



Original article

The International Fitness Scale (IFIS): A valid tool to assess physical fitness in French children

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ABSTRACT

Background: The need for monitoring regularly physical fitness in youth is well established for public health issues. The aim of this study was to assess the validity and reliability of the International Fitness Scale questionnaire (IFIS) to assess physical fitness in French children in the school context.

Methods: A sample of 2 060 children (1054 boys), aged 10.6 ± 0.9 years, participated in the validation study while an independent sample of 366 children (175 boys), aged 9 to 11 years, participated in the assessment of reliability. Physical fitness was measured by a self-report of 5 questions with a 5-point Likert-scale (from very poor to very good) (IFIS), and also measured objectively by 4 field tests: cardiorespiratory fitness, muscular strength, speed/agility and flexibility. For the test-retest reliability assessment, children were instructed to complete the questionnaire twice, 1 week apart.

Results: For all physical fitness components studied, children reporting a good or a very good physical fitness in the IFIS had better results in objective measurements of physical fitness tests compared to children reporting a very poor to an average physical fitness ($p < 0.001$) without or with adjustments for sex, age and weight status. The reliability coefficients were acceptable for all components of physical fitness (0.59–0.72).

Conclusions: These results suggest that IFIS appears to be a useful instrument for teachers to estimate physical fitness levels of French children, possibly on a large scale.

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Introduction

Physical fitness is the ability to carry out daily tasks with vigor and alertness without undue fatigue and ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies [1]. Attributes of physical fitness include cardiorespiratory fitness (CRF), musculoskeletal fitness (muscular strength, power, endurance, and flexibility), motor fitness (agility, speed of movement, balance and coordination) and body composition/anthropometry (height, body mass, body mass index (BMI), and waist circumference) [2].

Physical fitness is now widely recognized as a powerful health indicator that is inversely associated with cardiovascular events, cancer and all-cause mortality [3]. Recently, two systematic reviews and meta-analysis showed the evidence linking both CRF and muscular strength in children and adolescents with the health status later in life [4,5]. Authors showed that low muscular strength and CRF in adolescence are strongly associated with risk factors for major causes of death in adulthood [4,5].

The interest of monitoring regularly physical fitness in youth is well established and underlined by the American Heart Association [6]. Physical fitness can be assessed by laboratory tests (considered as gold standard) or by field-based tests. Laboratory tests are not fitted for epidemiological survey because of their cost, the time needed, and the limited number of laboratories with trained team and relevant equipment. Field-based tests seem to be a good alternative in order to assess physical fitness components in children, especially in the school environment. However, these tests also present limits for

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large population survey: the needs time, specific equipment, and also training sessions for teachers to improve reliability. Indeed, the estimated time to perform a physical fitness assessment in 20 youth is approximately 2 h and 30 min, i.e. three 55-minutes physical education classes [7].

Thus, self-reported questionnaires appear interesting in order to assess and follow children physical fitness on a large scale in the school context. The International Fitness Scale (IFIS) has been developed and considered as a useful, quick, and inexpensive alternative to objectively measured physical fitness in youth [8]. This self-questionnaire is available in several different languages and allow to assess overall physical fitness, cardiorespiratory endurance, muscular fitness, agility and flexibility. The IFIS has been validated in several condition such as pregnancy, elderly adults and youth, disease and in several geographic locations such as Chile, Colombia, Brazil, Spain and some European countries for adolescents population [8–14]. Reliability of IFIS has been extensively studied in a systematic review and meta-analysis [15]. Studies previously mentioned have been conducted in adolescents. The body of knowledge in this field in children relies on a still relatively limited number of studies [12,13,16]. Thus, it is unknown whether the IFIS is a valid and reliable instrument to assess physical fitness in French children. Therefore, the aim of this study was to assess the validity and reliability of the International Fitness Scale (IFIS) for measuring physical fitness levels in a large-scale sample of French children in their school settings.

Methods

Sample

Children included in this study are part of the French health programme *Diagnoform*[®] (<https://irfo.fr/>). As previously described, the programme aims to assess physical fitness levels in French population from the age of 5 years, and is carried out in large settings such as school playgrounds or sports club gymnasiums throughout France [17,18]. For the present analysis about the validity of the questionnaire (IFIS), a sub-sample from the cohort using the *DiagnoKid* battery was included.

A total of 2 060 children (1 054 boys, 1 006 girls) participated in the validity study from 6 regions of France (Auvergne Rhône Alpes, Bretagne, Grand Est, Hauts-de-France, Normandie and Pays de la Loire). From this specific cross-sectional study, children were instructed to complete the questionnaire about their physical fitness levels (IFIS). Then, children performed different physical fitness tests in order to assess objectively their physical fitness levels.

To assess the reliability of the questionnaire (IFIS), an independent sample of 366 children (191 girls and 175 boys) aged from 9 to 11 years old was included. Since physical fitness tests were performed just after answering the IFIS, the same children cannot realise the reliability test because the results of the field tests could influence the answers [8]. Therefore, we asked to children from 16 classrooms in three different cities in western France, not involved in the validity study, to complete the IFIS two times 7 days apart.

All data obtained from the organizer IRFO of the event were anonymized, and declared and approved by the Commission Nationale de l'Informatique et des Libertés (National Commission on Informatics and Liberty). Data were recorded by the organizer in an electronic data system. An audit of the complete dataset was performed, and aberrant data were excluded. As this research was not performed to improve biological or medical Human knowledge, this present study is not considered as a clinical research according to French regulatory requirement ("Jardé" law). In this context, this study do not need any approval from an ethical committee [19].

Participant anthropometric characteristics

Body weight was measured with the participant wearing light clothes and without shoes to the nearest 0.1 kg using an electronic scale. Height was measured without shoes to the nearest 0.1 cm using a standard physician's scale. Body Mass Index was calculated as weight/height^2 (kg/m^2). Underweight, normal weight, overweight and obesity were assessed using specific thresholds regarding the age, according to WHO classification [20]. These international cut-offs are defined by values of BMI at age 18: BMI 18.5 normal weight, 25 (overweight) and 30 (obesity).

Self-reported physical fitness

Self-reported physical fitness was assessed using the French version of the IFIS questionnaire [8]. The IFIS questionnaire comprises only five closed questions and it can be completed in few minutes (5 min). The IFIS questionnaire encompasses five specific domains: overall physical fitness, CRF, muscular fitness, speed/agility, and flexibility levels. The IFIS uses a five-point Likert response scale ranging from 1 to 5 (very poor, poor, average, good, and very good) for all answers. Because forward and backward translations were previously conducted for an European study in adolescents, cross-cultural adaptation was not required [8]. The French version of IFIS is available at the website of the PROFITH research group (<http://profith.ugr.es/IFIS>). In the present paper, we studied the validity and reliability of this French version in French children.

Physical fitness assessment

The physical fitness components were assessed using the *Diagnoform* battery tests, as previously published [17,18]. This battery of tests assesses CRF, muscular strength (lower limbs), speed/agility and flexibility. Muscular strength, speed/agility and flexibility tests were performed twice and the best score was recorded. Cardiorespiratory fitness test was measured only once because it is exhausting and it requires considerable time. Physical education teachers who had undergone special training to correctly administer tests performed all physical fitness tests.

Cardiorespiratory fitness

CRF was measured by a 20-meter shuttle run-walk test during 6 min. This test is adapted from the classic 6 min walk test [21,22] and the semi-cooper test [23]. Adolescents were instructed to run and walk as far as possible between two lines located 20 m apart during 6 min. The adolescent ran as quickly as possible from the starting line to the other line and returned to the starting line at a fast walking pace, crossing each line with at least one foot throughout the complete test. The need to alternate running 20 m, then walking 20 m, before running another 20 m is designed to avoid children with poor pace regulation adopting a negative split during a free 6-min run, which would alter the result [24]. The test began on the whistle and was concluded after 6 min. The distance covered by the adolescent was recorded and was expressed in meter (m).

Muscular strength

Muscular strength was assessed by the standing broad jump (SBJ) test. This test showed a good reliability (0.84) [25,26]. From a starting position immediately behind a line, standing with the feet approximately shoulder width apart, adolescent jumped as far as possible with their feet together. The result was recorded in cm. A nonslip hard surface and a tape measure were used to perform the test.

Speed/agility

Speed was assessed by running as fast as possible in 5 s [25]. The children stood still in a comfortable position, feet behind the starting line, with no rocking movement. The test began on the whistle and was concluded when the countdown reached zero. The distance covered by the runner was recorded by marks placed on the ground and is expressed in meter (m).

Flexibility

Flexibility was assessed by a version of the stand-and-reach test. An excellent reliability was found (0.91) [25]. From a standing position, with both legs straight and feet together, the participant flexed their trunk and reached down as far as possible with their hands. Participant had to maintain the position for 3 s. Results of this test were indexed: a score of 5 for placing the hands flat on the ground; 4 for fingers touching the ground; 3 for fingers reaching the ankle; 2 for fingers reaching the tibia; and 1 for fingers/hands reaching the knees.

Overall fitness

Individual Z-scores for each test were computed to allow comparisons among the tests and to get an “overall fitness” variable for each subject as the average of the four tests.

Statistical analysis

Continuous variables are reported as mean (standard deviation, SD) in the case of normal distribution or median (25th percentile to 75th percentile) otherwise. Categorical variables are reported as frequency (percentage). Normality of distributions was assessed using histograms and using the Shapiro-Wilk test.

The comparison between self-reported fitness categories (IFIS scale) and objective physical fitness measures was studied by the analysis of variance without adjustment (ANOVA) and after adjustment (ANCOVA) for age, sex and weight status. Post-hoc analysis were performed using linear contrasts, after applying a Bonferroni correction for multiple comparisons. Normality of models' residuals was checked. If normality of model residuals was not satisfied (except if a logarithmic transformation could be applied), nonparametric analyses were used. Measured fitness variables were entered as dependent variables and self-reported fitness variables as fixed factors. The methodology as described before was also applied to evaluate the differences in measured fitness z-scores among self-reported fitness categories.

To evaluate the test–retest reliability of the IFIS, the intra-observer agreement in percentage, the Weighted Cohen's Kappa coefficients and its 95 % confidence interval were calculated.

All statistical tests were done at the two-tailed α -level of 0.05 using the SAS software version 9.4 (SAS Institute, Cary, NC).

Results

Participants' characteristics

Characteristics of children included are described in Table 1. Two thousand and sixty children (1 054 boys and 1 006 girls) participated in this validity study. Mean age was 10.6 ± 0.9 years. The mean of height and weight was 144.0 ± 9.1 cm and 36.2 ± 8.1 kg, respectively. Among the participants sample, 15 % were underweight, 71 % normal weight, 12 % overweight and 2 % obese. Means of each physical fitness tests are also presented in Table 1.

Table 1

Anthropometric characteristics and field test results of children studied (1 006 Girls and 1 054 Boys).

	N	Mean \pm SD	Range
Age (years)	2060	10.6 \pm 0.9	7.9–14.3
Height (cm)	2059	144.0 \pm 9.1	110.0–172.0
Body mass (kg)	2045	36.2 \pm 8.1	18.3–75.0
BMI ($\text{kg}\cdot\text{m}^{-2}$)	2044	17.3 \pm 2.7	9.3–33.9
Cardiorespiratory fitness (m)	2049	840.3 \pm 118.3	120–1400
Muscular strength (cm)	2054	135.4 \pm 24.3	25–220
Speed/Agility (m)	2045	26.1 \pm 3.5	12–40
Flexibility (/5)	2054	3.5 \pm 0.9	1–5

All values are expressed in mean \pm SD.

Construct validity of the IFIS in French children

Comparisons between objectively measured physical fitness and the International Fitness Scale (IFIS) in children, without or with adjustments for sex, age and weight status are presented in Table 2.

For all physical fitness components studied, children reporting a good or very good physical fitness in the IFIS had better results in fitness tests compared to children reporting a very poor to an average physical fitness ($p < 0.001$). Results between the categories very poor and poor were not significant for all fitness components assessed objectively. Differences were also found between categories poor and average, except for muscular strength. Using the adjusted models, the associations between self-reported and objectively measured fitness remained.

Secondary analyses using z-scores are displayed in Supplementary File (Table S1) and Fig. 1. Similar results were found without or with adjustments for sex, age and weight status (Table S1). For overall physical fitness, the children reporting a good or very good fitness had better overall physical fitness score measured objectively compared to children reporting very poor to poor fitness level ($p < 0.001$).

Reliability

Test–retest reliability and agreements for CRF, muscular strength, speed/agility, flexibility and overall fitness are presented in Table 3. Test–retest agreement was observed in 66.4–71.3 % of children included, with means of 66.4 %, 69.1 %, 65.6 %, 71.3 % and 70.8 % for CRF, muscular strength, speed/agility, flexibility and overall fitness, respectively. This agreement is confirmed by the kappa coefficients (Table 3), which were acceptable for all components of physical fitness, including the overall fitness score.

Discussion

Due to time limitations and expensive cost, the objective assessment of physical fitness (either through laboratory or field tests) may be not relevant for large-scale school use [8]. In this context, IFIS questionnaire has been developed to assess quickly physical fitness levels in youth [8]. Today, the French version of the IFIS questionnaire had never been validated in French children. Our findings show that the French version of the IFIS questionnaire is valid and reliable to assess the physical fitness of French children at school.

Regarding the validity of the IFIS questionnaire, in the 4 fitness components evaluated, children reporting better fitness in the questionnaire had globally higher results in the corresponding field-based test. In these 4 components, children answering “very good” presented higher results than those reporting a “good” condition. In 3 out of 4 fitness components (CRF, speed/agility and flexibility, not muscular strength) children answering “good” presented also higher results than those reporting a “good” condition. These findings indicate that French children properly understood the terminology used

Table 2
Comparisons between objectively measured physical fitness and the International Fitness Scale (IFIS) in children.

	N	Very poor (1)	Poor (2)	Average (3)	Good (4)	Very good (5)	P-value	Pairwise comparisons			
								1-2	2-3	3-4	4-5
CRF (m)	1259/1253	745.3 ± 95.8 N = 15/15	769.5 ± 90.2 N = 95/95	823.9 ± 98.9 N = 344/342	843.1 ± 93.6 N = 532/529	893.2 ± 101.9 N = 273/272	<0.001/ <0.001	1.00/1.00	<0.01/ 1.00	0.016/ <0.01	<0.01/ <0.01
Muscular strength (cm)	1265/1259	112.4 ± 23.8 N = 7/7	125.3 ± 20.3 N = 52/51	127.2 ± 24.1 N = 331/331	135.3 ± 23.9 N = 608/605	141.9 ± 23.6 N = 267/265	<0.001/ <0.001	0.72/0.26	1.00/1.00	<0.01/ <0.01	<0.01/ <0.01
Speed/Agility (m)	1250/1244	ND	23.3 ± 3.1 N = 55/55	25.2 ± 3.2 N = 244/242	26.4 ± 3.1 N = 526/524	27.3 ± 3.4 N = 424/422	<0.001/ <0.001	NA/NA	<0.01/ <0.01	<0.01/ <0.01	<0.01/ <0.01
Flexibility* (/5)	1268/1262	3.00 (3.00-3.00) N = 41/40	3.00 (2.00-3.00) N = 148/148	3.00 (3.00-4.00) N = 400/398	4.00 (3.00-4.00) N = 436/433	4.00 (4.00-5.00) N = 243/243	<0.001/ <0.001	1.00*/1.00*	<0.01*/<0.01*	<0.01*/<0.01*	<0.01*/<0.01*

Values are expressed as mean ± SD, as median (IQR) or as individual value when n < 5. N and p values are presented from unadjusted model (left /) and then from adjusted model (/ right) for age, sex and weight status. *P-values are calculated after rank-transformation.

Abbreviations: SD, Standard Deviation; IQR, Interquartile Range; N, Number of available observations; NA, Not Available; CRF, Cardiorespiratory Fitness.

in the IFIS and had a correct self-concept about their levels of CRF, muscular strength, speed-agility, flexibility, and overall fitness.

The lack of difference found in our study between “very poor” and “poor” in the 4 fitness components could be explained by the relatively small number of children who answered “very poor” (15 vs. 95; 7 vs. 52; 0 vs 55 and 41 vs. 148, for CRF, muscular strength, Speed/Agility and Flexibility, respectively). For CRF and muscular strength, our means and SD values are 745.3 ± 95.8 vs. 769.5 ± 90.2 m (very poor vs. poor for CRF); and 112.4 ± 23.8 vs. 125.3 ± 20.3 cm (very poor vs. poor for muscular strength). Thus, statistical difference may be reached with a much large sample size in the group reporting “very poor” condition. Ortega et al. already reported that the percentage of adolescents reporting a “very poor” fitness was very small, from 1.0 to 2.7 %, as other studies [8,13]. They recommended to merge in a single group the “very poor” and “poor” fitness groups.

Furthermore, there were no statistical difference regarding muscular strength between “poor” and “average” groups (125.3 ± 20.3 cm, n = 52 vs. 127.2 ± 24.1 cm, n = 331). It may be that for this specific physical fitness component, children do not manage to differentiate between a poor and an average level. Previously, using another questionnaire, Jurimae and Saar found an association between self-reported and measured physical fitness components, except for muscular strength (assessed by handgrip) [27]. Ramirez-Vélez et al. also reported no difference between groups based on self-perception questions and the results in muscular strength (handgrip and standing broad jump) whereas there were differences for CRF, agility and flexibility [13]. This could also be explained by the multifactorial aspect of the “strength” components in physical fitness: legs strength, torso strength, arms strength or other which can also be explosive or endurance strength. The self-representation of children of their own muscular strength when they answer the questionnaire may not be relative to the strength of their legs during a jump test. Thus, the 5-scale question relatives to the strength may be specific to a type of strength (leg strength, or jump, in this case), and/or separated into several questions according to the different types of strength.

Another outcome of our study shows moderate-to-good levels of test-retest reliability of the IFIS according to the established standards for reliability coefficients [28]. These results indicate that the French version of the IFIS had an acceptable reliability to measure physical fitness in the French children. The IFIS questionnaire developed in other countries also showed moderate-to-strong test-retest reliability in children or adolescents, with the retest after 1 or 2 weeks according to studies [8,13,16,29]. Our good overall reliability might be explained by the face-to-face method used and therefore being of the teacher on hand to help children complete the second (retest) questionnaire. Reliability should therefore be tested further in a different context (e.g., without a teacher or trained person).

Our study has some strengths and limitations. The main limitation of this study could be the file-based fitness tests used. Indeed, some of this field tests are customized from classical field-test battery. The aim of this adaptation is to better fit logistical concerns in order to easily evaluate several classes in a classic gymnasium and in a limited time. In France, this Diagnofom battery has been largely used, optimized to fit scholar context, with normative health-related fitness values previously published [17]. Regulatory and ethical constraints represent a further limitation of our study. It was not possible to collect several qualitative and quantitative data, such as parents’ education level, socioeconomic status or physical activity, which have effects on our results. The first strength of the study is the validation, for the first time, of the IFIS questionnaire in a large sample of French children. Our results were closed to similar studies carried out in other countries. This study is also a proof of feasibility to use the IFIS in the school context. Therefore, findings from our study add to previous literature in other countries and will be useful for French health professionals, researchers and teachers.

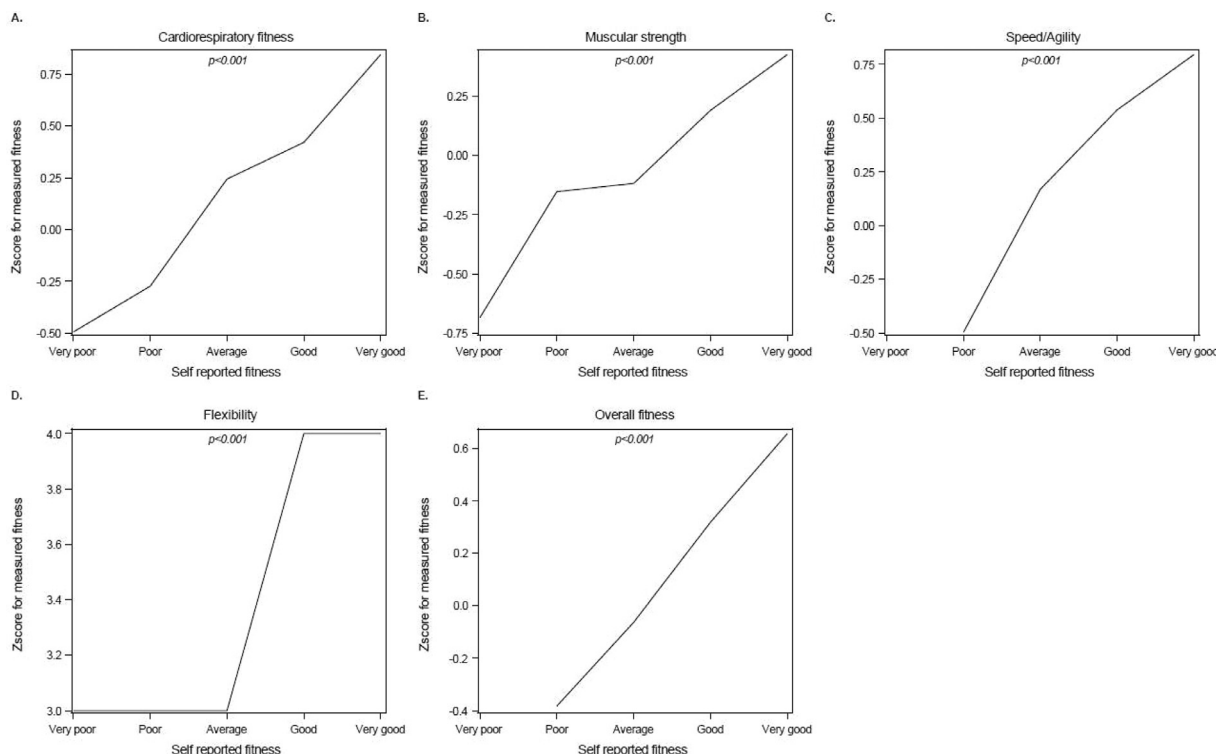


Fig. 1. Comparison between self-reported and measured physical fitness in French children.

Table 3
Test-retest reliability of the International Fitness Scale (IFIS) in French children (retest after 1 week).

	Agreement (%)	Reliability index*
Cardiorespiratory Fitness	66.39	0.66 (0.60–0.72)
Muscular strength	69.13	0.64 (0.58–0.70)
Speed/Agility	65.57	0.59 (0.52–0.66)
Flexibility	71.31	0.72 (0.66–0.77)
Overall fitness	70.77	0.65 (0.59–0.72)

*Reliability index indicates the Kappa value (95 %Confidence interval (CI)).

Conclusion

In summary, results from this study suggest that the French version of the IFIS is a valid and reliable instrument for assessing physical fitness levels in French children. The French version of this questionnaire is a quick, simple and useful tool for teachers, health professionals and researchers to assess physical fitness levels in children. Thus, we recommend the use of this questionnaire to assess physical fitness in children, an important marker of health. This screening can support the need for physical fitness interventions at school, for every students or for those who need it the most. Like the weight status recorded in the health booklet, the IFIS could be also used to track physical fitness across the lifespan. In a such way, the physician could early detect children with low physical fitness levels, which is a risk to develop future chronic diseases, and implement a strategy (such as adapted physical activity programs) aiming at increasing their physical fitness.

Declaration of competing interest

The remaining authors state no conflict of interest.

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Authors contributions

Jérémy Vanhelst, Laurent Béghin and David Matelot conducted the initial analyses and drafted the initial manuscript. Claire Martin conducted statistical analysis and drafted the initial manuscript. Hervé Ovigneur, Thibault Deschamps designed data collection instruments, coordinated and supervised data collection and reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Ethics approval

As this research was not performed to improve biological or medical Human knowledge, this present study is not consider as a clinical research according to French regulatory requirement (“Jardé” law). In this context, this study do not need any approval from an ethical committee [30].

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi: [10.1016/j.jep.2024.202380](https://doi.org/10.1016/j.jep.2024.202380).

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