judge risk of bias	Low risk	Low risk	Low risk	Low risk	Low risk
Vafa et al. (2016)	Moderate risk	No information to judge risk of bias	Low risk	Low risk	Moderate risk	Low risk	Low risk
Labayen et al. (2012)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

Source: authors, 2022

4. Discussion

This systematic review was conducted in order to investigate the association between exclusive or non-exclusive breastfeeding and athletic performance. It is noteworthy that of the seven studies evaluated, five showed that children or adolescents who were breastfed during childhood had better physical fitness. Moreover, longer duration of exclusive breastfeeding may have a beneficial increase in physical fitness.

Breastfeeding has several short and long-term advantages, so there is a worldwide consensus that should be exclusive to for the first 6 months of life and should be continued with the addition of solid foods after that age [17-19]. The recommendation is that the child is breastfed in the first hour of life and for 2 years or more. In the first 6 months, the intake of liquids, such as water, coconut water, tea, juice or milk, or any other food, such as baby food and porridge are discouraged [1].

The ingestion other foods before 6 months can increase the risk of sickness, since it can impair the absorption of iron and zinc, which are nutrients present in breast milk. In addition, in general, the child is only mature enough to ingest other types of after around 6 months old [1].

Another advantage of breastfeeding is that it has a low financial cost for families, as it reduces spending on infant formulas, bottles, pacifiers. Additionally, it also has an impact on the public sector economy with a reduction in hospitalizations resulting from the early introduction of liquids and foods [20].

The two studies that did not find a significant association between breastfeeding and athletic performance were precisely the ones with the smallest sample size ($n=230$ and 233), which may have interfered in the results. Silveira-Rodrigues et al. [15] highlights that the sample of their study (Brazilians) was different compared to that of other

investigations, most of them conducted in Europe, which share a greater common ancestry than the Latin American population.

Another important aspect is that only studies with children and adolescents were found. It is not known whether these benefits of breastfeeding on physical fitness will extend to adulthood or the elderly. It is worth mentioning that they were not investigated with a specific group, such as athletes, who already have a good physical condition. It is known that regular physical activity can maintain or improve certain aspects of physical conditioning [6]. However, it is not known whether athletes can enhance their results due to the duration of breastfeeding they had.

The level of physical conditioning is associated with several health indicators, such as total and central adiposity, risk factors for cardiovascular diseases, and skeletal health [6]. In addition, cardiorespiratory fitness affects the ability to perform exercise, as it is an important determinant of physical function and the ability to perform daily activities at all ages [21].

Maternal pre-gestational BMI and gestational weight gain interfere with children's physical fitness. Children of mothers with an BMI ≥ 25 kg/m² and excess GWG had almost 30% and 20% increased odds for low performances in physical fitness tests than those of mothers with an BMI < 25 kg/m² and adequate GWG, respectively [22].

Breast milk are rich in immunoglobulins, sodium, potassium, zinc, vitamins, minerals, protein, carbohydrates, and lipids [23]. The polyunsaturated fatty acids, adipokines and prostaglandin J2 present in human milk are the components that could explain the beneficial effects of breastfeeding on cardiorespiratory fitness [14, 24].

Considering that the first years of life are the most crucial for the child's growth and development, breastfeeding during this period can prevent the onset of several diseases in adult life [1]. There is a protective association between breastfeeding and cardiovascular risk factors in childhood,

which correlate with negative consequences in adulthood, such as dyslipidemia, hypertension, diabetes mellitus, and obesity [25, 26].

Despite the short- and long-term health benefits of breastfeeding, only 37% of children under 6 months of age are exclusively breastfed in low- and middle-income countries and it is less frequent or of shorter duration in high-income countries [4].

As limitations of this systematic review, it is important to highlight the differences in the assessment protocols of physical fitness tests, variation in the assessment of variables that can interfere with physical fitness (such as BMI, habitual food consumption, birth weight, or physical activity) and the method of assessing breastfeeding, which relies on the memory of mothers or guardians. Therefore, further studies are needed, mainly controlled and longitudinal, to elucidate, for example, epigenetic mechanisms associated with breastfeeding and follow up children in the long term and verify if they will not present better physical fitness. This study contributes to support new research and support studies related to the association between breastfeeding and physical fitness.

5. Conclusion

Data from this review provide evidence that children and adolescents who were exclusively breastfed for 6 months and continued to be breastfed had better cardiorespiratory fitness, more lower limb strength, balance, flexibility and speed. Thus, longer duration of breastfeeding is associated with better athletic performance. The practical implication of the results found is that breastfeeding is a low-cost measure, with a great social impact and may also contribute to defining future athletes.

However, the importance of carrying out new research becomes evident, mainly in the perspective of elucidating the mechanisms involved between the components of breast milk and athletic performance.

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