

## Prevalence of Brazilian children and adolescents who met health criteria for aerobic fitness: systematic review update for Report Card Brazil Project

### *Prevalência de crianças e adolescentes brasileiros que atenderam aos critérios de saúde para aptidão aeróbia: atualização de revisão sistemática para o Projeto Report Card Brasil*

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**Abstract** – The aim of the study was to update Brazilian evidence on the prevalence of children and adolescents who met health criteria for aerobic fitness. This systematic review is part of the Report Card Brazil Project and the search was restricted to studies published during the period from January 2018 to December 2019 in nine electronic databases. Studies with different designs, which allowed extracting information about the prevalence of children and adolescents who met health criteria for aerobic fitness (age up to 19 years or average age up to 19 years) were included. Studies published from 2020 were not included due to the possible effect of the pandemic on this indicator and because there is no certainty as to when the pandemic will end. Of the 694 studies initially identified, 13 studies with information of 14,673 children and adolescents were included after reading titles, abstracts, full texts and references. The prevalence of children and adolescents who met health criteria for aerobic fitness was 26.9% (29.7% for girls; 44.6% for boys). In this search, eight different cutoff points were used to determine adequate aerobic fitness levels and five tests were used to determine aerobic fitness. Analyzing data from the present review with the previous systematic review of this project, one third of children and adolescents in Brazil meet health criteria for aerobic fitness.

**Keywords:** Adolescent health; Brazil; Oxygen uptake; Physical fitness.

**Resumo** – O objetivo do estudo foi realizar uma atualização das evidências brasileiras sobre a prevalência de crianças e adolescentes que atenderam aos critérios de saúde para aptidão aeróbia. Essa revisão sistemática integra o Projeto Report Card Brasil e a busca foi restrita aos estudos publicados durante o período de Janeiro de 2018 a Dezembro de 2019 em nove bases de dados eletrônicas. Estudos com diferentes delineamentos, os quais permitiram extrair informações acerca da prevalência de crianças e adolescentes que atenderam aos critérios de saúde para a aptidão aeróbia (idade até 19 anos ou com média de idade até 19 anos) foram incluídos. Estudos publicados a partir de 2020 não foram incluídos por conta do possível efeito da pandemia nesse indicador e por não haver uma certeza de quando finalizará a pandemia. Do total de 694 estudos inicialmente identificados, 13 estudos com informações de 14.673 crianças e adolescentes foram incluídos após a leitura de títulos, resumo, textos completos e referências. A prevalência de crianças e adolescentes que atenderam aos critérios de saúde para aptidão aeróbia foi de 26.9% (29.7% para as meninas; 44.6% para os meninos). Nessa busca, oito pontos de corte distintos para determinar níveis adequados de aptidão aeróbia foram utilizados, bem como cinco testes foram empregados para se determinar a aptidão aeróbia. Analisando-se os dados da presente revisão com a revisão sistemática anterior desse projeto, um terço das crianças e adolescentes do Brasil atendem aos critérios de saúde para aptidão aeróbia.

**Palavras-chave:** Saúde do adolescente; Brasil; Consumo de oxigênio; Aptidão física.

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**Received:** December 12, 2020

**Accepted:** May 13, 2021

#### How to cite this article

Martins PC, Alves Junior CAS, Lima TR, Silva AF, Moraes MS, Zanlorenci S, Chula de Castro JA, Silva DAS. Prevalence of Brazilian children and adolescents who met health criteria for aerobic fitness: systematic review update for Report Card Brazil Project. Rev Bras Cineantropom Desempenho Hum 2021, 23:e78858. DOI: <http://doi.org/10.1590/1980-0037.2021v23e78858>

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## INTRODUCTION

Aerobic fitness is an important global health marker in children and adolescents<sup>1</sup>, considering the inverse association with risk factors for cardiovascular diseases (e.g., general obesity, abdominal obesity, metabolic syndrome)<sup>2</sup>, in addition to improving cognitive and mental health<sup>3</sup>. However, evidence described in literature has reported unique health benefits through good aerobic performance; data from 137 studies comprising 965,264 children and adolescents from 19 countries have identified moderate decline (7.3%) in aerobic fitness levels during the years of 1981 and 2014<sup>4</sup>. Such findings indicate that although the relationship between maintaining good aerobic performance and general health in adolescents is known<sup>1-3</sup>, constant monitoring of this physical fitness component is necessary.

Regarding the prevalence of children and adolescents who met criteria for aerobic fitness, compilation of results from studies conducted in countries in Europe, North America and South America has identified average percentage of variation in meeting these criteria from 36% ( $\pm$  13%) to 95% ( $\pm$  4%) among girls, and from 51% ( $\pm$  7%) to 96% ( $\pm$  16%) among boys<sup>5</sup>. In Brazil, systematic review of the Report Card Brazil project identified that between 2005 and 2017, 32.2% of children and adolescents met these criteria<sup>6</sup>. These data are worrying when considering that there is a progressive decline in the aerobic fitness levels of children and adolescents over the years<sup>6</sup>. In addition, the scenario regarding reduction of aerobic fitness levels possibly tends to be worsened due to the negative effects of the COVID-19 pandemic on the lifestyle of children and adolescents worldwide<sup>7</sup>.

To classify the pediatric population according to criteria for aerobic fitness, different cutoff points are available in literature<sup>8-12</sup>. Such cutoff points were proposed from different tests, such as the 6- and 9-minute walk / run<sup>13</sup>, the Modified Canadian Aerobic Fitness Test (Mcaft)<sup>8</sup> and the 20-meter shuttle-run test<sup>14</sup>. However, the diversity of tests available to assess and classify aerobic fitness in children and adolescents in relation to meeting health or performance standards may lead to divergences in results found, which makes comparisons difficult and consequently, scientific advances.

The present study is an update of the systematic review published by Gonçalves et al.<sup>6</sup>. The updating of scientific evidence enables identifying data contained in new studies, and thus analyzing how this information differs from findings previously found, or whether these results reinforce results previously found. In addition, they can support new strategies and actions with the aim of increasing aerobic fitness levels in children and adolescents. Therefore, the aim of this study was to systematically review literature to identify the prevalence of Brazilian children and adolescents who met health criteria for aerobic fitness in studies published from 2018 to 2019.

## METHOD

This systematic review is part of the Report Card Brazil research project: Health indicators for children and adolescents (3rd edition). The macro-project protocol was registered under DOI number 10.17605/OSF.IO/SJGV9<sup>15</sup>. The report of this review is in accordance with the Preferred Reporting Items for Systematic Reviews (PRISMA)<sup>16</sup>.

## Information sources

This systematic search is the updating of the study by Gonçalves et al.<sup>6</sup>, which composed the second edition of the Report Card Brazil project: Health indicators for children and adolescents<sup>17</sup>. At that time, the existing literature was revised on a pre-selected basis until January 2018. Therefore, the search for the current review was for literature published from January 2018 to December 2019. The authors chose not to include the year of 2020 in searches due to the possible effects of the COVID-19 pandemic on the outcome. The search was carried out in nine databases: 1) Medical Literature Analysis and Retrieval System Online (MEDLINE) through PubMed; 2) Web of Science (main collection); 3) Scopus; 4) ScienceDirect; 5) MEDLINE, through the EBSCOhost platform; 6) SportDiscus, through the EBSCOhost platform; 7) Latin American and Caribbean Literature in Health Sciences (LILACS), through the virtual health library (VHL); 8) Scientific Electronic Library Online (SciELO), through the Web of Science platform and 9) Cumulative Index to Nursing and Allied Health Literature (CINAHL) through the EBSCOhost platform.

## Search strategy, descriptors and keywords

The search for articles in databases was carried out using the advanced search tool, based on the construction of blocks of descriptors and keywords related to the theme. Descriptors were selected based on the consultation with the Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS) platforms. Keywords were also selected by consensus from published sources (original articles and systematic reviews). Keywords and descriptors were inserted in Portuguese, English or Spanish according to the database.

The first block (outcome) was composed of terms referring to the outcome (aerobic fitness): “physical fitness”, “aerobic capacity”, “aerobic fitness”, “cardiorespiratory capacity”, “cardiovascular fitness”, “aerobic power”, “aerobic endurance”, “cardiorespiratory endurance”, “oxygen consumption”, “maximum oxygen consumption”, “maximal oxygen uptake”, “VO<sub>2</sub> maximal”. The second block was composed of the population of interest (children and adolescents): child\*, schoolchildren, adolescent\*, student, teen, teenager, young, “school-age”, childhood, scholar, “school children”, “school teenager”. The third block was composed of the term related to the location where studies were conducted (Brazil): Brazil\*.

The “OR” Boolean operator was used to add in the advanced search at least one keyword or descriptor of each block and the “AND” operator was used to relate blocks of keywords / descriptors to each other. In addition, quotation marks were used in compound words and to search for exact terms or expressions. Parentheses were used to combine the search terms by outcome, exposure and population categories. Asterisk was used to search for all words derived from the same prefix.

## Eligibility criteria

Inclusion criteria were: a) population composed of children and / or adolescents (age up to 19 years old or average age up to 19 years old); b) studies carried out with sample composed of Brazilian children and / or adolescents; c) studies

with cross-sectional, longitudinal design, case-control or randomized clinical trials that allow extracting information about the prevalence of children and adolescents who met health criteria (cutoff points, tertiles, quartiles, or other forms of categorization by any battery of physical tests) for aerobic fitness of children and adolescents.

The study had the following exclusion criteria: a) athletes (members of competitive sports teams); b) children and / or adolescents with special needs (diagnosed with acute or chronic diseases, physical or intellectual disabilities); c) theses, dissertations, monographs, abstracts, book chapters, points of view and review articles, validation and / or reproducibility articles, articles for determining cutoff points; d) articles that did not present numerical data classifying individuals according to aerobic fitness (quantity or prevalence of fit and / or unfit, regardless of parameter considered).

### **Selection of studies**

Two reviewers (CASAJ and PCM) independently examined each database to obtain potential articles and, after extracting articles from databases, duplicate articles were excluded and then articles were excluded by reading titles and abstracts. Subsequently, the texts of selected articles were read in full to select studies. In addition, a literature search was carried out in the references of selected studies in order to select possible studies eligible for this review, not identified in the systematic search in databases. Disagreements between the two reviewers were resolved by consensus meeting. The opinion of a third reviewer (DASS) was consulted for unresolved disagreements.

The Zotero® bibliographic manager version 5.0 (Roy Rosenzweig Center for History and New Media, Fairfax, Virginia, USA), was used to create specific libraries, which allow the identification and exclusion of duplicate studies, division and organization of results of each database.

### **Data extraction**

Data were extracted by two independent reviewers and the consistency between them was verified. The following information was extracted: names of authors, year of publication, methodological quality score, place of study, age group investigated, population and sample, study design, stratification, test used to estimate aerobic fitness, measure of estimated aerobic fitness (example: VO<sub>2</sub>max, VO<sub>2</sub>peak, number of laps, etc.), cutoff point and battery of tests used to classify aerobic fitness and to estimate prevalence / number of individuals who meet health criteria for aerobic fitness.

### **Bias risk / methodological quality**

The risk of bias / methodological quality of included studies was independently assessed by two researchers (MSM and JACC). For cases of disagreement between researchers, a third researcher with experience in systematic review was consulted through consensus meeting. To assess the risk of bias, a tool proposed by the National Heart, Lung and Blood Institute (NIH) was used according to each type of study. For cross-sectional and longitudinal studies, the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies was used

and for the intervention study without control group, the Quality Assessment Tool for Before-After (Pre-Post) Studies with no control group was used. The tool's criteria include questions that help identifying possible risk of bias regarding the research problem, studied population, recruited groups, eligibility criteria, sample size, assessed exposure, time in relation to the expected effect, exposure levels of interest, exposure and evaluation measures, outcome measures, blindness in the evaluation of results, follow-up rate and statistical analysis<sup>18</sup>.

Each question was scored with "N", "Y", "NR" and "NA", in which "N" was applied to questions answered as this information was not provided and "Y" for those answered as yes, this information was provided. The option "NR" corresponded to not reported and "NA" as not applicable, being used when it was not possible to evaluate one of the criteria of the instrument due to the type of study (as in the case of cross-sectional design). The total score was obtained by adding the score of each question answered as "Y" and "NA".

## RESULTS

Overall, 694 articles were identified; however, 171 were duplicated, resulting in 523 articles. After reading titles and abstracts, 413 studies were excluded and then 110 articles were read in full. Of these, 13 studies were included because they met the eligibility criteria. The references of included articles were read, but no new articles were included in the present review from the list of references (Figure 1).

The characteristics of the 13 studies included in the review are shown in Table 1. Seven studies were carried out in the southern region, with three studies in the state of Paraná<sup>20,29,31</sup>, two studies in Santa Catarina<sup>19,22</sup> and two studies in Rio Grande do Sul<sup>26,30</sup>. Four studies<sup>23,25,27,28</sup> were carried out in the northeastern region (Piauí, Bahia, Ceará and Paraíba, respectively), one study<sup>21</sup> was carried out in the northern region (Amazonas) and one study<sup>24</sup> was carried out considering all regions of the country (Northern, Northeastern, Midwestern, Southeastern and Southern).

The evaluated population covered the age group of 3-19 years. Eleven studies had cross-sectional design<sup>19-27,29,30</sup>, one study had longitudinal design<sup>19</sup> and one was an intervention study<sup>28</sup> (Table 1).

The prevalence of children and adolescents with adequate aerobic fitness varied among studies, and the lowest prevalence found was 5.5%<sup>26</sup> and the highest prevalence was 79.1%<sup>23</sup>, which resulted in total prevalence of 24.6% considering all studies. For males, the prevalence of adequate aerobic fitness ranged from 14.7%<sup>23</sup> to 85.8%<sup>20</sup>, which resulted in total prevalence, considering all studies, of 19.6%. For females, the prevalence of children and adolescents with adequate aerobic fitness ranged from 2.7%<sup>26</sup> to 45.3%<sup>30</sup>, which resulted in total prevalence (considering all studies) of 30.7% (Table 2).

Studies verified the aerobic fitness of children and / or adolescents through different tests: 6-minute walk / run test<sup>21,26,27</sup>, 9-minute walk / run test, Mcaft test<sup>19,22,24,30,31</sup>, 20-meter shuttle-run test<sup>20,23,29</sup> and Yo-Yo Intermittent Recovery Test<sup>28</sup>. Different cutoff points were found in literature, and the cutoff point most widely used was proposed by PROESP-BR31.

Table 3 presents information regarding cutoff points used in studies included in this review. These data enabled identifying that seven different cutoff points

were used. The majority (n = 05) of these cutoff points<sup>8-11,33</sup> present maximum VO2 as aerobic fitness result.

Regarding the risk of bias / methodological quality, when considering the general score of included studies (n = 13), it was found that of studies with cross-sectional or longitudinal design, that by Werneck et al.<sup>31</sup> had the highest score, while that by Menezes et al.<sup>27</sup> had the lowest score. The intervention study by Oliota-Ribeiro et al.<sup>28</sup> had score of eight (Supplementary Material Table 1A: <https://osf.io/f3psy/>).

Table 4 presents information regarding the previous systematic review of the Project Report Card Brazil with some specific information of this review. These data show that in Brazil, studies on the prevalence of adequate aerobic fitness published from 2005 to 2019 resulted in a total sample of 63,666 subjects evaluated, with ages ranging from three to 19 years. The prevalence of adequate aerobic fitness in this period was 30.8%, being 23.7% for males and 24.0% for females.

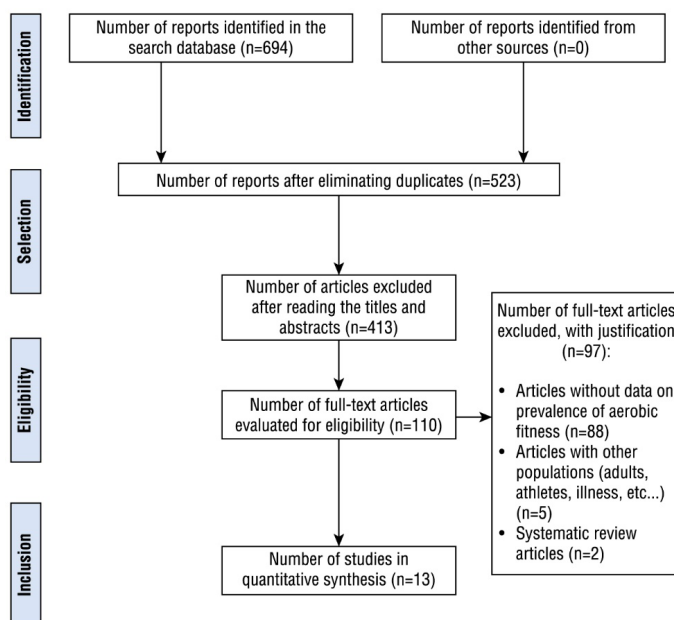


Figure 1. Flowchart of search, selection and exclusion of articles. n=number.

Table 1. Description of studies on the prevalence of aerobic fitness in Brazilian children and/or adolescents.

Author(s), Year and Place	Study design	Sample	Age range	Purpose of the study
Claumann et al. <sup>19</sup> – São José, SC	Cross-sectional	1,058 adolescents ♂: 488 ♀: 570	15 to 19 years	To estimate the prevalence of dissatisfaction with body image and to verify the association between dissatisfaction with thinness and excess weight and components of physical fitness related to health (body composition, muscle strength and aerobic fitness) in adolescents.

Note. AM= Amapá, BA= Bahia, CE= Ceará, DF=Distrito Federal, ES=Espírito Santo, GO=Goiás, MG=Minas Gerais, MT=Mato Grosso, PB= Paraíba, PI=Piauí, PR=Paraná, RJ= Rio de Janeiro, RN=Rio Grande do Norte, RS=Rio Grande do Sul, SC=Santa Catarina, SP= São Paulo, TO= Tocantins, ♀= Women, ♂= Male, \* Data information stratified by sex were not available.

Table 1. Continued...

Author(s), Year and Place	Study design	Sample	Age range	Purpose of the study
Coledam et al. <sup>20</sup> – Londrina, PR	Cross-sectional	729 adolescents ♂: 359 ♀: 370	10 to 17 years	To analyze whether the association between sex and aerobic and muscular fitness is independent of physical activity, sports practice and sedentary behavior in adolescents.
Da Silva Reis et al. <sup>21</sup> – Manaus, AM	Cross-sectional	100 adolescents ♂: 69 ♀: 31	11 to 14 years	To evaluate levels of physical fitness related to health (body composition, aerobic fitness, abdominal resistance, flexibility, power strength of lower and upper limbs, agility and speed) and motor performance in adolescents.
De Lima and Silva <sup>22</sup> – São José, SC	Cross-sectional	1,110 adolescents ♂: 519 ♀: 591	14 to 19 years	To estimate the prevalence of poor sleep quality and to identify the association with sociodemographic factors, lifestyle, weight status and aerobic fitness in adolescents.
De Moraes et al. <sup>23</sup> – Teresina, PI	Cross-sectional	190 children* 110 adolescents*	03 to 10 years 11 to 17 years	To determine the reliability and validity of the criteria and constructs of the International Fitness Scale in Portuguese in children and adolescents.
Gaya et al. <sup>24</sup> - 16 Brazilian states: AM, BA, CE, DF, ES, GO, MG, MT, PI, PR, RJ, RN, RS, SC, SP and TO	Cross-sectional	2008/2009: 4.538 adolescents ♂: 2.649 ♀: 1.889 2013/2014: 3.106 adolescents ♂: 1.706 ♀: 1.400	12 to 17 years	To verify the occurrence of additional risk to cardiometabolic and musculoskeletal health of Brazilian adolescents in the periods of 2008/09 and 2013/14 and to identify if there are differences in risk between the sexes in those periods.
Lima et al. <sup>25</sup> – Bahia	Cross-sectional	663 adolescents ♂: 291 ♀: 372	12 to 18 years	To identify factors associated with aerobic fitness in adolescents.
Mello et al. <sup>26</sup> – Porto Alegre, RS	Cross-sectional	236 adolescents ♂: 146 ♀: 90	14 to 18 years	To identify the association of aerobic fitness among adolescents with physical activity and the pedagogical characteristics of school physical education.
Menezes et al. <sup>27</sup> – Fortaleza, CE	Cross-sectional	160 adolescents ♂: 74 ♀: 86	14 to 17 years	To correlate screen time with health-related fitness levels (abdominal resistance, body composition, aerobic fitness and flexibility) in adolescents.
Oliota-Ribeiro et al. <sup>28</sup> – PB	Intervention	12 children*	8 to 10 years	To analyze the chronic effect of indoor soccer training on aerobic performance and fitness in children.

Note. AM= Amapá, BA= Bahia, CE= Ceará, DF=Distrito Federal, ES=Espírito Santo, GO=Goiás, MG=Minas Gerais, MT=Mato Grosso, PB: Paraíba, PI=Piauí, PR=Paraná, RJ= Rio de Janeiro, RN=Rio Grande do Norte, RS=Rio Grande do Sul, SC=Santa Catarina, SP= São Paulo, TO= Tocantins, ♀= Women, ♂= Male, \* Data information stratified by sex were not available.

**Table 1.** Continued...

Author(s), Year and Place	Study design	Sample	Age range	Purpose of the study
Oliveira and Guedes <sup>29</sup> – Jacarezinho, PR	Cross-sectional	1,035 adolescents ♂: 470 ♀: 565	12 to 19 years	To test the cutoff points of the health criteria of physical fitness variables proposed by the Fitnessgram Program for the detection of metabolic syndrome.
Saldanha et al. <sup>30</sup> – Santa Cruz do Sul, RS	Cross-sectional	1,251 children and adolescents ♂: 566 ♀: 685	7 to 17 years	To investigate the association between health-related physical fitness (aerobic fitness, flexibility and abdominal resistance) and the presence of metabolic risk in children.
Werneck et al. <sup>31</sup> – Londrina, PR	Longitudinal	375 children ♂: 197 ♀: 178 Total: 14.673 Total ♂: 7.534 Total ♀: 6.827	07 to 10 years	To evaluate the tracking of aerobic fitness from childhood to adolescence and to test the path of moderation by somatic maturation.

Note. AM= Amapá, BA= Bahia, CE= Ceará, DF=Distrito Federal, ES=Espírito Santo, GO=Goiás, MG=Minas Gerais, MT=Mato Grosso, PB= Paraíba, PI=Piauí, PR=Paraná, RJ= Rio de Janeiro, RN=Rio Grande do Norte, RS=Rio Grande do Sul, SC=Santa Catarina, SP= São Paulo, TO= Tocantins, ♀= Women, ♂= Male, \* Data information stratified by sex were not available.

**Table 2.** Studies on the prevalence of aerobic fitness in Brazilian children and/or adolescents.

Author(s)	Physical test adopted	Reference for cut-point	Prevalence of adolescents who met the aerobic fitness criteria
Claumann et al. <sup>19</sup>	Mcaft	CSEP, 2003 <sup>8</sup>	Total: 12.6% (n=104) ♂: 14.9% (n=58) ♀: 10.6% (n= 46)
Coledam et al. <sup>20</sup>	20-m shuttle run test	FitnessGram <sup>11</sup>	Total: 63.0% (n=459)* ♂: 85.8% (n=308)* ♀: 40.8% (n= 151)*
Da Silva Reis et al. <sup>21</sup>	6-minute walk/run test	PROESP-BR <sup>33</sup>	Total: 53.0% (n=53)* ♂: 65.2% (n=45)* ♀: 25.8% (n=08)*
De Lima and Silva <sup>22</sup>	Mcaft	CSEP, 2003 <sup>8</sup>	Total: 12.6% (n=110)
De Moraes et al. <sup>23</sup>	Children modified version of the original test 5 (children)	Children: De Miguel-Etayo et al. <sup>10</sup>	Total children: 68.0% (n=129)*
	20-m shuttle run test (adolescents)	Adolescent: De Miguel-Etayo et al. <sup>10</sup> Ortega et al. <sup>11</sup>	Total adolescents: 78.2% (n=86)*
Gaya et al. <sup>24</sup>	9-minute walk/run test	PROESP-BR <sup>32</sup>	Total: 20.7%* (n=1584)* 2008/09: 23.7% (n=810) 2013/14: 44.1% (n=774)
Lima et al. <sup>25</sup>	20-m shuttle run test	Classification by percentiles of the sample itself	Total: 58.4% (n=387)
Mello et al. <sup>26</sup>	6-minute walk/run test	PROESP-BR <sup>32</sup>	Total: 5.5%* (n=13)* ♂: 14.7% (n=10) ♀: 2.7% (n=03)
Menezes et al. <sup>27</sup>	6-minute walk/run test	PROESP-BR <sup>32</sup>	Total: 7.5% (n=11)

Note. \* Calculated values, CSEP: Canadian Society For Exercise Physiology, PROESP-BR: Sport Brazil Project, mCaft: Canadian modified aerobic fitness test, n: number.



**Table 2.** Continued...

Author(s)	Physical test adopted	Reference for cut-point	Prevalence of adolescents who met the aerobic fitness criteria
Oliota-Ribeiro et al. <sup>28</sup>	Yo-Yo Intermittent Recovery Test	Rodrigues et al. <sup>33</sup>	Pre total: 6.2%* (n=01)* Total post: 58.3%* (n=07)* ♂: 12-15 years: 44.2%
Oliveira and Guedes <sup>29</sup>	20-m shuttle run test	FitnessGram <sup>11</sup>	♀: 12-15 years: 18.7% ♂ 16-20 years: 53.7% ♀ 16-20 years: 33.5%
Saldanha et al. <sup>30</sup>	9-minute walk/run test	PROESP-BR <sup>32</sup>	Total: 49.2% (n=616) ♂: 54.1% (n=306) ♀: 45.3% (n=310)
Werneck et al. <sup>31</sup>	9-minute running or walking test	Classification by tertiles of the sample itself	Baseline: 33.3%* (n=124)* After 3 years: 33.3%* (n=124)* Total (26,9%) (n=3.683) ♂: 44.6% (n=727) ♀: 29.7% (n=518)

Note. \* Calculated values, CSEP: Canadian Society For Exercise Physiology, PROESP-BR: Sport Brazil Project, mCaft: Canadian modified aerobic fitness test, n: number.

**Table 3.** Different cut-points for aerobic fitness used in the included studies for children and adolescents stratified according to sex and age.

	PROESP-BR 9-minute walk/run test <sup>3,4</sup> meters	PROESP-BR 6-minute walk/run test <sup>3,2,35</sup> meters	FITNESSGRAM 20-m shuttle run test <sup>9</sup> VO2 maximum	Mcaft (CSEP, 2003) <sup>8</sup> VO2 maximum	20-m shuttle run test <sup>11</sup> VO2 maximum	Children modified version of the original test 5 <sup>10</sup> VO2 maximum	Yo-Yo Intermittent Recovery Test <sup>33</sup> VO2 maximum
<b>Male</b>							
5	-	-	Participation in the running	-	-	-	-
6	-	675	Participation in the running	-	-	25.3	-
7	1157	730	Participation in the running	-	-	32.3	-
8	1157	768	Participation in the running	-	-	39.3	-
9	1174	820	Participation in the running	-	-	-	-
10	1208	856	≥40.2	-	-	-	48.0
11	1384	930	≥40.2	-	-	-	48.0
12	1425	966	≥40.3	-	-	-	48.0
13	1500	995	≥41.1	-	8.8	-	48.0
14	1560	1060	≥42.5	≥488	10.0	-	48.0
15	1634	1130	≥43.6	≥488	10.2	-	-
16	1660	1190	≥44.1	≥488	9.9	-	-
17	1660	1190	≥44.2	≥488	10.3	-	-
17+	-	-	≥44.3	≥488	-	-	-
<b>Female</b>							
5	-	-	Participation in the running	-	-	-	-
6	-	630	Participation in the running	-	-	20.7	-
7	1090	683	Participation in the running	-	-	25.7	-
8	1101	715	Participation in the running	-	-	30.7	-
9	1103	745	Participation in the running	-	-	-	-
10	1157	790	≥40.2	-	-	-	38.8
11	1179	840	≥40.2	-	-	-	38.8
12	1210	900	≥40.1	-	-	-	38.8
13	1210	940	≥39.7	-	6.1	-	38.8

Note. PROESP-BR: Sport Brazil Project, mCaft: Canadian modified aerobic fitness test, CSEP: Canadian Society for Exercise.

**Table 3.** Continued...

	PROESP-BR 9-minute walk/run test <sup>34</sup> meters	PROESP-BR 6-minute walk/run test <sup>32,35</sup> meters	FITNESSGRAM 20-m shuttle run test <sup>9</sup> VO2 maximum	Mcaft (CSEP, 2003) <sup>8</sup> VO2 maximum	20-m shuttle run test <sup>11</sup> VO2 maximum	Children modified version of the original test 5 <sup>10</sup> VO2 maximum	Yo-Yo Intermittent Recovery Test <sup>33</sup> VO2 maximum
14	1220	985	≥39.4	≥395	6.5	-	38.8
15	1240	1005	≥39.1	≥395	6.4	-	-
16	1256	1070	≥38.1	≥395	6.2	-	-
17	1256	1110	≥38.8	≥395	6.0	-	-
17+	-	-	≥38.6	≥395	-	-	-

Note. PROESP-BR: Sport Brazil Project, mCaft: Canadian modified aerobic fitness test, CSEP: Canadian Society for Exercise.

**Table 4.** Information on systematic reviews of the prevalence of adequate aerobic fitness in the Report Card Brazil Project.

Systematic Review of the Report Card Brazil Project	Age-range	Sample	Physical test used	Cut-point for aerobic fitness	Prevalence of adequate aerobic fitness <sup>†</sup>
Gonçalves et al. <sup>6</sup>	june/19	Total: 49,093*	Field tests: 20 meters shuttle run; 1.600 meters running/walking test; 9-minute run/walk test; 6-minute run/walk test; mCAF.	Different propositions	Total: 32.2% (n=15,789)
		Stratified by Sex:			♂: 27.7% (n = 7,291)
		♀: 25,358			♀: 28.4% (n = 7,195)
Current review	mar/19	Total: 14,673*	Field tests: 20 meters shuttle run; 1.600 meters running/walking test; 9-minute run/walk test; 6-minute run/walk test; Mcaft; Yo-Yo Intermittent Recovery Test	Different propositions	Total: 26.9% (n=3,683)
		Stratified by Sex:			♂: 44.6% (n=727)
		♀: 6,827			♀: 29.7% (n=518)
Total (Data from Gonçalves et al. <sup>6</sup> and data from current review)	mar/19	Total: 63,766*	Field tests: 20 meters shuttle run; 1.600 meters running/walking test; 9-minute run/walk test; 6-minute run/walk test; Mcaft; Yo-Yo Intermittent Recovery Test	Different propositions	Total: 30.8% (n = 19,673)
		Stratified by Sex:			♂: 23.7% (n=8,018)
		♀: 32,185			♀: 24.0% (n=7,713)

Note. \*The total sample is not equivalent to the sum of the sample of male and female because some studies have not reported the sample stratified by sex; \* value calculated based on the following equation: [(number of subjects with adequate aerobic fitness/number of subjects in the total sample) \* 100]; n: number; †: calculate.

## DISCUSSION

The present study identified that during the years 2018 and 2019 (period of publication of articles included in this systematic review), the prevalence of Brazilian children and adolescents who met health criteria for aerobic fitness was

26.9%. When stratified by sex, girls (29.7%) had lower prevalence of adequate aerobic fitness levels, when compared to boys (44.6%). When grouping the data from the present review with the systematic review by Gonçalves et al.<sup>6</sup> for the same macro-project, it was observed that the prevalence of children and adolescents who meet criteria of adequate aerobic fitness is 30.8%, being 23.7% for males and 24.0% for females.

Information regarding the low prevalence of children and adolescents who meet criteria of adequate aerobic fitness are even more worrying when considering the future scenario resulting from the COVID-19 pandemic. A previous study identified that the COVID-19 pandemic will significantly affect the lifestyle of children and adolescents worldwide, with significant reductions in habitual physical activity and aerobic fitness<sup>7</sup>. It is recognized that the school environment is favorable for the development of aerobic fitness; however, the United Nations Educational, Scientific and Cultural Organization<sup>36</sup> estimated that approximately 1.5 billion children and adolescents are out of school due to the COVID-19 pandemic. Therefore, the practice of physical activity at home is recommended, in which exercises such as jumping, burpees, jumping jacks, may reduce the negative effects of social isolation<sup>37</sup> on the aerobic fitness of children and adolescents. However, it is estimated that the negative effects of COVID-19 on physical activity and aerobic fitness will last for many years<sup>7</sup>. Thus, public policies that aim to provide increases in aerobic fitness levels after social isolation such as the creation of more public spaces for leisure and the enhancement of physical education at school are extremely necessary.

In the present review, girls had lower prevalence of adequate aerobic fitness. Historically, several determining factors have been described for girls to have less aerobic fitness compared to boys, with the greatest emphasis being on less engagement (time and intensity) in physical activities<sup>38</sup>. This systematic review reinforces what the previous systematic review of this project<sup>6</sup> identified, which is the fact that different protocols and cutoff points were used to assess the aerobic fitness of Brazilian children and adolescents. Although there is a cutoff point specifically created for the Brazilian population from the 6-minute running / walking test<sup>39</sup> (in the age group of 6-17 years), of the 13 studies included in the present review, five used cutoff points of "Projeto Esporte Brasil" (PROESP-BR)<sup>32</sup>. The other studies used other cutoff points, such as CSEP<sup>8</sup> for the Mcaft test, Fitnessgram and Ortegá et al.<sup>3,32</sup> with the 20 meter shuttle run test, De Miguel-Etayo et al.<sup>10</sup> with the Children modified version of the original test 5 (children) and Rodrigues et al.<sup>33</sup> with the Yo-Yo Intermittent Recovery. PROESP-BR cutoff points were created in 1994 and the latest version was published in 2018, with normative data on physical growth and physical fitness related to the health of children and adolescents<sup>39</sup>. The different tests and protocols used can impact the prevalence found and make it difficult to systematize and compare results.

More than half (n = 07) of studies included in the present review were carried out in the southern region of the country. Disparities between regions of Brazil were also found in other studies that aimed to estimate the prevalence of children and adolescents who met health criteria for health-related physical fitness<sup>6</sup>. Regional inequalities regarding scientific production are strongly related to disparities in the distribution of financial resources. These inequalities impair the creation of interventions and public leisure spaces conducive to physical

activities, and consequently, increase health problems resulting from inadequate aerobic fitness levels.

Of the 13 studies included in the current review, one had longitudinal design and one was an intervention study, the others had cross-sectional design. The intervention study included in the present review<sup>27</sup> showed reduced sample power, which may underestimate or overestimate the results found. In addition, the scarcity of Brazilian studies that investigated the aerobic fitness of children under seven years of age is considered a gap, as studies are needed at different stages of life, since growth directly interferes with aerobic fitness<sup>40</sup>. On the other hand, it is important to highlight the strengths of studies found. One of included studies<sup>35</sup> investigated children and adolescents from all regions of Brazil (Northern, Northeastern, Midwestern, Southeastern and Southern), which allows making comparisons, since all participants were submitted to the same protocols.

The present study evaluated the methodological quality of included studies and found that most of them had score greater than 10, which results were also observed by Gonçalves et al.<sup>6</sup>. In addition, Gonçalves et al.<sup>6</sup> identified that most studies did not use sexual maturation (n = 51) and level of physical activity (n = 40 studies) as control variables in the analysis of aerobic fitness data. In the present review, no study (n = 13) used these variables to control analyses. These variables directly influence aerobic fitness levels in children and adolescents. Therefore, despite the high score presented by studies included in this review, there are gaps in Brazilian studies aimed to analyze the aerobic fitness of children and adolescents.

This systematic review presented limitations that must be considered. The heterogeneity of included studies, such as age, sample size, tests and cutoff points to assess aerobic fitness, may partially affect the results that were estimated as the national prevalence of meeting aerobic fitness recommendations. In addition, some studies did not show the prevalence of aerobic fitness in the total sample or stratified by sex, which influences the general calculation for the Report Card Brazil project. The present study also presents strengths such as the systematic search with the use of nine different databases, including studies that were rigorously reviewed by peers through a methodological quality analysis tool, which allows verifying aspects of internal and external validity of studies. In addition, this research gathered data from more than 14 thousand Brazilian children and adolescents regarding aerobic fitness.

## CONCLUSION

This study is an update of the study by Gonçalves et al.<sup>6</sup>, which allowed estimating the aerobic fitness profile of Brazilian children and adolescents over more than ten years. Thus, it is possible to monitor the effectiveness of public policies aimed at increasing aerobic fitness and to identify the most affected subgroups. In summary, this systematic review identified that less than one third of Brazilian children and adolescents met the health criteria for aerobic fitness and the results become even more worrying for girls. Eight different cutoff points were used, as well as five tests to determine aerobic fitness. In addition, it was found in the present review that the northern and northeastern regions still concentrate the smallest number of studies that evaluate the aerobic fitness of children and adolescents.

## COMPLIANCE WITH ETHICAL STANDARDS

### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This study was funded by the authors.

### Ethical approval

This research is in accordance with the standards set by the Declaration of Helsinki

### Conflict of interest statement

The authors have no conflict of interests to declare.

### Author Contributions

DASS is the principal investigator and conceived the idea of the manuscript. PCM, CASAJ, TRL, AFS, MSM, SZ and JACC draft of the first version of the paper and made the extractions of the data. All authors read and approved the final manuscript.

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## **SUPPLEMENTARY MATERIAL**

Supplementary material accompanies this paper.

Supplementary Table 1A: Free access in <https://osf.io/f3psy/>

This material is available as part of the online article from <http://www.scielo.br/rbcdh>