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Role of physical activity and health-related fitness on self-confidence and interpersonal relations in 14-year-old adolescents from secondary school settings: DADOS study

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Background: The effect of physical activity (PA) and physical fitness (PF) on self-confidence and interpersonal relations in adolescents is uncertain.

Aim: To analyzed the associations of PA and PF with self-confidence and interpersonal relations in adolescents.

Sample: A total of 268 (138 boys) adolescents (13.9 ± 0.3 years) from the DADOS study were included in the analysis.

Methods: PA was evaluated using GENEActiv accelerometers and the health-related PF components by the ALPHA health-related fitness test battery. The levels of self-confidence and interpersonal relations were determined by the Behavior Assessment System for Children Level 3.

Results: The associations of PA levels and PF components with self-confidence reported positive associations of moderate-vigorous PA (MVPA), standing long jump, and 20-m shuttle run (shuttle run test) tests (all $p < 0.05$), and negative association of 4 × 10-m shuttle run test (4 × 10-m test), but only the 4 × 10-m test remained significant in the adjusted model for the whole sample and only in boys ($p \leq 0.01$) when analyzed by sex. Regarding interpersonal relations, positive associations of standing long jump and shuttle run test (all $p < 0.05$), and negative association of 4 × 10-m test were found in all the adolescents. The shuttle run test was associated with interpersonal relations in boys independently of confounders. PA levels were not associated with interpersonal relations.

Conclusion: A higher level of lower-limb muscle strength, speed-agility, and cardiorespiratory fitness might improve self-confidence and interpersonal relations in adolescents, but these relationships seem to be influenced by sex, body mass index, and pubertal status. Speed-agility and cardiorespiratory fitness seem to have a stronger impact on boys. MVPA may improve self-confidence in adolescents.

KEYWORDS
adolescent, interpersonal relations, physical activity, physical fitness, self-confidence

1 | INTRODUCTION

Adolescence is a period of multiple physical, psychological, and social changes that increase vulnerability to mental health problems, such as depression or anxiety, among others.[1] Mental disorders affecting this population have expanded significantly over the last three decades around the world and, currently 10%–20% of adolescents worldwide are affected.[1]This could be due to increased exposure to risk factors such as social networks and cultural and social changes resulting in less family and community integration.[1,2] Prevention of these disorders includes both, the presence of psychological well-being and the absence of psychological ill-being.[3,4] The development and maintenance of healthy, social, and emotional habits that promote psychological well-being are crucial during this life period.[5]

Psychological well-being is based on the combination of social, subjective, and psychological dimensions that leads people to act positively[6] and often includes aspects such as self-confidence, self-esteem, self-concept, self-efficacy, optimism, life satisfaction, and interpersonal relations among others.[3]

Physical activity (PA) has been related to greater psychological well-being and, consequently, to mental health in children and adolescents.[4,7] Likewise, a recent systematic review[8] highlights the lack of sufficient specific studies with objectively measured PA instead of questionnaires on sports participation or attendance rate.

This review[8] indicates that sport participation and high PA levels are associated with improvements in self-esteem and self-concept. In this line, the meta-analysis of Rodriguez-Ayllon et al.[4] emphasises the role of PA levels and physical exercise interventions on the improvement of many aspects conforming the psychological well-being.

On the other hand, it has been reported that higher participation in sports increases social health benefits in adolescents, although the associations with interpersonal relations were not studied.[8] In addition, most of the literature has been focused on the influence of related concepts, such as social skills or social support on performance in physical activities instead of the inverse relationship.[9,10]

Moreover, health-related physical fitness (PF) has shown some benefits in adolescents concerning psychological well-being,[11,12] although less evidence exists. Higher PF levels promote higher scores of self-esteem in adolescents.[13] Cardiorespiratory fitness and muscle strength showed positive associations with optimism, while muscle strength was also related to higher self-esteem in obese children.[14] In addition, exercise training focused on improving physical performance has shown gains in self-confidence in adolescent athletes.[15] Even self-reported PF has revealed a relationship with self-confidence in secondary school students.[16] On the other hand, Fernández-Bustos et al.[17] showed that having higher cardiorespiratory fitness and muscle strength levels improved positive social health and decreased negative social health in preadolescents.

Therefore, despite the evidence reported in previous studies,[4,8–14] it would be of interest to expand the scarce knowledge about the role of objectively measured PA and health-related PF components levels on self-confidence and interpersonal relations in adolescents. These two terms are relevant and specifically related to the overall concept of psychological well-being as they have their own meaning in this field, however, little evidence focuses on such concepts while others related (self-esteem, self-efficacy, self-concept, optimism, and social health) are more common in the literature.

Thus, the aim of the current study was to analyze the associations of objectively measured PA and health-related PF components levels with self-confidence and interpersonal relations in adolescents.

2 | METHODS

2.1 | Participants and study design

The present study is part of the DADOS (Deporte, ADOlescencia y Salud) study, which has been described previously.[18] Briefly, it is a 3-year longitudinal research project (from 2015 to 2017) aimed to analyze the influence of PA on health, academic performance, and psychological well-being in adolescents from the Castellon province (Spain). The results presented in this study belong to cross-sectional baseline data obtained between February and May of 2015. A convenience sampling technique was used to require participants; thus, it was not considered as a representative population. For that purpose, advertising leaflets about the research project were sent to secondary schools and sports clubs, which included basic information and the general DADOS study inclusion criteria (i.e., born in 2001, to be enrolled in the second grade of secondary school and without diagnosed physical or neurological chronic diseases). Volunteers who met the inclusion criteria (as reported by participants' parents or guardians) were included in the study. We estimated that a sample of 300 participants would be required to provide statistical power of 80% with a level of significance of 0.05, assuming a dropout rate of 20%.[18] Finally, from the total DADOS study sample ($n = 274$), a subset of 268 adolescents aged 13.9 ± 0.3 years (138 boys) was included in the analysis. This final sample came from 38 secondary schools, out of 85 were located in the province of Castellon and had valid

data for weight status, PA, PF components, and psychological well-being.

2.2 | Ethical considerations

Adolescents and their parents or guardians were informed of the nature and characteristics of the study, and all participants provided written informed parental consent. The DADOS study protocol was designed in accordance with the ethical guidelines of the Declaration of Helsinki 1961 (last revision of Fortaleza, Brazil, 2013) and approved by the Research Ethics Committee of the Universitat Jaume I of Castellon in Spain (UJI-28/04/2014).

2.3 | Physical activity

The PA levels were objectively measured using a triaxial GENEActiv accelerometer (Activinsights, Kimbolton, UK). This device provides a reliable (coefficient of variation intra- and inter-instrument of 1.4% and 2.1%, respectively) and valid measurement of PA in young people ($r = 0.925$, $p = 0.001$).[19] Participants were instructed to wear the accelerometer on their non-dominant wrist for at least six consecutive days (including sleeping and water-based activities). At least four complete days including two weekend days were required to be included in the analysis. Accelerometers were programmed to collect data at a sampling frequency of 100 Hz and stored in gravity (g) units. The raw acceleration output was aggregated in 1-s epochs using the GENEActiv postprocessing PC software (version 2.2: GENEActiv). By combining all registered days for each participant and using the Excel macro provided by the commercial brand to summarize the data, PA was expressed as average minutes per day in light, moderate, and vigorous PA. Moderate-vigorous PA (MVPA) was calculated by adding moderate PA and vigorous PA.

2.4 | Health-related physical fitness

The Field-based Assessing Levels of Physical fitness and Health in Adolescents (ALPHA) health-related fitness test battery, a well-known and validated tool,[20] was used to objectively measure PF components.

Cardiorespiratory fitness was measured using the 20-m shuttle run test (shuttle run test). Briefly, each participant ran straight between two lines 20 m apart, while keeping pace with audio signals. The test was completed when participants could not reach the end lines at the pace of the audio signals two consecutive times, or when they stopped because of fatigue. The final score, computed as the number of shuttles completed, was used in the analysis.

Speed-agility was measured using the 4×10-m shuttle run test (4×10–m test). Briefly, the participant ran as fast as possible four times between two parallel lines 10 m apart. The test was performed twice, and the best time (s) was used in the analysis. Higher values in this test indicate worse speed-agility.

Upper-limb muscular strength was measured using a hand dynamometer with adjustable grip (TKK 5401 Grip D: Takey Scientific Instruments). Briefly, the participant squeezed gradually and continuously for at least 2 s, performing the test with the right and left hands in turn, and using the optimal grip span. The test was performed twice for each hand alternatively. The handgrip score (kg) was calculated as the average of the best score for each hand.

Lower-limb muscular strength was measured using the standing long jump test. Briefly, the participant jumped as far as possible from a starting position immediately behind a line, standing with feet approximately shoulder's width apart. The test was performed twice, and the longest distance (cm) was used in the analysis.

2.5 | Psychological well-being

The psychological well-being indicators included in the present study were self-confidence and interpersonal relations. Specifically, self-confidence is defined as the person's ability to make decisions and to trust his/her own possibilities.[21] On the other side, interpersonal relations are defined as associations between two or more people based on emotions and feelings, take place in many contexts such as family, friends, and sports clubs, and are very relevant during the adolescence period.[22] This study concerns peer relations.

These indicators were measured by the Spanish version of the Behavior Assessment System for Children (BASC), which is a multimethod, multidimensional system used to evaluate the behavior and self-perceptions of children and adolescents.[23] BASC has shown extensive psychometric properties in both non-referred ($\alpha = 0.92$) and clinical populations ($\alpha = 0.93$) with reliabilities for the subscales ranging from 0.80 to 0.87.[24] The level-3, the version designed for adolescents, was applied for 14-year-old participants, and precisely, self-confidence and interpersonal relations belong to the self-reported personality scale. For each indicator, standard *T*-score with an average of 50 and standard deviations of 10 points were used in the analysis.

2.6 | Covariates

2.6.1 | Anthropometry and maturity as covariates

Anthropometric characteristics were measured twice by trained members of the DADOS research group following standardized procedures.[25] Average measures were used for data analysis. Briefly, body weight was measured to the nearest 0.1 kg using an electronic scale (SECA 861), lightly dressed and without shoes. Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer (SECA 213). Body mass index (BMI) was calculated as weight/height square (kg/m^2).

Pubertal status was self-reported according to the five stages described by Tanner and Whitehouse[26] based on external primary and secondary sex characteristics. Standardized pictures were used to measure (self-reported) two components: pubic hair growth for boys and girls, plus breast development in girls, and genital development in boys. A 5-point maturity rating was used where Stage 1 corresponds to the prepubertal state and Stage 5 corresponds to mature state. The highest rating of the two components was used for data analyses.

2.7 | Statistical analysis

Study sample characteristics are presented as mean ± standard deviation (SD) for continuous variables or percentages for categorical variables. All variables were checked for normality using both graphical (normal probability plots) and statistical (Shapiro–Wilk test) procedures. For continuous variables, *t*-test was used to analyze sex differences.

Multiple linear regression analyses were used to analyze the association of PA levels and PF components (independent variables) with self-confidence and interpersonal relations (dependent variables) and using specific adjusting models for each lineal regression. Model 1 was the unadjusted model and Model 2 was the adjusted model built based on statistical and scientific criteria. In particular, for Model 2, both the individual association of each potential confounder and its modifying effect on the pure coefficient (>10%) were analyzed. Thus, considering this criterion, a final adjusted regression model was built for each PA and PF variable including sex and/or BMI and/or pubertal status (ordinal categorical variable; 1–5) as covariates based on the results of the specific statistical verifications previously described. This process has been done separately for each association, and therefore each relationship has a different set of confounders in the model. Moreover, for confounding variables included in Model 2, the interaction was verified by generating virtual dummy variables in STATA (independent * confounder). No significant interactions were found for any of the studied variables in the regression models ($p > 0.05$). However, considering the previously published evidence on PA and PF differences by sex in adolescence,[27] sensitivity analyses were also performed separately by sex. All the analyses were performed using the STATA software for Windows version 13.0. The level of significance was set at $p < 0.05$.

3 | RESULTS

The characteristics of the sample included in this study are shown in Table 1 for both, all participants together and by sex. Briefly, boys were taller and had higher PA levels and PF performance than girls (all $p < 0.001$), except for light PA. Significant differences were observed for self-confidence (*T*-score), being higher in boys, but not for interpersonal relations (*T*-score).

The associations of PA levels and PF performance with self-confidence and interpersonal relations are shown in Tables 2 and 3, respectively. In the whole sample and after adjusting by specifically selected confounders, the performance in the 4 × 10–m test was independently associated with self-confidence ($p \leq 0.05$). Moreover, others such as MVPA levels, standing long jump and shuttle run tests were also associated with self-confidence, however, these relationships were not independent of confounders (all $p \leq 0.05$). Furthermore, when sensitivity analyses were applied separately by sex based on scientific rationale (not statistical interactions), the performance in the 4 × 10–m test remained significantly associated with self-confidence independently of confounders only in boys (all $p \leq 0.01$).

On the other hand, in the whole sample the performances in standing long jump, shuttle run and 4 × 10-m tests were associated with interpersonal relations independently of confounders (all $p < 0.05$). In addition, when sensitivity analyses were applied separately by sex only the performance in the shuttle run test was independently associated with interpersonal relations in boys. Also, performance on 4 × 10-m reported a significant association that disappear after including confounder in the model (all $p \leq 0.05$).

4 | DISCUSSION

The present study aimed to analyze the associations of objectively measured PA and PF levels with self-confidence and interpersonal relations in adolescents. Our study revealed a positive association of MVPA with self-confidence, but not with interpersonal relations.

TABLE 1 Descriptive characteristics of the study sample.

	All ($n=268$)		Boys ($n=138$)		Girls ($n=130$)		p-Value
	Mean ± SD	Min/max	Mean ± SD	Min/max	Mean ± SD	Min/max	
Age (years)	13.89 ± 0.30	13.27/14.43	13.89 ± 0.29	13.27/14.43	13.89 ± 0.30	13.32/14.43	0.98
Weight (kg)	54.11 ± 9.23	31.4/88.55	54.55 ± 9.64	31.40/88.55	53.66 ± 8.78	32.85/86.20	0.43
Height (cm)	163.01 ± 7.91	142.60/181.05	164.72 ± 8.57	142.60/181.05	161.19 ± 6.73	145.65/175.85	<0.001**
BMI (kg/m^2)	20.29 ± 2.73	14.14/32.27	19.99 ± 2.55	14.14/32.27	20.61 ± 2.89	14.76/31.47	0.06
Pubertal stage (I–V) (%)	0/8/34/49/9		0/10/32/44/14		0/5/36/54/5		
Physical Activity (min/day)							
Light	175.10 ± 55.90	107.61/642.16	173.83 ± 58.95	107.61/642.16	176.43 ± 52.75	107.74/591.56	0.70
Moderate	76.89 ± 25.50	31.37/260.26	81.82 ± 24.87	41.70/244.32	71.65 ± 25.28	31.37/260.26	<0.001**
Moderate-vigorous	89.39 ± 30.50	32.21/284.97	97.48 ± 29.12	48.06/261.24	80.81 ± 29.71	32.21/284.97	<0.001**
Vigorous	12.51 ± 8.41	0.52/46.88	15.66 ± 7.81	1.77/46.88	9.16 ± 7.77	0.52/40.67	<0.001**
Health-related physical fitness							
HG (kg)	28.9 ± 5.9	13.3/51.8	30.9 ± 6.7	13.3/51.8	26.8 ± 4.0	19.5/44.1	<0.001**
SLJ (cm)	171.20 ± 26.40	87/248	180.57 ± 24.62	116/248	161.28 ± 24.59	87/224	<0.001**
4×10–m test (s)	12.55 ± 0.99	10.90/15.80	12.04 ± 0.71	10.90/14.20	13.09 ± 0.95	11.10/15.80	<0.001**
SRT (nº shuttles)	64.62 ± 24.90	13/115	78.00 ± 20.96	13/115	50.42 ± 20.59	18/105	<0.001**
Phycological well-being (outcomes)							
Self-confidence (T-score)	49.76 ± 9.70	12/59	51.11 ± 8.93	12/59	48.32 ± 10.29	12./59	0.02*
Interpersonal relations (T-score)	51.81 ± 7.25	7/57	52.38 ± 6.1	16/57	51.20 ± 8.28	7/57	0.18

Note: Data are presented as mean ± standard deviation and minimum/maximum or percentages. Differences between sexes were examined by independent t test.

Abbreviations: BMI, body mass index; HG, handgrip; Max, maximum; Min, minimum; SD, standard deviation; SLJ, standing long jump; SRT, 20-m shuttle run test.

*$p<0.05$.; **$p<0.001$.

TABLE 2 Multiple linear regression analyses of PA and PF with self-confidence.

	All ($n=268$)						Boys ($n=138$)						Girls ($n=130$)					
	Model 1			Model 2			Model 1			Model 2			Model 1			Model 2		
Variable	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*
PA (min/day)																		
Light	0.012	0.071	0.247	-	-	-	0.009	0.059	0.489	-	-	-	0.018	0.092	0.296	-	-	-
Moderate	0.044	0.115	0.060	0.036	0.094	0.137	0.035	0.097	0.260	0.033	0.093	0.286	0.034	0.083	0.351	0.035	0.086	0.343
MVPA	0.040	0.126	0.039*	0.031	0.098	0.126	0.026	0.085	0.319	0.025	0.079	0.363	0.034	0.097	0.271	0.036	0.103	0.259
Vigorous	0.125	0.109	0.075	0.074	0.064	0.344	0.012	0.011	0.899	−0.003	−0.002	0.978	0.137	0.103	0.243	0.152	0.115	0.219
Health-related physical fitness																		
HG (kg)	0.161	0.098	0.108	0.068	0.041	0.565	0.040	0.030	0.726	−0.03	−0.019	0.852	0.246	0.095	0.284	0.262	0.101	0.274
SLJ (cm)	0.052	0.141	0.021*	0.029	0.079	0.244	0.057	0.157	0.066	0.040	0.107	0.232	0.017	0.040	0.648	0.018	0.042	0.645
4×10–m test (s)	−2.203	−0.224	<0.001**	−1.914	−0.194	0.010*	−3.393	−0.268	<0.001**	−3.006	−0.237	0.010*	−1.227	−0.113	0.199	−1.326	−0.123	0.186
SRT (nº shuttles)	0.063	0.163	0.010*	0.044	0.111	0.160	0.050	0.118	0.169	0.028	0.064	0.502	0.043	0.086	0.331	0.053	0.106	0.282

Note: Data are presented for all sample and by sex as unstandardized regression coefficient (*b*), standardized regression coefficient (*β*), and *p*-value (*p*).
Model 1 was unadjusted and Model 2 was adjusted for sex, pubertal stage and body mass index in all, and pubertal stage and body mass index in boys and girls according to previous statistical analyses.

Abbreviations: HG, handgrip; MVPA, moderate-vigorous physical activity; PA, physical activity; SLJ, standing long jump; SRT, 20–m shuttle run test.

*$p<0.05$.; **$p<0.001$.

TABLE 3 Multiple linear regression analyses of PA and PF with interpersonal relations.

	All ($n = 268$)						Boys ($n = 138$)						Girls ($n = 130$)					
	Model 1			Model 2			Model 1			Model 2			Model 1			Model 2		
Variable	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*	*b*	*β*	*p*
PA (min/day)																		
Light	0.002	0.019	0.754	0.003	0.021	0.730†	0.002	0.016	0.849	-	-	-	0.004	0.026	0.767	-	-	-
Moderate	0.005	0.017	0.780	−0.001	−0.004	0.946†‡§	0.008	0.033	0.699	0.002	0.009	0.913‡§	−0.008	−0.024	0.788	−0.008	−0.023	0.799‡§
MVPA	0.010	0.041	0.501	0.003	0.013	0.845†‡§	0.012	0.056	0.517	0.006	0.028	0.742‡§	−0.002	−0.007	0.935	−0.002	−0.007	0.939‡§
Vigorous	0.084	0.098	0.111	0.057	0.066	0.332†‡§	0.079	0.102	0.236	0.059	0.075	0.380‡§	0.053	0.050	0.571	0.056	0.052	0.577‡§
Health-related physical fitness																		
HG (kg)	0.078	0.064	0.300	0.040	0.032	0.649†‡	0.110	0.122	0.154	0.116	0.127	0.198‡	−0.139	−0.066	0.452	−0.147	−0.070	0.434‡
SLJ (cm)	0.025	0.091	0.139	0.281	1.013	0.022*†‡§	0.017	0.068	0.427	0.102	0.402	0.576‡§	0.022	0.065	0.464	0.410	1.217	0.057‡§
4 × 10–m test (s)	−1.152	−0.157	0.010*	−0.984	−0.134	0.033*§	−1.680	−0.195	0.022*	−1.350	−0.156	0.066§	−0.866	−0.100	0.260	−0.849	−0.098	0.290§
SRT (nº shuttles)	0.047	0.008	0.162	0.0392	0.135	0.040*§	0.070	0.239	0.005**	0.052	0.177	0.049*§	0.026	0.0655	0.459	0.025	0.062	0.524§

Note: Data are presented of all and by sex as unstandardized regression coefficient (*b*), standardized regression coefficient (*β*), and *p*-value (*p*). Model 1 was unadjusted and Model 2 was adjusted for sex† and/or pubertal stage‡ and/or body mass index§ according to previous statistical analyses.

Abbreviations: HG, handgrip; MVPA, moderate-vigorous physical activity; PA, physical activity; SLJ, standing long jump; SRT, 20-m shuttle run test.

*$p < 0.05$.; **$p < 0.01$.

Moreover, adolescents with better performance on lower-limb muscle strength, speed-agility, and cardiorespiratory fitness showed higher levels of self-confidence and interpersonal relations. Particularly, boys with higher performance in speed-agility presented higher levels of self-confidence and interpersonal relations. Similarly, it has been found the better cardiorespiratory fitness, the higher interpersonal relationship in boys. In addition, pubertal status and BMI have shown an influence on the association of PA and/or PF performances with self-confidence and interpersonal relations. These findings contribute to the current scientific knowledge by suggesting that both MVPA and PF could contribute to optimal mental health in adolescence, with a special role in boys.

4.1 | Physical activity

Few studies have investigated the self-confidence of adolescents, related to PA, and furthermore, this PA has been defined as sports participation. The study of Holt et al.[28] showed that perceptions of psychological benefits of parents and their children were associated with participation in youth sport. They measured confidence with a semi-structured interview of adolescents and their parents. Moreover, PA was estimated from the time of sports participation.[28] Another study with similar results[29] used extracurricular sports participation and youth sport as a proxy for PA, while the adolescent's confidence, divided into self-worth and positive identify, was measured by an empiric scale. In consonance with these previous studies,[28,29] the present work showed a positive association between objectively measured PA (particularly MVPA) and self-confidence, however, the use of accelerometers to measure PA provides additional accuracy and strength to the scientific evidence by using objective methods rather than qualitative or self-reported tools.

Other studies have analyzed the associations of self-confidence related concepts. This is the case of Garn et al.[30] that found a positive association between objectively measured MVPA and self-concept in 1767 adolescents after controlling for sex and BMI. In addition, Young et al.[31] found a positive association of objective MVPA with physical self-concept and self-esteem in adolescent girls. Moreover, another recent study[32] reported similar associations of regular PA with emotional, physical self-concept, and general self-efficacy in Spanish teenagers ($n = 167$, 14–15 years), although, PA was self-reported. A similar trend was observed by Dishman et al.[33] that reported lower values of self-efficacy and objectively measured PA in preadolescents girls. Those authors[33] concluded that PA decreased more in students with higher declines in self-efficacy; however, they only consider sex as a confounder instead of analyzing the interaction effect of sex by performing separate analyses for boys and girls as our study did. In fact, in the scientific literature described above, the sex influence was considered by including this as a confounder variable. In our study, a double approach was considered by analyzing first the role of several confounders (sex, BMI, and pubertal status), and second; studying the interaction role of sex by sensitivity analyses separately for boys and girls. In summary, our findings showed an association between MVPA and self-confidence that disappeared after adjusting for confounders and/or interaction analyses by sex. This could suggest that the initial association found for MVPA could be influenced, at least partially, by sex, BMI and/or pubertal status or even the total sample size. Furthermore, it is noteworthy and necessary to point out that several studies reported associations with specifically MVPA, as does the present study. MVPA includes time spent at both moderate and vigorous intensity activity. Therefore, it is plausible that considering the role of the higher amount of time registered in MVPA will provide a clearest picture (higher sensitivity) of its association with self-confidence. In this sense, the lack of associations between objective measured PA and interpersonal relations in adolescents found in our study concurs with previous cross-sectional data[34] showing that prosocial behaviors and social functioning were unrelated to objectively measured PA in boys and girls aged 11 years old. In fact, this study also showed the same tendency that our results regarding differences in MVPA levels between sexes, with a tendency to have less favorable levels in girls than boys. On contrary, previous literature[28,35,36] studying PA, through sport participation or attendance in sport activities, revealed that a highest participation and the consequent increase in PA level were related to better psychosocial health, interpersonal development or relations and social connections in both preadolescence and adolescence. However, several methodological aspects could explain the contradictory results among studies. In this sense, using an indirect measure of PA (self-reported) could overestimate the PA level. These studies[28,35,36] collected information about the type of activity and in most cases it was structured PA like physical sports activities, which have previously shown their influence on mental health.[37] By contrast, our study collected information about the effect of intensity and amount of PA. Thus, the fact to objectively measure PA in adolescents could ensure a more precise indicator of overall PA than extracting from interviews, qualitative methods, or data survey analysis. However, it is necessary to highlight the relevance to consider not only the objective quantification of PA volume and intensity, but also the type of activity and/or sports participation for a more complete understanding.

4.2 | Physical fitness

On the other hand, previous scientific evidence[15,16] studied the associations of PF components with the self-confidence concept literally. However, these studies did not use objective measures of PF. In this regard, self-reported fitness level was associated with changes in adolescents' self-confidence.[16] Moreover, in the field of sport performance, an increase in speed led to improved self-confidence.[15] For all these reasons, other related concepts were considered as proxy indicators of self-confidence. In this sense, literature about concepts equivalent to such term suggested that muscular strength and cardiorespiratory fitness were the principal fitness components acting as predictors of self-confidence.[14,38] In addition, Reigal et al.[39] showed that cardiorespiratory fitness was a great predictor of general self-efficacy and life satisfaction; but lower-limb muscular strength could also adequately predict the level of life satisfaction in Spanish adolescents. Furthermore, the same author in another study[32] found positive associations of cardiorespiratory fitness and standing long jump with self-concept. Others[38] showed positive associations of upper and lower-limb muscular strength, speed-agility and cardiorespiratory fitness with physical self-concept, although cardiorespiratory fitness was the best predictor for physical self-concept and self-esteem in those adolescents. In addition, cardiorespiratory fitness and upper and lower-limb muscular strength were associated with optimism and self-esteem, respectively, in obese preadolescents.[14] Overall, our results are in line with these studies reporting associations of lower-limb muscular strength, cardiorespiratory fitness and speed agility. Nevertheless, based on our data speed agility showed the strongest association with self-confidence with special relevance for boys. The methodology and concepts used as outcomes and the use of confounders could explain some differences among studies in relation to the PF component showing higher relevance, but agreement on a clear association of PF on self-confidence exists. Finally, the associations of PF components with interpersonal relations have been recently reported in Spanish preadolescents,[17] where the authors reported direct associations of cardiorespiratory fitness with positive social health and inverse associations with negative social health in both boys and girls. Muscular upper and lower-limb strength showed similar associations although to a lesser extent. However, a final analysis separately by BMI categories showed greater differences by sex, highlighting that normal weight girls had better positive social health, while underweight boys had fewer positive social health and higher negative social health than their normal weight peers. In our study, the performances in lower-limb muscular strength, cardiorespiratory fitness and speed agility were associated with interpersonal relations. Overall, our findings support the previous literature, but the particular role of speed agility appears as one of the main findings adding value to the current evidence.

4.3 | Strengths and limitations

This study has some limitations; thus, its findings should be interpreted with caution. First, the cross-sectional design of our analyses avoids us to infer causal effects, thus, longitudinal/interventional studies are needed. Second, the sample may not be large enough when statistical analyses by sex were applied. The age homogeneity of the adolescent sample is a strength of the current work despite the variability in pubertal status. In addition, the use of objective methods to measure PA and health-related PF components is an added value providing accuracy to the results.

5 | CONCLUSION

This study suggests that higher levels of lower-limb muscle strength, cardiorespiratory fitness and speed-agility could contribute to better self-confidence and interpersonal relations in adolescents. Precisely, speed-agility and cardiorespiratory fitness seem to have a stronger impact on boys. Furthermore, increasing levels of objectively measured MVPA may improve self-confidence in adolescents and this relationship seems to be influenced by BMI and/or pubertal status.

6 | PERSPECTIVE

The results of this study are relevant and complement the evidence on the role of PA and PF on the mental health status of adolescents.[4] Specifically, self-confidence and interpersonal relations are factors that have been little studied and are relevant to psychological well-being.[39] The use of a comprehensive battery of fitness tests and objective tools allows us to determine that the most relevant physical skills are lower limb muscle strength, cardiorespiratory fitness, and speed-agility, as well as the relevance of MVPA level. Finally, knowledge of the key role of PA and PF may be useful as a strategy to manage the increased mental disorders affecting this target population.

AUTHOR CONTRIBUTIONS

SOG was involved in analysis and drafting of the initial manuscript. MAR was involved in the data collection and critical revision of the manuscript. ACB and DJP were

involved in manuscript preparation and critical revision. DMU was involved in the study design and data collection and critical revision of the manuscript. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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