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Measurement in Physical Education and Exercise Science

ISSN: 1091-367X (Print) 1532-7841 (Online) Journal homepage: www.tandfonline.com/journals/hmpe20

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To cite this article: Vanilson Batista Lemes, Caroline Brand, Natalia Zurita-Corvalán, Nicolas Aguilar-Farias & Fernando Rodríguez-Rodríguez (12 Sep 2025): Reliability and Reproducibility of the International Fitness Scale (IFIS) in Children and Adolescents in Chile: An Analysis Through Structural Equation Modeling, Measurement in Physical Education and Exercise Science, DOI: 10.1080/1091367X.2025.2558534

To link to this article: https://doi.org/10.1080/1091367X.2025.2558534

MEASUREMENT IN PHYSICAL EDUCATION AND EXERCISE SCIENCE
https://doi.org/10.1080/1091367X.2025.2558534

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Reliability and Reproducibility of the International Fitness Scale (IFIS) in Children and Adolescents in Chile: An Analysis Through Structural Equation Modeling

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ABSTRACT

This study aimed to describe the reliability and reproducibility of the International Fitness Scale (IFIS) through a structural equation model (SEM) in children and adolescents in Chile. A cross-sectional design was developed with 160 participants (9 to 17 years) from Viña del Mar, Chile. The IFIS was administered twice with a 7-day interval, and assessed the self-perception of general physical fitness, cardiorespiratory fitness, strength, speed/agility, and flexibility. Cronbach's alpha and structural equation model were applied. The results showed that the IFIS demonstrates high reliability (Cronbach's alpha between 0.80 and 0.83). Reproducibility was high (β = 0.93), with all indirect effects in the SEM being significant. These results were consistent in both the crude model and the sex/age-adjusted model. In conclusion, the IFIS demonstrated high reliability and excellent reproducibility, proving to be a reliable and alternative tool for assessing physical fitness in children and adolescents in Chile.

KEYWORDS

Physical condition; questionnaire; psychometric properties; youth

Introduction

Physical fitness is defined as the ability to perform daily activities with vigor and without undue fatigue, and encompasses several domains including cardiovascular endurance, muscular strength, flexibility, and body composition (Ortega et al., 2008). Individuals exhibiting higher levels in physical fitness tests are protected against various comorbidities, such as obesity (Brand et al., 2024), cardiovascular risk, and metabolic health (Bagatini et al., 2023). Additionally, they experience enhanced physical and mental well-being, improved learning, and cognition (Lemes et al., 2021; V. B. Lemes et al., 2023, 2024; Wassenaar et al., 2021). Therefore, physical fitness is an important health indicator for children and adolescents (Ortega et al., 2008), and its assessment through noninvasive tests is highly relevant (Mello et al., 2016).

Indeed, the issue of low levels of physical fitness has become increasingly concerning over the last 30 years. Global studies highlight that physical fitness, particularly cardiorespiratory fitness (CRF) is in decline in various regions, including North America, Europe, Asia, and Oceania, emphasizing the urgent need for public health interventions to improve physical fitness in youth (Fühner et al., 2021; Tomkinson et al., 2019). Data from Brazil indicates high prevalences of low CRF levels, muscular strength/endurance, and flexibility in adolescents, approximately 74.1%, 27.4%, and 33.1%, respectively (Pereira et al., 2016).

In Chile, within the context of the present research, the same tendency is observed. Specifically, 26% of boys and 55% of girls in Chile exhibit unhealthy CRF (Garber et al., 2014). Additionally, 29% of boys and 35% of girls have unhealthy musculoskeletal fitness, while 29% of boys and 44% of girls have unhealthy body mass index (BMI) (Garber et al., 2014). Furthermore, low levels of cardiorespiratory and musculoskeletal fitness are observed among underweight, overweight, and obese adolescents in Chile when compared to their normal-weight peers (García-Hermoso et al., 2019). Lifestyle habits appear to play a significant role in these findings, given that more than 92% of children and adolescents in Chile spend over two hours a day watching screens or using electronic devices, and excessive central adiposity is associated with reduced physical fitness (Albornoz-Guerrero et al., 2022).

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This article was originally published with errors, which have now been corrected in the online version. Please see Correction (http://dx.doi.org/10.1080/1091367X.2025.2572205)

Thus, given the high prevalence of low physical fitness among Chilean children and adolescents and its association with sedentary behaviors and health risks (Reuter et al., 2019), the need for accessible, valid, and scalable assessment tools becomes critical. In this context, having a reliable and validated self-report instrument could serve as an essential strategy for large-scale fitness screening and monitoring, especially in educational settings where access to laboratory or field-based tests is limited (Oliveira et al., 2017). In this context, it is imperative to identify Chilean children and adolescents with low physical fitness to intervene and prevent possible future diseases. Also, although fitness is a recognized protective factor for several areas of development, including physical, mental, and cognitive domains (Agredo-Zuñiga et al., 2024; Fochesatto et al., 2019; Solis-Urra et al., 2021), Chile lacks representative estimates of fitness in children and adolescents. Most available instruments require trained personnel or access to field-based protocols (Rodriguez-Rodriguez et al., 2016; Ruiz et al., 2011), which limits their use in public schools with scarce resources. Furthermore, there is a lack of culturally adapted and validated self-report tools for assessing physical fitness in this population, representing a significant gap in both research and practice.

The International Fitness Scale (IFIS) is a reliable self-report questionnaire that classifies children and adolescents based on their measured levels of child and adolescent physical fitness (Ortega et al., 2011). In this sense, some authors have demonstrated that this approach is effective for screening and evaluation, and serves as an excellent, fast, and easy indicator for designing population-based, pre-evaluation, and planning interventions to enhance physical fitness (Lemes et al., 2020, 2022, Lemes et al., 2021). There are several advantages to using this type of instrument, including its low cost, the opportunity for attentive listening and care toward participants regarding their health, as well as its applicability, feasibility, usability, and accessibility in any school setting, including those with limited resources and higher vulnerability (De Moraes et al., 2019; Lemes et al., 2020, 2022; Sánchez-López et al., 2015). Regarding the IFIS, studies conducted in various countries, including Brazil, Colombia, France, and, China have reported moderate to high reliability scores, supporting its use as a valid and reliable instrument for assessing physical fitness in youth populations (Bao et al., 2022; De Moraes et al., 2019; Español-Moya et al., 2014; Matelot et al., 2024). A study involving Chilean adolescents aged 12 to 18 years demonstrated that the IFIS is a valid and reliable tool for assessing physical fitness (Olivares et al., 2017). However, their focus was limited to adolescents, whereas our study includes both Chilean children and adolescents. To date, no studies have examined the psychometric properties of the IFIS among Chilean children, limiting its generalizability and practical use in this subgroup. Given the developmental and perceptual differences between children and adolescents (De Moraes et al., 2019), it is essential to determine whether the IFIS functions reliably across age groups. Additionally, international literature highlights the need to validate self-perception instruments across diverse cultural and socioeconomic contexts to ensure measurement equivalence (De Moraes et al., 2019; Ortega et al., 2011; Sánchez-López et al., 2015). In this context, accounting for sex is also crucial, given that previous studies have shown that boys tend to report higher self-perceptions of physical fitness than girls (Bao et al., 2022).

Moreover, the present study holds significant importance not only for measuring the reliability and reproducibility of a physical fitness questionnaire in children and adolescents in Chile but also due to the use of sophisticated and highly robust statistical parameters, such as structural equation validity models. This method, in addition to estimating statistical validity, will also provide information on reproducibility and whether the quality of theoretical constructs translates effectively into the practical assessment of physical fitness through a questionnaire. Therefore, this study aimed to describe the reliability, reproducibility and construct validity of the IFIS through a structural equation model (SEM) in children and adolescents in Chile.

Methods

Study design

This cross-sectional study is part of the "'ACTIBESE Project'" - Active Behaviour in School Education: Ecological Model Application on School Physical Education to improve active behaviors in schoolchildren, whose main objective is to determine the school, interpersonal and personal factors that influence the active behavior of schoolchildren, considering the ecological theory as a model of interaction at school and in the physical education (Rodríguez-Rodríguez et al., 2025). The sample was selected according to convenient criteria and comprised 160 children and adolescents aged 9 to 17 years (71 boys and 89 girls) from two schools in the commune of Viña del Mar.

Sample size and test power

The criteria for sample power in the SEM were adopted as proposed by Hu and Bentler (1999), which suggests 15 to 20 participants per indicator variable as an adequate sample size for SEM validation (Hu & Bentler,

1999). Consequently, our study had an adequate sample size, consisting of 160 children and adolescents with 5 observable variables in the test and re-test.

Data collection

Before data collection, a meeting was held with the school directors and parents to explain the objectives and procedures of the study. All participants in this study signed an informed consent form accepting their voluntary participation. Also, informed consent was signed by their parents or legal guardians. The reliability and reproducibility of the IFIS questionnaire were evaluated through a test-retest applied seven days apart for each group between August and September 2023. Both evaluations were carried out on the same day of the week and at the same hour, during physical education classes with the supervision of a project member. Those who had not completed both questionnaires or did not answer any of them completely were eliminated from the analysis.

This study was approved by the Ethics Committee of the Pontificia Universidad Católica de Valparaíso (Code: BIOPUCV-H 638–2023) and was carried out following the rules by the guidelines for ethical procedures with human beings in line with the Declaration of Helsinki (World Medical Association, 2013).

International fitness scale (IFIS)

The IFIS (Ortega et al., 2011) is a questionnaire that assesses general physical fitness and the different components of physical fitness in youth. For the present study, we used the Spanish-translated version of the instrument as presented in the study by Ortega et al. (2011) and adapted to the Chilean context. The IFIS questionnaire is composed of five Likert-type scale questions that ask about children´s and adolescents' perceived general fitness, CRF, muscle strength, speed/agility, and flexibility in comparison with the physical fitness of their friends. The general fitness item reflects an overall perception of physical fitness, while the remaining components are assessed separately through individual questions focused on each specific domain. The answers were: "1 = very bad condition," "2 = bad condition," "3 = average condition," "4 = good condition" and "5 = very good condition."

Statistical analyses

Initially, we described the sample characteristics according to sex and each question of the IFIS questionnaire. Subsequently, the individual questions of the IFIS were adjusted for age and sex using quintiles for future adjusted SEM analysis. Before organizing the SEM, we calculated Cronbach's alpha at test and re-test, both crude and adjusted.

The general model of SEM is presented in Figure 1. First, the model was applied in its crude form, and then it was applied to the data adjusted for age and sex. We chose to evaluate the reliability and reproducibility of IFIS according to a unique, robust, and complex theoretical model transmuted into a mathematical model (Hu & Bentler, 1999, Lemes et al., 2021; Lemes, et al., 2021; V. B. Lemes et al., 2024). This model considers two latent constructs and uses SEM goodness-of-fit indicators as parameters to assess the mathematical validation of IFIS in the present sample (Hu & Bentler, 1999). The indicators of IFIS quality were: CMIN/DF (Minimum Discrepancy divided by Degrees of Freedom), which is a measure of the model's goodness of fit. Lower values (less than 3) indicate a good fit. CFI (Comparative Fit Index): It compares the model's fit with a baseline model. Values close to 1 indicate a good fit. TLI (Tucker-Lewis Index): It is also known as the Non-Normed Fit Index. Like CFI, values close to 1 indicate a good fit. RMSEA (Root Mean Square Error of Approximation): It measures the discrepancy between the hypothesized model with optimally chosen parameter estimates and the population covariance matrix. Values less than 0.08 indicate a good fit. SRMR (Standardized Root Mean Square Residual), which indicates the square root of the difference between the residuals of the sample covariance matrix and the hypothesized covariance model. Values less than 0.08 indicate a good fit. AIC/BIC (Akaike/Bayesian Information Criterion): These are used for model selection. The model with the lowest AIC or BIC is preferred. All of these criteria were applied in some previously published studies (Hu & Bentler, 1999; Lemes, Gaya, et al., 2021, Lemes et al., 2021; V. B. Lemes et al., 2024).

Figure 1 also illustrates the structure of SEM analyses, where R^2 represents the explanatory power of the latent constructs (ellipses), and the squares represent the indicator variables that form the constructs (general scores of IFIS). The "β" values represent the strength of relations between all variables. When considering the relation between two IFIS latent constructs evaluated at different moments with the same group of participants, the "β" value represents the reproducibility of the construct. Additionally, through the SEM, we also calculated the indirect effects of the latent construct in the test on each of the indicator variables in the retest, considering the mediating effect of all variables. In the context of our model, "e1 to e10" represents the error terms associated with each of the indicator variables. These errors capture the variation in the indicators not

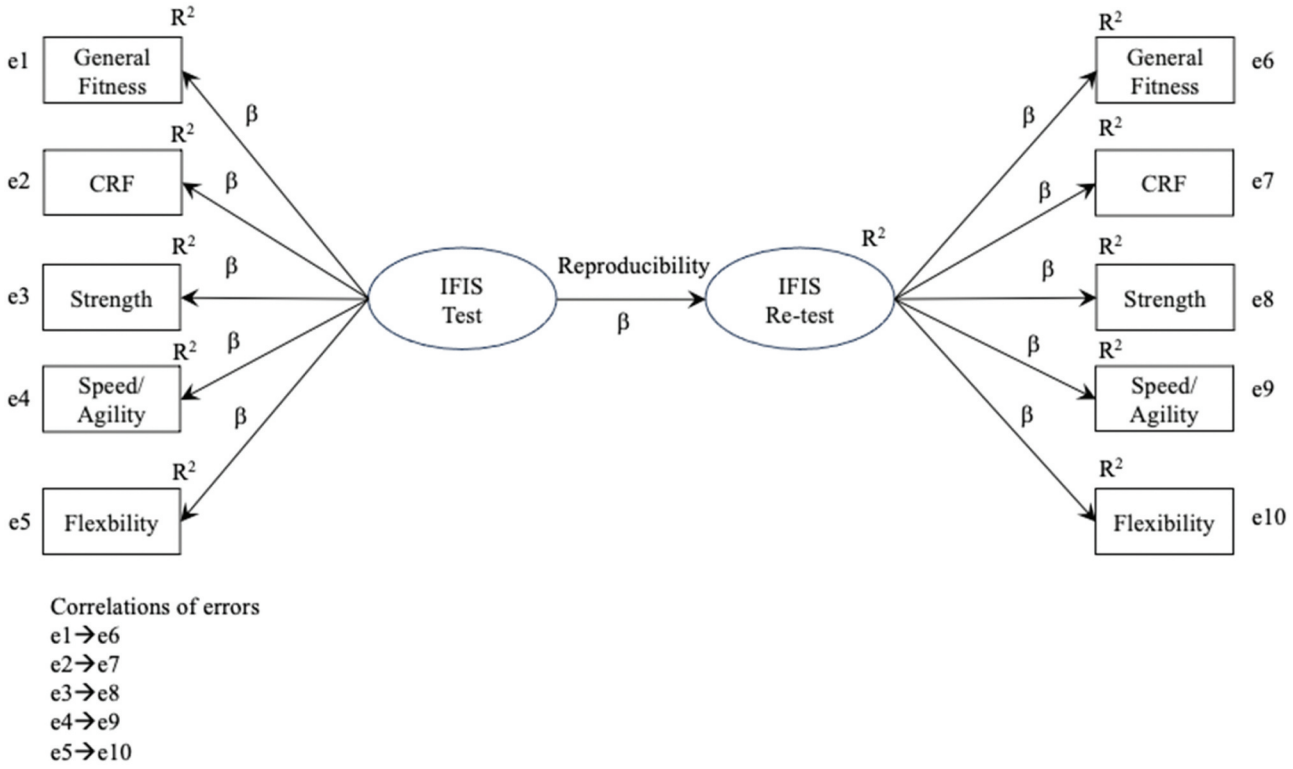

Figure 1. General model of the structural equation modelling for the International fitness scale (IFIS) validation. CRF: cardiorespiratory fitness.

explained by the latent constructs. The correlations between these errors were tested to determine if they were similar at two different moments of the IFIS application. This can provide evidence of the stability or reproducibility of the IFIS over time. If the correlations are high and similar across the two moments, it

Table 1. Descriptive sample characteristics of IFIS in test and re-test.

		General Fitness		CRF		Strength		Speed/Agility		Flexibility	
Test	Responses	N	%	N	%	N	%	N	%	N	%
Boys	Very poor			1	1.4	2	2.8			3	4.2
(*n*=71; 12.7 years)	Poor	5	7.0	6	8.5	3	4.2	8	11.3	24	33.8
	Acceptable	25	35.2	22	31	26	36.6	23	32.4	17	23.9
	Good	17	23.9	24	33.8	19	26.8	17	23.9	16	22.5
	Very good	24	33.8	18	25.4	21	29.6	23	32.4	11	15.5
Girls	Very poor	5	5.6	3	3.4	4	4.5	5	5.6	6	6.7
(*n*=89; 13.1 years)	Poor	6	6.7	16	18	10	11.2	12	13.5	15	16.9
	Acceptable	37	41.6	33	37.1	35	39.3	29	32.6	31	34.8
	Good	25	28.1	30	33.7	33	37.1	30	33.7	21	23.6
	Very good	16	18.0	7	7.9	7	7.9	13	14.6	15	16.9
		General Fitness		CRF		Strength		Speed/Agility		Flexibility	
Re-test	Responses	N	%	N	%	N	%	N	%	N	%
Boys	Very poor	1	1.4	1	1,4	1	1,4			6	8,5
(*n*=71; 12.7 years)	Poor	5	7	8	11,3	2	2,8	8	11,3	18	25,4
	Acceptable	26	36.6	24	33,8	25	35,2	21	29,6	24	33,8
	Good	17	23.9	19	26,8	30	42,3	15	21,1	13	18,3
	Very good	22	31	19	26,8	13	18,3	27	38	10	14,1
Girls	Very poor	3	3.4	4	4.5	3	3.4	4	4.5	9	10.1
(*n*=89; 13.1 years)	Poor	8	9	17	19.1	12	13.5	13	14.6	18	20.2
	Acceptable	43	48.3	41	46.1	41	46.1	36	40.4	31	34.8
	Good	24	27	21	23.6	26	29.2	23	25.8	15	16.9
	Very good	11	12.4	6	6.7	7	7.9	13	14.6	16	18

CRF. Cardiorespiratory fitness.

suggests that the IFIS has good reproducibility. Conversely, if the correlations are low between the two moments, it may indicate issues with the reproducibility of the IFIS. This reinforces the model's ability to evaluate reproducibility and reliability.

The analyses were conducted using IBM SPSS Statistics for Windows, Version 28.0 (Statistical Package for the Social Sciences) and IBM SPSS AMOS, Version 28.0 (Analysis of Moment Structures) (IBM Corp., Armonk, NY, USA).

Results

Table 1 presents the descriptive results concerning physical fitness levels measured through IFIS. The data showed that in the first test, boys demonstrated higher strength levels, with 56.4% falling into the "Good" and "Very good" categories, compared to girls at 45.0%. However, girls exhibited better speed/agility, with 48.3% in the same category, surpassing boys at 56.3%. Flexibility showed similar patterns, with both sexes performing well in the "acceptable" category (32.4% for boys and 34.8% for girls). Interestingly, CRF was lower in boys (33.8% "Very good"), compared to girls (37.1%).

The re-test demonstrated important findings in strength and speed/agility. Boys showed a higher prevalence in the "good" category in strength (42.3%), while girls maintained a high percentage in the "acceptable" category in speed/agility (46.1%). Flexibility remained consistent (33.8% for boys and 34.8% for girls). Surprisingly, girls reported a higher percentage in the "acceptable" category, compared to boys (46.1% and 33.8%, respectively).

Overall, both sexes demonstrated similar physical fitness perception. The majority of boys and girls in the sample responded that their fitness levels were either "acceptable," "good" or "very good," except for flexibility.

Regarding the Cronbach´s Alpha, the results were: Crude test (α=0.82); Crude re-test (α =0.83); age and sex-adjusted test (α =0.80); age and sex-adjusted re-test (α =0.80). The SEM quality of models for Crude (Figure 2) and adjusted (Figure 3) goodness fit parameters were: 1. Crude model: (CMIN/DF=1.5; CFI=0.98; TLI=0.98; RMSEA=0.056; AIC=115; BIC=120; SRMR=0.034). 2. Adjusted model: (CMIN/DF=1.5; CFI=0.98; TLI=0.97; RMSEA=0.060; AIC=117; BIC=123; SRMR=0.044).

The results of the crude SEM model are described in Figure 2. We observed moderate to strong relationships between all variables, confirming the reliability and reproducibility of the questionnaire. The reproducibility

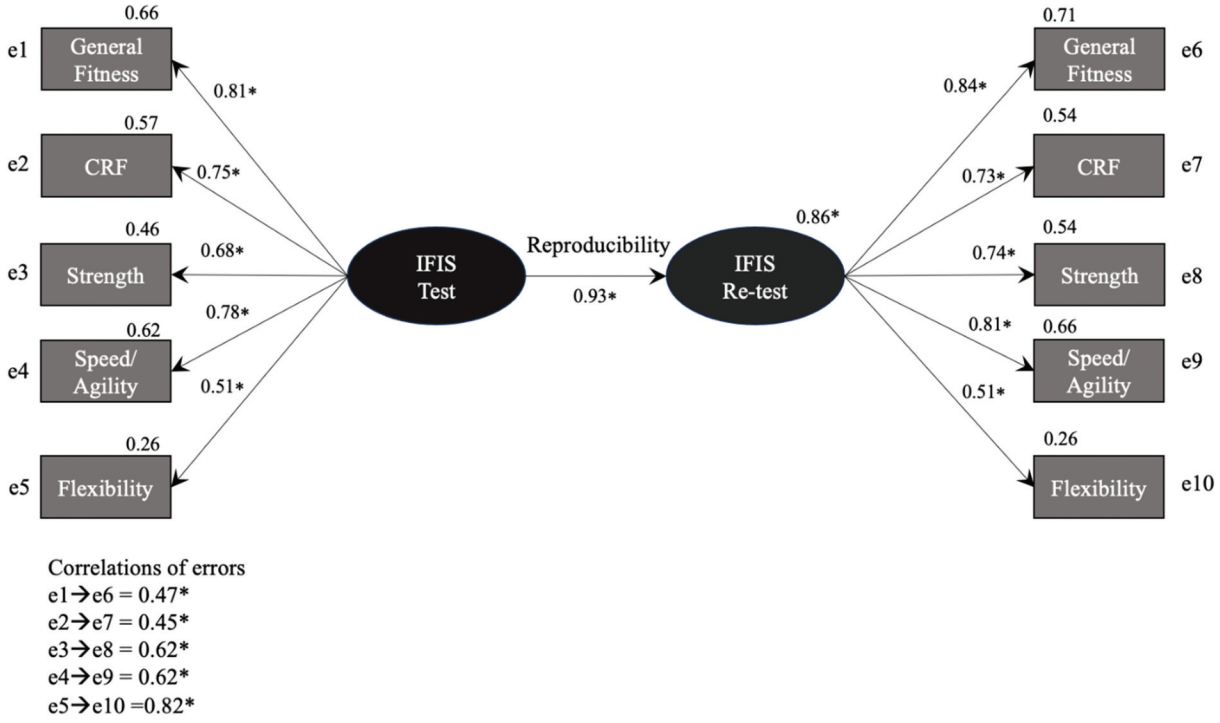

Figure 2. Crude model of structural equation modeling for the International fitness scale (IFIS) validation. CRF: cardiorespiratory fitness. Quality of the model parameters: (CMIN/DF = 1.5; CFI = 0.98; TLI = 0.98; RMSEA = 0.056; AIC = 115; BIC = 120; SRMR = 0.034).

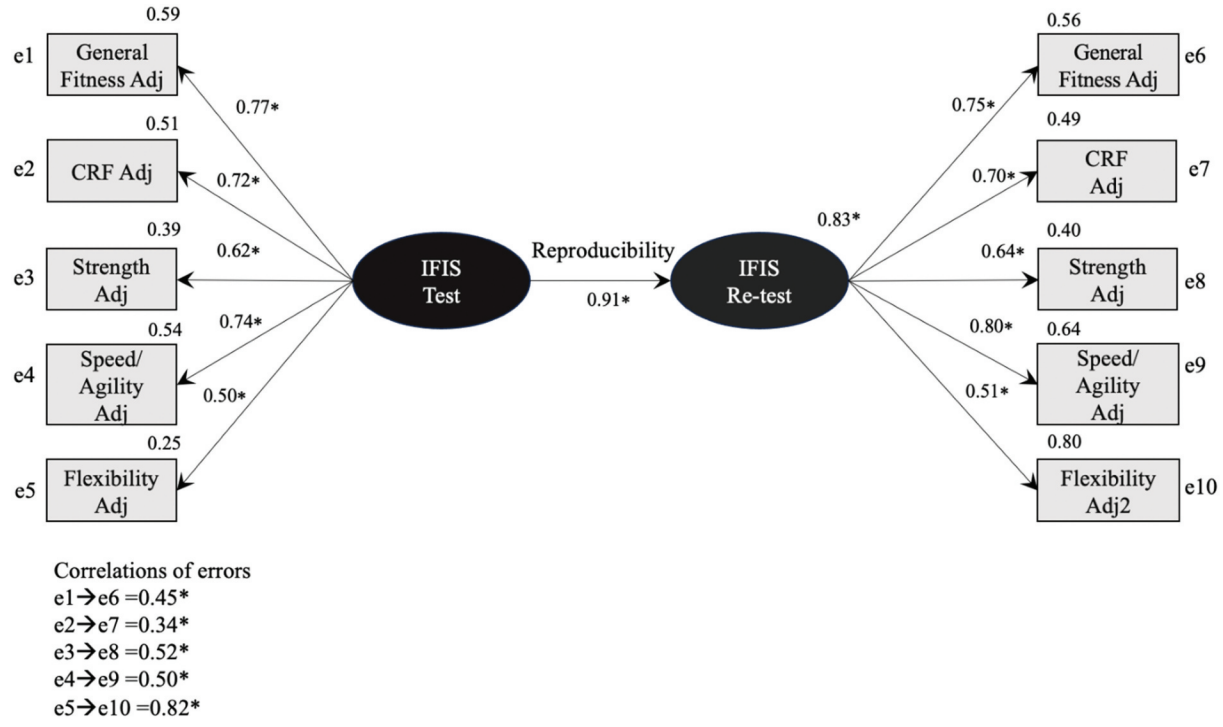

Figure 3. Adjusted model by sex and age of structural equation modeling for the International fitness scale (IFIS) validation. CRF: cardiorespiratory fitness. Quality of the model parameters: (CMIN/DF = 1.5; CFI = 0.98; TLI = 0.97; RMSEA = 0.060; AIC = 117; BIC = 123; SRMR = 0.044).

beta is notably high at 0.93. The high-quality fit of the model is confirmed by the strength of error correlations, which are higher than 0.47, reaching up to 0.82. The lowest relationship in the model pertains to the explanatory capacity of flexibility, with an R^2 of 0.26 at two points. However, these details about understanding flexibility do not affect the overall high quality, reliability, and reproducibility of the two latent constructs.

In Figure 3, it can be observed that the adjusted model (by sex and age) is like the crude model. However, it could be interpreted as an alternative model with correlations and goodness-of-fit parameters of lower quality. This suggests that varying perceptions of fitness and health across different sexes and age groups could lead to different interpretations of the IFIS. However, this does not negatively impact the application of the questionnaire across both sexes and these age groups because both the crude and adjusted models were valid, reproducible, and reliable according to a series of evaluated parameters.

Similarly, the latent construct of IFIS in the test presents the following indirect effect values on retest indicator variables. Crude model: general fitness (b = 0.78; p = .001), CRF (b = 0.68; p = .001); strength (b = 0.68; p = .001); speed/agility (b = 0.75; p = .001); Flexibility (b = 0.47; p = .001). In the adjusted model, these indirect impact values were: general fitness (b = 0.68; p = .001), CRF (b = 0.64; p = .001); strength (b = 0.58; p = .001); speed/agility (b = 0.73; p = .001); flexibility (b = 0.46; p = .001). Thus, the indirect effects of both models showed high reproducibility, even for variables adjusted for sex and age. The present results indicate that the IFIS performs consistently well among younger participants, as evidenced by satisfactory internal consistency and a strong model fit, even after adjusting for age.

Discussion

The present study aimed to describe the reliability and reproducibility of the IFIS through a SEM in children and adolescents in Chile. The Cronbach's alpha reliability was found to be between 0.80 and 0.83, indicating a high level of internal consistency. All SEM parameters and goodness-of-fit indices were within acceptable ranges. The reproducibility exhibited a beta value of 0.93 in the general construct evaluation, and all indirect effects in the SEM were significant.

The present findings paint a contrasting picture. General physical fitness and CRF seem to have declined for both sexes from the test to the re-test. An improvement in strength was observed among boys, but a decline was noted for girls. Agility remained unchanged for both girls and boys. Intriguingly, while

flexibility improved for boys, it declined for girls. These results can be elucidated by the fact that some adolescents, after perceiving their health status during the IFIS response, may have actively sought methods to enhance their health condition following their initial self-evaluation (Lemes et al., 2021; V. Lemes et al., 2020, 2022). This underscores the importance of the current questionnaire as an applicable and straightforward method for monitoring and assisting adolescents in modifying health indicators through both school-based and non-school-based interventions.

The reliability and validity of the SEM, along with the reproducibility results of IFIS, substantiate the aforementioned assertions. The Cronbach's alpha reliability ranged from 0.80 to 0.83, demonstrating strong internal consistency. Additionally, all the SEM parameters and goodness-of-fit indices met acceptable criteria. The general construct evaluation showed a reproducibility beta value of 0.93, with all indirect effects in the SEM proving significant. These results were consistent in both the crude model and the sex/age-adjusted model. In essence, the IFIS demonstrated satisfactory reliability and reproducibility. Furthermore, the IFIS is an easy-to-use, low-cost, and quick measure suitable for use in an educational context for children and adolescents, given that the questionnaire structure comprises only five questions with four multiple-choice responses each.

In terms of effectiveness, the IFIS questionnaire is one of the most widely recognized tools for evaluating self-perceived physical fitness in youth populations. It has demonstrated robust psychometric properties across diverse samples, supporting its reliability and applicability. For instance, a study conducted in Spain reported reliability coefficients ranging from 0.80 to 0.90, along with satisfactory goodness-of-fit indices after construct adjustments (Rojo-Ramos et al., 2023). Similarly, data from children and adolescents in Brazil showed high reliability, with kappa values ≥ 0.93 in children and ≥ 0.88 in adolescents (De Moraes et al., 2019). In France, the IFIS also demonstrated acceptable reliability coefficients across all physical fitness components, ranging from 0.59 to 0.72. These findings collectively reinforce the consistency of the IFIS across different cultural contexts and age groups, and support the current study's results regarding its reliability and reproducibility among Chilean children and adolescents (Matelot et al., 2024).

Indeed, this study took a unique approach by presenting all the indices of the structural equation model, indirect effects, crude values, and adjustments for age and sex. Additionally, it included a reproducibility measure in a longitudinal form. The current design of the mathematical structural equation models aligns with the studies conducted by V. Lemes et al. (2020, 2022). In these studies, the reliability and reproducibility over time were measured using the "QAPA questionnaire." This questionnaire consists of an ordinal scale with three levels of responses and ten items, demonstrating high internal and external consistency. Furthermore, other studies that used physical education questionnaires related to physical activity and fitness correlated factors have also presented consistent results, similar to the findings of the current study. This further underscores the reliability and feasibility/validity of such questionnaires in assessing physical activity, fitness, and related factors (Cossio-Bolaños et al., 2016; De Moraes et al., 2019, Lemes et al., 2021; Mendonça et al., 2022).

Additionally, a key strength of this study lies in the inclusion of both children and adolescents, which allowed us to explore the reliability and reproducibility of the IFIS across a broader age range. To our knowledge, this is the first study in Chile to include children in the validation of this instrument. This supports its applicability in younger age groups and strengthens its utility for early identification of physical fitness perceptions in school settings. Other research has provided evidence that this could be an effective solution for evaluating physical fitness based on self-perception, despite some inherent subjective limitations (De Moraes et al., 2019; V. Lemes et al., 2022). Indeed, it is widely recognized that self-reported perceptions of physical fitness, as assessed through psychometric tools, are significantly associated with objectively measured physical fitness (Ortega et al., 2011). This suggests that our mental processes and physical health are closely interconnected (De Moraes et al., 2019; V. Lemes et al., 2022, Lemes et al., 2021; Mendonça et al., 2022; Sánchez-López et al., 2015).

Considering these strengths, some limitations should be addressed. The first is that the IFIS is reproducible; however, it requires future evaluation of its association with direct physical fitness tests in larger samples and with diverse populations to broaden its use and application in various Chilean contexts and other countries. The present study is a starting point for this type of instrument evaluation; therefore, it is not the conclusion. Finally, the main limitation of all questionnaires and self-reported psychometric scales is the participant's interpretation, a fact that we have minimized in the present methodology by providing described assistance to students during the evaluations. However, despite these limitations, science must offer strategies for assessing

physical fitness that are pedagogically appropriate, that is, adapted to school settings, feasible to implement, and supportive of the educational development and well-being of children and adolescents, particularly in the post-COVID-19 pandemic context in Latin America.

Conclusion

The IFIS demonstrates high reliability, high reproducibility and satisfactory construct validity in the current sample, which consists of children and adolescents aged 9–17 years. Therefore, this is a recommended method to evaluate self-reported physical fitness and can be applied to track physical fitness and health status over time in children and adolescents in Chile.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This project has been financed by the Fondo Nacional de Investigación para el Desarrollo Científico y Tecnonlógico, FONDECYT of the Agencia Nacional de Investigación y Desarrollo (ANID) of the Chilean Government. FONDECYT Regular project 2023, Nº [1230801]; Agencia Nacional de Investigación y Desarrollo [1230801].

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Data availability statement

The database used and analyzed in the present study is not publicly available as its information may compromise the participants' privacy and the consent involved in the research. However, the data are available from the corresponding author upon request.

Generative artificial intelligence

The tool ChatGPT (version GPT-4) was used only to review and edit the English language of the manuscript, to improve clarity and fluency.

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