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Physical fitness and disordered eating among adolescents: Results from the EHDLA study

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ABSTRACT

The aim of this study was to examine the association between a comprehensive spectrum of physical fitness components and disordered eating symptoms in a sample of Spanish adolescents. This cross-sectional study analysed a representative sample of 741 adolescents (55.1% girls) from the Eating Healthy and Daily Life Activities (EHDLA) study (*Valle de Ricote*, Region of Murcia, Spain). Objective physical fitness (i.e., cardiorespiratory fitness, upper body strength, lower body strength, speed-agility, and flexibility) was assesed by the ALPHA-FIT Test Battery for a young population. Disordered eating symptoms were assessed with the Sick, Control, One, Fat, Food (SCOFF) questionnaire. An incremental inverse association was found in participants with low cardiorespiratory fitness (OR = 2.33; 95% CI: 1.56–3.50), low handgrip strength (OR = 1.99; 95% CI: 1.33–2.97), low lower body strength (OR = 1.91; 95% CI: 1.28–2.86), low speed-agility (OR = 1.75; 95% CI: 1.17–2.62), and low global physical fitness (OR = 2.03; 95% CI: 1.37–3.01) and disordered eating symptoms, compared to participants with a high level of each of these physical fitness components. Our study provides evidence that, in Spanish adolescents, disordered eating symptoms are inversely associated with a comprehensive set of physical fitness components. Hence, it could be relevant to promote physical fitness, e.g., by a multifactorial approach, since it seems to be related to lower disordered eating symptoms in adolescents.

1. Introduction

Eating disorders are severe psychiatric disorders characterized by abnormal eating or weight control behaviors, which can lead to serious health problems, such as arrhythmias, electrolyte disturbances, or leukopenia (among others) (Treasure et al., 2020). The Diagnostic and Statistical Manual of Mental Disorders-version 5 (DSM-5) recognises these illnesses which are specifically identified by defined signs and symptoms for which a degree of severity has been established, such as anorexia nervosa, bulimia nervosa, binge eating disorder, and eating disorder not otherwise specified (American Psychiatric Association, 2022). Similarly, they are recognized within the mental disorders included in the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 (GBD 2019 Mental Disorders Collaborators, 2022) and are currently a public health concern in developed countries because their prevalence in young people has markedly increased over the past 50 years (Treasure et al., 2020). Considering that mid-to-late adolescence is a peak period of eating disorder and its component symptoms, understanding the potential causes of eating disorders among young people is a crucial issue (Stice et al., 2013).

In addition to diagnosed eating disorders, there are symptoms of disordered eating, which include behaviors such as weight-loss dieting, binge eating, self-induced vomiting, excessive exercise, and the use of laxatives or diuretics (Toni et al., 2017). Although symptoms of

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disordered eating (e.g., unhealthy weight-control behaviors) predict outcomes related to eating disorders (and obesity) in adolescents five years later (Neumark-Sztainer et al., 2006), it is important to distinguish disordered eating from eating disorders (Quick et al., 2013). As such, these types of behaviors cannot be classified as full-blown illnesses and, although seemingly mild, should be closely evaluated because they may evolve into full-blown eating disorders (Toni et al., 2017).

One of the most powerful markers of health is physical fitness (Ortega et al., 2008). Several studies have analysed the relationship between physical fitness and certain cardiometabolic risk factors among youth (e.g., blood pressure, insulin resistance) (García-Hermoso et al., 2019; 2020) because all of them have been shown to track from childhood into adulthood (García-Hermoso et al., 2022). Similarly, other health outcomes, such as cognition, bone health, academic performance, and mental health, are also commonly studied in this population (Ortega et al., 2008).

A previous systematic review pointed out the negative association between eating disorders and physical fitness (in adults) (El Ghoch et al., 2013). In young adults, previous studies by Parreño-Madrigal et al. among university students found that high levels of both objective physical fitness (Parreño-Madrigal et al., 2020) and self-reported physical fitness (Lukács et al., 2021) were inversely associated with disordered eating symptoms. In the single study that we were able to identify among adolescents, an inverse relationship between physical fitness levels and disordered eating symptoms was found (Veses et al., 2014). Notwithstanding, their analyses explored only two components of physical fitness (i.e., cardiorespiratory fitness and self-reported global physical fitness).

There is a lack of studies examining the association between physical fitness and disordered eating symptoms in adolescents. Particularly, no previous study has analysed the association between muscular fitness (both upper and lower body strength), speed agility, or flexibility and disordered eating symptoms in adolescents. Therefore, the aim of the present study is to examine the association between a comprehensive spectrum of physical fitness components and disordered eating symptoms in a sample of Spanish adolescents.

2. Methods

2.1. Study design and population

This cross-sectional study analysed data from 741 adolescents (55.1% girls) from the Eating Healthy and Daily Life Activities (EHDLA) study, which included a representative sample of adolescents aged 12–17 years from the *Valle de Ricote* (Region of Murcia, Spain). A total of three secondary schools were assessed for this study (*CE El Ope*, *IES Vicente Medina*, and *IES Pedro Guillén*). Data were collected during the 2021/2022 academic year. The detailed methodology of the EHDLA study has been published elsewhere (López-Gil, 2022).

Regarding participation in this study, the parents or legal guardians of the adolescents received a signed written informed consent form before the participants' enrolment. Additionally, both parents or legal guardians and their children received an information sheet explaining the aims of this research project and the tests and questionnaires administered. Likewise, adolescents were asked about their willingness to participate in the study.

As inclusion criteria, participants had to comply with the following conditions: (1) aged between 12 and 17 years old; and (2) registered and/or lived in *Valle de Ricote*. Regarding exclusion criteria, adolescents were not enrolled when they (1) were exempt from the subject of Physical Education at school because both the tests and the fulfillment of the questionnaires were performed during the physical education lessons; (2) suffered any pathology that contraindicated physical activity or that demanded special attention; (3) were under some kind of pharmacological treatment; (4) were not authorized by the parents or legal guardians to participate in the study; or (5) did not agree to take part in the study.

This study obtained ethics approval from the Bioethics Committee of the University of Murcia (ID 2218/2018) and the Ethics Committee of the Albacete University Hospital Complex and the Albacete Integrated Care Management (ID 2021-85). Moreover, the study was carried out following the Helsinki Declaration and respected the human rights of the participants enrolled.

2.2. Procedures

2.2.1. Objective physical fitness

The ALPHA-FIT Test Battery for a young population (Ruiz et al., 2011) was used to evaluate physical fitness. This battery contains different tests to evaluate different components of physical fitness. Cardiorespiratory fitness was estimated as the maximum volume of oxygen consumed by performing a maximum incremental field test (20-m Shuttle Run Test). Due to the high variability in body composition of children, a curvilinear allometric model was used to improve the fit and validity of the 20-m Shuttle Run Test as a predictor of cardiorespiratory fitness in youth proposed by Nevill et al. (Nevill et al., 2021) instead of the traditionally used Léger et al. formula (Léger et al., 1988). The Handgrip Strength Test was used to evaluate upper body strength using a hand dynamometer with an adjustable grip (TKK 5401 Grip D, Takei, Tokyo, Japan). The absolute handgrip strength (kg) was computed as the mean of the left and right and, therefore, was normalized to body weight. The Standing Broad Jump Test was used to determine lower body strength. The 4 × 10 m Shuttle Run Test was applied to assess speed-agility (Ruiz et al., 2011). Flexibility was evaluated by the Sit-and-Reach Test (Castro-Piñero et al., 2009). Finally, in an estimation of the global physical fitness variable, the results of the five different tests were transformed into z scores by sex and age as follows: z score value = (value − mean)/standard deviation (SD). Previously, since more time spent in the 4 × 10 m Shuttle Run Test (i.e., speed agility) means lower performance in this physical fitness component, the z score value obtained was transformed (i.e., multiplying by −1) to homogenize all the variables represented. Then, the sum of these z scores was computed to establish the global physical fitness score (Delgado-Alfonso et al., 2018; López-Gil et al., 2020).

On the other hand, in the absence of cut-off points for some of the physical fitness variables analysed (e.g., normalized cardiorespiratory fitness by Nevill et al. (Nevill et al., 2021), normalized handgrip strength, flexibility, global physical fitness), the different estimations were categorized into tertiles by sex and age for the entire sample and categorized as low (third tertile), medium (second tertile), and high (first tertile).

2.2.2. Disordered eating symptoms

Disordered eating symptoms were assessed with the Sick, Control, One, Fat, Food (SCOFF) questionnaire, a five-question test that can be both hetero and self-administered with an acceptable sensitivity and specificity at a threshold of two (i.e., if patients provided positive responses to at least two of the five questions). In this study, SCOFF was administered by two psychologists. The Spanish SCOFF questionnaire version has been validated for its use in primary care settings (Garcia-Campayo et al., 2005). A score ≥2 points was used to indicate disordered eating symptoms, since this cut-off point has provided high sensitivity and specificity for the detection of disordered eating behaviour in primary care (Garcia-Campayo et al., 2005).

2.2.3. Covariates

2.2.3.1. Sociodemographics. Age and sex were self-reported by adolescents. Socioeconomic status (SES) was assessed with the Family Affluence Scale (FAS-III) (Currie et al., 2008). The FAS-III score was calculated by the sum of the responses for 6 different questions: a) "Does your family own a car, van, or truck?" (0 = no; 1 = yes, one; 2 = yes, two or more); b) "Do you have your own bedroom for yourself?" (0 = no; 1 = yes); c) "How many computers do your family own (including laptops and tablets, not including game consoles and smartphones)?" (0 = none, 1 = one, 2 = two, 3 = more than two); d) "How many bathrooms (room with a bath/shower or both) are in your home?" (0 = none, 1 = one, 2 = two, 3 = more than two); e) "Does your family have a dishwasher at home?" (0 = no; 1 = yes); f) "How many times did you and your family travel out of Spain for a holiday/vacation last year?" (0 = not at all, 1 = once, 2 = twice, 3 = more than twice).

2.2.3.2. Lifestyle. The Youth Activity Profile Physical (YAP), a 15-item self-report instrument, was used to obtain information related to physical activity and sedentary behavior among adolescents (Saint-Maurice & Welk, 2015). The YAP is a self-administered 7-day recall (previous week) questionnaire adapted to young people aged 8–17 years. The items use a 5-point Likert scale and are separated into three sections: 1) activity at school, 2) activity out-of-school, and 3) sedentary habits. Activity at school includes transportation to and from school, as well as activity during physical education classes, lunch, and recess time. The out-of-school activity section denotes activity before school, activity immediately after school, activity during the evening, and activity on each weekend day (Saturday and Sunday). The sedentary habits section refers to time spent watching television, playing videogames, using the computer, using a cell phone and an overall sedentary time item. Physical activity (at school and out-of-school) and sedentary behavior (sedentary habits) scores were determined by summing the items in each section. The Spanish version of YAP (YAP-S) has been validated and adapted (Segura-Díaz et al., 2021).

Sleep duration was assessed by asking participants for weekdays and weekend days separately: "What time does your child usually go to bed?" and "What time does your child usually get up?". The average daily sleep duration was computed for each participant as follows: [(average nocturnal sleep duration on weekdays × 5) + (average nocturnal sleep duration on weekends × 2)]/7.

2.2.3.3. Anthropometric. Following the standard protocols, the body weight of the adolescents was measured by an electronic scale (with an accuracy of 0.1 kg) (Tanita BC-545, Tokyo, Japan), while the height was determined by a portable height rod with an accuracy of 0.1 cm (Leicester Tanita HR 001, Tokyo, Japan). Body mass index was calculated by dividing body weight (in kg) by height (in squared meters). Furthermore, the body mass index z score was computed by the WHO age-specific and sex-specific thresholds (de Onis, 2007). The waist circumference was measured to the nearest 0.1 cm at the level of the umbilicus using a constant tension tape. These procedures were all based on the recommendations of the International Society for the Advancement of Kinanthropometry.

2.3. Statistical analysis

Means (*M*) and standard deviation (*SD*) or frequencies (*n*) and percentages (%) were reported for all quantitative or qualitative variables, respectively. Variable normality distribution was verified with a Kolmogorov–Smirnov test with Lilliefors correction, and the homogeneity of variances was verified with Levene's test. Since preliminary analyses showed no interaction between sex and physical fitness components in relation to SCOFF mean score (cardiorespiratory fitness: $p = 0.470$; handgrip strength: $p = 0.806$; lower body strength: $p = 0.876$; speed-agility: $p = 0.665$; and flexibility: $p = 0.634$), we analysed both sexes together. This absence of interaction was also found when testing school and physical fitness components according to SCOFF mean score (cardiorespiratory fitness: $p = 0.529$; handgrip strength: $p = 0.843$; lower body strength: $p = 0.780$; speed-agility: $p = 0.321$; and flexibility: $p = 0.567$). For this reason, all participants for the different schools were analysed jointly. Analyses of covariance (ANCOVA) were performed to estimate differences in the mean values of SCOFF means across different levels of physical fitness established for each component. Furthermore, *post hoc* pairwise comparisons were carried out to verify differences among the group levels (low, medium, and high tertiles). Binary logistic regression analyses were conducted to estimate the odds ratio (OR) and the 95% confidence interval (CI) of the association between different group levels (low, medium, and high tertiles) of each physical fitness component (i.e., cardiorespiratory fitness, muscular fitness, speed agility, flexibility, and global physical fitness) and disordered eating symptoms. Since multiple associations were made, in order to avoid incorrectly rejecting the null hypothesis, we applied the Bonferroni correction. This takes $\alpha = 0.05/K$, where K is the number of predictors. Hence, with $K = 6$, the result of a comparison is considered significant if $p < 0.008$ (Glickman et al., 2014). Age, sex, socioeconomic status, waist circumference, physical activity, sedentary behavior, and sleep duration were included as covariates. All analyses were performed with SPSS software (IBM Corp, Armonk, NY, USA) for Windows (version 25.0).

3. Results

Table 1 shows the characteristics of the study participants. The proportion of participants with excess weight (overweight or obesity) was 46.2%. A total of 30.6% of participants showed disordered eating symptoms.

Fig. 1 depicts the comparisons between the mean score in the SCOFF questionnaires across the levels of physical fitness for each component. Participants with low cardiorespiratory fitness, low handgrip strength, low lower body strength, and low speed-agility showed significant differences in the mean SCOFF score compared to those with high performance in these physical fitness components ($p < 0.008$ for all). Similarly, statistically significant differences were found between the SCOFF scores of participants with low cardiorespiratory fitness and those of

Table 1
Characteristics of the study participants (N = 741).

Variables	M ± SD/n (%)
Age	13.9 ± 1.5
Sex (girls)	408 (55.1)
FAS-III (score)	8.1 ± 2.1
Recruiting school	
CE El Ope	148 (20.0)
IES Vicente Medina	401 (54.1)
IES Pedro Guillén	192 (25.9)
Weight (kg)	59.6 ± 15.0
Height (cm)	161.4 ± 8.8
BMI (kg/m^2)	22.7 ± 4.7
BMI (z-score) [a]	0.89 ± 1.25
Excess weight	342 (46.2)
Waist circumference (cm)	73.1 ± 10.4
YAP-S Physical activity (score)	2.6 ± 0.7
YAP-S Sedentary Behaviors (score)	2.6 ± 0.6
Sleep duration (min)	492.5 ± 54.9
20-m Shuttle Run Test (stages)	3.9 ± 2.0
CRF (ml/kg/min) [b]	49.2 ± 7.4
Absolute handgrip strength	47.5 ± 14.6
Handgrip strength/BW	0.41 ± 0.10
Standing broad jump (cm)	143.5 ± 57.1
4 × 10 Shuttle Run Test (s)	12.8 ± 1.3
Sit-and-Reach Test (cm)	24.4 ± 9.4
SCOFF (score)	1.0 ± 1.2
Disordered eating symptoms [c]	227 (30.6)

BMI, body mass index, BW, body weight; CE, *Cooperativa de Enseñanza*; CRF, cardiorespiratory fitness; FAS-III, Family Affluence Scale – IIII; IES, *Instituto de Educación Secundaria*; SCOFF, Sick, Control, One, Fat, Food; YAP-S, Spanish Youth Active Profile. [a] According to the World Health Organization criteria (de Onis, 2007); [b] According to the curvilinear allometric model proposed by Nevill et al. (2021); [c] According to the Garcia-Campayo et al. (2005) criteria.

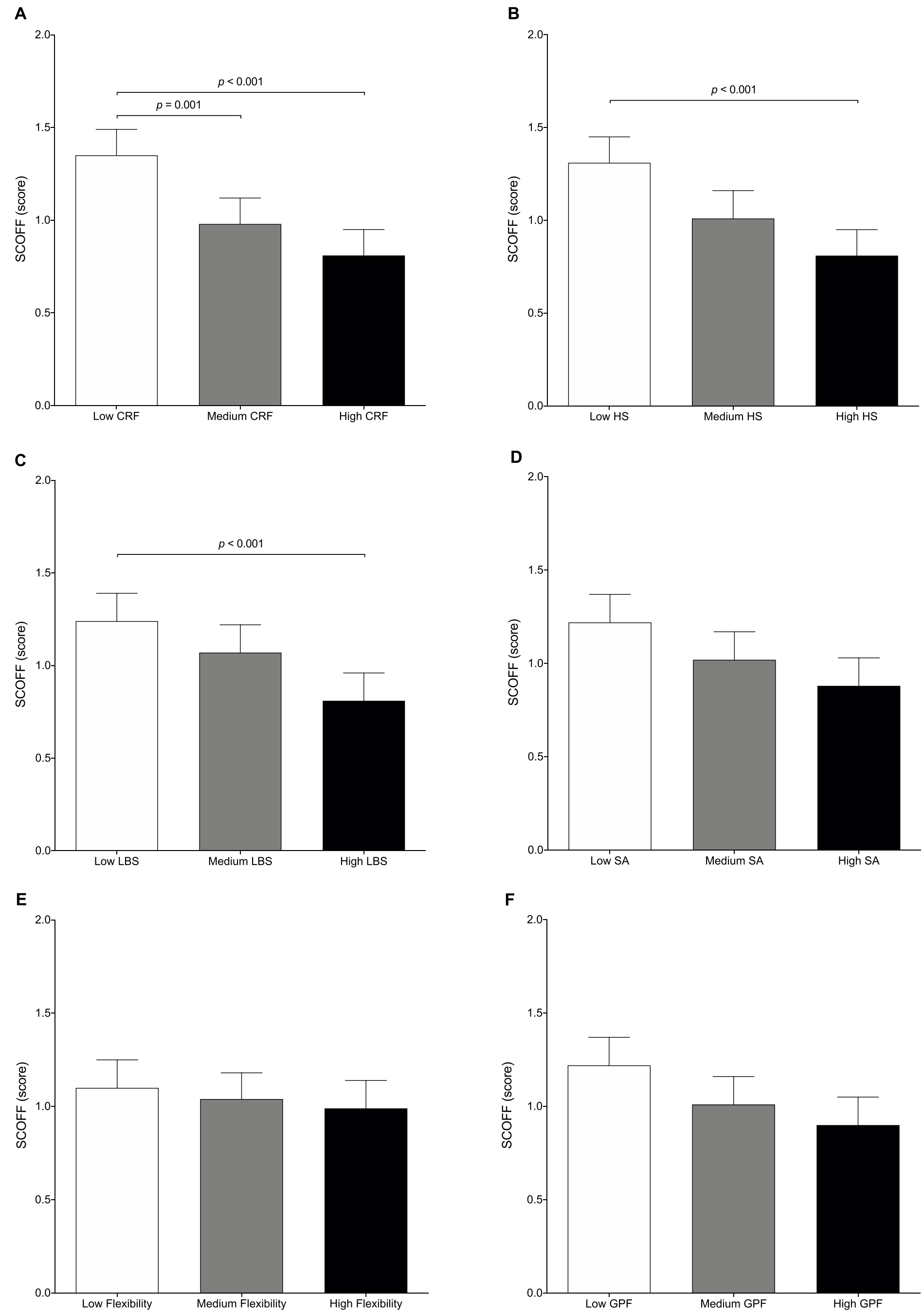

Fig. 1. Mean differences between the Sick, Control, One, Fat, and Food questionnaires in relation to physical fitness among Spanish adolescents. Analysis of covariance was adjusted for age, sex, socioeconomic status, waist circumference, physical activity, sedentary behavior, and sleep duration. A: Cardiorespiratory fitness; B: Handgrip strength; C: Lower body strength; D: Speed agility; E: Flexibility; F: Global physical fitness. CRF, cardiorespiratory fitness; GPF, global physical fitness; HS, handgrip strength; LBS, lower body strength; SA, speed agility; SCOFF, Sick, Control, One, Fat, Food questionnaire.

participants with medium performance in these physical fitness components ($p < 0.008$ for all).

The association between the different physical fitness categories and disordered eating symptoms is shown in Fig. 2. An incremental inverse association was found in participants with low cardiorespiratory fitness (OR = 2.33; 95% CI: 1.56–3.50), low handgrip strength (OR = 1.99; 95% CI: 1.33–2.97), low lower body strength (OR = 1.91; 95% CI: 1.28–2.86), and low global physical fitness (OR = 2.03; 95% CI: 1.37–3.01) and disordered eating symptoms, compared to participants with a high level of each of these physical fitness components ($p < 0.008$ for all).

4. Discussion

Overall, our findings showed that several components of physical fitness are inversely associated with disordered eating symptoms in Spanish adolescents. Although our results found that low physical fitness in most of the components was associated with disordered eating symptoms, there was an exception in the case of flexibility. However, this discrepancy could be partially explained by the fact that flexibility has little predictive or concurrent validity with health and performance outcomes in apparently healthy individuals (Nuzzo, 2020).

Our findings are in line with previous studies in young adults (Lukács et al., 2021; Parreño-Madrigal et al., 2020) and adolescents (Veses et al.,

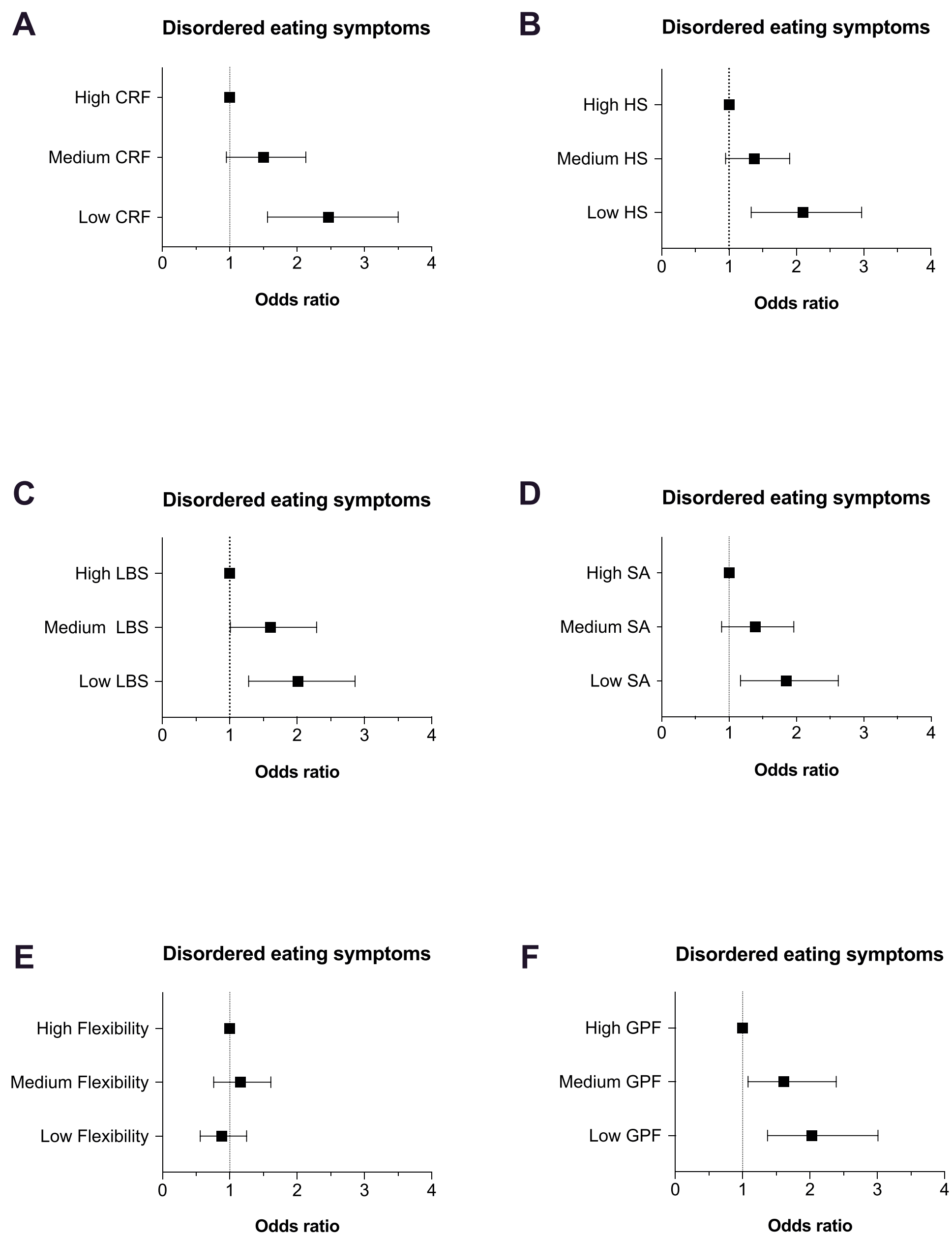

Fig. 2. Association between physical fitness components and disordered eating symptoms among Spanish adolescents. Data are shown as odds ratios (dots) and 95% confident intervals (lines) obtained through logistic regression models adjusted by age, sex, socioeconomic status, physical activity, sedentary behavior, and sleep duration. A: Cardiorespiratory fitness; B: Handgrip strength; C: Lower body strength; D: Speed agility; E: Flexibility; F: Global physical fitness. CRF, cardiorespiratory fitness; GPF, global physical fitness; HS, handgrip strength; LBS, lower body strength; SA, speed agility; SCOFF, Sick, Control, One, Fat, Food questionnaire.

2014). In the only study conducted in adolescents, Veses et al. (Veses et al., 2014) found negative association between physical fitness levels and disordered eating symptoms in a sample of 3571 Spanish adolescents. However, these same authors only analysed this cardiorespiratory fitness (through the 20-m Shuttle Run Test) and global physical fitness (self-reported) and disordered eating symptoms among adolescents. Conversely, our study is the first to include objective muscular fitness tests (Handgrip Strength Test and Standing Broad Jump), speed-agility test (4 × 10 Shuttle Run Test) and flexibility test (Sit-and-Reach Test), which is the main strength of this study.

As mentioned above, although little is known about the association between physical fitness and disordered eating symptoms (Parreño-Madrigal et al., 2020), there are some possible pathways that could be helpful for understanding these findings. First, two meta-analyses found weak-to-moderate and moderate-to-large associations of cardiorespiratory fitness (García-Hermoso et al., 2020) and muscular fitness (García-Hermoso et al., 2019) at baseline (respectively) with some obesity-related markers, such as body mass index and skinfold thickness, later in life. In addition, because of stigmatization, obesity in youth has been shown to be a risk factor for psychopathology, which may manifest itself through body dissatisfaction, shape and weight concerns, dieting and eating disorders (Haines & Neumark-Sztainer, 2006). Similarly, childhood obesity and disordered eating symptoms attitudes are each related to several physical health issues that track into adulthood, as well as the increased disordered eating symptoms during adolescence (Hayes, 2018). Thus, one possible explanation is that physical fitness improves body composition and, therefore, reduces the likelihood of having disordered eating symptoms.

Second, a further reason explaining our results could lie in the positive association between physical fitness and depression, anxiety, mood status and self-esteem in young people (in the short- and long-term). For instance, a meta-analysis by Donato et al. (Alves Donato et al., 2021) found a weak inverse relationship between cardiorespiratory fitness and depressive symptoms in children and adolescents. Furthermore, some observational studies have also pointed out the inverse association between handgrip strength and the risk of depressive symptoms in girls (Ren et al., 2020) or lower mental health in boys (Hwang et al., 2021). On the other hand, strong associations of anxiety and depression with eating disorders have been reported in previous studies including adolescents (Caqueo-Urízar et al., 2021; Sander et al., 2021). Supporting this idea, Kenny et al. (Kenny et al., 2021) provided an important symptom-level conceptualization of the association between depression symptoms and eating disorder among adolescents, where "irritable", "social eating", and "depressed" were identified as the most important nodes connecting (i.e., bridging) symptoms of depression and eating disorders. Therefore, it is reasonable to consider that the association between physical fitness and disordered eating symptoms could be mediated by its close relationship with adolescent mental health.

Third, there is a clear link between body image and disordered eating symptoms (Štefanová et al., 2020). Previous studies performed among adolescents have pointed out this relationship in different countries, such as Slovakia (Štefanová et al., 2020), Lithuania (Baceviciene & Jankauskiene, 2020) and Spain (Jáuregui Lobera et al., 2009). In the same line, body appreciation has been linked to a lower disordered eating symptoms in adolescents (both boys and girls) (Baceviciene & Jankauskiene, 2020). Additionally, physical fitness has been related to body image, with adolescents with low physical fitness levels having more body dissatisfaction (Claumann et al., 2019). Another study with Polish adolescents reported that physical fitness is a great predictor of body acceptance, even higher than moderate-to-vigorous physical activity (Laudańska-Krzemińska et al., 2020). Thus, it could be hypothesized that low physical fitness might increase body dissatisfaction, which in turn would increase disordered eating symptoms.

4.1. Methodological considerations

This study includes some limitations that should be declared. This was a cross-sectional study and does not allow causal inferences to be made. Future prospective observational and experimental studies are required to examine whether increased physical fitness leads to reduced disordered eating symptoms in adolescents. Likewise, information on the SCOFF questionnaire may result in some differential desirability bias because of information and recall bias by adolescents. Furthermore, although a meta-analysis concluded that SCOFF is a useful and simple screening tool for disordered eating behaviour (especially for young women), further examination of the validity of SCOFF or the development of a new screening tool to identify the range of EDs included in the DSM-5 is needed (Kutz et al., 2020). Finally, although our analyses controlled for important sociodemographic, lifestyle, and anthropometric covariates, residual confounding is still possible (e.g., waist circumference, sleep duration). Conversely, one strength of the study is the representative sample of adolescents from *Valle de Ricote* (Spain) analysed, which confers substantial external validity to our findings. Another strength is that the results from this study offer further cross-sectional evidence of the understudied association between physical fitness and disordered eating symptoms among adolescents.

In conclusion, our study provides evidence that, in Spanish adolescents, disordered eating symptoms are inversely associated with a comprehensive set of physical fitness components. Hence, it could be relevant to promote physical fitness, e.g., by a multifactorial approach, since it seems to be related to less disordered eating symptoms in young people.

Ethical statement

This study obtained ethics approval from the Bioethics Committee of the University of Murcia (ID 2218/2018) and the Ethics Committee of the Albacete University Hospital Complex and the Albacete Integrated Care Management (ID 2021-85). Moreover, the study was carried out following the Helsinki Declaration and respected the human rights of the participants enrolled.

Author Contribution

JFL-G designed the study. JFL-G and AG-H contributed to interpretation and analysis of the data. JFL-G wrote the initial draft. AG-H, LS, MT, RL-B, HG-E, AEM, and PJT-L. contributed to the revision of the manuscript. All authors approved the final version of the manuscript.

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Declarations of interest

None.

Data availability

Data will be made available on request.

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