

The International Fitness Scale (IFIS): usefulness of self-reported fitness in youth

Francisco B Ortega,^{1,2*} Jonatan R Ruiz,^{1,3} Vanesa España-Romero,^{1,4} Germán Vicente-Rodriguez,^{5,6} David Martínez-Gómez,⁷ Yannis Manios,⁸ Laurent Béghin,⁹ Dénes Molnar,¹⁰ Kurt Widhalm,¹¹ Luis A Moreno,^{5,12} Michael Sjöström,¹ Manuel J Castillo² and on behalf of the HELENA study group†

¹Department of Biosciences and Nutrition, Unit for Preventive Nutrition, Karolinska Institutet, Huddinge, Sweden, ²Department of Physiology, School of Medicine, University of Granada, Granada, Spain, ³Department of Physical Education and Sport, School of Physical Activity and Sport Sciences, University of Granada, Granada, Spain, ⁴Department of Exercise Science, University of South Carolina, Columbia, SC, USA, ⁵Growth, Exercise, Nutrition and Development (GENUD) Research Group, Universidad de Zaragoza, Spain, ⁶Faculty of Health and Sport Science (FCSD), Department of Physiotherapy and Nursing, Universidad de Zaragoza, Huesca, Spain, ⁷Department of Metabolism and Nutrition, Immunonutrition Research Group, Instituto del Frio, Institute of Food Science, Technology and Nutrition (ICTAN), Spanish National Research Council (CSIC), Madrid, Spain, ⁸Department of Nutrition and Dietetics, Harokopio University, Athens, Greece, ⁹Unité U995 Institut National de la Santé et de La Recherche Médicale and Institut de Médecine Prédictive et Thérapeutique, Faculté de Médecine, Université Lille Nord de France, France, Centre d'Investigation Clinique CIC-9301, Centre Hospitalier and Universitaire de Lille, France, ¹⁰Department of Paediatrics, Medical Faculty, University of Pécs. József A, Pécs, Hungary, ¹¹Division of Clinical Nutrition and Prevention, Department of Paediatrics, Medical University of Vienna, Vienna, Austria and ¹²Department of Physiotherapy and Nursing, School of Health Sciences (EUCS), Universidad de Zaragoza, Zaragoza, Spain

*Corresponding author. Department of Biosciences and Nutrition at NOVUM, Karolinska Institutet, 14157 Huddinge, Sweden. E-mail: ortegaf@ugr.es

†The members of the HELENA Study Group are listed in the Appendix 1 available as [Supplementary Data](#) at *IJE* online.

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Background We examined: (i) the usefulness of the International Fitness Scale (IFIS) to correctly rank adolescents into physical fitness levels; (ii) the capacity of the IFIS for predicting cardiovascular disease (CVD) risk; and (iii) the reliability of the IFIS in adolescents.

Methods The study comprised 3059 adolescents (aged 12.5–17.5 years) from nine European countries (HELENA study). Blood samples were collected in one-third of the participants (randomly selected, $n = 981$). Test–retest reliability of the IFIS was studied in a separate sample of 277 adolescents. Physical fitness—cardiorespiratory fitness (CRF), muscular fitness (MF), speed–agility (SP–AG), flexibility and overall fitness—was self-reported using 5-point Likert-scale questions (1 = very poor, 5 = very good) and measured using standard field-based tests. The CVD risk factors measured included total/central adiposity indices and mean arterial pressure, total and high density lipoprotein cholesterol, triglycerides, insulin resistance (HOMA) and C-reactive protein.

Results Analysis of covariance showed that adolescents reporting better fitness had higher measured fitness levels for all the variables studied (all $P < 0.001$), regardless of gender, age and weight status. Adolescents reporting very good overall fitness, CRF and SP–AG had a healthier cardiovascular profile in eight out of nine CVD risk factors studied. Perfect agreement (same test–retest answer) was observed in 65% of the adolescents and perfect-acceptable agreement (same answer or ± 1) in 97% of the adolescents.

Conclusions (i) The IFIS is able to correctly rank adolescents according to their measured physical fitness levels; (ii) adolescents reporting a good/very good overall fitness, CRF or SP-AG have a more favorable cardiovascular profile; and (iii) The IFIS is reliable in adolescents.

Keywords Adolescent, physical fitness, questionnaires, risk factors, self-report

Introduction

Physical fitness is a powerful predictor of detrimental health outcomes that include all-cause mortality, cardiovascular disease (CVD) events and cancer events.^{1–3} Interestingly, there is evidence that physical fitness is a marker of health in youth⁴ and that levels of physical fitness at these ages are associated with health in adulthood.⁵ Therefore, the assessment of physical fitness in youth throughout the world is of public health interest, and timely research on different methods for physical fitness assessment is needed.

Physical fitness can be objectively and accurately measured through laboratory tests. However, their use is limited in population-based studies due to the high cost, the time required to complete laboratory tests and the impracticality of measuring a large number of youths. Field-based tests provide a reasonable alternative to laboratory tests. Another alternative method that could be used in large epidemiological surveys is self-reported physical fitness. An accurate self-report measure of fitness specifically for youths could be used to identify low-fit (and perhaps low-active) adolescents for targeted physical activity and obesity prevention interventions.

A questionnaire translated into different languages, to assess overall physical fitness and the main components—cardiorespiratory fitness (CRF), muscular fitness (MF), speed–agility (SP-AG) and flexibility—in youth is lacking. Such a fitness scale, which is valid and reliable and shown to relate to established CVD risk factors, would be a useful epidemiological measurement tool.^{4,5}

In the present study, we investigate the International Fitness Scale (IFIS). This novel scale is adapted for youths, measures the main physical fitness components and can be completed within 5 min. We specifically aimed to examine: (i) the ability of the IFIS to correctly rank adolescents into physical fitness levels; (ii) if the IFIS is related to CVD risk in adolescents; and (iii) the test–retest reliability of the IFIS in adolescents.

Methods

Study design and sample

The Healthy Lifestyle in Europe by Nutrition in Adolescence cross-sectional study (Aims 1 and 2)

The Healthy Lifestyle in Europe by Nutrition in Adolescence cross-sectional study (HELENA-CSS)

obtained standardized data from a random sample of European adolescents on a broad battery of nutrition and health-related parameters.^{6,7} Data collection took place during 2006 and 2007 in 10 European cities: Athens (inland city) and Heraklion (Mediterranean island city) in Greece, Dortmund in Germany, Ghent in Belgium, Lille in France, Pecs in Hungary, Rome in Italy, Stockholm in Sweden, Vienna in Austria and Zaragoza in Spain. The adolescents were sampled from classes in the school setting. Full details on all aspects of the HELENA-CSS have been published elsewhere.^{6,8}

All adolescents meeting the general HELENA inclusion criteria (not participating simultaneously in another clinical trial, free of any acute infection or disease lasting <1 week before the inclusion)⁸ and with valid data for age, gender and body mass index (BMI), were considered the final HELENA-CSS sample: 3528 adolescents aged 12.5–17.5 years. For the purpose of the current study, the participants also had to have valid data on all IFIS items, and have completed at least one of the fitness tests. Based on these criteria, a total of 3059 adolescents (52% girls) participated in this study. Body weight, height and BMI in the current study sample were similar to the original HELENA-CSS sample (all $P > 0.05$).

In the HELENA study, one-third of the classes were randomly selected for blood collection, resulting in a total of 1089 participants providing fasting blood.⁹ Sampling of these participants was balanced by centre, age and gender.⁸ From this sub-sample, 981 adolescents (53% girls) had valid data on self-reported fitness variables and were included in the current study. This sub-sample also had similar body weight, height, BMI and physical fitness (all the fitness variables) compared with the original HELENA-CSS sample (all $P > 0.05$).

Reliability study (Aim 3)

The HELENA adolescents were not included for test–retest reliability purposes, since the physical fitness tests took place immediately after the IFIS was administered and this could influence the perception on their fitness levels at the retest. Therefore, we asked adolescents from five different cities in southern Spain, not involved in the HELENA study, to complete the IFIS twice, 2 weeks apart. A total of 277 adolescents (51% girls) aged 12.5–17.5 years successfully completed the IFIS on the two occasions and were

included in the current study. None of these adolescents was participating in another study.

Ethics

After receiving complete information about the aims and methods of the study, all parents/guardians signed a consent form, and all adolescents gave assent to participate in the study. The study was performed following the ethical guidelines of the Declaration of Helsinki 1961 (revision of Edinburgh 2000), the Good Clinical Practice and the legislation about clinical research in humans in each of the participating countries. The protocol was approved by Human Research Review Committees at the centres involved.¹⁰

Description of the IFIS

We aimed to develop a simple and short self-administered scale to assess physical fitness, which could be completed in a few minutes (the IFIS). To be of use to researchers, the IFIS should be able to accurately rank the adolescents according to their overall physical fitness and by the main physical fitness components. The IFIS is composed of five Likert-scale questions asking about the perceived adolescents' overall fitness, CRF, MF, SP-AG and flexibility in comparison with their friends' physical fitness (very poor, poor, average, good and very good). The IFIS was originally written in English and then culturally adapted and translated (and reverse-translated) to all the languages involved in the HELENA study: German, Austrian German, Greek, Flemish, French, Hungarian, Italian, Spanish and Swedish. Versions of the IFIS in the nine different languages are available in the [Supplementary Data 1](#) (available at *IJE* online), and also at the HELENA study website (www.helenastudy.com/IFIS).

Physical fitness

A detailed manual of operations on the field-based fitness tests was read by every researcher involved in the fieldwork before data collection started. In addition, workshop training lasting 1 week was carried out in Zaragoza (Spain) in January 2006, in order to standardize and harmonize the measurement of the physical fitness tests. The instructions given to the participants in every test were standardized for all the cities and were translated into the local language, to ensure that the same verbal information was given to all participants in the HELENA study.

Physical fitness characteristics of the study sample, as well as all the procedures used for assessing physical fitness in the HELENA study, have been published elsewhere.¹¹ In brief, 'CRF' was assessed by the 20 m shuttle run test.¹² The equation reported by Léger *et al.*¹² was used to estimate the maximum oxygen consumption (VO_{2max} , ml/kg/min) from the 20-m shuttle run test scores. Adolescents were classified according to their CRF levels based on the FITNESSGRAM Standards for Healthy Cardiorespiratory Fitness Zone.^{13,14} Males with

a VO_{2max} of ≥ 42 ml/kg/min were classified as having a healthy CRF level. Females aged 12 and 13 years with a VO_{2max} of 37 and ≥ 36 ml/kg/min, respectively, were classified as having a healthy CRF level. Females aged ≥ 14 years with a VO_{2max} of ≥ 35 ml/kg/min were classified as having a healthy CRF level. For exploratory purposes, we additionally estimated VO_{2max} using the equation developed by Ruiz *et al.*,¹⁵ in order to test if the results could be affected by the equation chosen. 'MF' was assessed by means of the handgrip strength¹⁶ and standing long jump tests. 'SP-AG' was assessed with the 4 × 10-m shuttle run test, and 'flexibility' with the back-saver sit and reach test. The scientific rationale for the selection of all these tests has been previously published.¹⁷ The physical fitness tests mentioned above have shown to be valid and reliable in young people.^{18–20} Further information about the validity and reliability of the fitness tests used in this study are available in the [Supplementary Data 2](#) (available at *IJE* online).

Sex- and age-specific 'z-scores' were computed for all the fitness tests in order to allow comparisons among the tests. We computed an 'MF' variable as the average of the two MF tests (z-score variables), and an 'overall physical fitness' variable as the average of all four physical fitness components studied (z-score variables).

CVD risk factors

Physical examination

The anthropometric methods followed in the HELENA study has been described in detail by Nagy *et al.*²¹ Briefly, height was measured to the nearest 0.1 cm in barefeet using a stadiometer (SECA 225). Body weight was measured to ~ 0.05 kg using an electronic scale (SECA 861), with the participants in their underwear. BMI was calculated as body weight (kg) divided by height (m) squared. Waist circumference was measured in triplicate at the midpoint between the lowest rib and the iliac crest, using an anthropometric tape (SECA 200). Waist-to-height ratio was computed as dividing waist circumference (cm) by height (cm), and this provides a surrogate measure of central body fat. Skinfold thicknesses were measured to ~ 0.2 mm, in triplicate, at the triceps, biceps, subscapular, suprailiac, thigh and calf on the left side of the body, using a Holtain Caliper (Crymmych, UK).²¹ Body fat percentage was calculated by the equation described by Slaughter *et al.*,²² and fat mass index (fat mass in kg/height in m^2) was calculated. A sum of the six skinfolds measured was also computed and used in the analyses. Pubertal status was measured according to the methods described by Tanner and Whitehouse.²³ Briefly, pubertal status was assessed during a medical examination by a physician/paediatrician. Degree of pubertal development ranged from 1 to 5 (stages), and classification was based on the development of the testes, scrotum and penis size in the boys, and on breast development and pubic hair in the girls.

Blood pressure

Systolic and diastolic blood pressure was measured with an automatic oscillometric device (OMRON M6). The adolescents sat on a chair quietly for 5 min before the measurements were conducted on the right arm in an extended position. Two measures were taken 5 min apart, and the lowest value was recorded in mmHg. The mean arterial pressure, defined as the average arterial pressure during a single cardiac cycle, was calculated using the following equation: diastolic blood pressure + $[0.333 \times (\text{systolic blood pressure} - \text{diastolic blood pressure})]$.²⁴

Biochemical analyses

A detailed description of the blood sampling procedures has been published elsewhere.⁹ In short, serum concentrations of cardiovascular risk factors were measured in centralized laboratories, from the fasting blood samples. Serum total cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides and glucose were measured on the Dimension RxL clinical chemistry system (Dade Behring, Schwalbach, Germany) with enzymatic methods that used the manufacturer's reagents and instructions. Insulin was measured by a solid-phase two-site chemiluminescent immunometric assay with an Immulite 2000 analyzer (DPC Biermann GmbH, Bad Nauheim, Germany). The homeostasis model assessment (HOMA) was also calculated.²⁵ High sensitive C-reactive protein was measured by immunoturbidimetry (Olympus AU2700 Analyzer, Olympus UK Ltd, Watford, UK).

Socio-economic status

Maternal education was used as an indicator of socio-economic status, consistent with previous studies.^{26–28} The highest level of education was reported by the mothers and coded as 1=lower education, 2=lower secondary education, 3=higher secondary education and 4=higher education or university.

Statistical analysis**The IFIS and measured fitness (Aim 1)**

The capacity of the IFIS to correctly rank adolescents into appropriate physical fitness levels was determined by means of analysis of variance without any adjustment (ANOVA) and after adjustment for the following confounders [analysis of covariance (ANCOVA)]: sex, age, sexual maturation status and centre. Measured fitness variables were entered as dependent variables and self-reported fitness variables as fixed factors. Differences in measured fitness z-scores among self-reported fitness categories were analysed by ANOVA (unadjusted models) and ANCOVA (models adjusted for the set of confounders). We performed additional analyses that were stratified by gender, age (<14.5 and ≥ 14.5 years, based on the median) and weight status (non-overweight and overweight/obesity). We used binary

logistic regression to determine the odds ratios (ORs) and 95% confidence intervals (CIs) of having a healthy CRF according to self-reported CRF.

The IFIS and CVD risk factors (Aim 2)

We studied the association between self-reported fitness and CVD risk factors by means of ANCOVA after adjustment for the set of confounders. Since blood sampling was carried out in one-third of the study sample, the adolescents in the 'very poor' and 'poor' categories were merged to allow for a sufficient sample size for analytical purposes.

Reliability (Aim 3)

The test-retest reliability of the IFIS was examined by means of per cent agreement and weighted Kappa coefficients. For per cent agreement, we calculated the difference between the initial test (T1) and the retest (T2). A difference (T2–T1) equal to 0 was called 'perfect' agreement (same test-retest answer); and a difference of 0 ± 1 was called 'perfect-acceptable' agreement. We also calculated weighted κ -coefficients, which is more appropriate when dealing with ordered categorical data.²⁹ Cohen's weighted κ not only accounts for strict agreement (as does the 'unweighted' κ), but also provides weighting to adjacent categories. For example, exact agreements might be given full weight, one-category difference given weight 1/2 and so on. Of the two ways of weighting, linear and quadratic, we chose linear weights as this is recommended when the difference between the first and second category has the same importance as a difference between the second and third category. For all the analyses, we used SPSS 17.0 software for Windows (SPSS Inc., Chicago, IL, USA) and the significance of the tests was interpreted as suggested by Sterne and Davey-Smith.³⁰ Cohen's weighted κ is not available in the standard SPSS package, but command syntax is available from the 'Knowledgebase' at SPSS.com.³¹ Data for imputation into the syntax were generated from cross-tabulation.

Results

The distributions of the answers to each of the five items assessed by the IFIS are shown in [Supplementary Data 3 \(Figure S1; available at IJE online\)](#). The distributions for all the items were negatively skewed, with a small number of adolescents reporting very poor fitness (percentage ranging from 1.0 to 2.7 of the study sample). Higher scores were reported for the boys compared with the girls with regard to CRF, MF, SP-AG and overall physical fitness (Chi-squared tests, $P < 0.001$). No differences between girls and boys were observed for self-reported flexibility ($P = 0.114$) (data not shown). Overweight/obese adolescents reported higher muscular strength than non-overweight adolescents ($P < 0.001$).

The IFIS and measured fitness (Aim 1)

Comparisons between self-reported fitness and measured fitness, without and with adjustment for a set of confounders (sex, age, sexual maturation and centre), are shown in Table 1. For all the fitness variables studied, the adolescents reporting a good or very good fitness had better measured fitness compared with those reporting poor or very poor fitness level (all $P < 0.001$). No differences were observed between the categories very poor and poor with regard to measured fitness. Overall, the associations between self-reported and measured fitness were slightly strengthened after adjusting for the confounders.

The associations between self-reported and measured physical fitness, without and with adjustment for the confounders, are graphically shown in Figure 1. In general, a linear dose–response relationship between self-reported and measured fitness was observed. The ORs for having a healthy CRF (based on the FITNESSGRAM cut-offs) in adolescents reporting a good or very good CRF were 4.6 (95% CI 2.6–8.3) and 7.3 (95% CI 4.0–13.5) respectively, compared with those reporting a very poor CRF (Figure 2). After adjusting for the confounders, the corresponding ORs increased to 5.6 (95% CI 3.0–10.5) and 12.0 (95% CI 6.2–23.1), respectively (Figure 2). When Ruiz's equation instead of Leger's equation was used in the analyses, the result did not substantially change (data not shown).

Stratified analyses showed consistent results for boys and girls, younger and older adolescents (<14.5 and ≥ 14.5 years), and non-overweight and overweight/obese adolescents (data not shown). Likewise, further adjustment for maternal education did not influence the results.

The IFIS and CVD risk factors (Aim 2)

The association of self-reported fitness with adiposity indices and other CVD risk factors are shown in Figures 3 and 4, respectively. Adolescents reporting a very good overall physical fitness had healthier levels in most of the CVD risk factors studied, compared with their peers reporting very poor/poor overall physical fitness level. Similar findings were observed for self-reported CRF and self-reported SP-AG. Self-reported MF was positively related to BMI. The use of the sum of six skinfolds instead of fat mass index provided identical results (data not shown). Adolescents reporting a very good CRF, SP-AG and overall fitness level had an 80, 84 and 87%, respectively, lower risk of being overweight/obese compared with adolescents reporting a very poor/poor fitness (OR 0.20, 95% CI 0.14–0.30; OR 0.16, 95% CI 0.11–0.24 and OR 0.13, 95% CI 0.08–0.19, respectively; Figure S2, Supplementary Data 4; available at *IJE* online). Self-reported MF was not associated with the risk of being overweight, in line with the results presented in Figure 3. Further adjustment for maternal education did not influence any of the results described above.

Table 1 Means and SE of measured physical fitness by self-reported physical fitness categories in adolescents

	<i>n</i>	Very poor (1) Mean (SE)	Poor (2) Mean (SE)	Average (3) Mean (SE)	Good (4) Mean (SE)	Very good (5) Mean (SE)	<i>P</i> -value	Pair-wise comparisons			
								1–2	2–3	3–4	4–5
Unadjusted models											
CRF: 20-m shuttle run (stage)	2635	3.0 (0.2)	3.4 (0.1)	4.2 (0.1)	5.5 (0.1)	6.9 (0.1)	<0.001	0.852	<0.001	<0.001	<0.001
MF: handgrip (kg)	3043	24.0 (0.9)	26.3 (0.4)	28.6 (0.2)	32.2 (0.3)	36.3 (0.6)	<0.001	0.491	<0.001	<0.001	<0.001
Standing long jump (cm)	3018	142.2 (4.5)	149.6 (1.8)	155.5 (1.0)	169.5 (1.0)	181.9 (2.0)	<0.001	0.744	0.042	<0.001	<0.001
SP-AG: shuttle run 4 × 10 m (s) ^b	2919	13.4 (0.2)	12.9 (0.1)	12.6 (0.1)	12.0 (0.1)	11.6 (0.1)	<0.001	0.164	0.002	<0.001	<0.001
Flexibility: back-saver sit and reach (cm)	3034	15.8 (0.8)	18.3 (0.4)	21.8 (0.2)	24.5 (0.2)	26.4 (0.4)	<0.001	0.056	<0.001	<0.001	<0.001
Adjusted models^a											
CRF: 20-m shuttle run (stage)	2405	3.6 (0.3)	3.8 (0.1)	4.5 (0.1)	5.6 (0.1)	6.9 (0.1)	<0.001	0.520	<0.001	<0.001	<0.001
MF: handgrip (kg)	2727	27.0 (1.1)	28.2 (0.3)	29.9 (0.2)	31.9 (0.2)	34.8 (0.3)	<0.001	0.231	<0.001	<0.001	<0.001
Standing long jump (cm)	2710	154.0 (4.7)	153.8 (1.5)	161.3 (0.8)	169.5 (0.8)	178.7 (1.5)	<0.001	0.976	<0.001	<0.001	<0.001
SP-AG: shuttle run 4 × 10 m (s) ^b	2677	13.3 (0.2)	12.9 (0.1)	12.6 (0.1)	12.1 (0.1)	11.7 (0.1)	<0.001	0.047	<0.001	<0.001	<0.001
Flexibility: back-saver sit and reach (cm)	2721	16.3 (0.8)	18.6 (0.4)	21.8 (0.2)	24.7 (0.2)	27.2 (0.4)	<0.001	0.006	<0.001	<0.001	<0.001

SE: standard error.

^aAnalysis of covariance adjusted for sex, age, sexual maturation status and centre.

^bThe lower the score (time in seconds), the better the performance.

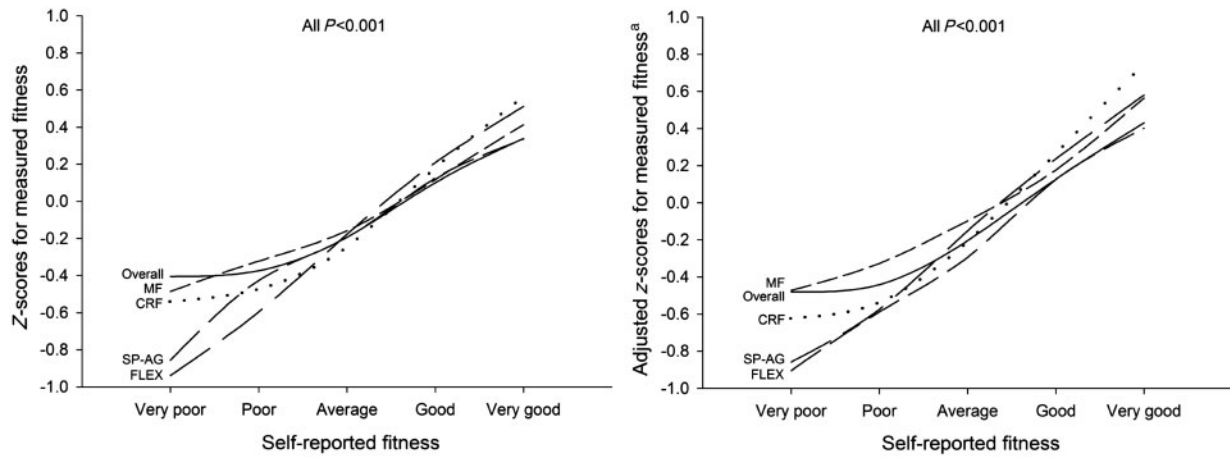


Figure 1 Comparison between self-reported and measured physical fitness in adolescents without and with adjustment for: FLEX, flexibility; Overall, overall physical fitness. All z-scores are sex and age specific. MF is an average z-score computed from handgrip and standing long jump; and overall is an averaged z-score computed from CRF, MF, SP-AG and FLEX z-scores (SP-AG z-score was inverted by multiplying by -1 so that the higher the score the better the performance).^aAnalysis of covariance adjusted for sex, age, sexual maturation status and centre

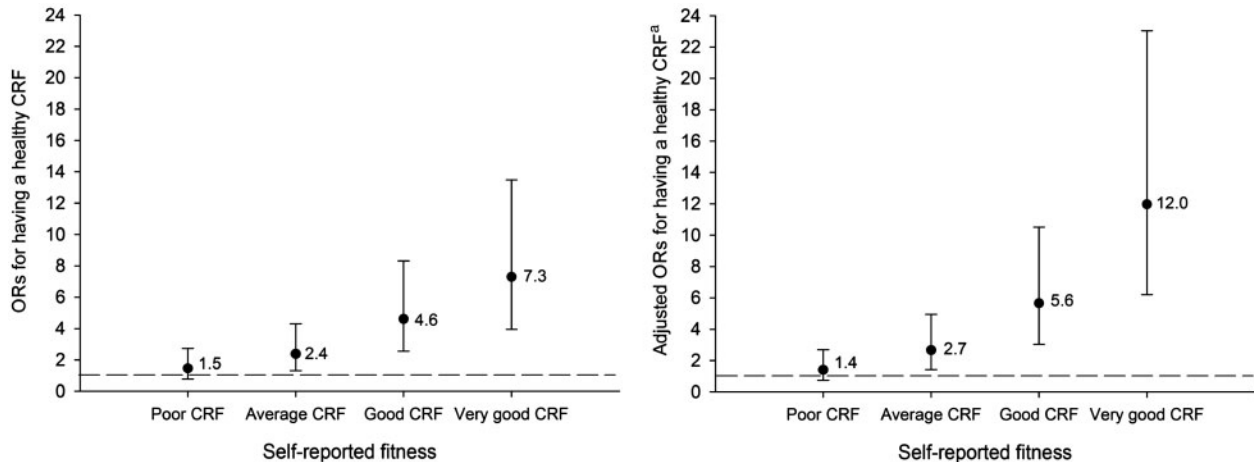


Figure 2 ORs of having a healthy CRF according to self-reported CRF in adolescents. Very poor CRF was set as reference group in the analyses and is graphically represented by the dashed line. Healthy CRF was defined according to the FITNESSGRAM cut-offs.^aModel adjusted for sex, age, sexual maturation status and study centre

Reliability (Aim 3)

On average, perfect agreement was observed in 65% (range 61–70) of the adolescents and perfect-acceptable agreement in 97% (range 96–99) for the self-reported overall physical fitness and the main components (Figure S3, Supplementary Data 5; available at *IJE* online). Test-retest weighted κ -coefficients for CRF, MF, SP-AG, flexibility and overall fitness were 0.58, 0.54, 0.60, 0.59 and 0.65 (all $P < 0.001$), respectively. These figures were similar in males and females, and in younger and older adolescents (data not shown).

Discussion

The IFIS and measured fitness

The findings in the current study suggest that the IFIS is a valid tool for ranking adolescents according

to their objectively measured physical fitness levels. These findings indicate that adolescents properly understood the terminology used in the IFIS, and had a correct self-concept about their levels of CRF, MF, SP-AG and flexibility. Interestingly, the single question about their self-perceived overall fitness level was strongly associated with their actual overall fitness. We observed a dose-response relationship between reported and measured fitness in boys and girls, younger and older adolescents and overweight and non-overweight participants.

Currently available self-report fitness methods greatly differ in content and structure. Some questionnaires, such as the Huet questionnaire,³² are composed of 10 questions to estimate CRF (expressed as VO_{2max} in ml/kg/min). Similarly, Mikkelsen *et al.*³³ used several questions to estimate specific physical

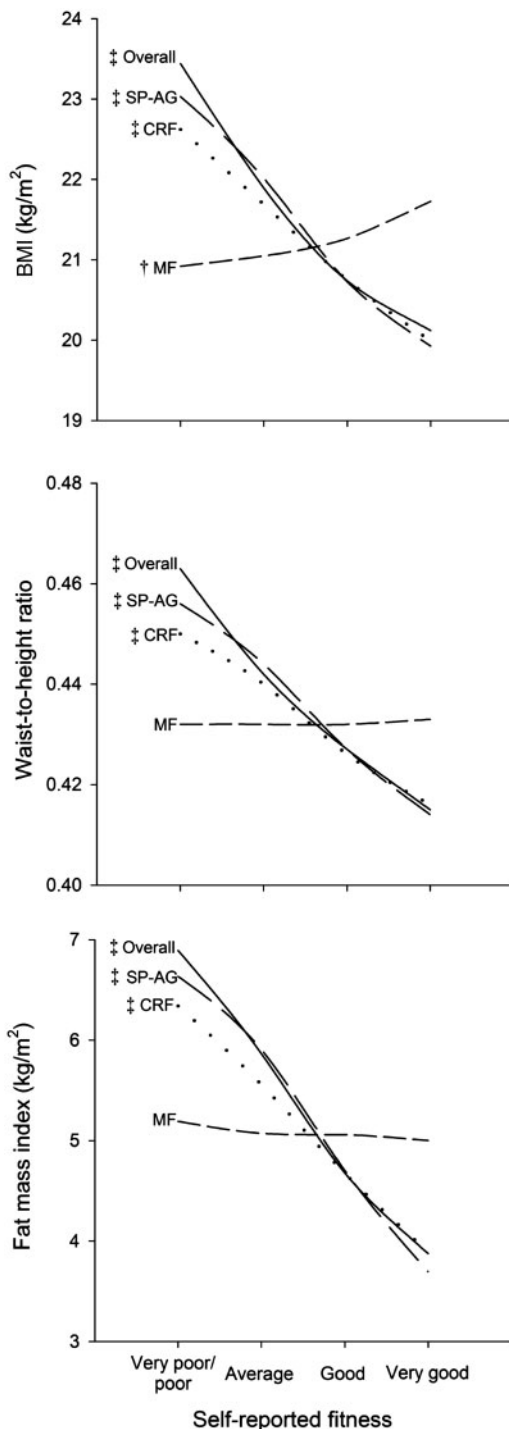


Figure 3 Differences in adiposity indicators according to categories of self-reported physical fitness in adolescents ($n = 2741$, 2713 and 2712, for BMI, waist-to-height ratio and fat mass index, respectively). † $P < 0.01$, ‡ $P < 0.001$, between 'Very good' and 'Very poor/poor'. Analysis of covariance adjusting for sex, age, sexual maturation and centre. Overall, overall physical fitness

fitness components, such as self-reported endurance (also called CRF), which was assessed by computing an endurance index from several questions regarding self-perceived distance that the participants could complete running, cycling, skiing and walking in a continuous way. The approach used to design the IFIS was totally different. The adolescents were directly asked how they perceived their own CRF compared with their friends, which estimates their fitness level at a given age. A similar approach has been used in another study in adults.³⁴ We postulate that the human brain might be more accurate at classifying than at quantifying information, yet this needs to be scientifically proved. For instance, it seems easier to classify people into weight status categories (normal-weight vs overweight) than to estimate their weight. The IFIS was designed based on this principle.

The questionnaires/scales mentioned above were designed and tested in adults. There are few available studies examining the validity of self-reported fitness in young people. Jürimäe and Saar³⁵ compared self-reported and measured physical fitness components and found a good association for all of them, except for MF (handgrip strength). In contrast, we found an association between self-reported and measured MF, including handgrip strength test. In agreement with our results, the perceived fitness of Australian school children was associated with measured CRF and MF.³⁶ Earlier physical self-perception instruments include Fox and Corbin's Physical Self-Perception Profile, a 30-item measure of physical self-perception, which includes five subscales: physical self-worth, physical strength, sports competence, physical condition and body attractiveness.³⁷ The Physical Self-Description Questionnaire is another physical self-concept instrument designed to measure 11 scales, including strength, endurance/fitness and flexibility, with the questionnaire showing good internal consistency, reliability and construct validity in high-school students.³⁸ Collectively, these results contribute to the growing body of support for the validity of physical self-concept responses.

The IFIS and CVD risk factors

We studied nine established CVD risk factors in relation with self-reported fitness, including total and central adiposity indices, total and HDL cholesterol, triglycerides, blood pressure, insulin resistance (HOMA) and C-reactive protein. Measured CRF, MF and SP-AG are associated with most of these CVD risk factors in adolescent populations.⁴ We hypothesized that valid self-reported fitness measures should be associated with these risk factors in a similar fashion. Self-reported flexibility was not analysed, since there is no scientific evidence or physiological rationale supporting the association between measured flexibility and the CVD risk factors studied.^{4,5} We found that high levels of self-reported CRF, SP-AG and overall physical fitness were associated with

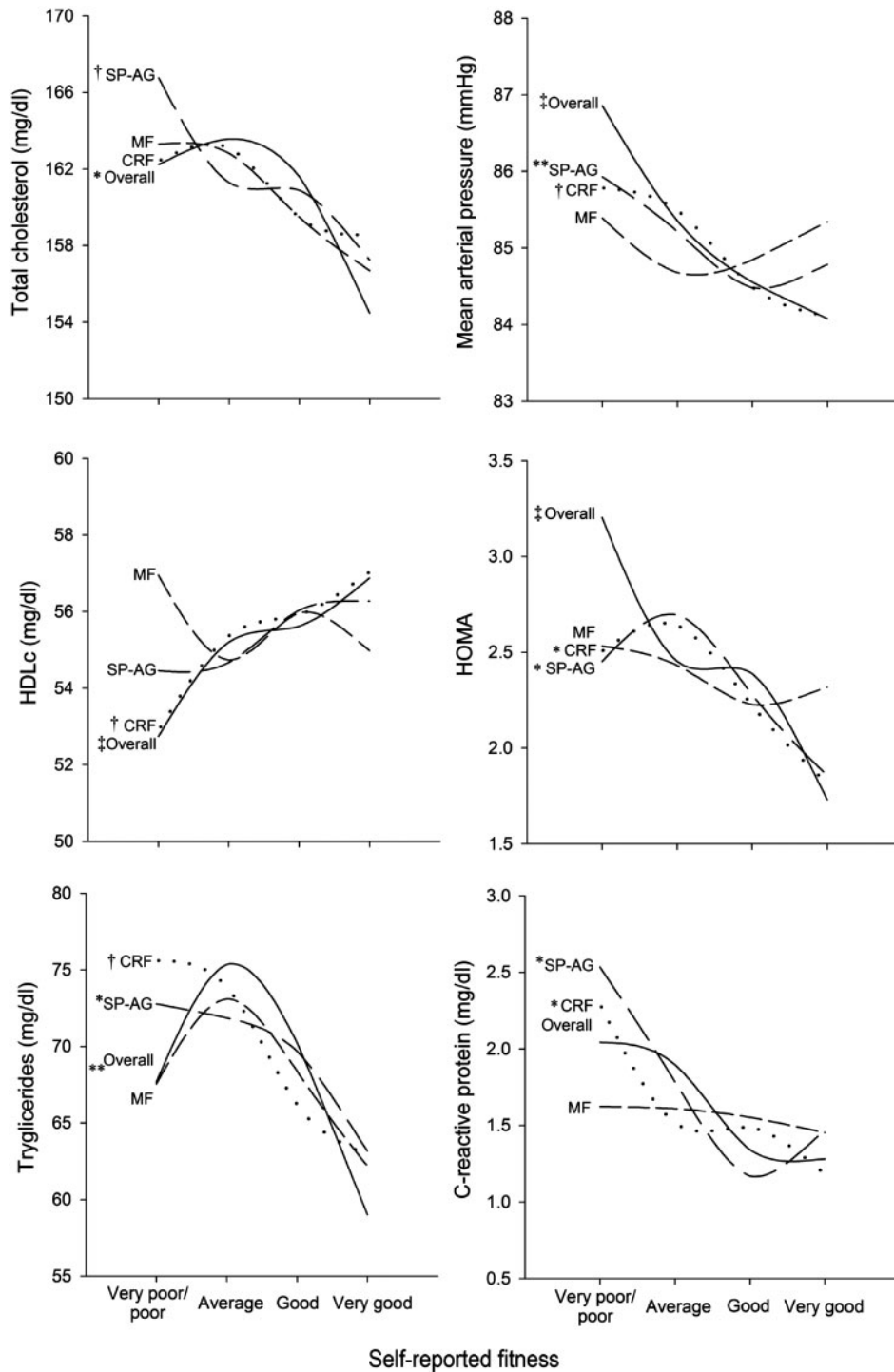


Figure 4 Differences in several CVD risk factors—i.e. total cholesterol $n=855$, high density lipoprotein cholesterol (HDLc) $n=855$, triglycerides $n=855$, mean arterial pressure $n=2727$, insulin resistance $n=839$ and C-reactive protein $n=594$ —according to categories of self-reported physical fitness in adolescents. * $P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$, ** $P < 0.1$ between 'Very good' and 'Very poor/poor'. Analysis of covariance adjusting for sex, age, sexual maturation and centre. Overall, overall physical fitness

healthier levels in most of the CVD risk factors studied (eight out of nine). The IFIS showed a good capacity to identify overweight/obese adolescents, particularly adolescents reporting a very good CRF, SP-

AG or overall fitness who were 80–87% less likely to be overweight/obese than their peers reporting a very poor/poor fitness level. This finding suggests that asking adolescents about their perceived fitness

levels provides additional information about their weight status.

Self-reported MF was not associated with cardiovascular profile. It is possible that the adolescents interpreted the question about MF as absolute strength, which has shown to be higher in overweight/obese adolescents.³⁹ In this study, overweight/obese adolescents reported a higher strength than non-overweight adolescents (chi-squared test, $P < 0.001$). It is well known that overweight/obesity has an adverse effect on health; therefore, the fact that the high self-reported MF group was over-represented by overweight/obese adolescents, may partially explain the lack of association between self-reported muscular strength and CVD risk.

Borodulin *et al.*,³⁴ using an identical scale for self-reported overall physical fitness that was used in the current study (from 1 = very poor to 5 = very good), also observed an inverse association with C-reactive protein in a sample of Finnish adults. Recently, Phillips *et al.*⁴⁰ found that self-reported fitness is a predictor of mortality in middle-age adults, suggesting that where the objective assessment of aerobic fitness is not feasible, a simple measure of subjective fitness could prove a useful alternative. To the best of our knowledge, this is the first study examining the associations between a complete set of self-reported fitness components and CVD risk in young population.

Reliability

When the test–retest reliability of IFIS was examined on 277 adolescents, on average, perfect agreement was observed in 65%, and perfect-acceptable agreement on 97% of them. Test–retest weighted Kappa coefficients ranged from 0.54 to 0.65, which can be considered ‘moderate’ to ‘good’ agreement.⁴¹

Limitations

A limitation of the IFIS is that the output can be affected by the average fitness level of region/country differences. For this reason, the IFIS should be mainly used for categorizing a study population into different fitness levels and to relate this with different health outcomes. The percentage of people reporting a ‘very poor’ fitness was very small (from 1.0 to 2.7%). Our interpretation of this result is that adolescents (probably as anybody else) do not like to recognize/report that they are ‘very bad’ at something. For this reason, when interpreting the results from the IFIS, the categories ‘very poor’ and ‘poor’ can be merged in a single ‘very poor/poor’ fitness group. No accurate information about ethnicity is available in the HELENA study; future studies should test the validity and reliability of the IFIS in different ethnic groups. Also, the reliability study was performed in Spain; further reliability studies in other countries are needed. It is important to highlight the need for additional

cross-validation testing in different samples and ethnics before the IFIS can be considered acceptable for global use.

Strengths and practical implications

The findings in this study suggest that the IFIS is a useful and reliable tool for estimating fitness in adolescent populations. The structure and content of the IFIS is simple and it can be completed within 1–5 min. A major strength of the current study was that IFIS was tested in nearly 3000 adolescents from northern, southern, western and eastern Europe, and is available in nine different languages (English, German, Austrian German, Greek, Flemish, French, Hungarian, Italian, Spanish and Swedish). In addition, we conducted a health-related validity study and found a strong association between self-reported physical fitness and the CVD risk factors studied.

The field-fitness tests used in this study have been widely used and tested for validity and reliability. Our group has recently carried out a number of systematic reviews and methodological studies in order to test the validity and reliability of fitness testing in young people.^{5,15–20,42–48} As a result of these investigations we believe that the tests used in this study provide a good measure of physical fitness in adolescents, and they can therefore be used to test the research question addressed in this study. The [Supplementary Data 2](#) (available at *IJE* online) includes further discussion and rationale about the validity and reliability of the fitness test selected for this study.

The IFIS can be considered a useful and meaningful tool for the subjective assessment of physical fitness. Large surveys that focus on youth, in which field-based fitness measures cannot be included for time or practical reasons, will have the opportunity to use the IFIS as an alternative. Further, the IFIS could be used to target populations with low physical fitness level and implement physical fitness enhancing programmes in such populations where interventions are most needed.

Conclusion

The results suggest that: (i) the IFIS is a simple and useful assessment tool able to correctly rank adolescents according to their measured physical fitness levels; (ii) adolescents reporting a good/very good overall fitness, CRF or SP–AG have a healthier cardiovascular profile; and (iii) the IFIS is a reliable method to be used in adolescents.

Supplementary data

[Supplementary data](#) are available at *IJE* online.

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KEY MESSAGES

- This study provides a valid and reliable self-report tool, the IFIS, for correctly ranking adolescents according to their measured physical fitness levels.
- The IFIS is available in nine different languages (English, German, Austrian German, Greek, Flemish, French, Hungarian, Italian, Spanish and Swedish), requires 1–5 min to complete and can be a useful assessment tool in large surveys in which fitness cannot be measured for time or practical reasons.
- Adolescents reporting good/very good CRF, SP-AG or overall fitness, as assessed by the IFIS, have a more favourable cardiovascular profile.

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SELF-REPORTED PHYSICAL FITNESS

It is very important that you do this test by yourself without taking into account the answers given by your classmates. Your answer is only useful for the progress of science and medicine. Please answer all the questions and do not leave any blank. Mark only one answer per question, and more important: be sincere. Thank you for your cooperation.

Please try to think about your level of physical fitness (compared to your friends) and choose the right option.

Your general physical fitness is:

- Very poor
 - Poor
 - Average
 - Good
 - Very good
-

Your cardiorespiratory fitness (capacity to do exercise, for instance running, for a long time) is:

- Very poor
 - Poor
 - Average
 - Good
 - Very good
-

Your muscular strength is:

- Very poor
 - Poor
 - Average
 - Good
 - Very good
-

Your speed / agility is:

- Very poor
 - Poor
 - Average
 - Good
 - Very good
-

Your flexibility is:

- Very poor
 - Poor
 - Average
 - Good
 - Very good
-

THANK YOU FOR YOUR TIME AND PARTICIPATION

Vragenlijst over je fysieke fitheid

Gelieve na te denken over jouw niveau van fysieke fitheid (in vergelijking met je vrienden) en kies de juiste optie.

1. Jouw algemene fysieke fitheid is:

- heel zwak
- zwak
- middelmatig
- goed
- heel goed

2. Jouw cardiorespiratoire fitheid (je uithoudingsvermogen om langdurige inspanningen te leveren) is:

- heel zwak
- zwak
- middelmatig
- goed
- heel goed

3. Jouw spiersterkte is:

- heel zwak
- zwak
- middelmatig
- goed
- heel goed

4. Jouw snelheid / behendigheid is:

- heel zwak
- zwak
- middelmatig
- goed
- heel goed

5. Jouw flexibiliteit/lenigheid is:

- heel zwak
- zwak
- middelmatig
- goed
- heel goed

QUESTIONNAIRE DE FORME PHYSIQUE

Il est très important que vous fassiez ce test par vous-même sans tenir compte des réponses données par vos camarades de classe. Votre réponse est seulement utile pour le progrès de la science. Veuillez répondre à toutes les questions et ne laissez pas de blanc. Marquez seulement une réponse par question. Et plus important : soyez sincère. Merci de votre coopération avec la science.

Essayez svp de penser à votre niveau de forme physique (comparée à vos amis) et de choisir la bonne option.

1. Votre condition physique générale est

- très mauvaise
- mauvaise
- juste
- bonne
- très bonne

2. Votre forme cardiorespiratoire (capacité à faire de l'exercice, par exemple courir pendant longtemps) est:

- très mauvaise
- mauvaise
- juste
- bonne
- très bonne

3. Votre force musculaire est:

- très mauvaise
- mauvaise
- juste
- bonne
- très bonne

4. Votre vitesse/agilité est:

- très mauvaise
- mauvaise
- juste
- bonne
- très bonne

5. Votre souplesse est:

- très mauvaise
- mauvaise
- juste
- bonne
- très bonne

Fragebogen zur Selbsteinschätzung der körperlichen Fitness

Es ist ganz wichtig, dass du bei der Bearbeitung des Tests für dich alleine arbeitest und nicht schaust, was dein Nachbar oder deine Nachbarin ankreuzen. Deine Antworten werden nur für die Wissenschaft verwendet. Bitte beantworte alle Fragen ohne eine auszulassen. Kreuze nur eine Antwort pro Frage an. Ganz wichtig ist: sei ehrlich. Vielen Dank für deinen Beitrag zur Wissenschaft.

Denke bitte an deine körperliche Fitness (im Vergleich zu deinen Freunden) und wähle die zutreffende Antwort.

1. Deine allgemeine körperliche Fitness ist:

- sehr schlecht
- schlecht
- ausreichend
- gut
- sehr gut

2. Deine Ausdauer (Fähigkeit, sich über längere Zeit sportlich zu betätigen, z.B. Dauer-Lauf) ist:

- sehr schlecht
- schlecht
- ausreichend
- gut
- sehr gut

3. Deine Muskelkraft ist:

- sehr schlecht
- schlecht
- ausreichend
- gut
- sehr gut

4. Deine Schnelligkeit / Wendigkeit ist:

- sehr schlecht
- schlecht
- ausreichend
- gut
- sehr gut

5. Deine Beweglichkeit ist:

- sehr schlecht
- schlecht
- ausreichend
- gut
- sehr gut



ΑΥΤΟΑΝΑΦΕΡΟΜΕΝΟ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΓΙΑ ΤΗ ΦΥΣΙΚΗ ΚΑΤΑΣΤΑΣΗ

Είναι πολύ σημαντικό να κάνετε αυτό το τεστ μόνοι σας χωρίς να επηρεάζεστε από τις απαντήσεις των συμμαθητών σας. Η απάντησή σας είναι σημαντική για την επιστημονική πρόοδο. Παρακαλώ απαντήστε όλες τις ερωτήσεις χωρίς να αφήσετε κενά. Σημειώστε μόνο μια απάντηση σε κάθε ερώτηση.

Προσπάθησε να σκεφτείς το επίπεδο της φυσικής σου κατάστασης (σε σύγκριση με τους φίλους σου) και επέλεξε το πιο σωστό.

1. Η γενική φυσική σου κατάσταση είναι: (ο ορισμός της γενικής φυσικής κατάστασης δίνεται πιο πάνω)

- Πολύ κακή
- Κακή
- Μέτρια
- Καλή
- Πολύ καλή

2. Η καρδιοαναπνευστική αντοχή σου (η ικανότητα να κάνεις μια άσκηση πχ τρέξιμο για πολύ ώρα) είναι:

- Πολύ κακή
- Κακή
- Μέτρια
- Καλή
- Πολύ καλή

3. Η μυϊκή σου δύναμη είναι:

- Πολύ κακή
- Κακή
- Μέτρια
- Καλή
- Πολύ καλή

4. Η σβελτάδα / ευκινησία σου είναι:

- Πολύ κακή
- Κακή
- Μέτρια
- Καλή
- Πολύ καλή

5. Η ευλυγισία σου είναι:

- Πολύ κακή
- Κακή
- Μέτρια
- Καλή
- Πολύ καλή

Fizikai Fittség Teszt Saját Nézőpontból

Nagyon fontos, hogy egyedül, az osztálytársaid segítségével válaszolj a kérdésekre. A válaszaid a kutatás előremenetele szempontjából fontosak. Kérlek minden kérdésre válaszolj, ne hagyj üres helyet. Kérdésenként csak egy választ jelölj meg. És a legfontosabb: légy őszinte. Köszönjük a tudományos kutatáshoz való hozzájárulásodat.

Kérlek gondold végig milyen a fittséged (a barátaidhoz hasonlítva) és válaszd ki a megfelelő választ.

1 Az általános fittséged:

- Nagyon gyenge
- Gyenge
- Elég jó
- Jó
- Nagyon jó

2 A szív-érrendszeri fittséged (gyakorlatok teljesítési képessége, futás alkalmával, hosszabb ideig):

- Nagyon gyenge
- Gyenge
- Elég jó
- Jó
- Nagyon jó

3 Az izomerőd:

- Nagyon gyenge
- Gyenge
- Elég jó
- Jó
- Nagyon jó

4 A sebességed / gyorsaságod:

- Nagyon gyenge
- Gyenge
- Elég jó
- Jó
- Nagyon jó

5 A rugalmasságod:

- Nagyon gyenge
- Gyenge
- Elég jó
- Jó
- Nagyon jó

QUESTIONARIO AUTO-SOMMINISTRATO SULLA FORMA FISICA (FITNESS)

È molto importante che tu compili da solo questo test senza tenere conto delle risposte date dai tuoi compagni di classe. La tua risposta è utile soltanto per il progresso di scienza. Per favore rispondi a tutte le domande e non lasciare nessuno spazio vuoto. Marcare soltanto una risposta per domanda. E ancora più importante: sii sincero. Ti ringraziamo molto per la tua cooperazione con la scienza.

Per favore cerca di pensare del tuo livello di forma fisica (paragonato ai tuoi amici) e scegli l'opzione giusta.

1. La tua forma fisica generale è:

- Molto povera
- Povera
- Corretta
- Buona
- Molto buona

2. La tua salute cardiorespiratoria (la capacità di fare esercizio, per esempio correre, per tanto tempo) è

- Molto povera
- Povera
- Corretta
- Buona
- Molto buona

3. La tua forza muscolare è:

- Molto povera
- Povera
- Corretta
- Buona
- Molto buona

4. La tua velocità / agilità è:

- Molto povera
- Povera
- Corretta
- Buona
- Molto buona

5. La tua flessibilità:

- Molto povera
- Povera
- Corretta
- Buona
- Molto buona



Cuestionario de autoevaluación de la condición física

Es muy importante que contestes a estas preguntas tu solo, sin tener en cuenta las respuestas de tus compañeros. Tus respuestas solo son útiles para el progreso de la ciencia. Por favor, contesta todas las preguntas y no las dejes en blanco. Y aun más importante, se sincero. Gracias por tu cooperación con la ciencia.

Por favor, piensa sobre tu nivel de condición física (comparado con tus amigos) y elige la opción más adecuada.

1. Tu condición física general es:

- Muy mala
- Mala
- Aceptable
- Buena
- Muy buena

2. Tu condición física cardiorespiratoria (capacidad para hacer ejercicio, por ejemplo, correr durante mucho tiempo) es:

- Muy mala
- Mala
- Aceptable
- Buena
- Muy buena

3. Tu fuerza muscular es:

- Muy mala
- Mala
- Aceptable
- Buena
- Muy buena

4. Tu velocidad / agilidad es:

- Muy mala
- Mala
- Aceptable
- Buena
- Muy buena

5. Tu flexibilidad es:

- Muy mala
- Mala
- Aceptable
- Buena
- Muy buena



Självrapporterad enkät om kondition

Det är viktigt att du gör denna testen själv utan att bry dig om dina klasskamraters svar. Ditt svar är endast viktigt för forskningsprocessen. Snälla svara på alla frågorna! Markera endast ett svar per fråga. Viktigt var ärlig. Tack för ditt samarbete med forskningen.

Snälla försök att tänka på din konditionsnivå (jämförd med dina vänner) och välj det rätta alternativet.

1. Din generella fysiska kondition är:

- Mycket dålig
- Dålig
- Varken bra eller dålig
- God
- Mycket god

2. Din syreupptagningsförmåga (kapaciteten att utöva motion, som exempel springa under en längre tid) är:

- Mycket dålig
- Dålig
- Varken bra eller dålig
- God
- Mycket god

3. Din muskelstyrka är:

- Mycket dålig
- Dålig
- Varken bra eller dålig
- God
- Mycket god

4. Din förmåga att vara snabb/vig är:

- Mycket dålig
- Dålig
- Varken bra eller dålig
- God
- Mycket god

5. Din smidighet är:

- Mycket dålig
- Dålig
- Varken bra eller dålig
- God
- Mycket god



Supplementary Data 2

RATIONALE FOR THE SELECTION OF THE FITNESS TESTS: VALIDITY AND RELIABILITY ISSUES

1) Assessing cardiorespiratory fitness using the 20m shuttle run test

Our group has been responsible for assessing physical fitness in several national and European projects (e.g. AVENA and HELENA) and has recently coordinated the ALPHA project (www.thealphaproject.eu), an EU-funded project aiming to further develop the current knowledge on physical activity and fitness assessment tools. Under the frame of this project we have just carried out three systematic reviews.¹⁻³ The reviews conclude that:

- 1) There is strong evidence indicating that the 20m shuttle run test is a valid test to estimate cardiorespiratory fitness.¹
- 2) There is strong evidence indicating that the 20m shuttle run test is a reliable test in a test-retest basis.²
- 3) Finally, there is strong evidence indicating that higher levels of cardiorespiratory fitness, as measured by 20m shuttle run test, in childhood and adolescence are associated with a healthier cardiovascular profile later in life.³

In addition, we have measured VO_{2max} by means of a portable gas analyzer in 193 adolescents⁴ while they (simultaneously) performed the 20m shuttle run test. We observed a high validity of this test for estimating VO_{2max} (see also the bullet point 6, gold standards).

2) Assessing muscular fitness using the handgrip and standing long jump tests

Our systematic review of the literature supports that:

- 1) There is strong evidence indicating that the handgrip strength test is a valid test to estimate muscular fitness.¹
- 2) There is strong evidence indicating that the handgrip strength test is a reliable test in a test-retest basis.²

In addition, we carried out a number of studies to improve the accuracy of the measurement of handgrip strength in young people.⁵⁻⁷

Fewer studies were however found for standing long jump test. Our group performed a series of studies under the frame of the HELENA and ALPHA studies to contribute to fill in this gap in the literature. Our results suggest that standing long jump is a good indicator not only of lower body muscular strength, but also upper body muscular strength, as measured in our laboratory using isokinetic methods in adolescents.⁸ This tests explained 80% ($r=0.899$, $P<0.001$) of the variance of an overall muscular strength index computed from upper and lower body isokinetic strength tests. This study concluded that among 7 muscular fitness tests, the handgrip strength and standing long jump tests were the most valid.

In a separate study, we also found the standing long jump as the most useful general index of muscular fitness, when compared with maximal isometric strength from upper and lower body strength tests.⁹

3) Assessing speed-agility using the 4x10m shuttle run test

This is a very particular case, since there is not known reference methods or gold standard for measuring speed and agility. For the speed, the accuracy of the measurement can only be improved using an automatic device to measure the time spent to perform a test. In this context, we studied the inter-rater reliability (trained vs. untrained raters) and criterion-related validity (manual vs. automatic timing) in adolescents.¹⁰ The findings indicated that manual measurements by a trained rater, using a stopwatch, seem to be a valid method to assess speed and agility fitness testing in adolescents. The mean difference (also called systematic error) observed between manual and automatic measures was 0.01 seconds.

4) Assessing flexibility using the back-saver sit and reach test

We have recently measured hip, lumbar and dorsal angles by angular kinematic analysis (two high speed digital video cameras Photon focus MV-D640) while the adolescents were performing the back-saver sit and reach test.¹¹ The results suggest that hip flexibility is the main determinant of the back-saver sit and reach test score in adolescents, followed by lumbar flexibility. This test can therefore be considered an appropriate and valid test for assessing hip and low-back flexibility at these ages.¹¹

5) Reliability of the tests used

In addition to the systematic review of the literature concerning reliability of field-based tests,² we studied all the physical fitness tests used in the HELENA study in a test-retest basis, and observed an acceptable reliability in all of them.^{12, 13}

6) Gold standards

As mentioned in the manuscript, there is no established gold standard for some physical fitness components, such as speed and agility. Therefore, only field-tests such as the one presented in this study can be used.

Among the different physical fitness components, the most established reference method is the VO_{2max} measured by a gas analyzer as indicator of cardiorespiratory fitness. Even this method have some limitation and feasibility problems for the purpose of the present study. To standardize the devices and criteria for an accurate measure of adolescents in 10 cities from 9 different countries is extremely complex. Although this study could be performed in a sub-sample, this sub-sample should be selected from each of the European cities involved in the HELENA, to ensure that the questionnaire is valid in the 9 different languages provided.

When the VO_{2max} is estimated from the score achieved in the 20m shuttle run test instead of being measured using a gas analyzer, we are assuming an estimation error, that according to our validation study (N=193 adolescents) is very small.⁴ The results showed a mean difference (also called systematic error) between estimated and measured VO_{2max} of 0.5 ml/kg/min, following the Bland-Altman method. These findings, together with the three systematic reviews¹⁻³, support the use of the 20 m shuttle run test as a valid measure of cardiorespiratory fitness.

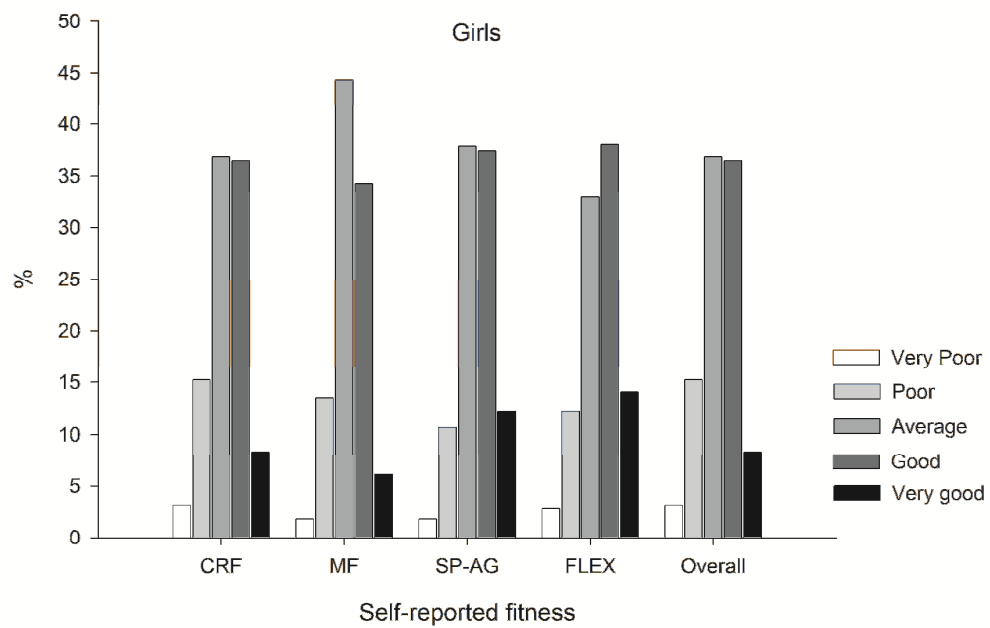
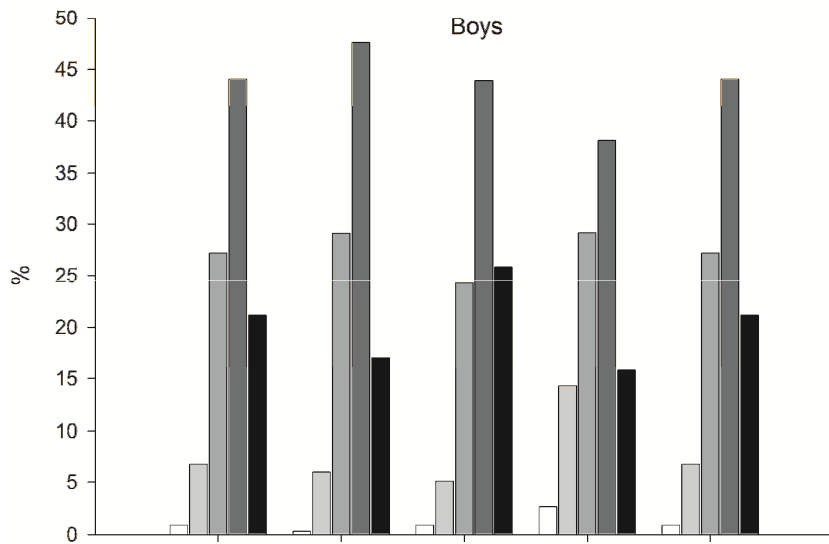
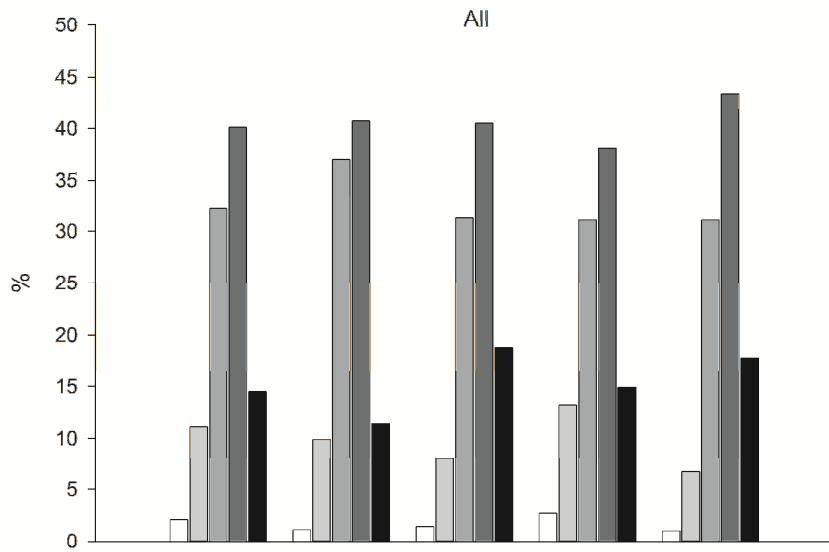
Finally, in addition to the high validity observed for the 20m shuttle run test, the body of evidence supporting that cardiorespiratory fitness in childhood and adolescence, as measured by this test, predicts cardiovascular health later in life, is not available for any other test, including laboratory tests directly measuring VO_{2max} . Consequently, the fact that the new developed scale (IFIS) is able to accurately predict cardiorespiratory fitness measured by 20m shuttle run test is of relevance from the public health point of view.

Overview

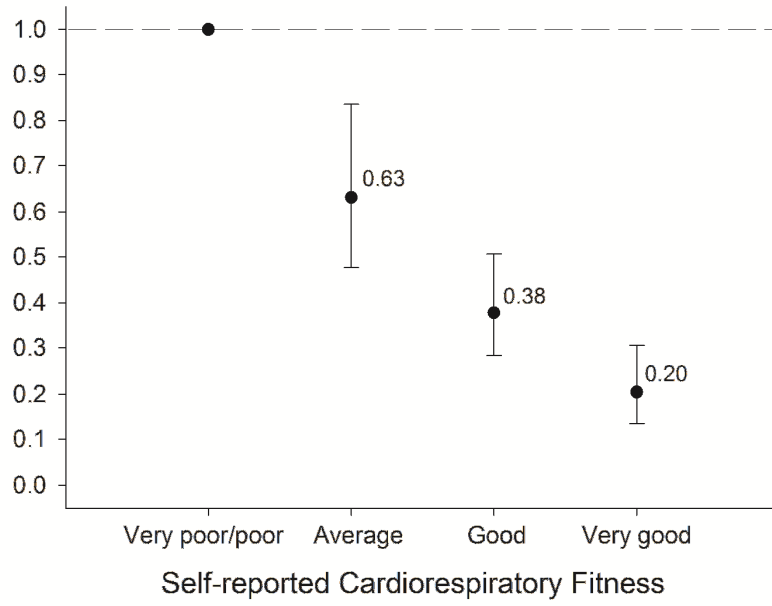
The body of evidence presented above makes us to believe that the methods used in the present study provides a good measure of physical fitness in adolescents, and they can therefore be used to test the research question addressed in this study, i.e. the usefulness of the International Fitness Scale (IFIS) to correctly rank adolescents into their actual physical fitness level. For more information about validity and reliability of fitness testing in young people, see the ALPHA summary report on fitness in youth.¹⁴

Writing group's experience supporting the validity and reliability of the methods used in this study to assess fitness (14 papers: 11 published, 1 in press and 2 currently submitted)

- ¹ Castro-Pinero J, Artero EG, Espana-Romero V, et al. Criterion-related validity of field-based fitness tests in youth: A systematic review. *Br J Sports Med* 2009.
- ² Artero EG, Espana-Romero V, Castro-Piñero J, et al. Reliability of field-based fitness tests in youth: A systematic review. *Int J Sport Med* 2nd review.
- ³ Ruiz JR, Castro-Pinero J, Artero EG, et al. Predictive validity of health-related fitness in youth: a systematic review. *Br J Sports Med* 2009;**43**:909-23.
- ⁴ Ruiz JR, Ramirez-Lechuga J, Ortega FB, et al. Artificial neural network-based equation for estimating VO(2max) from the 20m shuttle run test in adolescents. *Artif Intell Med* 2008;**44**:233-45.
- ⁵ Espana-Romero V, Ortega FB, Vicente-Rodriguez G, Artero EG, Rey JP, Ruiz JR. Elbow position affects handgrip strength in adolescents: validity and reliability of Jamar, DynEx, and TKK dynamometers. *J Strength Cond Res* 2010;**24**:272-7.
- ⁶ Espana-Romero V, Artero EG, Santaliestra-Pasias AM, Gutierrez A, Castillo MJ, Ruiz JR. Hand span influences optimal grip span in boys and girls aged 6 to 12 years. *J Hand Surg [Am]* 2008;**33**:378-84.
- ⁷ Ruiz JR, Espana-Romero V, Ortega FB, Sjöström M, Castillo MJ, Gutiérrez A. Hand span influences optimal grip span in male and female teenagers. *J Hand Surg [Am]* 2006;**31**:1367-72.
- ⁸ Artero EG, España-Romero V, Ruiz JR, et al. Criterion-related validity of field-based muscular fitness tests in youth. submitted.
- ⁹ Castro-Pinero J, Ortega FB, Artero EG, et al. Assessing muscular strength in youth: usefulness of standing long jump as a general index of muscular fitness. *J Strength Cond Res* 2010.
- ¹⁰ Vicente-Rodriguez G, Rey-López JP, Ruiz JR, et al. Inter-rater Reliability and Time Measurement Validity of Speed-Agility Field Tests in Adolescents. *Journal of Strength and Conditional Research* In press.
- ¹¹ Chillón P, Castro-Pinero J, Ruiz JR, et al. Hip flexibility is the main determinant of the back-saver sit-and-reach test in adolescents. *J Sports Sci* 2010:1-8.
- ¹² Ortega FB, Artero EG, Ruiz JR, et al. Reliability of health-related physical fitness tests in European adolescents. The HELENA Study. *Int J Obes (Lond)* 2008;**32 Suppl 5**:S49-57.
- ¹³ Espana-Romero V, Artero EG, Jimenez-Pavon D, et al. Assessing health-related fitness tests in the school setting: reliability, feasibility and safety; the ALPHA Study. *Int J Sports Med* 2010;**31**:490-7.
- ¹⁴ Ruiz JR, Castro-Pinero J, Espana-Romero V, et al. Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. *Br J Sports Med* 2010.



- Very Poor
- Poor
- Average
- Good
- Very good



Adjusted* Odds Ratios of being overweight/obese

