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Associations between health-related quality of life and physical fitness in 4–7-year-old Spanish children: the MOVIKIDS study

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Abstract

Purpose Health-related quality of life (HRQOL) in childhood is defined as an individual's subjective perception of the impact of health status on physical, psychological and social functioning. Nowadays, measuring of HRQOL has become an important outcome indicator in evaluating health-care. However, in younger children, the role of cardiorespiratory and other physical fitness components on HRQOL is unclear. The aims of this study were to analyse the association between components of physical fitness and HRQOL, as well as to determine which component of physical fitness was the best predictor of higher HRQOL.

Methods This was a cross-sectional study of 1413 schoolchildren (4 to 7 years old) from Spain. HRQOL was evaluated with the KINDL-R questionnaire for parents. Cardiorespiratory fitness, muscle strength and speed-agility were assessed using the ALPHA-Fitness battery. ANCOVA models were used to assess differences in HRQOL across physical fitness categories, controlling for age and BMI, by gender. Multiple linear regression was used to determine the independent association between the different physical fitness components and HRQOL.

Results Children with high physical fitness levels had better scores in physical well-being, school and total HRQOL score than those who had low physical fitness levels. The best predictor of HRQOL (total score) was muscular strength in boys and speed-agility among girls.

Conclusions Children with high physical fitness levels have higher HRQOL, although the association between components of physical fitness and HRQOL varies according to gender. Improving physical fitness could be a good strategy for improving HRQOL in children.

Keywords Fitness · Schoolchildren · Cardiorespiratory fitness · Muscular strength · Speed-agility · KINDL-R

Background

Health-related quality of life (HRQOL) in childhood is defined as an individual's subjective perception of the impact of health status on physical, psychological and social functioning, including also the ability to perform appropriate activities according to the age of the individual [1, 2]. Nowadays, measuring of HRQOL has become an important outcome in evaluating health-care interventions and treatments from the clinical and epidemiological point of view [3, 4]. Thus, knowledge about HRQOL and the conditions that affect it are especially important.

Physical fitness related to health is the ability to perform physical activity that integrate most body functions (i.e. of the locomotor, cardiorespiratory, neurocirculatory, endocrine metabolic and psychoneurological systems) involved

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in body movement. A high level of physical fitness implies a good physiological response from all of them. On the contrary, having poor physical fitness indicates a malfunction of one or several of those body functions [5]. The components of physical fitness related to health in children include, among others, cardiorespiratory fitness (CRF), muscle strength (MS) and speed-agility (S-A). In addition, several studies have described that optimal levels of physical fitness improves bone mass status, prevents the onset of symptoms related to anxiety and depression, improves cognitive and academic performance, and decreases the amount of body fat, which is therefore a protective factor for obesity, and decreases the risk of morbidity and mortality [6–10].

Studies that investigate the association between different physical fitness components and HRQOL among children under 7 years of age are scarce and show conflicting results [11–13]. Several studies have described a positive association between CRF and some HRQOL dimensions such as physical well-being and psychological health in children. However, the relationship between HRQOL and social dimensions or academic performance is not as pronounced [11, 14–17]. Likewise, the association between HRQOL and MS and S-A has hardly been studied in young people [16, 17]. Moreover, to the best of our knowledge, no study has analysed the independent association of different physical fitness components with HRQOL to determine which component is the best predictor of HRQOL in children.

Therefore, the aims of this study were to analyse the association between physical fitness components and HRQOL in a sample of 4 to 7 years old schoolchildren of Castilla-La Mancha (Spain), as well as to determine which component of physical fitness (CRF, MS and S-A) was the best predictor of higher HRQOL.

Methods

Study design and population

This was a cross-sectional analysis based on baseline measurements (September–November 2013) of a clinical trial in schoolchildren from 4 to 7 years of age in 21 schools in the provinces of Cuenca and Ciudad Real, Spain [18]. All the school's centres participating in the study were public, except for two private school's centres. All schoolchildren attending the third grade of pre-school (4 and 5 years old) and the first grade of primary school (6–7 years old) were invited to participate in the study ($n = 2407$). The clinical trial included 1604 schoolchildren (66.6%), but only participants who had complete data from the HRQOL questionnaire reported by parents or legal guardians and physical fitness variables available ($n = 1413$) were included in this study (88.1%).

Ethical and legal aspects

The study protocol was approved by the Clinical Research Ethics Committee of the Virgen de la Luz Hospital in Cuenca and the General University Hospital of Ciudad Real. After the approval of the School Councils of the schools' centres, an informative letter was sent to the parents or legal guardians of the students, inviting them to a meeting where the objectives and methodology of the study were presented. Finally, the parents or guardians provided written consent for their children to participate in the study, while the students gave oral consent when their collaboration was requested.

Data collection

The anthropometric and physical fitness measurements were carried out by nurses and physical activity science graduates trained for the project to guarantee standardization. The HRQOL questionnaires were completed by the children's parents or legal guardians and were returned to teachers a week later.

Measures of results used

Dependent variable: health-related quality of life

HRQOL was assessed using the Spanish validated version [19] of the KINDL-R questionnaire for parents. The KINDL-R is a generic HRQOL instrument for children and adolescents, which was developed in Germany for use both in clinical practice and with healthy children [20]. Because there were not norm values for Spanish population, we used the German ones [21]. KINDL was chosen for its good reliability, validity and for being easy and quick to fill it by children under 7 years old. This instrument contains 24 items, referring to the previous week, that are distributed in six dimensions: physical well-being, emotional well-being, self-esteem, family, friends and school. The answers are collected on a Likert scale of five categories (never, almost never, sometimes, almost always, always). The average score of each dimension was transformed into a scale from 0 to 100 points, making it possible to obtain a single total score or global index of HRQOL from the means of the six dimensions, where a higher score represents better HRQOL [22].

Independent variables: physical fitness

Cardiorespiratory fitness was measured using the 20-m shuttle run test. Participants had to run between two lines 20 m apart at a pace marked by an acoustic signal. The initial speed was 8.5 km/h, which increased at a rate of 0.5 km/h

each stage (1 stage equals 1 min) [5]. The schoolchildren were encouraged to run for as long as possible during the test, and the last half stage reached by the participants was recorded.

Muscle strength was evaluated by the standing long jump test (which measures explosive strength of the lower body) performed from a starting position immediately behind a line with feet spaced at hip width. Students were asked to jump horizontally to reach the maximum distance [5]. The result was recorded in centimetres as the best value of the three attempts made.

Speed-agility was obtained through the test of maximum speed/agility 4×10 meters. This test measures agility and speed while running between two lines 10 meters apart to pick up small blocks. There was a small block at the starting line and two blocks at the opposite line, so that when the start was indicated the students had to run as fast as possible towards the other line, returning again to the starting point with the first block and exchanging it for a second, then they went to the other line and exchanged the block for another again, and finally returning to the starting line [5]. Two attempts were made with a 5-min rest between them and the lower value of the two was recorded in seconds.

Covariables: anthropometric measures

Both the weight and height of the children were measured twice. A digital scale model SECA 821 with an accuracy of 0.1 kg and a stadiometer model SECA 222 with a precision with approximation to the nearest millimetre were used. Subjects were measured standing, with the column aligned with the stadiometer and the chin parallel to the floor. Body mass index (BMI) was calculated from the mean of the two weight and height records, that is, weight in kilograms divided by the square of the height in meters (kg/m^2).

Statistical analyses

The data were analysed using IBM SPSS Statistics version 25 software, setting the significance level at $p < 0.05$. The distribution of all variables was evaluated by graphical procedures and the Kolmogorov–Smirnov test. It was not necessary to transform any variable since all of them were seemingly adjusted to a normal distribution.

Intra-class correlations (ICC) were determined as random effect proportion of the sum of the variances of each variable-level, children-level and school-level [23]. In our study, the construct HRQOL is framed by the WHO definition of health integrating at the same importance of physical, mental and social well-being. Thus, we assessed the association between all the HRQOL dimensions and physical fitness components using linear mixed models including covariates as fixed effects, and school's centres as random effect.

Partial correlation coefficients were calculated to examine the relationship between HRQOL with CRF, MS, S-A and BMI controlling for age, by gender. A value of < 0.1 was considered as trivial, 0.1–0.29 as small, 0.3–0.49 as moderate and values ≥ 0.5 as large [24].

ANCOVA models were used to assess differences in HRQOL across CRF, MS and SA categories, controlling for age and BMI, by gender. Given that there is no clinical criterion to establish categories of physical fitness for this age group, we categorize this variable in quartiles to establish three categories for the analysis: low (first quartile), medium (second and third quartiles) and high (fourth quartile). This allow us to compare differences between fourth and first categories with enough statistical power. Pairwise post hoc hypotheses were tested using the Bonferroni correction for multiple comparisons.

In addition, to know the independent association of each physical fitness variable (considered not categorized, but in their original interval scale of measurement) with HRQOL, controlling for each one and for age, sex and BMI, multiple linear regression was used.

Results

Table 1 describes the main characteristics of the sample by gender. Compared to girls, boys obtained higher scores in all physical fitness components and in the physical well-being dimension ($p < 0.05$). In contrast, girls scored higher in HRQOL (total score), self-esteem and school ($p < 0.05$). All ICCs were close to zero, [25] and linear mixed models (Supplementary material 1) showed no association between school's centres and HRQOL dimensions. Thus, measurement varies across children without regard to which schools' centres they are.

Partial correlation coefficients between HRQOL domains with CRF, MS, S-A and BMI controlling for age, by gender are presented in Table 2. Independent variables were related to each other, with a correlation coefficient between small and moderate. Overall, CRF and MS were positively correlated to HRQOL, but S-A was negatively associated with HRQOL (lower scores indicate higher levels of S-A).

Table 3 shows the difference of means in HRQOL between physical fitness categories controlled for age and BMI, by gender. Schoolchildren with high levels of CRF, MS and S-A had better scores in physical well-being, school and HRQOL (total score) dimensions, than those who had low levels of CRF, MS and S-A. By gender, girls with a high CRF level obtained better scores in all dimensions of HRQOL, except for family and self-esteem than their peers in other CRF levels. While girls who had high levels of MS and S-A scored better at school, and in physical well-being, friends and HRQOL (total score) for S-A only, than their

Table 1 Characteristics of the sample by gender

	Total ($n=1413$)	Boys ($n=726$)	Girls ($n=687$)	p	*ICC*
Age	5.34 (0.61)	5.31 (0.60)	5.37 (0.62)	0.069	0.00
Weight (kg)	21.37 (4.77)	21.65 (4.88)	21.06 (4.64)	**0.021**	0.02
Height (cm)	115.45 (4.77)	115.87 (6.15)	114.99 (6.03)	**0.006**	0.01
BMI (kg/m^2)	15.89 (2.46)	15.98 (2.46)	15.80 (2.45)	0.171	0.02
Overweight/obesity (%)	20.17 (5.83)	20.01 (5.24)	20.32 (6.41)	0.338	0.01
Cardiorespiratory fitness (20-m shuttle run, stage)	1.90 (1.23)	2.05 (1.36)	1.76 (1.05)	**<0.001**	0.11
Muscular strength (standing broad jump, cm)	92.22 (19.57)	96.45 (19.83)	87.75 (18.27)	**<0.001**	0.00
Speed-agility (4 × 10 m, s)[a]	17.22 (2.20)	16.94 (2.24)	17.51 (2.11)	**<0.001**	0.01
Health-related quality of life[b]					
Physical well-being	84.66 (13.29)	85.64 (12.94)	83.62 (13.59)	**0.004**	0.01
Emotional well-being	84.01 (12.25)	83.45 (12.40)	84.60 (12.07)	0.079	0.01
Self-esteem	77.35 (15.51)	76.00 (15.86)	78.78 (15.01)	**0.001**	0.01
Family	83.48 (12.52)	82.94 (12.63)	84.04 (12.39)	0.099	0.00
Friends	86.39 (12.39)	85.79 (12.63)	87.01 (12.10)	0.063	0.02
School	84.55 (12.70)	82.67 (13.49)	86.55 (11.48)	**<0.001**	0.02
Total score	83.41 (9.02)	82.76 (9.21)	84.08 (8.76)	**0.006**	0.00

The data are presented as means and standard deviations

BMI body mass index calculated as weight/height^2 (kg/m^2), *ICC* intracluster correlation coefficient

The p values in bold indicate significant differences between boys and girls ($p<0.05$)

[a]Lower scores indicate higher levels of speed-agility

[b]Higher scores indicate a better health-related quality of life

Table 2 Partial correlation coefficients between health-related quality of life domains with cardiorespiratory fitness, muscular strength, speed-agility and body mass index controlling for age, by gender

		Physical well-being	Emotional well-being	Self-esteem	Family	Friends	School	Total score	CRF	MS
BMI	Total	−0.017	**−0.092**	−0.009	−0.031	**−0.075**	−0.043	**−0.060**		
	♂	−0.036	**−0.158**	−0.007	−0.073	**−0.094**	−0.063	**−0.095**		
	♀	−0.001	−0.016	−0.004	0.016	−0.051	−0.008	−0.015		
CRF	Total	**0.096**	0.043	−0.003	0.018	0.045	**0.105**	**0.072**		
	♂	**0.094**	0.031	−0.017	−0.010	0.043	**0.149**	0.072		
	♀	**0.086**	**0.080**	0.049	0.043	0.065	**0.097**	**0.102**		
MS	Total	**0.143**	**0.077**	0.010	0.023	0.047	**0.089**	**0.093**	**0.326**	
	♂	**0.179**	**0.097**	0.054	0.066	**0.075**	**0.117**	**0.140**	**0.363**	
	♀	0.072	**0.087**	0.009	0.002	0.043	**0.157**	**0.086**	**0.217**	
S-A[a]	Total	**−0.163**	**−0.065**	−0.005	0.007	**−0.065**	**−0.096**	**−0.091**	**−0.435**	**−0.389**
	♂	**−0.144**	−0.073	−0.004	−0.003	−0.055	**−0.102**	**−0.089**	**−0.450**	**−0.396**
	♀	**−0.158**	−0.075	−0.043	−0.003	**−0.099**	**−0.163**	**−0.130**	**−0.395**	**−0.321**

Measured by KINDL-R parents' version ($n=1373$)

CRF cardiorespiratory fitness, *MS* muscular strength, *S-A* speed-agility, *BMI* body mass index

The values in bold indicate significant differences ($p<0.05$)

[a]Lower scores indicate higher levels of S-A

peers in low categories, respectively. On the other hand, boys with high levels of CRF, MS and S-A obtained higher scores in physical well-being, and in school for CRF only, than their peers in the different categories, respectively.

Table 4 shows the independent association between CRF, MS and S-A with HRQOL, controlling for age and BMI, by gender. Among boys, physical well-being and HRQOL (total score) were associated with MS ($\beta=0.147$, $p=0.001$;

Table 3 Analysis of covariance (ANCOVA) testing mean differences in health-related quality of life scores by physical fitness categories, controlling for age and body mass index, by gender

		Cardiorespiratory fitness				Muscle strength				Speed-agility			
		Low ($n=266$)	Medium ($n=787$)	High ($n=343$)	p	Low ($n=339$)	Medium ($n=710$)	High ($n=340$)	p	Low ($n=349$)	Medium ($n=699$)	High ($n=343$)	P
		$n=$ ♂124/♀142	$n=$ ♂425/♀362	$n=$♂168/♀175		$n=$♂180/♀159	$n=$♂360/♀350	$n=$♂173/♀167		$n=$♂178/♀171	$n=$♂360/♀339	$n=$♂176/♀167	
Physical well-being	Total	83.21 (0.82) [H]	84.30 (0.47) [H]	86.60 (0.72)	**0.005**	82.54 (0.73) [M, H]	85.00 (0.50)	86.06 (0.72)	**0.002**	81.91 (0.71) [M, H]	85.24 (0.50)	86.31 (0.71)	**< 0.001**
	♂	83.01 (1.18)	85.88 (0.63)	86.78 (1.04)	**0.045**	82.96 (0.98) [H]	85.67 (0.68)	88.00 (0.99)	**0.002**	83.17 (0.97) [M, H]	86.04 (0.68)	87.34 (0.98)	**0.008**
	♀	83.23 (1.15)	82.55 (0.71) [H]	86.37 (1.03)	**0.009**	82.13 (1.08)	84.30 (0.72)	84.00 (1.05)	0.236	80.60 (1.03) [M, H]	84.40 (0.73)	85.19 (1.04)	**0.003**
Emotional well-being	Total	84.18 (0.76)	83.55 (0.44)	84.90 (0.67)	0.230	82.84 (0.67)	84.36 (0.46)	84.45 (0.67)	0.136	83.09 (0.65)	84.38 (0.46)	84.33 (0.66)	0.243
	♂	82.82 (1.12)	83.83 (0.60)	82.93 (0.96)	0.596	82.02 (0.93)	84.51 (0.65)	82.79 (0.94)	0.062	82.75 (0.93)	83.88 (0.65)	83.29 (0.94)	0.594
	♀	85.44 (1.02)	83.17 (0.63) [H]	86.85 (0.92)	**0.003**	83.85 (0.97)	84.18 (0.65)	86.13 (0.94)	0.164	83.58 (0.92)	84.89 (0.65)	85.32 (0.93)	0.370
Self-esteem	Total	76.86 (0.97)	77.20 (0.55)	77.99 (0.85)	0.644	77.98 (0.85)	76.85 (0.58)	77.86 (0.85)	0.427	77.09 (0.83)	77.60 (0.59)	77.36 (0.84)	0.876
	♂	75.07 (1.46)	76.64 (0.77)	74.98 (1.24)	0.407	75.90 (1.21)	75.79 (0.84)	76.70 (1.22)	0.824	76.62 (1.20)	76.20 (0.84)	75.28 (1.21)	0.723
	♀	78.68 (1.29)	77.70 (0.79)	81.02 (1.15)	0.060	80.22 (1.20)	77.97 (0.81)	79.16 (1.18)	0.283	77.61 (1.16)	79.09 (0.82)	79.53 (1.16)	0.458
Family	Total	84.00 (0.78)	83.06 (0.45)	83.89 (0.68)	0.430	82.81 (0.69)	83.76 (0.47)	83.32 (0.68)	0.511	83.54 (0.67)	83.01 (0.47)	84.20 (0.68)	0.353
	♂	83.58 (1.15)	83.03 (0.61)	82.19 (0.99)	0.641	82.21 (0.96)	83.21 (0.67)	82.93 (0.97)	0.701	83.30 (0.96)	82.62 (0.67)	83.21 (0.96)	0.798
	♀	84.43 (1.06)	83.05 (0.65)	85.56 (0.94)	0.079	83.54 (0.99)	84.32 (0.66)	83.72 (0.96)	0.767	83.88 (0.95)	83.41 (0.67)	85.17 (0.96)	0.323
Friends	Total	85.48 (0.77)	86.27 (0.44)	87.42 (0.67)	0.157	85.82 (0.68)	86.52 (0.46)	86.95 (0.67)	0.497	85.27 (0.66)	86.73 (0.47)	87.07 (0.67)	0.109
	♂	83.74 (1.15)	86.37 (0.61)	85.99 (0.98)	0.127	84.93 (0.95)	86.66 (0.66)	85.38 (0.96)	0.263	85.58 (0.95)	85.91 (0.66)	86.05 (0.96)	0.936
	♀	87.09 (1.03)	86.08 (0.63) [H]	88.84 (0.92)	**0.048**	86.81 (0.97)	86.38 (0.65)	88.57 (0.94)	0.154	85.01 (0.91)	87.60 (0.65)	88.10 (0.93)	**0.031**
School	Total	83.82 (0.78) [H]	83.71 (0.45) [H]	87.01 (0.68)	**< 0.001**	82.10 (0.68) [M, H]	85.26 (0.47)	85.73 (0.68)	**< 0.001**	82.61 (0.67) [M, H]	84.82 (0.47)	86.17 (0.68)	**0.001**
	♂	80.64 (1.22) [H]	82.00 (0.65) [H]	85.57 (1.03)	**0.004**	80.83 (1.02)	83.36 (0.70)	83.31 (1.02)	0.104	80.93 (1.01)	83.13 (0.71)	83.46 (1.02)	0.140
	♀	86.93 (0.98)	85.51 (0.60) [H]	88.58 (0.87)	**0.014**	83.48 (0.91) [M, H]	87.24 (0.61)	88.26 (0.89)	**< 0.001**	84.45 (0.87) [H]	86.58 (0.62)	88.97 (0.88)	**0.001**
Total score	Total	82.87 (0.56) [H]	83.01 (0.32) [H]	84.69 (0.49)	**0.011**	82.37 (0.50)	83.64 (0.34)	84.02 (0.49)	**0.042**	81.91 (0.71) [H]	85.24 (0.50)	86.31 (0.71)	**0.011**
	♂	81.51 (0.84)	82.95 (0.45)	83.12 (0.72)	0.270	81.46 (0.70)	83.25 (0.49)	83.18 (0.71)	0.097	82.07 (0.69)	82.97 (0.49)	83.12 (0.70)	0.493
	♀	84.16 (0.74)	83.01 (0.46) [H]	86.25 (0.66)	**< 0.001**	83.38 (0.71)	84.05 (0.47)	84.89 (0.68)	0.303	82.51 (0.66) [H]	84.32 (0.47)	85.34 (0.67)	**0.010**

Data are presented as marginal means and standard error

When the results are expressed for the total sample, the analyses were also adjusted by gender

The categories of cardiorespiratory capacity, muscle strength and speed-agility correspond to the first quartile (Low, L), second and third quartile (Medium, M) and fourth quartile (High, H)

Where L < stages 1 in cardiorespiratory capacity, < 80 cm in muscle strength and > 18.4 s in speed-agility, M stages 1–2.5 in cardiorespiratory capacity, between 80 and 104 cm in muscle strength and between 18.4 and 15.7 s in speed-agility, H > stages 2.5 in cardiorespiratory capacity; > 104 cm in muscle strength and < to 15.7 s in speed-agility

The values in bold indicate significant differences ($p < 0.05$)

Statistical significance ($p < 0.05$) between two or more pairs of means in Bonferroni post hoc test is indicated by using superscripts indicating the category (L, M or H) for which differences were found (i.e. M and H superscript in mean of physical well-being scores in low category of muscle strength indicates that the differences in low-medium and low-high pairs are statistically significant)

Table 4 Independent association between cardiorespiratory fitness, muscle strength and speed-agility with health-related quality of life, controlling for age and body mass index, by gender

	Boys			Girls		
	R^2	β	p	R^2	β	p
Physical well-being	0.038			0.033		
Cardiorespiratory fitness		0.016	0.729		0.036	0.430
Muscle strength		0.147	**0.001**		0.017	0.696
Speed-agility		−0.086	0.054		−0.154	**0.002**
School	0.033			0.038		
Cardiorespiratory fitness		0.112	**0.014**		0.032	0.484
Muscle strength		0.066	0.132		0.128	**0.004**
Speed-agility		−0.028	0.540		−0.123	**0.011**
Total score	0.024			0.022		
Cardiorespiratory fitness		0.004	0.928		0.065	0.152
Muscle strength		0.112	**0.011**		0.039	0.379
Speed-agility		−0.036	0.425		−0.108	**0.027**

The data are presented as standardized regression coefficient, and interval variables were entered into their original values

The p values in bold indicate statistical significance for the corresponding predictor in the model with the health-related quality of life ($p < 0.05$)

$\beta = 0.112$, $p = 0.011$, respectively), and school with CRF ($\beta = 0.112$, $p = 0.014$). In girls, physical well-being, school and HRQOL (total score) were associated with S-A ($\beta = -0.154$, $p = 0.002$; $\beta = -0.123$, $p = 0.011$; $\beta = -0.108$, $p = 0.027$, respectively), and school with MS ($\beta = 0.128$, $p = 0.004$). Emotional well-being, self-esteem, family and friends HRQOL dimensions were not associated with physical fitness components (data not shown).

Discussion

The results of this study indicated a direct association between physical fitness and HRQOL. CRF levels were associated with physical well-being and school in both genders, and with emotional well-being and friends in girls. MS levels were associated with physical well-being in boys and with school in girls. S-A levels were associated with physical well-being in both genders, and with school and friends in girls. Finally, the results of this study showed that the best predictor of HRQOL (total score) was MS in boys and S-A in girls.

HRQOL and CRF

Several studies show that high levels of CRF are associated with better physical and psychological health indicators in children and adolescents [5–10]. Therefore, it suggests that CRF improvements could have a positive effect on several HRQOL dimensions. In accordance with other studies [14–17], our results revealed a direct relationship between high levels of CRF and physical well-being in children under 7 years of age. This seems to indicate that there is a positive association between CRF and physical health perception in children. However, the relationship between CRF and other HRQOL dimensions, such as social and school, is not clear. In line with our findings, other researchers have not found an association between the social dimension and CRF [16, 17], and solely one study observed a positive relation between CRF and the school dimension [17]. However, the lack of studies examining this association in younger children hinders the comparison of our data with others.

As far as we know, only two studies have shown the results of the association between CRF and HRQOL separately for boys and girls [16, 26]. Both studies used the KIDSCREEN 10 index as an indicator of total HRQOL and CRF was measured using the Course-Navette test. Gálvez et al. showed that HRQOL in both genders was significantly higher in schoolchildren with a high level of CRF compared to those with a low level [26]. While Morales et al., coinciding with our results, only found this positive association in girls [16].

HRQOL and MS and S-A

The relationship of MS and S-A with HRQOL in children has been seldom studied. Andersen et al. found a small positive association of MS (measured with the standing broad jump test) with the autonomy and parents dimensions (KIDSCREEN questionnaire) in 10-year-old children [17]. Morales et al. showed a direct association of an index of muscular strength (composed of the standardized scores of the handgrip strength test/weight and standing broad jump test) with physical well-being, social support and peers,

and social acceptance in boys, and physical well-being and the KIDSCREEN-10 index in girls [16]. In line with these studies, the present results showed a positive relationship of good levels of MS with physical well-being, school and HRQOL (total score). On the other hand, this study also found that there is a positive association between better levels of S-A and higher HRQOL scores (total score, physical and school dimensions). No previous study has analysed the relationship of S-A with HRQOL in children, though one study performed in adolescents found a direct relationship between perceptions of S-A and HRQOL [27].

HRQOL and fitness components

The present study is, as far as we know, the first one that analyses the independent association between the three components of physical fitness and HRQOL in schoolchildren with the objective of determining the best predictor of HRQOL. Among boys, these results suggest that MS was the best predictor of physical well-being and the total HRQOL score, while the best predictor for school was CRF. However, in girls, the best predictor of physical well-being and the total HRQOL score was S-A, while in the case of school, the best predictor was MS followed by S-A.

In our opinion, these differences between boys and girls in the association between physical fitness and HRQOL may be due to stereotypes. Gender stereotypes, norms and beliefs, which are established and determined in childhood by society, are important in how people develop their own gender-based their understandings of what it approaches to be boy or a girl [28–30]. Thus, one study showed that physical education teachers perceive dance and outdoors activities such a girls and boys activities, respectively [31]. Another potential explanation for these differences due to the type of playground games and sports chosen by children. It is likely that boys usually play dynamic activities (fighting, pushing and pulling) that favour muscle strength development, while girls play more coordinative (dancing, doing acrobatics, or participating in pursuit games) but less dynamic activities that favour motor fitness development (S-A) [32–34].

Limitations and strengths of the study

One of the limitations of this study was its cross-sectional design that prevent us from making cause-effect inferences. Second, we have not adjusted for potential confounders and mediators (dietary habits, TV watching, electronic media use or physical activity) [13, 35, 36], which are factors that should be considered in future research. Third, the fact that a 33.4% of the children invited to participate in the study did not accept to participate could indicate a bias in the selection of the sample. Nevertheless, no differences were found in age and sex between the children who accepted to participate and those who did not. Thus, we believe that the bias could be minimized. Fourth, the findings of this study must, however, be treated carefully given that the relationship between HRQOL and CRF on ANCOVA models did not show a dosage–response relationship. Difficulties on measuring aerobic fitness by using the 20-m shuttle-run test are responsible for this. In our opinion, this test did not have enough sensitivity, since, it was extremely difficult for children younger than 6 years to complete the first lap (20 meters). In fact, in 2014, an adapted version of this test was validated for children under 6 years of age in which the speed of the start at the first stage was reduced to 6.5 km/h by increasing 0.5 km/h every minute [37]. Finally, in our study, children's HRQOL was assessed by parent-report questionnaires instead of self-report by children, although the studies that have analysed the association between fitness and self-perceived quality of life in children show similar results to ours. In addition, it has been shown that all subscales have a high degree of reliability and satisfactory convergent validity, so the acceptance of the measure is high both among children and parents [20, 38].

The strengths of our study include a large sample size, the standardization of physical fitness measurements and the provision of evidence on HRQOL related to physical fitness in a population that has been seldom studied thus far.

Conclusion

Our results show that high levels of physical fitness are associated with better HRQOL in children under 7 years. This association was found to be stronger between physical fitness and the physical health and school dimensions in both genders. Furthermore, good physical fitness was associated with better peer relationships and greater emotional well-being in girls. Finally, the best predictor of HRQOL (total score) was motor fitness in girls, and muscular fitness in boys. However, additional studies that analyse the relationship between HRQOL and physical fitness separately between boys and girls are needed before any firm conclusions can be drawn.

Therefore, our findings suggest that the design and implementation of physical activity interventions that improve all components of physical fitness could be effective strategies to improve HRQOL in children from an early age.

Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

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