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Evidencia de validez basada en la estructura interna de la versión brasileña de la "*International Fitness Scale*" (IFIS)

Validity evidence based on the internal structure of the brazilian version of the 'International Fitness Scale' (IFIS)

Evidência de validade baseada na estrutura interna da versão brasileira do "*International Fitness Scale*" (IFIS)

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RESUMEN

Introducción: La evaluación de los niveles de aptitud física en adolescentes sirve como indicador de enfermedades crónicas degenerativas en la edad adulta. Por ello, la medición mediante una herramienta sencilla, barata, fácilmente aplicable y con buenas propiedades psicométricas, como la Escala Internacional de Condición Física, es de interés mundial para la salud pública. *Objetivo:* Validar el constructo y la confiabilidad de la versión brasileña de la "*International Fitness Scale*" (IFIS-BRA) en adolescentes. *Métodos:* 319 adolescentes (12 a 17 años) de ambos sexos se sometieron a la evaluación de la IFIS-BRA dos veces entre dos semanas. La validez de constructo se verificó mediante análisis factorial exploratorio y análisis de consistencia interna (*Cronbach's Alpha*, *McDonald's Omega*, *Composite Reliability and Higher Lower Limit*). Para evaluar la verosimilitud se utilizaron las herramientas *Unidimensional Congruence* (UNICO) y *Mean of Item Residual Absolute Loadings* (MIREAL). Para evaluar la fiabilidad entre las dos respuestas se usó el método test-retest, mediante *kappa* ponderado cuadrática. *Resultados:* La edad media de la muestra fue de 14.7 años, con una mayor prevalencia de mujeres. La consistencia interna fue adecuada, con valores *Cronbach's Alpha* de 0.79, *McDonald's Omega* de 0.80, *Composite Reliability* de 0.80 y *Greatest Lower Bound* de 0.81. El valor UNICO fue de 0.98 y el valor MIREAL de 0.25, lo que indica validez y unidimensionalidad del constructo. La media general de *Kappa* fue de 0.76 (sustancial), que osciló entre 0.63 y 0.89, y se clasificó de "sustancial" a "casi perfecta". *Conclusiones:* El instrumento puede ser considerado unidimensional y confiable, pues tiene validez factorial que representa bien la aptitud física autorreportada por los participantes y tiene capacidad de respuesta satisfactoria entre los dos momentos evaluados, lo que puede ser una ganancia para la ciencia.

Palabras clave: Adolescentes, Aptitud Física, Cuestionario, Confiabilidad y Validez, Autoinforme.

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ABSTRACT

Background: The assessment of physical fitness levels in adolescents serves as a predictor for chronic degenerative diseases in adulthood. Therefore, the measurement using a simple, cost-effective, easily applicable, and with good psychometric properties tool like the International Fitness Scale is of global public health interest. *Purpose*: Validate the construct and reliability of the Brazilian version of the 'International Fitness Scale' (IFIS-BRA) in adolescents. *Methods*: 319 adolescents (12 to 17 years old) of both sexes underwent the IFIS-BRA assessment twice between two weeks. Construct validity was verified through exploratory factor analysis and internal consistency analysis (Cronbach's Alpha, McDonald's Omega, Composite Reliability and Higher Lower Limit). To assess plausibility, Unidimensional Congruence (UNICO) and Mean of Item Residual Absolute Loadings (MIREAL) tools were used. The test-retest method was used to assess the reliability between the two responses, using quadratic weighted Kappa. *Results*: The mean age of the sample was 14.7 years, with a higher prevalence of females. Internal consistency was adequate, with values: Cronbach's Alpha of 0.79, McDonald's Omega of 0.80, Composite Reliability of 0.80 and Greatest Lower Bound of 0.81. The UNICO value was 0.98 and the MIREAL value was 0.25, indicating validity and unidimensionality of the construct. The overall Kappa mean was 0.76 (substantial), which ranged from 0.63 to 0.89, and was classified from 'substantial' to 'almost perfect'. *Conclusion*: The instrument can be considered unidimensional and reliable, as it has factor validity that represents well the participants' self-reported physical fitness and has a satisfactory response capacity between the two evaluated moments, which can be a gain for science.

Keywords: Adolescents, Physical Fitness, Questionnaire, Reliability, Validity, Self Report.

RESUMO

Introdução: A avaliação dos níveis de aptidão física em adolescentes serve como um indicador de doenças crônicas degenerativas na idade adulta. Portanto, a medição por meio de uma ferramenta simples, econômica, facilmente aplicável e com boas propriedades psicométricas, como a Escala Internacional de Aptidão Física, é de interesse global para a saúde pública. *Objetivo:* Validar a construção e confiabilidade da versão brasileira do "*International Fitness Scale"* (IFIS-BRA) em adolescentes. *Métodos:* 319 adolescentes (12 a 17 anos) de ambos os sexos foram submetidos à avaliação IFIS-BRA duas vezes entre duas semanas. A validade da construção foi verificada através da análise exploratória de fatores e análise de consistência interna (*Cronbach's Alpha*, *McDonald's Omega*, *Composite Reliability* e *Highe Lower Limit*). Para avaliar a plausibilidade, foram utilizadas ferramentas *Unidimensional Congruence* (UNICO) e *Mean of Item Residual Absolute Loadings* (MIREAL). O método de teste-reteste foi usado para avaliar a confiabilidade entre as duas respostas, usando *Kappa* ponderado quadrático. *Resultados:* A idade média da amostra foi de 14,7 anos, com uma maior prevalência de participando do sexo feminino. A consistência interna era adequada, com valores: *Cronbach's Alpha* de 0,79, *McDonald's Omega* de 0,80, *Composite Reliability* de 0,80 e *Greatest Lower Bound* de 0,81. O valor UNICO foi de 0,98 e o valor MIREAL de 0,25, indicando a validade e unidimensionalidade da construção. A média geral do *Kappa* foi de 0,76 (substancial), que variou de 0,63 a 0,89, classificada de "substancial" a "quase perfeita". *Conclusão:* O instrumento pode ser considerado unidimensional e confiável, pois tem validade de fator que representa bem a aptidão física autorrelatada dos participantes, com uma capacidade de resposta satisfatória entre os dois momentos avaliados, o que pode ser um ganho para a ciência.

Palavras-chave: Adolescentes, Aptidão Física, Questionário, Confiabilidade e Validade, Autorrelato.

Internal structure of the IFIS-BRA

INTRODUCTION

Physical fitness (PF) is strongly correlated with overall health, psych, quality of life and adolescence development (Bernal-López et al., 2024; Campos et al., 2018; Chinchilla-Fonseca et al., 2022; Cordel et al., 2018; Xing et al., 2017). According to a recent study, more than 80% of teenagers globally did not reach the daily moderate-to-vigorous physical activity guidelines (Guthol et al., 2020; Huang et al., 2022). PF assessment is essential for promoting physical activity (PA) programs (Sedlačík et al., 2023), yet the gold standard method to assess PF is complex, expensive, requires specific equipment which is not available in all places and must be conducted by a trained expert (Pereira et al., 2023). Hence, from a public health perspective, there is a critical need for the development of feasible, accurate and less expensive methods to assess PF (Álvarez-Gallardo et al., 2016; Ortega et al., 2011). The development of questionnaires was driven by their affordability and suitability for large-scale implementation (Chirivella, 2016; Falconi et al., 2019; Lopes & Sá, 2021; Pedreira et al., 2016).

The International Fitness Scale (IFIS) is an instrument widely used in research studies to measure the perceived PF in adolescents (Albornoz-Guerrero et al., 2022; Brazo Sayavera et al., 2023; Carneiro-Barrera et al., 2024; Chen et al., 2022; Martinez-Gomez et al., 2012; Fonseca-Camacho et al., 2014; Ha et al., 2021; Neira-Navarrete et al., 2024; Ruiz-Montero et al., 2020; Shi et al., 2022). The questionnaire was developed and validated in English and other 9 languages (Pereira et al., 2020; PROFITH research group, 2024). It is a quick, simple and self-reported questionnaire aiming to assess cardiorespiratory fitness (CrF), muscle strength, agility/speed and flexibility, in different contexts (Table 1) (Álvarez-Gallardo et al., 2016; Ayán et al., 2020; Bao et al., 2022; Carballo Afonso et al., 2022; Español-Moya & Ramírez-Vélez, 2014; Henström et al., 2021; İnce Parpucu et al., 2023; Matelot et al., 2024; Merellano-Navarro et al., 2017; Moraes et al., 2019; Ortega et al., 2011, 2013; Pereira et al., 2019; Pereira et al., 2023; Ramírez-Vélez et al., 2017; Romero-Gallardo et al., 2019; Sánchez-López et al., 2015; 2023).

In a Systematic Review and Meta-analysis, Pereira et al. (2020) synthesized available scientific evidence and analyzed the psychometric properties of the IFIS. quadratic weighted kappa Test-retest reliability, measured by quadratic weighted kappa, subdivided by the AGF, CC, FM, VA and Flex. Based on seven studies the test-retest reliability coefficients ranged from 0.40 to 0.99, with most studies achieving values ≥0.60, indicative of moderate to substantial reliability. We have already performed its transcultural adaptation to the Brazilian population in advance (Pereira et al., 2019). However, before its utilization in a large scale, confirming its psychometric properties such as reliability and construct validation (Souza et al., 2017) is a mandatory step.

Although reliability is indispensable for the use of this instrument, of all the published studies, only one study has performed construct validation based on an exploratory factor analysis (Table 1). Thus, the aim of the present study was to validate the construct and reliability of the Brazilian version of the International Fitness Scale (IFIS-BRA) when applied to adolescents.

Table 1

Analysis of the psychometric properties of studies on the IFIS instrument

Authors	Article Title	Psychometric Properties
Ortega et al., 2011	The International Fitness Scale (IFIS): usefulness of self-reported fitness in youth	VEBIE; VEBROV; ER
Ortega et al., 2013	Self-reported and measured cardiorespiratory fitness similarly predict cardiovascular disease risk in young adults	VEBROV; ER
Español-Moya & Ramírez-Vélez, 2014	Validación del cuestionario International Fitness Scale (IFIS) em sujetos colombianos de entre 18 y 30 años de edad	VEBIE; ER
Sánchez-López et al., 2015	Construct validity and test–retest reliability of the International Fitness Scale (IFIS) in Spanish children aged 9–12 years	VEBIE; VEBROV; ER
Álvarez-Gallardo et al., 2016	The International Fitness Scale (IFIS): construct validity and reliability in women with fibromyalgia. The al-Ándalus Project	VEBIE; ER
Merellano-Navarro et al., 2017	Validity of the International Fitness Scale "IFIS" in older adults	VEBROV
Ramirez-Vélez et al., 2017	Construct validity and test–retest reliability of the International Fitness Scale (IFIS) in Colombian children and adolescents aged 9–17.9 years: the FUPRECOL study	VEBROV; ER
Moraes et al., 2019	Is Self-Reported Physical Fitness Useful for Estimating Fitness Levels in Children and Adolescents? A Reliability and Validity Study	VEBIE; VEBROV; ER
Romero-Gallardo et al., 2019	International Fitness Scale - IFIS: Validity and association with health-related quality of life in pregnant women	VEBIE; VEBROV
Sánchez-López et al., 2023	Validity and reliability of the International fItness scale (IFIS) in preschool children	VEBIE; ER
Bao et al., 2022	Reliability of International Fitness Scale (IFIS) in Chinese Children and Adolescents	VEBIE; ER
Matelot et al., 2024	The International Fitness Scale (IFIS): A valid tool to assess physical fitness in French children	ER
Carballo Afonso et al., 2022	Reliability and Validity of the Perceived Physical Fitness Scale questionnaire in Spanish students	VEBIE; ER
İnce Parpucu et al., 2023	Adaptation of the International Fitness Scale and Self-Perceived Health-Related Physical Fitness Questionnaire into Turkish	VEBC; VEBIE; ER
Ayán et al., 2020	Reliability and Validity of a Questionnaire for Assessing Self-Perceived Health-Related Fitness in Spanish Children	VEBIE; VEBROV; ER
Henström et al., 2021	Self-reported (IFIS) versus measured physical fitness, and their associations to cardiometabolic risk factors in early pregnancy	VEBROV
Pereira et al., 2023	Parâmetros psicométricos do International Fitness Scale –versão brasileira via on-line e impresso	VEBIE
Pereira et al., 2019	Adaptação transcultural: tradução e validação de conteúdo da versão brasileira do instrumento the international fitness scale	VEBC

Note. VEBC - Validity Evidence Based on Content, VEBIE - Validity Evidence Based on Internal Structure, VEBROV - Validity Evidence Based on Relations to Other Variables, ER - Evidence of Reliability.

MATERIALS AND METHODS

Study design

This study is characterized as an observational, cross-sectional investigation and constitutes instrumental research (Ato et al., 2013).

Internal structure of the IFIS-BRA

Participants

This study has used a non-probabilistic sampling composed of adolescents of both sexes from five schools whose age ranged between 12 and 17 years old. With the number, classes, and age range of students in each school, the researchers have selected all those who met the criteria for eligibility. They ranged from 7th grade in elementary school to 3rd grade in high school, totaling 1935 adolescents.

Lastly, only the adolescents who handed in the two signed forms and those who met the eligibility criteria were included in the sample, representing a total of 319 volunteers. Those who proved to have the physical or cognitive (e.g. dementia and blindness) conditions that would ensure the completion of the evaluation were chosen, while adolescents who had used psychoactive drugs in the last six months before the evaluation and/or were unable to answer the questionnaire have been ruled out from the sample. Health information was provided by participants/teachers in a self-reported manner.

As previously proposed, for the validation of psychometric instruments this study expects to cover at least 100 individuals per assessed factor, or 20 to 30 individuals per items or variables (Laros, 2012; Marôco, 2011; Pasquali, 2010).

Instruments

Developed by Ortega et al. (2011), the IFIS is a self-reported questionnaire which aims to assess overall PF of a given subject, as well as its components, namely, cardiorespiratory fitness, muscle strength, speed/agility and flexibility. The IFIS is composed by five questions and the answers are based on a Likert scale with multiple choices (very poor, poor, average, good and very good).

In the original study with adolescents, construct validation (discriminant) was performed, obtaining expected differences in the results regarding sex, age, weight status, and sexual maturation. An association with risk factors for cardiovascular diseases has also been shown, since adolescents who reported better levels of physical fitness had a healthier cardiovascular profile. Criterion validation has demonstrated similarities in the results of self-reported physical fitness from the IFIS and the physical fitness measured from physical tests ($p<0.001$), which suggests that the IFIS correctly classifies adolescents according to their levels of physical fitness. And lastly, the test-retest reliability proved adequate, obtaining 65% perfect concordance and 97% perfectly acceptable concordance, besides the weighted Kappa having varied from 0.54 (moderate) to 0.65 (substantial) (Landis & Koch, 1977).

Procedures

This study complies with the Helsinki Declaration and was approved by the University of Pernambuco (UPE) Research Ethics Committee (Approval No: 3.015.407 and CAAE 93550718.0.0000.5207). During the invitation of candidates to participate in the study, all of them were provided with the Informed Consent Form (ICF), with required legal guardians to sign, authorizing the participation of the adolescent in the research. Additionally, the students were given an Assent Form (AF) to read and sign if they agreed to participate. The research was conducted according to requirements of Research Ethics in Sports and Exercise Sciences (Harriss et al., 2019) and also Organic Law 3/2018 of December 5 on Personal Data Protection and Digital Rights Guarantee.

After the Informed Consent Forms and the Informed Assent Forms were handed in, 309 adolescents from five public schools agreed to participate in our research and answered the IFIS-BRA questionnaire.

The test-retest method was conducted by applying the IFIS-BRA in a subsample of 52 individuals at two times (T1 and T2), with a two-week interval between the evaluations. We chose this interval because it is considered adequate for the evaluation of instrument reproducibility (Marx et al., 2003).

To minimize interference in the answers, the IFIS-BRA questionnaire was applied in quiet, reserved rooms in groups of 10 adolescents and with the presence of three trained applicators to supervise the process, read the instructions, ask questions, and not allow any conversations among the participants. Before starting the application and filling out the questionnaires, all participants were given standardized instructions. No time limit was set, and if there were any further questions, the applicants would be the only ones allowed to answer them.

Data analysis

Initially, the data was entered by double entry and *a posteriori* verification. After the consolidation and validation of the data, descriptive statistics were conducted: measure of central tendency (mean), dispersion (standard deviation), measure of accuracy (95% confidence interval) and measure of frequency distribution. The normality of the data distribution was assessed by Mardia's multivariate normality test (Mardia, 1970). To verify the construct validity of the IFIS-BRA, an Exploratory Factor Analysis (EFA) was performed using the statistical software FACTOR for Windows, version 10.10 (Ferrando & Lorenzo-Seva, 2018). Considering there were insufficient validity studies based on the IFIS's internal structure, the EFA was selected. The scientific literature suggests performing an EFA in order to confirm the instrument's factorial structure (Damásio & Borsa, 2017). The figures were created via GraphPad Prism for Windows, version 8.

To verify factor estimation, we have based the EFA on the Unweighted Least Squares (ULS) estimation method, and to identify the number of factors to be retained, we have used the following methods: (a) Kaiser-Guttman criterion (eigenvalue > 1); (b) Catell criterion and (c) Parallel Analysis (Minimum Rank Factor Analysis, based on 500 randomly simulated correlation matrices). All procedures were based on polychoric correlation matrices, considering the adequacy of this type of correlation for the analysis of ordinal variables (Auerswald & Moshagen, 2019; Baglin, 2014; Ferrando & Lorenzo-Seva, 2018). To assess the plausibility of the instrument, we have chosen the Closeness to Unidimensionality Assessment Test, represented by the values of Unidimensional Congruence (UNICO > 0.95) and Mean of Item Residual Absolute Loadings (MIREAL < 0.30), whose aim is to verify its unidimensionality (Ferrando & Lorenzo-Seva, 2018).

Regarding internal consistency, we have checked the indicators of accuracy of the IFIS-BRA by the following coefficients: Cronbach's Alpha, McDonald's Omega and Greatest lower Bound (GLB) through FACTOR. The Composite Reliability (CC) was assessed through a calculator available at: *https://www.thestatisticalmind.com/composite-reliability/* (Colwell, 2016). As described in the literature, all these coefficients are considered adequate when values are equal or higher than 0.70 (Tabachnick & Fidell, 2012; Ventura-León & Caycho-Rodríguez, 2017).

Moreover, we have also assessed the test-retest reliability through the average of the percentage of concordance and the quadratic weighted Kappa using the R software for Windows, version 3.6.1. The percentage of concordance was calculated as the difference between the initial test (T1) and the retest (T2). A difference (T2-T1) equal to 0 was classified as "perfect" agreement (same test-retest response); on the other hand, a difference of 0 ± 1 was classified as "perfectly acceptable". The following rankings were used for the squared weighted Kappa classification: < 0.00 (none); 0.00 - 0.20 (mild); 0.21 - 0.40 (small); 0.41 - 0.60 (moderate); 0.61 - 0.80 (substantial) and 0.81 - 1.00 (near perfect) (Landis & Koch, 1977).

RESULTS

The sample was composed of 319 adolescents, with an average age of 14.7 ± 15 years, of both sexes, out of which 46.1% (n=147) were male and 53.9% (n=172) were female. The participants had 3 to 5 minutes to complete the IFIS questionnaire.

With respect to the mean of the instrument categories, for general physical fitness we have found (3.48 ± 0.90 and 95% CI 3.36 to 3.62); for cardiorespiratory capacity, we have found (3.20 ± 1.0 and 95% CI 3.06 to 3.34); for

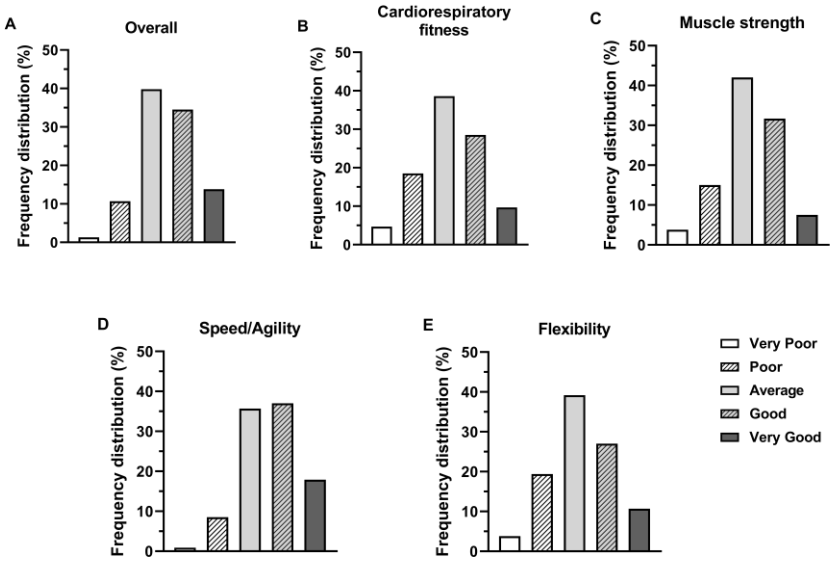
muscle strength, we have found (3.24 ± 0.92 and 95% CI 3.11 to 3.37); for speed/agility, we have found (3.62 ± 0.90 and 95% CI 3.49 to 3.75) and for flexibility, we have found (3.21 ± 0.99 and 95% CI 3.07 to 3.36). According to Mardia's multivariate normality test, all results were considered normal (p= 0.9907).

The distributions of responses for each of the five items assessed by the IFIS were "average" and "good", followed by "poor" for the categories: cardiorespiratory fitness, muscular strength, and flexibility, and "very good" for the categories: general physical fitness and speed/agility (Figure 1 a-e).

Before moving on to the EFA, we have checked the sample adequacy indices by means of the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity (Pasquali, 2012). Our results (KMO = 0.80) and significant chi-square: [χ^2 (10) = 370.6; p < 0.001)] indicated the possibility of moving on to the EFA. The Guttman-Kaiser criterion indicated the extraction of one factor, since only the first factor presented an eigenvalue greater than 1: 2.754, which helps explain 55% of the total variance; also, agreement was verified according to Cattell's criterion (graphical representation of the eigenvalues) (Figure 2).

Figure 1

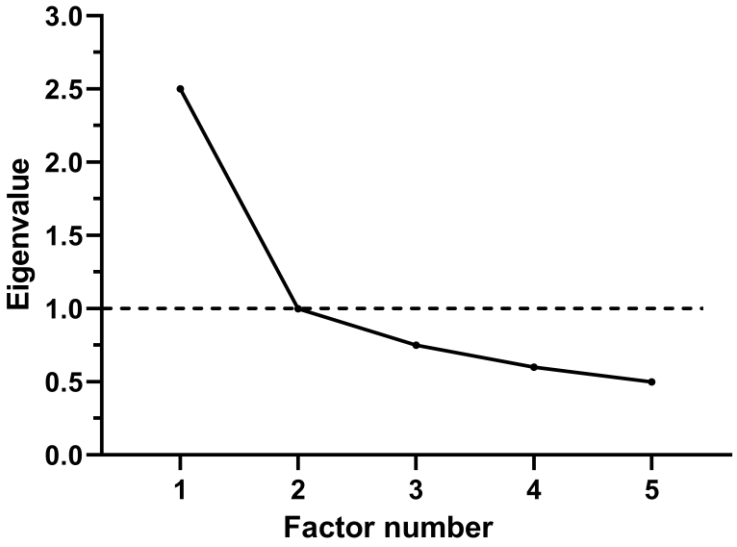
Frequency distribution of responses for the five questions of the IFIS-BRA in male and female adolescents (n = 309)



Note. a - General physical fitness; b - Cardiorespiratory fitness; c - Muscle strength; d - Speed/agility; e – Flexibility

Figure 2

Screen plot of the factors which were to be extracted from the IFIS-BRA



In order to define the best number of factors to be retained, we used the Parallel Analysis (PA), which confirmed the retention of only one factor that presented a higher explained variance percentage in the real data compared to the variance percentage of the simulated data (Table 2). Hence, only one factor of the real data has presented a greater explained variance than the variances of the randomly generated data. From the indications verified in the three factor retention methods, we conclude that the retention of a single factor is the most adequate to represent the factor structure of the IFIS-BRA.

Table 2

Parallel analysis of the factors which were to be retained

Factors	%Variance of real data	% Variance of random matrices	95% of the % Variance of random matrices
1	65.13*	41.14	51.52
2	17.61	30.03	36.62
3	11.99	19.23	25.25
4	5.26	9.60	17.20

Note. * Recommended number of dimensions: 1.

When we observe that the grouping of items that stems from the EFA corresponds to the theoretical perspective, we verify that, by having items with communality indexes (h2) ranging from 0.21 (Item 5 - Flexibility) to 0.73 (Item 1 - General Physical Fitness), as well as factor loadings (Factor 1) ranging from 0.46 (Item 5) to 0.85 (Item 1), one can infer the items' excellent ability to assess the factor target construct (Table 3).

After estimating the first evidence of validity based on the internal structure of the IFIS-BRA, it is possible to consider the existence of a unifactorial structure of the IFIS - BRA, corroborating a previous study (Español-Moya & Ramírez-Vélez, 2014). In light of this, the plausibility indices (UNICO = 0.98 and MIREAL = 0.25) confirm the possibility of treating the IFIS as unidimensional, not to mention its construct validity in the Brazilian context.

Internal structure of the IFIS-BRA

Table 3

Unifactorial structure of the IFIS-BRA

Item	Factor 1	h^2
General physical fitness	0.85	0.72
Cardiorespiratory fitness	0.77	0.59
Muscle strength	0.56	0.32
Speed/agility	0.64	0.41
Flexibility	0.46	0.21
Eigenvalue	2.75	
Explained variance	55%	-
Cronbach's Alpha	0.79	
McDonald's Omega	0.80	-
Composite reliability	0.80	
Greatest lower bound	0.81	-

Note. * Reference values for accuracy indicators should be ≥ 0.7 (Ventura-León & Caycho-Rodríguez, 2017).

The study has also verified good indicators of accuracy of the items that made up the instrument (Table 3), since these ranged from 0.79 to 0.81, and the specialized literature considers values higher than 0.70 as adequate, and values equal or higher than 0.80 as good (Tabachnick & Fidell, 2012).

The measurement of the temporal stability of the responses evaluated by the test-retest has showed agreement of all items, being classified as "perfect" (64.2%) and "perfectly acceptable" (97.7%). When the items were evaluated separately, the agreement of the items rated as "perfect" was: General Physical Fitness (63.5%); Cardiorespiratory Fitness (59.6%); Muscle Strength (59.6%); Speed/Agility (59.6% and 63.5%) and Flexibility (78.8% and 50.0%). And these were the ones rated as "perfectly acceptable": General Physical Fitness (98.1% and 88.5%); Cardiorespiratory Fitness (100% and 94.2%); Muscle Strength (98.1% and 84.6%); Speed/Agility (92.3% and 88.5%) and Flexibility (100% and 86.5%) (Figure 3). For all items, the squared weighted Kappa values were rated as substantial and near perfect (Table 4).

Figure 3

Percentage of test-retest agreement

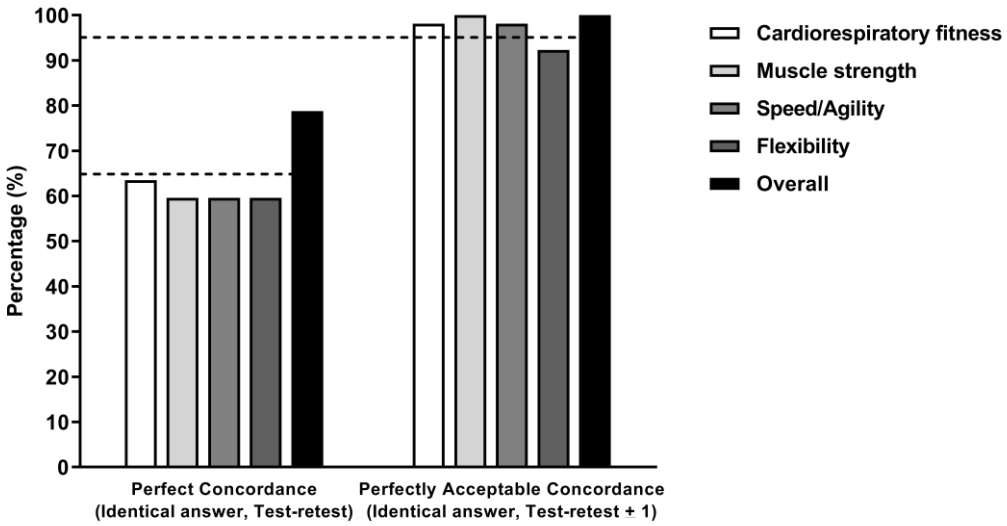


Table 4
Reliability of the IFIS-BRA questionnaire

Items	Weighted Kappa	p value	Classification
General physical fitness	0.76	p < 0,001	Substantial
Cardiorespiratory fitness	0.80	p < 0,001	Substantial
Muscle strength	0.73	p < 0,001	Substantial
Speed/Agility	0.63	p < 0,001	Substantial
Flexibility	0.89	p < 0,001	Near perfect

Note. Reference values: < 0.00 (none); 0.00 - 0.20 (mild); 0.21 - 0.40 (small); 0.41 - 0.60 (moderate); 0.61 - 0.80 (substantial) and 0.81 - 1.00 (near perfect) (Landis & Koch, 1977); (n = 52).

DISCUSSION

Our results suggest that the Brazilian Portuguese version of the IFIS is a useful instrument to subjectively assess physical fitness in adolescents.

Although this questionnaire has been used previously in Brazilian samples, some of its psychometric properties have not been mentioned, such as content validity before its application on adolescents and construct validity from exploratory factor analysis. Also, one should consider the fact that the manner in which the cross-cultural validation was conducted has not yet been published. Our study started the process of validating the IFIS from the standpoint of its cross-cultural and content validation (Pereira et al., 2019). And to continue, we have tested construct validity and reliability through exploratory factor analysis (EFA) and test-retest, respectively.

As observed by the description of the items' content, factor loadings, communality indices, precision indicators, and in agreement with the theoretical understanding of the items' grouping, the most adequate factor model has presented a single factor composed of five items, which confirms the factor structure of the original IFIS study for adolescents (Ortega et al., 2011).

The factor loadings of this study ranged between 0.46 (Item 5 - Flexibility) and 0.85 (Item 1 - General Physical Fitness), which may serve as an indicator of the items' good ability to assess the target construct of the factor. Also, its internal consistency has been represented by the value 0.79 of Cronbach's alpha. Corroborating these data, the study conducted with Colombian adolescents which has performed the EFA showed similar results to ours regarding factor loadings, also obtaining a lower value in the item of flexibility (0.44) and a higher value in the item of general physical fitness (0.82), as well as the value of Cronbach's alpha (0.80) (Español-Moya & Ramírez-Vélez, 2014). Both studies suggested factor I accuracy, and that the IFIS should be treated as unidimensional.

Furthermore, the present study presented other indicators of accuracy besides Cronbach's Alpha, since it can be sensitive to the size of the sample and the number of items in the instrument (Laros, 2012; Pasquali, 2010). Therefore, we have decided to verify the reliability through alternative indicators recommended by the literature in the field, such as McDonald's Omega, GLB, and Composite Reliability – all of which have presented adequate values (>0.70) in this research (Tabachnick & Fidell, 2012; Ventura-León & Caycho-Rodríguez, 2017), thereby confirming the accuracy of the IFIS-BRA.

Moreover, in a practical sense, the components of physical fitness that make up the items of the IFIS (cardiorespiratory fitness, muscle strength, speed/agility and flexibility) show strong association with health parameters related to risk factors for cardiovascular diseases (adiposity and metabolic syndromes) (Matthews et al., 1999; Ortega et al., 2013; Ramírez-Vélez et al., 2017; Sánchez-López et al., 2015) and performance in the daily activities of adolescents (Sánchez-Toledo et al., 2017). This shows that the IFIS represents construction aptly, thus allowing its use in conducting research that seeks to investigate the self-reported physical fitness of adolescents quickly and economically; by the same token, professionals in the area who may need to assess the physical fitness of adolescents could apply it as a complement to their practice.

In this study, the concordance of the test-retest reliability of the IFIS – with an interval of two weeks between applications – obtained a value identified as substantial (average weighted Kappa = 0.76), ranging from 0.63 (substantial) to 0.89 (near perfect), according to Landis and Koch (1977) (Landis & Koch, 1977). As to other studies that have used the IFIS in adolescents, also with this interval between applications, these data were higher than those of the original article recommended by Ortega et al. (2011) (Ortega et al., 2011), whose average was 0.59 (moderate), with values ranging from 0.54 (moderate) to 0.65 (substantial); also, it presented lower results concerning the average Kappa when compared to the study of Moraes et al (2019) (Moraes et al., 2019), which obtained a value of 0.92 (near perfect), ranging from 0.88 to 0.97. The study by Ramirez-Vélez et al. (2017), on the other hand, used a one-week interval between applications, obtaining a Kappa average of 0.81 (near perfect), ranging from 0.77 (substantial) to 0.84 (near perfect). These latter data were like our results, highlighting that the IFIS proved reliable at different times.

Apart from adolescents, the IFIS was tested on other populations (children, youth and adults of both sexes, and women with fibromyalgia). In general, among these groups, the average Kappa value ranged from 0.45 (moderate) to 0.96 (near perfect), which were considered as acceptable reliability values for the use of the instrument (Álvarez-Gallardo et al., 2016; Olivares et al., 2016; Ortega et al., 2013; Sánchez-López et al., 2015).

Regarding the mean score of the instrument categories, the item of speed/agility obtained the highest score (3.62 ± 0.90), while flexibility obtained the lowest score (3.21 ± 0.99). These data are corroborated by the literature, since in males, the gain in speed takes place up until they are 18 years of age, while in females, it occurs until they are 14 years of age (Pacífico et al., 2019; Reis et al., 2018). On the other hand, flexibility peaks in childhood and if not trained, it decreases over time (Montenegro & Carvalho, 2014).

The distributions of the responses for each of the five items evaluated by the IFIS found in the results of this study were "average" and "good", followed by "poor" regarding the categories: cardiorespiratory fitness, muscle strength and flexibility, and "very good" regarding the categories: general physical fitness and speed/agility. The study conducted with Colombians aged 9 to 18 years old showed similar results to ours (Ramírez-Vélez et al., 2017).

In light of this study's results as a whole, we argue that the IFIS-BRA can be considered as a reliable instrument to assess the physical fitness of Brazilian adolescents, with the advantages of having low costs, being easy to use and having a fast applicability – which make it a viable option to be used in large-scale epidemiological research.

Limitations of this study

Although the results found here demonstrate the IFIS-BRA's adequate psychometric evidence, there is also the need to highlight some potential limitations of this study. Due to cultural, social, climatic, and economic factors, the level of physical fitness may differ based on each region of our country, which limits our results to a specific region of northeastern Brazil. Although the Brazilian version of the IFIS has had good results in the psychometric properties observed so far, other types of validity evidence also ought to be presented, such as discriminant validity and criterion validity for national use. It is also important to verify whether the psychometric parameters remain independent of gender and the level of training of the adolescents by performing factor invariance analyses, for instance.

CONCLUSION

Even with these limitations, the IFIS-BRA has proven to be a simple, fast, accurate, valid, and reliable instrument. After the estimation of the evidence of validity based on its internal structure, as well as the indicators of accuracy of the items that made up the instrument, we believe this instrument can be considered as unidimensional. Moreover, the test-retest reliability values varied from 'substantial' to 'almost perfect', which indicates the stability of the results in the two distinct moments. Therefore, we conclude that the IFIS-BRA represents the construct aptly and presents adequate reliability.

PRACTICAL APPLICATIONS

In this sense, the IFIS-BRA also has good applicability, being a useful and reliable tool to estimate physical fitness in adolescents. It has a simple structure and can be completed in three to five minutes, which allows its use in large-scale studies, promoting the advancement of research in the field. It can also be used by different professionals to assess or monitor physical fitness, and can be part of complementary tests, since it has a strong association with cardiovascular disease risk factors (adiposity and metabolic syndromes). In light of all this, the application of the IFIS-BRA enables the development of interdisciplinary strategies to improve adolescent physical fitness and health parameters, but the limitations of this study must be taken into account.

CONFLICT OF INTEREST

The authors involved in the study have no potential conflict of interest.

CONTRIBUTIONS

D. A. Pereira contributed to the conception and planning of the project, critical intellectual review, data collection and approval of the final version, to be published. J. L. Correia Júnior contributed to the writing and elaboration of the article, data collection, critical intellectual review and approval of the final version, to be published. H. D. Sobral contributed to the writing and preparation of the article, data collection, critical intellectual review, and approval of the final version, to be published. M. P. Gonçalves contributed to the writing and elaboration of the article, critical intellectual revision and final approval, to be published. R. F. Dias contributed to the conception and planning of the project, writing of the article, critical intellectual review, analysis, interpretation of data, final approval, to be published; and took responsibility for all aspects of the work, ensuring the accuracy and integrity of any part of the work.

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