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Performance of Brazilian children and adolescents in flexibility tests: a systematic review update of published studies from 2020 to 2024

Desempenho de crianças e adolescentes brasileiros em testes de flexibilidade: uma atualização da revisão sistemática de estudos publicados entre 2020 e 2024

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Abstract – This systematic review aimed to identify and synthesize recent scientific evidence on flexibility levels in Brazilian children and adolescents. A systematic search was conducted between August and October 2025 in five databases (MEDLINE/PubMed, Scopus, LILACS, Web of Science, and SciELO). Of the 13,880 potential references retrieved by the searches, 19 met the inclusion criteria and composed the descriptive synthesis. The included studies were published between 2020 and 2024 and included 11,056 participants (5,955 boys) from different regions of Brazil. All studies assessed flexibility using the sit-and-reach test, although different test and batteries were adopted, including PROESP-BR®, Wells & Dillon, Fitnessgram®/ Eurofit, and the Canadian Society for Exercise Physiology protocol. The average prevalence of adequate flexibility among Brazilian children and adolescents was 61.0%, ranging from 21.2% to 81.0%. Among girls, the average prevalence was 61.9%, while among boys it was 60.3%. Overall, the results indicate that more than half of Brazilian children and adolescents have adequate levels of flexibility. Sit-and-reach test remains the most used protocol to evaluate flexibility in Brazilian children and adolescents.

Key words: Adolescent; Physical fitness; Child; Flexibility.

Resumo – *Esta revisão sistemática teve como objetivo identificar e sintetizar evidências científicas recentes sobre os níveis de flexibilidade em crianças e adolescentes brasileiros. Uma busca sistemática foi realizada entre agosto e outubro de 2025, em cinco bases de dados (MEDLINE/PubMed, Scopus, LILACS, Web of Science e SciELO). Foram identificados 13.880 registros, dos quais 19 estudos atenderam aos critérios de inclusão após a triagem. Os estudos incluídos foram publicados entre 2020 e 2024 e abrangeram 11.056 participantes (5.955 meninos) de diferentes regiões do Brasil. Todos os estudos avaliaram a flexibilidade utilizando o teste de sentar e alcançar, embora diferentes protocolos e baterias de testes tenham sido adotados, incluindo PROESP-BR®, Wells & Dillon, Fitnessgram®/ Eurofit e o protocolo da Sociedade Canadense de Fisiologia do Exercício. A prevalência média de flexibilidade adequada entre crianças e adolescentes brasileiros foi de 61,0%, variando de 21,2% a 81,0%. Entre as meninas, a prevalência média foi de 61,9%, enquanto entre os meninos foi de 60,3%. De modo geral, os resultados indicam que mais da metade das crianças e adolescentes brasileiros apresentam níveis adequados de flexibilidade. O teste de sentar e alcançar continua sendo o protocolo mais utilizado para avaliar flexibilidade em crianças e adolescentes brasileiros.*

Palavras-chave: *Adolescente; Aptidão física; Criança; Flexibilidade.*

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INTRODUCTION

Flexibility is an intrinsic property of body tissues that determines the maximum range of joint motion without injury[1,2]. The American College of Sports Medicine (ACSM) recognizes flexibility as a fundamental component of health-related physical fitness[3]. Adequate flexibility is supports posture, reduces joint stress, helps prevent injury, and enables greater autonomy in daily activities and sports[3].

In Brazil, previous systematic reviews for the Report Card Brazil project have critically summarized data on child and adolescent health[4]. Notably, the most recent update (Matrix 4.0), found that 58.9% of Brazilian youth had flexibility levels adequate for health, with boys showing a higher prevalence (62.0%) than girls (50.9%)[2]. Flexibility is a sensitive to endogenous factors, such as sex and maturational stage, and exhibits sexual dimorphism, for example, girls generally demonstrate higher absolute performance on the sit-and-reach test. Additionally, the onset of puberty can influence flexibility trajectories, as rapid growth during this period may temporarily reduce flexibility before it stabilizes in adolescence[1,5].

A new scientific update is needed to provide recent data. This allows analysis of temporal trends and reveals whether new studies support or challenge previous findings. The Global Matrix 5.0 update also refines indicators and benchmarks. This strengthens the credibility of information for policymakers and health professionals in Brazil, especially in the post-pandemic context. Therefore, this review aims to summarize recent data on flexibility in Brazilian children and adolescents and update fitness indicators of Report Card Brazil 5.0.

METHODS

This systematic review is part of the Global Matrix 5.0 initiative of the Active Healthy Kids Global Alliance[1] and is based on the Report Card Brazil: Health indicators for children and adolescents (4th edition)[6]. The macro-project protocol is registered on an open access platform and can be accessed at Silva et al.[6] The present review followed the PRISMA protocol checklist, as presented in Supplementary Material 1.

This systematic review was conducted between August 4, 2025, and October 30, 2025, through searches in the following databases: Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed; Scopus; Latin American and Caribbean Literature in Health Sciences (LILACS); Web of Science; and Scientific Electronic Library Online (SCIELO).

Search strategy

In each database, reviewers used the advanced search strategy and enabled the year filter to limit results to studies published from 2020 to 2024. Search terms appeared in the title or abstract in PubMed, LILACS, and Web of Science, and in the title in Scopus and SciELO. The Boolean operator "OR" included at least one term from each block, while "AND" combined the blocks of terms and keywords. The operator "NOT" was used to exclude irrelevant studies. An asterisk (*) captured words with different endings (e.g., plural or related forms).

Block 1 included terms related to the population and age group: *(Child** OR Teen OR Adolescent OR Youth). Block 2 referred to the main study indicator, flexibility, and included the following terms: *Flexibility OR fleximetry OR goniomet* OR pliability OR "range of movement" OR "range of motion" OR stretching OR "Physical Fitness" OR "Fitness Test" OR "shoulder stretch" OR "sit and reach" OR "sit-and-reach"*. Block 3 was added to exclude studies with adult populations (*not adult**). The complete search strategy and database outputs are in Supplementary Material 2. All searches were conducted on August 8, 2025, by the reviewers (JY and IKASP), using English descriptors. Only original research articles were included. Dissertations, theses, monographs, conference proceedings, case reports, as narrative and systematic reviews or research protocols were not included.

Eligibility criteria

The inclusion criteria comprised original studies involving Brazilian children and adolescents aged 6 to 19 years that assessed flexibility and reported the interpretation of this physical fitness component in relation to health criteria, to estimate the prevalence of participants meeting the standards. Studies of any design (observational or interventional) published in Portuguese, English, or Spanish, between January 2020 and December 2024, were considered, provided they included baseline data.

Studies were excluded if: (1) the topic was outside the scope of this review; (2) participants were younger than 6 or older than 19 years; (3) the sample included participants of nationalities other than Brazilian; (4) the children or adolescents had chronic diseases (such as HIV infection, congenital heart disease, cancer, or chromosomal abnormalities) or were athletes.

Study selection

After searching electronic databases, all relevant articles were imported into Rayyan. Initially, duplicate records were removed. Subsequently, two pairs of independent reviewers (pair 1: IKASP and KM and pair 2: JY and LGOL) screened the titles and abstracts. Discrepancies were resolved by a third reviewer (LGOL for pair 1 and IKASP for pair 2). In the next stage, the full texts of the selected articles were assessed, and once again, disagreements were resolved by the third reviewer. Finally, only the articles that met the eligibility criteria related to the indicator under study were included in the final report (Figure 1).

Data collection process

Information regarding authorship, year of publication, study location, sample size, and the percentage of participants by sex and age group was extracted from the eligible studies by two pairs of independent reviewers (pair 1: IKASP and KM and pair 2: JY and LGOL), with discrepancies resolved by a third reviewer (for pair 1: LGOL and for pair 2: IKASP). In addition, data were collected on the flexibility tests used, the cutoff points adopted, and the prevalence of participants meeting the flexibility criteria, stratified by sex and classification category when available. The data extraction procedure was later validated by another independent researcher (LRAL).

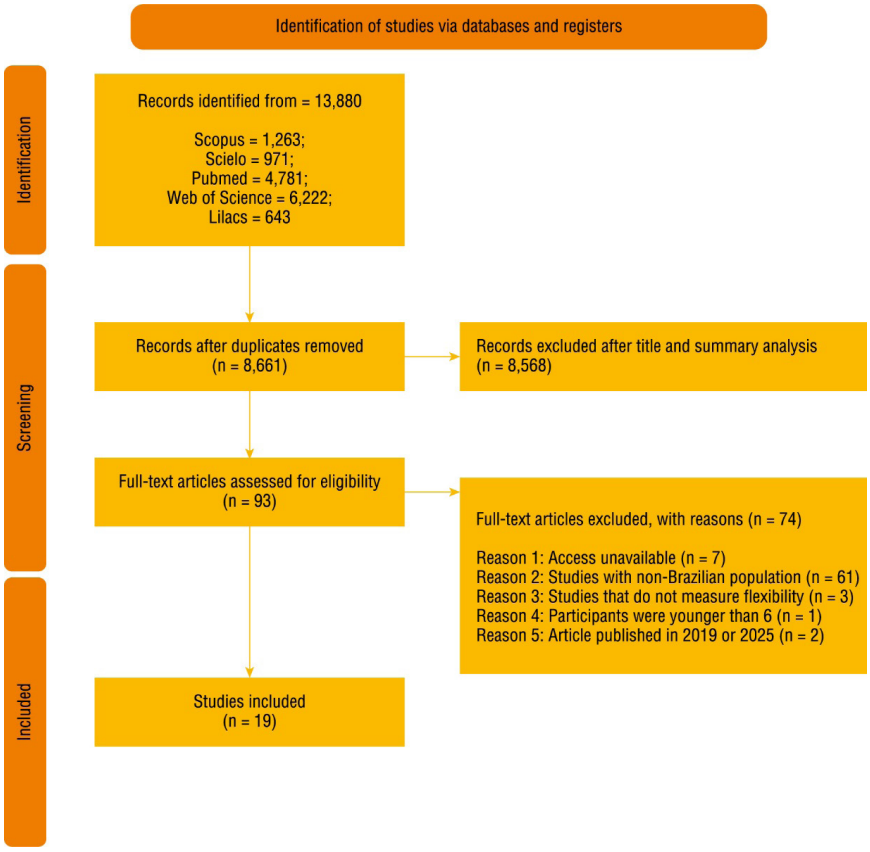

Figure 1. Flowchart of the search process results according to PRISMA.

Risk of bias assessment

The risk of bias and the methodological quality of the included studies were assessed by two independent reviewers (JY and IKIKASP), with any discrepancies resolved by a third reviewer (KM). The assessment was performed using specific instruments, as specified included studies. The instruments used were the Quality Assessment of Controlled Intervention Studies, Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, and Quality Assessment Tool for Before–After (Pre–Post) Studies With No Control Group, all developed by the National Heart, Lung, and Blood Institute (NHLIB)[3]. This instrument contains between 12 and 14 questions and assesses the internal validity of the included studies using "yes = 1" or "no = 0" answers to the questions. The final score indicates the potential risk of selection bias, information bias, measurement bias, and confounding factors, and classifies the risk as follows: 0.70: low risk of bias; ≥ 0.50: moderate risk of bias; < 0.50: high risk of bias.

Summary of results

When summarizing the results, the prevalence of children and adolescents who met the recommended health criteria for flexibility was based primarily on the cutoff points and classifications used in the eligible studies. As a summary indicator, a mean flexibility prevalence was calculated from available studies or from authors' responses to the message addressed to the corresponding authors of the studies.

RESULTS

The initial searches identified 13,880 articles in the databases (Scopus – 1,263 articles; Scielo – 971; PubMed – 4,781 articles; Web of Science – 6,222 articles, and Lilacs - 643 articles) that were imported into Rayyan. Duplicate references were removed (n=5,219), resulting in 8,661 articles. The remaining 8,661 articles were then assessed for relevance based on their titles and abstracts. This resulted in the removal of 8,568 studies from the database. The full text of the remaining 93 articles was examined; 74 were excluded because they did not meet the inclusion criteria. At the end of the screening process, 19 articles were eligible for detailed reading and analysis. Figure 1 presents the flowchart of the search and study selection process. All excluded records did not match the inclusion criteria previously described or were not retrieved.

Nineteen studies were included in this systematic review, with publication dates ranging from 2020 to 2024. Of these, nine studies were conducted in the Southern region of Brazil (Paraná, *n* = 3; Santa Catarina, *n* = 3; Rio Grande do Sul, *n* = 3)[7-15]; five studies in the South Eastern region (São Paulo, *n* = 4; Rio de Janeiro, *n* = 1)[16-20]; and three studies in the Northeastern region (Pernambuco, *n* = 1; Ceará, *n* = 2)[21-23]. In addition, one study did not report its location[24], and one used a national database[25].

Thus, this review included 11,056 participants (5,955 males and 5,101 females). All included studies had different age ranges. These varied from younger groups, such as 6 to 11 years[12] and 7 to 9 years[21], to broader groups, such as 10 to 18 years[17] and 7 to 15 years[14]. Only one study was conducted exclusively with participants aged 10 years or younger (*n* = 104)[21]. Regarding sex, seventeen studies were conducted with boys and girls, while two studies assessed flexibility only in male participants (*n* = 114)[21,23]. The information provided by each study is presented in Table 1.

Table 1. Studies included on the present review (n=19) on flexibility in Brazilian children and adolescents, Brazil, 2025.

Author, year	City - State	Both n	Male % (n)	Female % (n)	Age range (year)
Aimi et al.[7], 2020	Porto Alegre-RS	173	57.2 (99)	42.8 (74)	12 to 17
Cibinello et al.[8], 2020	Londrina-PR	40	15.0 (6)	85.0 (34)	8 to
Coledam and Oliveira[16], 2020	NR-SP	20	50.0 (10)	50.0 (10)	15 to 17
Gaya et al.[25], 2020	PROESP-Brazil (National Database)	4,044	55.0 (2,223)	45.0 (1,821)	10 to 17
Gadelha et al.[23], 2020	NR-CE	10	100.0 (10)	-	13 to 17
Silva et al.[24], 2020	NR	38	52.6 (20)	47.3 (18)	15.1*
Almeida et al.[21], 2021	Vitória de Santo Antão-PE	104	100.0 (104)	-	7 to 9
Sordi et al.[9], 2021	Lebon Régis-SC	120	58.3 (70)	41.7 (50)	11.9*
Costa et al.[20], 2021	Leme/ Pirassununga-SP	126	48.4 (61)	51.6 (65)	10a
Portella et al.[17], 2021	São Caetano do Sul-SP	3,062	51.0 (1,563)	49.0 (1,499)	10 to 18
Silva et al.[22], 2021	Iguatu-CE	179	52.5 (94)	47.5 (85)	11 to 15
Tadiotto et al.[10], 2021	Curitiba-PR	62	51.6 (32)	48.4 (30)	10 to 16
Pedretti et al.[11], 2022	Tramandaí-RS	91	62.6 (57)	37.4 (34)	09 to 12
Chagas and Barnett[18], 2023	Rio de Janeiro-RJ	128	44.5 (57)	55.5 (71)	12 and 13[a]
Lopes et al.[12], 2023	Rio do Sul-SC	45	62.2 (28)	37.8 (17)	6 to 11
De Marco et al.[13], 2023	Florianópolis-SC	981	51.4 (504)	48.6 (477)	14 to 18
Silveira et al.[14], 2023	Pelotas-RS	1,653	56.3 (930)	43.7 (723)	7 to 15
Ferreira et al.[19], 2024	Campinas-SP	152	44.7 (68)	55.3 (84)	11 to 16
Moraes et al.[15], 2024	Curitiba-PR	28	67.8 (19)	32.1 (9)	13 to 16

Note. NR: Not Reported; *mean: [a]chronological age of all participants in the sample.

The prevalence of adequate flexibility among Brazilian children and adolescents, along with the type of physical fitness test battery used, is presented in Table 2. All studies conducted the sit-and-reach test to assess flexibility. Eight studies assessed flexibility using the *Projeto Esporte Brasil* (PROESP-BR®) protocol[7,11,12,14,20,21,24,25]; eight studies used the Wells & Dillon test battery[8-10,15-17,19,23]; one study used the Fitnessgram®/EUROFIT[21]; and another used the Canadian Society for Exercise Physiology test battery[13]. Only six of 19 studies present flexibility results related to health-related criteria interpretation. Therefore, the average percentage of participants with adequate flexibility levels was 61.0% (21.2–81.0%), of which 61.9% (17.2–95.91%) were female participants and 60.3% (25.0–79.8%) were male participants.

Table 2. Prevalence of adequate flexibility in Brazilian children and adolescents, Brazil, 2025.

References	Physical Fitness Battery*	% Who meets criteria of adequate flexibility		
		Both % (n)	Male %(n)	Female % (n)
Aimi et al.[7]	PROESP-BR	85.0 (147)	76.8 (76)	95.9 (71)
Cibinello et al.[8]	Wells & Dillon	NR	NR	NR
Coledam and Oliveira[16]	Wells & Dillon	NR	NR	NR
Gaya et al.[25]	PROESP-BR	61.8 (2,498)	61.6 (1,369)	62.0 (1,129)
Gadelha et al.[23]	Wells & Dillon	NR	NR	NR
Silva et al.[24]	PROESP-BR	NR	NR	NR
Almeida et al.[21]	FITNESSGRAM /EUROFIT	NR	NR	NR
Sordi et al.[9]	Wells & Dillon	NR	NR	NR
Costa et al.[20]	PROESP-BR	NR	NR	NR
Portella et al.[17]	Wells & Dillon	NR	NR	NR
Silva et al.[22]	PROESP-BR	79.3 (142)	79.8 (75)	78.8 (67)
Tadiotto et al.[10]	Wells & Dillon	NR	NR	NR
Pedretti et al.[11]	PROESP-BR	34.1 (31)	43.9 (25)	17.6 (6)
Chagas and Barnett[18]	EUROFIT	NR	NR	NR
Lopes et al.[12]	PROESP-BR	57.8 (26)	53.3 (16)	66.7 (10)
De Marco et al.[13]	CSEP, 2004	21.2 (208)	25.0 (126)	17.2 (82)
Silveira et al.[14]	PROESP-BR	NR	NR	NR
Ferreira et al.[19]	Wells & Dillon	NR	NR	NR
Moraes et al.[15]	Wells & Dillon	NR	NR	NR

Note. *All studies used the sit and reach test; CSEP: Canadian Society for Exercise Physiology; NR: Not Reported.

Regarding the assessment of methodological quality and risk of bias of the studies included in this review, scores ranged from 0.4 (high risk of bias) to 0.9 (low risk of bias). In total, seven studies showed a low risk of bias[8,10,11,13,15,17,18], while 11 studies were classified as having a moderate risk of bias[7,12,14,16,19-25], and one study was classified as having a high risk[9]. Detailed results are presented in Table 3.

DISCUSSION

The present systematic review aimed to synthesize and update scientific evidence on the levels of flexibility among Brazilian children and adolescents. Overall, the results indicate that more than half of the children and adolescents demonstrate adequate flexibility, with similar proportions observed between boys and girls. However, these findings should be interpreted considering the methodological heterogeneity among the included studies and the fact that several of them did not report the prevalence of adequate flexibility. It is also noteworthy that all studies assessed flexibility using the sit-and-reach test, although different test batteries and classification criteria were adopted. Finally, it should be highlighted that more than half of the studies presented a moderate risk of bias.

Table 3. Risk of bias assessment in the studies included on the systematic review on flexibility in Brazilian children and adolescents, Brazil, 2025.

References	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Final Score	Classification
Aimi et al.[7b]	1	1	1	1	0	0	NA	NA	1	NA	1	0	NA	0	0.6	Moderate risk of bias
Cibinello et al.[8]	1	1	1	1	1	0	1	1	1	NR	1	1	1	1	0.9	Low risk of bias
Coledam and Oliveira[16b]	1	1	1	1	0	0	NA	NA	1	NA	1	0	NA	0	0.6	Moderate risk of bias
Gaya et al.[25a]	1	1	0	1	0	0	NA	NA	1	NA	1	0	NA	0	0.5	Moderate risk of bias
Neto et al.[23c]	1	0	0	1	0	1	1	1	1	1	0	0	-	-	0.6	Moderate risk of bias
Silva et al.[24c]	1	0	0	0	0	1	1	1	1	1	0	1	-	-	0.6	Moderate risk of bias
Almeida et al.[21a]	0	0	1	NR	0	1	1	1	1	NR	1	0	1	0	0.5	Moderate risk of bias
Sordi et al.[9a]	0	1	1	NR	0	1	0	0	1	NR	1	0	0	1	0.4	High risk of bias
Costa et al.[20a]	1	1	0	1	0	0	NA	NA	1	NA	1	0	NA	0	0.5	Moderate risk of bias
Portella et al.[17b]	1	1	1	1	0	0	NA	NA	1	NA	1	0	NA	1	0.7	Low risk of bias
Silva et al.[22b]	1	1	0	1	0	0	NA	NA	1	NA	1	0	NA	0	0.5	Moderate risk of bias
Tadiotto et al.[10b]	1	1	1	1	1	0	NA	NA	1	NA	1	0	NA	0	0.7	Low risk of bias
Pedretti et al.[11c]	1	1	0	1	0	1	1	1	1	1	0	0	-	-	0.7	Low risk of bias
Chagas and Barnet[18]c	1	1	0	1	0	1	1	1	1	1	0	0	-	-	0.7	Low risk of bias
Lopes et al.[12]a	1	1	0	1	0	0	NA	NA	1	NA	1	0	NA	0	0,5	Moderate risk of bias
De Marco et al.[13]a	1	1	1	1	1	0	NA	NA	1	NA	1	0	NA	0	0,7	Low risk of bias
Silveira et al.[14]a	1	1	0	1	0	0	NA	NA	1	NA	1	0	NA	0	0,5	Moderate risk of bias
Ferreira et al.[19]a	1	1	0	1	0	0	NA	NA	1	NA	1	0	NA	1	0,6	Moderate risk of bias
Moraes et al.[15]b	1	1	1	1	0	1	NA	NA	1	NA	1	0	NA	0	0,7	Low risk of bias

Note: [a]Quality Assessment of Controlled Intervention Studies; [b]Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies; [c]Quality Assessment Tool for Before–After (Pre–Post) Studies With No Control Group. **Q1.** Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?[a]; Was the research question or objective in this paper clearly stated?[b]; Was the study question or objective clearly stated?[c]. **Q2.** Was the method of randomization adequate (i.e., use of randomly generated assignment)?[a]; Was the study population clearly specified and defined?[b]; Were eligibility/selection criteria for the study population prespecified and clearly described?[c]. **Q3.** Was the treatment allocation concealed (so that assignments could not be predicted)?[a]; Was the participation rate of eligible persons at least 50%?[b]; Were the participants representative of those who would be eligible for the intervention in the target population?[c]. **Q4.** Were study participants and providers blinded to treatment group assignment?[a]; Were all the subjects selected or recruited from the same or similar populations with prespecified inclusion and exclusion criteria applied uniformly?[b]; Were all eligible participants that met the prespecified entry criteria enrolled?[c]. **Q5.** Were the people assessing the outcomes blinded to the participants' group assignments?[a]; Was a sample size justification, power description, or variance and effect estimates provided?[b]; Was the sample size sufficiently large to provide confidence in the findings?[c]. **Q6.** Were the groups similar at baseline on important characteristics that could affect outcomes?[a]; Were the exposure(s) of interest measured prior to the outcome(s) being measured?[b]; Was the intervention clearly described and delivered consistently across the study population?[c]. **Q7.** Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?[a]; Was the timeframe sufficient to reasonably expect an association between exposure and outcome if it existed?[b]; Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across participants?[c]. **Q8.** Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?[a]; Did the study examine different levels of the exposure as related to the outcome?[b]; Were the people assessing the outcomes blinded to the participants' exposures/interventions?[c]. **Q9.** Was there high adherence to the intervention protocols for each treatment group?[a]; Were the exposure measures clearly defined, valid, reliable, and implemented consistently across participants?[b]; Was the loss to follow-up after baseline 20% or less and accounted for in the analysis?[c]. **Q10.** Were other interventions avoided or similar in the groups (e.g., similar background treatments)?[a]; Was the exposure assessed more than once over time?[b]; Did the statistical methods examine changes in outcome measures from before to after the intervention and report statistical tests (e.g., p-values)?[c]. **Q11.** Were outcomes assessed using valid and reliable measures implemented consistently across participants?[a]; Were the outcome measures clearly defined, valid, reliable, and implemented consistently across participants?[b]; Were outcome measures taken multiple times before and after the intervention (interrupted time-series design)?[c]. **Q12.** Did the authors report that the sample size was sufficiently large to detect a difference in the main outcome between groups with at least 80% power?[a]; Were the outcome assessors blinded to the exposure status of participants?[b]; If the intervention was conducted at a group level, did the statistical analysis account for the use of individual-level data to determine group effects?[c]. **Q13.** Were outcomes reported or subgroup analyses prespecified (identified before analyses were conducted)?[a]; Was loss to follow-up after baseline 20% or less?[b]. **Q14.** Were all randomized participants analyzed in the groups to which they were originally assigned (intention-to-treat analysis)?[a]; Were key potential confounding variables measured and statistically adjusted for their impact on the relationship between exposure(s) and outcome(s)?[b].)?; NA, not applicable; NR, Not reported; 0: No; 1: Yes; 0.70: low risk of bias; ≥ 0.50: moderate risk of bias; <0.50 high risk of bias; To determine the total score, we considered the following equation: (total of positive answers / total of questions considered for that study).

Through a clinical perspective, flexibility represents a relevant component of physical fitness in children and adolescents, as it is associated with both musculoskeletal function and overall health throughout development. Adequate flexibility levels support joint range of motion, facilitate the efficient performance of activities of daily living, and contribute to functional independence from childhood onward[26]. In addition, evidence indicates that greater flexibility may reduce musculotendinous stiffness and help prevent injury, particularly in young populations engaged in sports and recreational activities[27]. From health surveillance perspective, systematic assessment using standardized tests allows early identification of deficits and monitoring of differences associated with individual and behavioral characteristics[2,26]. Considering that flexibility is a modifiable capacity and that regular physical activity during childhood and adolescence is associated with higher levels of this component[28], understanding the factors that influence its distribution across development is essential for interpreting findings in this population.

A temporal trend toward deterioration of flexibility in Brazil was observed between 2008 and 2014, with an increase in the prevalence of unhealthy levels from 35.2% to 38.4% in boys and from 23.5% to 38.0% in girls[25]. This scenario may have been further exacerbated during the COVID-19 period due to increased physical inactivity and sedentary behavior resulting from lockdown measures[29]. Corroborating this interpretation, recent evidence from an observational study indicates that, following the return to in-person school activities immediately after the lockdown period, flexibility levels, assessed using the sit-and-reach test, did not show significant changes across two assessments conducted three months apart[15] (from 19.0 ± 12.5 to 20.1 ± 11.0 cm; $p = 0.213$), remaining below normative reference values[30] and classified as low. Thus, although physical activity levels are associated with better flexibility, the first three months after returning to in-person school activities may not have been sufficient to reverse the impairments caused by confinement.

Overall, the included studies consistently demonstrate sexual dimorphism in flexibility performance, with an advantage for girls across different age groups[7]. Girls tend to present higher absolute values in the sit-and-reach test and a greater prevalence within healthy zones, which has been attributed to biological factors such as greater musculotendinous compliance, lower muscle mass indices, and hormonal influences (e.g., estrogen)[31]. Disparities in the proportion of children and adolescents meeting health criteria appear to be strongly influenced by sociocultural factors that promote greater engagement of boys in physical and sports activities compared with girls[7,19]. Evidence shows that boys engage in higher levels of physical activity (89.9% vs. 64.9% among girls) and greater participation in extracurricular sports (69% vs. 42.8%, respectively), which directly affects cardiorespiratory fitness and muscular endurance[7,13]. As a consequence of lower engagement in moderate-to-vigorous physical activity, girls are more frequently classified within the "health risk zone" for cardiorespiratory fitness, reaching inadequacy rates of up to 79.7% in some samples[7].

Although evidence from the included studies indicates that sex disparities in different components of physical fitness are strongly influenced by sociocultural barriers to physical activity, this pattern does not appear to fully apply to flexibility[7,31,32]. Nevertheless, the understanding of sex differences in physical performance should consider that cardiovascular and muscular capacities are qualitatively similar when normalized for lean mass[33]. Thus, physiological differences are mainly attributed to lower hemoglobin concentration in girls, rather than to reduced efficiency of the bioenergetic, cardiac, or muscular systems[33].

Collectively, these findings reinforce that social barriers and gender stereotypes act as constraints on full motor development and motor competence in girls, increasing their vulnerability to cardiometabolic risks and obesity throughout pubertal development[7,18,19].

Biological maturation was assessed in 6 of the 19 included studies, indicating limited incorporation of this determinant of flexibility in the analyzed literature. When considered, somatic maturation indicators predominated, particularly estimates of peak height velocity[18,34,35], based on predictive equations using anthropometric measures, whereas sexual maturation was less frequently and assessed through Tanner stages[36]. Conversely, 13 studies did not include any maturity data, which represents an important limitation for interpreting flexibility outcomes in adolescents. The absence of such information makes it difficult to understand variability in flexibility results from interventions or from natural growth, a limitation explicitly discussed in two of the included studies[18,23].

Regional disparities of studies across Brazil was found, with a massive research in the South and Southeast, particularly in Rio Grande do Sul[7,11,24], Santa Catarina[9,12,13], Paraná[8,10,15] and São Paulo[17,19,20], some representation in the Northeast[21,23]. However, none research was found the North and Midwest regions, appearing in only a single multicenter study[25] and may be were underrepresented. This geographic asymmetry limits the generalizability of findings to the Brazilian youth population[7,12]. Furthermore, many studies relied on local or convenience school samples[7,11,21,22], may suffering sample bias. However, research based on larger datasets, such as analyses derived from PROESP-BR, can contribute to a more comprehensive national perspective[25]. The overall body of evidence still lacks adequate nationwide representativeness. Future investigations should therefore prioritize multicenter samples and include historically underrepresented regions to produce more robust and equitable estimates of flexibility levels among Brazilian youth[20].

This review has limitations inherent to the available body of evidence, which precluded conducting a meta-analysis. Substantial methodological heterogeneity was observed across studies, including variability in study design, ranging from population-based cross-sectional investigations[13,14,25] to longitudinal follow-ups[15,18] and intervention research[8,11,21,24], as well as in sample characteristics. Sample sizes varied markedly, from small groups of approximately 20 adolescents[16] to national cohorts exceeding 10,000 participants[25], and were drawn from diverse school contexts (public and private)[14,20]. Regarding flexibility assessment, although the sit-and-reach test was the predominant method[13,16-18] , significant discrepancies were identified in instrumentation (e.g., Wells bench vs. floor-based tape measures)[12,14] and in classification criteria (e.g., PROESP-BR health zones vs. percentiles or absolute means)[7,12,14,21]. Moreover, the lack of standardized reporting of dispersion measures and effect sizes across several studies prevented quantitative synthesis. Finally, lack information of key variables, such as maturational stage (assessed in only about 20% of studies)[7,15,17,19] and habitual physical activity level[15,19,21], highlights the urgent need for methodological standardization in future research on flexibility in Brazilian children and adolescents.

CONCLUSION

In summary, this update review' findings indicate that flexibility among Brazilian children and adolescents shows that more than half of Brazilian children and adolescents have adequate levels of flexibility and sit-and-reach test remains the most used protocol to evaluate flexibility. From a practical standpoint, the results underscore the need to strengthen routine flexibility assessment within the physical activity and sports environment, preferably using standardized batteries. From a policy perspective, the evidence supports the importance of continuous physical fitness components surveillance and investment in school-based programs that promote equitable motor development across Brazilian regions. Future research priority should be given to studies with representative national samples or single studies to represent North and Midwest regions. Moreover, future research should consider including biological maturity and physical activity information, to better understand flexibility. Such advances are essential to reduce current heterogeneity, enable more robust comparisons, including the potential for future meta-analyses, and ultimately improve the interpretation of physical fitness indicators in Brazilian youth.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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

Performed the interpretation of the results: CCSMS, IKASP, KCSM, LGOL; Conception and design of the study: JY, IKASP, KCSM, LGOL, ECM, LRAL; Conducted the study screening and data extraction: IKASP, KCSM, JY, LGOL; Carried out the independent validation of the data extraction process: LRAL; Performed the risk of bias: JY, IKASP; Third reviewer in cases of disagreement: KCSM. All authors contributed to the writing, critical revision of the intellectual content, and approval of the final version of the manuscript.

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SUPPLEMENTARY MATERIAL

Supplementary material accompanies this paper.
Supplementary File 1. Free access in https://osf.io/bsj8k/
Supplementary File 2. Free access in https://osf.io/bsj8k/
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