

Flexibility in Brazilian children and adolescents: a systematic review

Flexibilidade em crianças e adolescentes brasileiros: uma revisão sistemática

Kenia Rejane de Oliveira Batista¹
Josiene de Oliveira Couto¹
Mona Gizelle Dreger de Oliveira¹
Roberto Jerônimo dos Santos Silva¹

Abstract – Flexibility is a health-related physical fitness component that has its importance related to the maintenance of functional independence and achievement of activities of the daily living. This systematic review aims to analyze the existing evidence in the literature regarding physical capacity flexibility in Brazilian children and adolescents. Searches were conducted in the Virtual Health Library, Scientific Electronic Library Online, Sportdiscus databases through the EBSCOhost and Pubmed platform. There were 89,553 articles, of which 69,197 were excluded for duplicity, 20,124 for the title, 160 for the abstract, 56 after a full analysis of the article, remaining 16 articles for the qualitative analysis. Of these, from the reading of references, 57 titles partially eligible for the review were identified, and after the application of the eligibility criteria, there were only 18 for the qualitative analysis. Of the 34 studies included for the qualitative analysis, 25 studies were excluded and nine were included in the review. All articles presented the cross-sectional design and used the sit-and-reach test to assess flexibility. It was evidenced that: a) flexibility has been treated as co-adjuvant in studies with children and adolescents; b) although females have absolute flexibility values greater than the opposite sex, males have higher frequency of subjects that meet the health classification criteria in this variable; c) there is greater prevalence of the use of FITNESSGRAM and PROESP-BR reference standards.

Key words: Adolescent; Brazil; Children; Range of motion.

Resumo – A flexibilidade é um componente da aptidão física relacionada à saúde que tem importância relacionada à manutenção da independência funcional e realização das atividades da vida diária. Esta revisão sistemática tem como objetivo analisar a evidência existente na literatura quanto a capacidade física flexibilidade em crianças e adolescentes brasileiros. As buscas foram realizadas nas bases de dados Biblioteca Virtual em Saúde, Scientific Electronic Library Online, Sportdiscus, através da plataforma EBSCOhost e Pubmed. Rastreou-se 89.553 artigos, dos quais 69.197 foram excluídos por duplicidade, 20.124 pelo título, 160 pelo resumo, 56 após análise integral do artigo e restaram 16 para a análise qualitativa. Destes, a partir da leitura das referências foram identificados 57 títulos parcialmente elegíveis para a revisão, após a aplicação dos critérios de elegibilidade restaram apenas 18 para a análise qualitativa. Dos 34 estudos incluídos para a análise qualitativa, 25 foram excluídos e nove estudos foram incluídos na revisão. Todos os artigos apresentaram delineamento transversal e utilizaram o teste de sentar e alcançar para avaliar a flexibilidade. Ficou evidenciado que: a) a flexibilidade tem sido tratada como coadjuvante nos estudos com crianças e adolescentes; b) embora o sexo feminino tenha valores absolutos de flexibilidade maiores que o sexo oposto, o sexo masculino tem maior frequência de sujeitos que atingem os critérios de classificação de saúde, nesta variável; c) há uma maior prevalência do uso dos padrões de referência do FITNESSGRAM e da PROESP-BR.

Palavras-chave: Adolescente; Brasil; Criança; Amplitude de movimento articular.

¹ Federal University of Sergipe. Postgraduate Program in Physical Education. Research Center on Physical Fitness, Health, and Performance of Sergipe. São Cristóvão, SE. Brazil.

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INTRODUCTION

Flexibility is a health-related physical fitness component that has its importance directly related to the maintenance of functional independence and accomplishment of activities of the daily living¹. Variation of its levels occurs according to stimuli², and there may be a reduction with advancing age if there is no adequate stimulus³.

The increase and decrease of flexibility levels can be linked to several determinants, being endogenous⁴ or exogenous factors⁵. Male adolescents have higher flexibility levels at more advanced stages of maturation⁶ and, when comparing sexes, females have higher absolute values for this variable⁷. The regular practice of physical exercise improves the flexibility levels⁸, and sports practitioners tend to present better flexibility levels when compared to their non-practitioner peers⁹.

The maintenance of adequate flexibility levels is associated with the prevention of postural problems, reducing the incidence of injuries, especially in the lower back, so that insufficient flexibility levels can contribute to the reduction of functional autonomy and activities of the daily living¹⁰.

In this sense, it is important to highlight and characterize Brazilian adolescents regarding flexibility levels, mainly due to its direct relationship with physical fitness and, consequently, activities of the daily living.

Thus, this systematic review aims to analyze the evidence in the literature regarding physical capacity flexibility in Brazilian children and adolescents.

METHODOLOGICAL PROCEDURES

Protocol

The present systematic review was constructed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology.

Eligibility Criteria

The question and strategy used to compose this study were based on the Population, Intervention, Comparison, Outcome (PICO) model, which is commonly used in the Evidence-Based Practice and highly recommended for the construction of systematic reviews¹¹.

Based on the above, for the current study, Brazilian children and adolescents aged 7-18 years were used as "Population"; for "Intervention", studies that assessed flexibility and the necessary evaluation instruments were considered; for "Control", the "not applicable" criterion was adopted; and "Outcome", the existing evidence about the physical capacity flexibility in Brazilian children and adolescents in the observed studies was considered.

The following inclusion criteria were independently applied: a) original articles published in Portuguese and English language until November 2017; b) observational studies (cross-sectional, case-control and cohort); c) studies with Brazilian children and adolescents aged 7-18 years; d) studies that assessed physical fitness and flexibility and described the test/method

used to measure flexibility; e) studies with any sample size; e) studies with STROBE $\geq 60\%$, which considers “moderate risk of bias”.

The following exclusion criteria were used: a) studies in which the population presented specific pathologies, chronic diseases or limitations; b) studies of narrative, systematic review, overview or meta-analysis; c) studies with animal models; d) those that the authors did not respond to the contact, when necessary; g) those that the abstract or full text was not found or was not available.

Sources of information

The Systematic Review was performed between November 2017 and March 2018 in the following databases: 1) Virtual Health Library (VHL); 2) Scientific Electronic Library Online (SciELO); 3) Sportdiscus, through the EBSCOhost platform; 4) PubMed.

Search

The search for eligible articles in databases was carried out using the advanced search tool available in each database using keywords through the construction of blocks of descriptors carried out by the authors. The entire search process was performed by two researchers independently and then compared for partial and total value verification. In cases where there were doubts, a third researcher was consulted.

Descriptors were inserted in Portuguese and English. The terms that composed the search were: “physical fitness”; “reference standards”; “flexibility”; “children”; “adolescents”; “fitness test”. Boolean operators “AND” and “OR” were used. The first one was used to relate “keyword” blocks to each other, and the second one was used to add a word from each block in the advanced search.

For each database, the following search strategy was used: “Physical Fitness” AND “Reference Standards” AND “Pliability” OR “Flexibility” AND “Child” OR “Children” AND “Adolescent” AND “Exercise Test” AND “Brazil” OR “Brazilian” – “Physical Fitness” AND “Pliability” OR “Flexibility” AND “Child” OR “Children” AND “Adolescent” AND “Exercise Test” AND “Brazil” OR “Brazilian” – “Pliability” OR “Flexibility” AND “Child” OR “Children” AND “Adolescent” AND “Exercise Test” AND “Brazil” OR “Brazilian”.

The process of creating specific libraries (identification, exclusion of duplicate studies, division and organization of the results of each database) was performed through spreadsheet tabulation.

Selection of Studies

The selection of studies was also carried out by two researchers independently. At first, the inclusion criteria were applied for the reading of titles and abstracts. Then, the inclusion criteria were applied to full texts of articles that were selected to be read in their entirety. Because it is a peer review, in case of doubts about the inclusion of articles, both researchers discussed

their inclusion. In cases where the doubt remained, a third researcher was consulted. The process of stratification, eligibility, selection, qualitative evaluation and studies included in the review are presented in Figure 1.

Data collection process

The process of extracting data from articles was carried out by the two researchers independently. Data were then confronted and organized into one table.

Risk of bias in each study

The process of assessing the risk of bias / methodological quality of included articles was carried out by two authors independently. The instrument used was the STROBE checklist, which includes 22 criteria to determine the risk of bias / methodological quality of studies. The instrument evaluates the quality of the observational research, making questions that help in the identification of possible risks of selection bias, information, measurement, and confounders¹².

The procedure for using STROBE was according to the following parameter: for each criterion evaluated, scores were given from 0, when the answer was “no”, to 1, when the answer was “yes”. At the end of classification, a score was generated for each study based on the scores of each criterion. Criteria that were not applicable for the assessed study or aspects that were not reported were excluded from the calculation to determine the final methodological quality score/risk of bias.

The quality of studies was classified as high methodological quality / low risk of bias (final score $\geq 70\%$), moderate methodological quality / moderate risk of bias (final score $\geq 60\%$) and low methodological quality / high risk of bias (final score $<60\%$). This stage was performed by two reviewers independently and cases of disagreement were resolved by debate and in the case of maintaining the doubt, a third evaluator was consulted.

RESULTS

Figure 1 presents the flowchart that summarizes the stages of identification and selection of articles that were selected and included in this review. As inclusion and exclusion criteria were applied for the eligibility of articles, 20,124 articles were excluded by the title and 160 by the abstract, remaining 72 articles for full analysis.

Figure 1 shows that after the complete analysis, 56 studies were excluded, as follows: due to the age group of participants ($n = 4$), the nationality of the investigated population ($n = 40$), presence of individuals with some pathology ($n = 6$), review studies ($n = 1$) and for not obtaining response from the study authors ($n = 5$).

At the end of the search, 16 original articles were included for the qualitative analysis. In these, the reading of references was performed, identifying 57 titles partially eligible for revision, which was submitted to the application of eligibility criteria, remaining 18 articles for the qualitative analysis. When added

to previously selected articles, 34 articles were included for the final qualitative analysis, of which 25 were excluded because they did not reach 60% in the STROBE evaluation and nine articles were included in the review (Figure 1).

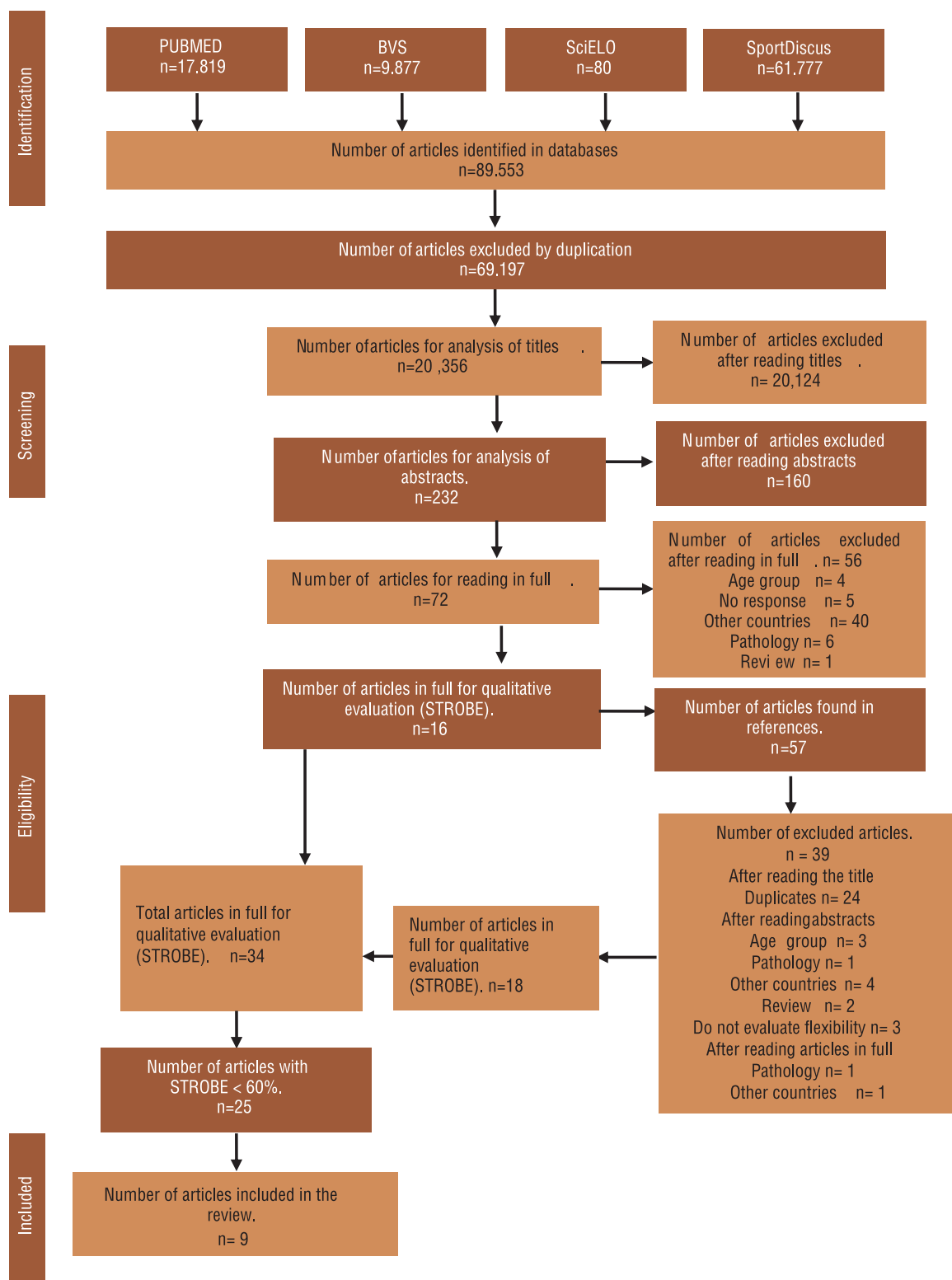


Figure 1. Study selection flowchart considering the inclusion and exclusion criteria.

Of the nine studies included, two are part of the same study^{13,14}, all had a cross-sectional design, seven¹³⁻¹⁹ had sample composed of both sexes and two^{20,21} evaluated only one sex. It was verified that 55% of studies had their sample composed only of adolescents and that sample size ranging from 129 to 2604, totaling 9,078 subjects, of which 53.09% were female (Table 1).

Table 1 also indicates that the Southern region of Brazil presented a greater number of publications on flexibility^{13-16,21}, and that only two studies^{17,21} had primary objective directly related to flexibility, while the others had focused on physical fitness. However, it was verified that all studies evaluated the flexibility component using the same test, with adjustments required by each adopted battery.

As for the criteria adopted for the performance and classification of flexibility results, one study¹⁹ used PHYSICAL BEST, three^{13,14,18} used FITNESSGRAM and five studies^{15-17,20,21} used PROESP-BR; however, only five studies make the classification of flexibility according to criteria of adopted batteries^{14,16,18,19,21}, and four^{14,18,19,21} make this classification by sex.

Table 1 also indicates that the absolute flexibility values indicate that females have higher absolute values than males; however, when considering the classification according to the reference criteria of each battery, males tend to have better prevalence values than females^{14,18,19}. Four studies^{14,18,19,21} showed that more than half of adolescents had adequate flexibility levels.

Table 1. Descriptive characteristics of included studies.

Authors	Study site	Population (age group)	Sex (F / M)	The primary aim of the study	Battery / Test used to evaluate FLEX	Outcome
Dumith et al. ¹⁵	Rio Grande/RS	1.132 school-children (11 ± 2 years)	311 / 354	To analyze the components of health-related physical fitness according to characteristics such as gender, age, school (public or private) and geographic area (rural or urban) in individuals aged 7-15 years	PROESP-BR/ Sit and reach	Flexibility was greater for girls, with reduction between 8 and 10 years and reducing after this age. There was no flexibility classification.
Minatto et al. ²¹	Cascavel/PR	2604 children and adolescents (females only)(8-17 years)	2604 / NA	Compare body mass, height, body mass index and flexibility with chronological age and sexual maturation and to verify the influence of these variables on the flexibility of students from public and private schools	PROESP-BR// Sit and reach	It was verified that 65.2% of the adolescents reached or surpassed the zone of physical fitness. There was no correlation between variables body mass, age, height, BMI and sexual maturation with flexibility.
Petroski et al. ¹⁹	Januária/MG	627 adolescents (14-17 years)	361 / 266	To evaluate health-related physical fitness (HRPF) in adolescents in a city with medium / low human development level.	PHYSICAL BEST/ Sit and reach	It was verified that 59.2% of adolescents reached the health criteria adopted (57.6% females and 60.9% males). At the age of 14 years, females had inadequate flexibility levels when compared to the opposite sex.

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Authors	Study site	Population (age group)	Sex (F / M)	The primary aim of the study	Battery / Test used to evaluate FLEX	Outcome
Guedes et al. ¹⁸	Montes Claros/MG	2849 children and adolescents (6-18 years)	1457 / 1392	Identify the sociodemographic and behavioral factors most strongly associated with health standards based on the scores of physical fitness components in a representative sample of Brazilian schoolchildren.	FITNESSGRAM / Sit and reach	Met criteria established for battery health standards adopted 63.4% females and 70.7% males. Flexibility was more likely to meet health standards for males, aged <9 years, with low economic level and physically active.
Silva et al. ²⁰	23 states of Brazil plus Federal District	1.348 adolescents (males only) (12.3 ± 1.3 years)	NA / 1.348	To compare the anthropometric and physical fitness characteristics of Brazilian adolescents practicing team sports and compare specific parameters obtained for adolescents with data from the general population.	PROESP-BR/ Sit and reach	Soccer and volleyball players showed better flexibility levels when compared to basketball and handball players. When comparing sports practitioners with the general population, practitioners scored higher than the general population.
Minatto et al. ^{13,14}	São Bonifácio/SC	270 adolescents (10-17 years)	129 / 141	To analyze the health-related physical fitness profile according to stages of sexual maturation in Brazilian adolescents (10-17 years) residing in a small town of Germanic colonization.	FITNESSGRAM / Sit and reach	It was verified that male adolescents belonging to the more advanced stages of maturation obtained better results in the flexibility test. With regard to females, flexibility remained stable during the pubertal period.
	São Bonifácio/SC	277 adolescents (10-17 years)	132 / 145	To identify the health-related physical fitness profile of Brazilian adolescents (10-17 years) of Germanic origin and to describe the prevalence of those with low physical fitness according to sex and age	FITNESSGRAM / Sit and reach	It was identified that 59.9% of adolescents reached the health-related physical fitness criteria (45.5% females and 73.1% males)
Schubert et al. ¹⁶	Londrina/PR	401 children and adolescents (8-16 years)	165 / 236	Identify which types of sports (individual or collective) may offer greater benefits to improve health-related the physical fitness components.	PROESP-BR/ Sit and reach	Females presented greater flexibility when compared with the opposite sex. 35.7% of the adolescents practicing some sports modality, meet the health criteria. No gender classification.
Joaquim et al. ¹⁷	The inner state of São Paulo	307 children (7-10 years)	149 / 158	To verify if there is a correlation between flexibility level and agility performance in school children aged 7-10 years and to identify possible differences in the average scores of each physical capacity and anthropometric profile between boys and girls.	PROESP-BR/ Sit and reach	No differences were found for flexibility levels. There was no classification by gender.

Note. Average; ± standard deviation; FLEX: flexibility; F: female; M: male; RS: Rio Grande do Sul; PR: Paraná; MG: Minas Gerais; SC: Santa Catarina; NA: not applicable.

As recommended by PRISMA, Table 2 indicates that of the nine studies analyzed, four^{17-19,21} obtained moderate risk of bias/moderate methodological quality, while the other five^{13-16,20} were considered with low risk

Table 2. Risk of bias assessment of included studies using STROBE.

Authors	1		2	3	4	5	6					12					13			14			15			16			17	18	19	20	21	22	Final score* (%)	Ranking	
	a	b					a	7	8	9	10	11	a	b	c	d	e	a	b	a	b	a	b	c	a	b	c										
Dumith et al. ¹⁵	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	77.20	Low risk of bias
Minatto et al. ²¹	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	0	0	1	0	1	-	-	-	1	1	1	1	1	0	0	67.86	Moderate risk of bias		
Petroski et al. ¹⁹	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0	0	1	0	1	-	-	-	0	1	1	1	1	1	1	67.86	Moderate risk of bias		
Guedes et al. ¹⁸	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	61.29	Moderate risk of bias		
Silva et al. ²⁰	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	-	-	1	1	1	1	1	1	1	72.41	Low risk of bias		
Minatto et al. ¹³	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	1	0	1	0	1	-	1	-	1	1	1	1	1	1	0	75.86	Low risk of bias			
Minatto et al. ¹⁴	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	-	-	-	0	1	1	1	1	1	1	85.71	Low risk of bias			
Schubert et al. ¹⁶	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	-	1	1	1	1	1	0	73.33	Low risk of bias			
Joaquim et al. ¹⁷	1	1	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	0	62.07	Moderate risk of bias				

of bias / high methodological quality, taking into account the qualitative evaluation that used STROBE as a reference.

DISCUSSION

The present study presents as main results that studies on flexibility in children and adolescents are linked to studies of physical fitness, which places flexibility in the background as a criterion to be studied in this group. It has been found that the “sit and reach” test with its variations is the test used in all studies. The study also identifies that although females have absolute flexibility values greater than the opposite sex; males have a higher frequency of subjects that meet the health classification criteria in this variable. In addition, it was verified that the FITNESSGRAM battery and that of PROESP-BR are the most used in studies and that most of the articles included in this study were carried out in the Southern region of the country.

Of articles included in this study, only two^{17,21} addressed flexibility as the main objective, and the others evaluated this capacity as a physical fitness component. According to Dantas and Conceição²², flexibility studies have been neglected in articles, and among health-related physical fitness components, flexibility presents a smaller number of published studies.

These results evidence the need for further studies addressing flexibility as the main point of observation in children and adolescents since this is an important component for maintaining the capacity to perform tasks of the daily living¹.

Although all studies used the same test to assess flexibility (sit and reach), three studies^{13,14,18} followed the FITNESSGRAM standardization,

assessing one leg at a time, while five studies followed standardization of the test used in the PROESP-BR^{15-17,20,21}. This may be due to the fact that the test is one of the most widely used for assessing flexibility in children and adolescents, because it has an easy application, low operational cost and short duration, regardless of standardization used²³.

Regarding the relationship between sexes, it was identified in studies that females present better flexibility levels when compared with the opposite sex; however, males have a greater proportion of children and adolescents who reach the health criteria for flexibility^{14,18,19}.

Corroborating this finding, the study by Ortega et al.²⁴ identified higher flexibility levels for females when compared to males among European adolescents. A study conducted in Latin America found similar results in children and adolescents, showing that females presented better flexibility performance when compared to the opposite sex²³. On the other hand, in the study of Joaquim et al.¹⁷, no differences between sexes were found.

With regard to the proportion of subjects that meet health criteria, it may be explained by the cultural context in which there is a greater involvement of males in the practice of physical exercises when compared with the opposite sex²⁵, since the regular practice of physical exercise is related to the improvement of health-related physical fitness components²⁶. In contrast to findings of the present study, Nogueira and Pereira²⁷ identified a higher proportion of women who met health criteria when compared to the opposite sex.

Regarding the reference standards used in studies, it was observed that most of them used FITNESSGRAM and PROESP-BR. In this context, Guedes et al.²⁸ points out proposals that were presented as a way of establishing cutoff points in analyses referenced by criteria such as the South Carolina Physical Fitness Test, Fit Youth Today, Physical Best and FITNESSGRAM.

In this sense, Guedes et al.²⁸ point to proposal of FITNESSGRAM as the most accepted worldwide; however, it should be emphasized that most studies^{15-17,20,21} used PROESP-BR, which was created with the objective of evaluating patterns of body development, nutritional status, health-related physical fitness and athletic performance in Brazilian children and adolescents²⁹, is an interesting reference for the standardization of responses obtained in children and adolescents in the country. Regarding the location of studies, five^{13-16,21} of them were developed in the Southern Region of the country.

CONCLUSION

It could be concluded that flexibility is apparently not adequately analyzed in studies, since it has been treated as co-adjuvant, suggesting the masking of its real importance.

It was also evidenced that the sit-and-reach test is the most used among studies with children and adolescents and that females when compared to the

opposite sex present better flexibility results, but that there is a greater proportion of male subjects that reach health criteria. There was a higher prevalence of the use of FITNESSGRAM and PROESP-BR reference standards.

COMPLIANCE WITH ETHICAL STANDARDS

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Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conception and definition of the study: KROB, JOC, RJSS. Conducted the survey and data collection: KROB, JOC, MGDO. Analyzed the data: KROB, JOC, MGDO, RJSS. Wrote the paper: KROB, JOC, MGDO, RJSS.

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CORRESPONDING AUTHOR

Roberto Jerônimo dos Santos Silva
Universidade Federal de Sergipe/
Departamento de Educação Física
Av. Marechal Rondon S/N – Jd.
Rosa Elze
São Cristóvão/Sergipe – 49100-000
E-mail: rjeronimoss@gmail.com