Positive health, cardiorespiratory fitness and fatness in children and adolescents

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Background: Positive health is a likely buffer against physical and mental illness. Positive health may explain some of the health benefits associated with increasing cardiorespiratory fitness and decreasing fatness in youth. We examined the association of cardiorespiratory fitness and fatness with positive health indicators in 684 (365 boys and 319 girls) Spanish children aged 6–17.9 years. Methods: Positive health indicators were self-reported using items of the Health Behavior in School-aged Children questionnaire. The study health indicators were: perceived health status, life satisfaction, quality of family relationships, quality of peer relationships and academic performance. Weight and height were measured and body mass index was computed. We also measured triceps and calf skinfolds thickness and body fat percentage was estimated. Cardiorespiratory fitness was measured by the 20m shuttle-run test. Results: Cardiorespiratory fitness was positively associated with life satisfaction in children and adolescents. Fatness was inversely associated with perceived health status in children and adolescents, whereas fatness was inversely associated with life satisfaction, quality of family relationships and academic performance only in children. Conclusion: These findings suggest a link between cardiorespiratory fitness and fatness and positive health indicators, suggesting that improving both fitness and fatness could exert a favourable effect on positive health during childhood and adolescence.

Introduction

Positive health is a multifactor construct that describes a state beyond the mere absence of disease. Positive health-related constructs include life satisfaction, social relationships, self-esteem, vigour, self-image and physical health status. Several studies suggested that positive health alleviates depression,1 promotes better relationships,2 produces higher self-esteem,3 acts as preventive against the common influenza,4 protects against cardiovascular events5 and is a predictor of mortality.6 The use of positive health indicators as an additional outcome measure in medical research has increased during past years. Assessment of positive health is typically based on reports and they can provide valid information about patient’s experience that complements clinical measures.

Cardiorespiratory fitness is a direct indicator of individual’s physiological status and reflects the overall capacity of the cardiovascular and respiratory system.7 Findings from cross-sectional studies showed that children and adolescents with high levels of cardiorespiratory fitness have also a more favourable cardiovascular profile compared with their unfit counterparts.8 Likewise, low levels of cardiorespiratory fitness during childhood and adolescence seems associated with later cardiovascular risk factors such as hyperlipidaemia, hypertension and obesity.9,10 Paediatric obesity is nowadays an important public health threat. Paediatric overweight/obesity is strongly associated with adult overweight.10 Adults who were overweight in childhood have higher levels of blood lipids and lipoproteins (i.e. dyslipidemia), blood pressure (i.e. hypertension) and fasting insulin levels (i.e. type 2 diabetes), and thus are at increased risk for cardiovascular disease compared with adults who were thin as children.8

Studies examining the relationship between positive health and cardiorespiratory fitness in children and adolescents are scarce and are mainly focused on self-esteem,11,12 and academic performance.13–15 There are, however, more studies examining the association between positive health and obesity in children and adolescents, yet the results are inconclusive.16–19 More research is needed before a determination of whether, and to what extent, positive health may be responsible for some of the health benefits associated with increasing cardiorespiratory fitness and decreasing fatness.

The aim of the present study was to examine the associations of cardiorespiratory fitness and fatness with positive health indicators in Spanish children and adolescents.

Methods

Subjects

A sample of 684 (365 boys and 319 girls) healthy Caucasian children and adolescents (6–17.9 years age) participated in the study. The sample was randomly selected using a two phases, proportional cluster sampling using as a reference the database of the census of the province of Cádiz (Spain). In the first phase, the school was selected from the stratum. The different strata were selected according to the geographical localization,
by age and sex. A total of 18 governmental schools agreed to participate in the study. In the second phase, classes from schools were randomly selected and used as the smallest sampling units. All the children of the selected classroom were invited to participate in the study. The participation rate was higher than 95%.

A comprehensive verbal description of the nature and purpose of the study was given to the children, adolescents, their parents and teachers. This information was also sent to parents or children supervisors by regular mail, and written consents from parents, children and adolescents were requested. The study was approved by the Review Committee for Research Involving Human Subjects at the University of Cádiz, Spain.

**Measures**

A number of positive health indicators were assessed: perceived health status, life satisfaction, quality of family relationships, quality of peer relationships and academic performance from the Health Behaviour in School-aged Children (HBSC) questionnaire. Participants completed the questionnaire in school classroom with trained investigators. All the questions used in the HBSC questionnaire have shown a good reliability and validity in schoolchildren.

**Perceived health status**

Children and adolescents reported how they perceived their health status (3-point scale: excellent, good, and fair) at present.

**Life satisfaction**

Participants indicated how they felt (4-point scale: very happy, happy, not very happy and not happy at all) about their life at present.

**Quality of family relationships**

Participants indicated how easy (5-point scale: very easy, easy, difficult, very difficult and I don’t have) was to talk to family members about things that were bothering them. The internal consistency of the items of quality of family relationships (father, mother, other adults, brother, sibling) was acceptable (Cronbach’s α = 0.734).

**Quality of peer relationships**

Participants indicated how easy (5-point scale: very easy, easy, difficult, very difficult and not relationship) was to talk with friends about things that were bothering them. The internal consistency of the items of quality of peer relationships (to talk with friends, to go out with friends, to have good friends, to find new friends) was acceptable (Cronbach’s α = 0.84).

**Academic performance**

Participants indicated what they think (4-point scale: very good, good, average and under average) about their academic performance compared with their classmates.

**Cardiorespiratory fitness**

Cardiorespiratory fitness was assessed by means of the 20 m shuttle run test as described by Léger et al. In brief, participants were required to run between two lines 20 m apart, while keeping the pace with audio signals emitted from a pre-recorded compact disk (CD). The initial speed was 8.5 km/h, which was increased by 0.5 km/h/min (1 min equal one stage). The CD used was calibrated over 1 min of duration. Participants were instructed to run in a straight line, to pivot on completing a shuttle, and to pace themselves in accordance with the audio signals. The participants were encouraged to keep running as long as possible throughout the course of the test. The test was finished when the participant failed to reach the end lines concurrent with the audio signals on two consecutive occasions. Otherwise, the test ended when the subject stopped because of fatigue. All measurements were carried out under standardized conditions on an indoor rubber floored gymnasium. The last stage completed was scored (precision of 0.5 steps).

Participants were classified in low and high cardiorespiratory fitness level, according to the FITNESSGRAM standards for Healthy Fitness Zone. All participants received a comprehensive instruction about the test after which they also practiced the test. They were instructed to abstain from strenuous exercises 48 h prior to the test.

**Body mass index**

Height and weight were measured with physical education clothing (short and t-shirt) and barefoot. Height was measured to the nearest 0.1 cm using stadiometer (Holttain LTD, Croymm, Pemb, UK). Weight was measured to the nearest 0.1 kg using a Seca scale (SECA, Hamburg, Germany). Instruments were calibrated to ensure the acceptable accuracy. Body mass index (BMI) was calculated as weight/height squared (kg/m²). Participants were categorized according to the BMI international cut-off values as non-overweight and overweight plus obese.

**Body fat percentage**

Body fat percentage was calculated by the equations reported by Slaughter using triceps and calf skinfolds. Skinfolds were measured to the nearest 0.1 cm with a skinfold caliper (Slim guide Tom Kit Rosscroft, Surrey, Canada). Triceps skinfold was measured on the right side of the body at the following site: a vertical fold halfway between the acromion process and the superior head of the radius, in the posterior aspect of the arm. Calf skinfold was measured on the inside of the right leg at the level of maximal calf girth. The right foot was placed flat on an elevated surface with the knee flexed at a 90° angle. The vertical skinfold should be grasped just above the level of maximal girth and the measurement made below the grasp. Participants were categorized in low and high body fat percentage, according to the FITNESSGRAM standards for Healthy Fitness Zone.

BMI and skinfold thickness were used as indicators of body fat because of: (i) the results on the association between positive health and obesity in children and adolescents are inconclusive, which might be due to the fact that the adiposity indicator used varies among studies; (ii) in order to make our data comparable with other studies using mainly BMI; (iii) because it could be argued that BMI is not a valid indicator of body fat in children and adolescents, and it could be also argued that skinfold thickness is not a valid indicator of body fat in obese children and adolescents due to the fact that the measurement error increases in these individuals.

**Statistical analysis**

Analyses were performed using the PASW (v. 18.0 for WINDOWS, Chicago, IL, USA), and the level of significance was set to 0.05. Data are presented as mean and standard deviation, unless otherwise indicated.

We compared positive health indicators between children and adolescents using the Mann–Whitney U-test. The association of cardiorespiratory fitness and fatness with positive health indicators was examined using regression analysis. Further, we performed binary logistic regression analysis to examine the association of having a low cardiorespiratory fitness, being overweight–obesity or having high levels of body fat with positive health indicators. Since there were no sex-positive health interactions with cardiorespiratory fitness and fatness, all the analyses were performed jointly for boys and girls and the models adjusted for sex.

**Results**

Children reported higher levels of positive health than adolescents, except for quality of peer relationships (table 1). Table 2 shows the association of cardiorespiratory fitness, BMI and body fat percentage with positive health indicators by age group. Cardiorespiratory fitness was positively associated with life satisfaction in children and adolescents, whereas it was positively associated with perceived health status only in adolescents. BMI was inversely associated with perceived health status in both children and adolescents. BMI was inversely associated with life satisfaction, quality of family relationships and academic performance only in children. Similar
Adolescents with low cardiorespiratory fitness had significantly higher OR of perceiving their health status as fair than those who were non-overweight. obese adolescents had higher OR of perceiving their health status as fair than those who were non-overweight.

Children being overweight–obese had significantly higher OR of being overweight than those who were non-overweight.

Table 3 shows that children with high body fat percentage (according to the FITNESSGRAM standards for Healthy Fitness Zone) had significantly higher OR of reporting low quality of family relationships and academic performance was borderline (table 4). Moreover, overweight–obese adolescents had higher OR of perceiving their health status as fair (vs. excellent) than those who were non-overweight.

Table 5 shows that children with high body fat percentage (according to the FITNESSGRAM standards for Healthy Fitness Zone) had significantly higher OR of reporting low quality of family relationships and academic performance was borderline (table 4). Moreover, overweight–obese adolescents had higher OR of perceiving their health status as fair (vs. excellent) than those who were non-overweight.

Children being overweight–obese had significantly higher OR of reporting low life satisfaction, whereas the association was borderline for children (table 3). Moreover, adolescents with low cardiorespiratory fitness had significantly higher OR of having low life satisfaction, whereas the association was borderline for children (table 3).

To our knowledge there are no available studies investigating the association between cardiorespiratory fitness and life satisfaction which hampers further comparisons. We also observed that cardiorespiratory fitness was positively associated with life satisfaction in children and adolescents, so that those with a high cardiorespiratory fitness reported a better positive health. We observed that fitness appears to be inversely associated with indicators of positive health, so that those with healthier levels of BMI and body fat percentage reported better positive health.

**Cardiorespiratory fitness and positive health**

We observed that cardiorespiratory fitness was positively associated with life satisfaction in children and adolescents. Life satisfaction is an essential criterion of psychosocial health, and it is likely a goal rated in the top of the importance scale of people well-being. On the other hand, cardiorespiratory fitness is considered as a well known cardiovascular health marker. To our knowledge there are no available studies investigating the association between cardiorespiratory fitness and life satisfaction which hampers further comparisons. We also observed that...
cardiorespiratory fitness was positively associated with perceived health status in adolescents. The perceived health status seems to be an effective summary of health and seems to be a strong predictor of future functional limitations, cognitive impairment and mortality.\(^{30}\) Finally, we did not observe associations of cardiorespiratory fitness with academic performance, quality of family relationships and quality of peer relationships. Previous studies observed positive associations between cardiorespiratory fitness and academic performance in children and adolescents,\(^{15-19}\) whereas others did not.\(^{19}\) Kwak et al.\(^{15}\) suggested that the absence of a significant association could be due to the low average fitness level of the subjects. The association of cardiorespiratory fitness with quality of family relationships and quality of peer relationships still remains unclear.

### Fatness and positive health

BMI in children and adolescents, and body fat percentage in children was inversely associated with perceived health status, which concurs with previous studies.\(^{31,32}\) Moreover, our data showed that youth having high body fat percentage had \(\sim 4.1\) in children and \(\sim 3.0\) in adolescents, higher OR of perceiving their health status as fair (vs. excellent). Likewise, overweight-obese adolescents had a higher OR perceiving their health status as fair (vs. excellent).

We also found an inverse association of fatness in children with life satisfaction, quality of family relationships and academic performance. Fonseca et al.\(^{31}\) and Al-Sabbah et al.\(^{23}\) suggested that BMI appears to be associated inversely with life satisfaction in adolescents. Regarding the association between fatness and quality of family relationships, several studies did not observe an association in adolescents\(^{16,34}\) whereas one study found that adolescent girls from cohesive and expressive families were at decreased risk for obesity.\(^{17}\) Previous studies reported that BMI was inversely associated with academic performance in children and adolescents\(^{18,35}\) whereas other did not.\(^{19}\)

Finally, we observed no associations between fatness and quality of peer relationships. In contrast, previous findings reported that overweight adolescents are more likely to be socially isolated\(^{36}\) and have difficulties in making new friends.\(^{31}\)

The associations between fatness and positive health indicators were more apparent in children than in adolescents. Adolescence is a period of life characterized by many physiological and psychological changes,\(^{3}\) thus adolescents tend to be more volatile emotionally than children and often experience extremes of mood.\(^{37}\) It might that adolescents blundered their answers either deliberately or unknowingly. More research is needed to contrast these findings.

### Table 5 Association of high body fat percentage (according to FITNESSGRAM standards for Healthy Fitness Zone) with positive health indicators in children and adolescents

<table>
<thead>
<tr>
<th></th>
<th>Children (6–11.9 years)</th>
<th>Adolescents (12–17.9 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N OR 95%CI</td>
<td>N OR 95%CI</td>
</tr>
<tr>
<td>Perceived health status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>220 1 Referent</td>
<td>105 1 Referent</td>
</tr>
<tr>
<td>Good</td>
<td>131 1.314 0.772–2.235</td>
<td>163 1.381 0.696–2.737</td>
</tr>
<tr>
<td>Life satisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very happy</td>
<td>289 1 Referent</td>
<td>241 1 Referent</td>
</tr>
<tr>
<td>Lower</td>
<td>78 1.573 0.907–2.727</td>
<td>51 1.219 0.659–2.253</td>
</tr>
<tr>
<td>Quality of family relationships</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>266 1 Referent</td>
<td>234 1 Referent</td>
</tr>
<tr>
<td>Lower</td>
<td>65 2.167 1.149–4.089</td>
<td>46 0.748 0.373–1.498</td>
</tr>
<tr>
<td>Quality of peer relationships</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>266 1 Referent</td>
<td>238 1 Referent</td>
</tr>
<tr>
<td>Lower</td>
<td>72 0.768 0.434–1.357</td>
<td>47 1.171 0.596–2.301</td>
</tr>
<tr>
<td>Academic performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>289 1 Referent</td>
<td>240 1 Referent</td>
</tr>
<tr>
<td>Lower</td>
<td>78 1.256 0.749–2.105</td>
<td>51 0.756 0.383–1.493</td>
</tr>
</tbody>
</table>

A limitation of this study is its cross-sectional nature, which does not permit inferences about causality. In addition, as we have highlighted before, it is possible that some study participants may have misreported either intentionally or inadvertently on any question asked. However, intentional misreporting was probably minimized by the fact that study participants completed the questionnaires anonymously, and the questions used in this study, belonging to the HBSC questionnaire, are reliable and valid.\(^{22,23}\) It should also be recognized that the studied sample is not representative of the Spanish children and adolescent population; yet, our data are fully comparable with nationally representative data obtained from the AVENA study\(^{38}\) and the HBSC 2005/2006 survey.\(^{39}\)

The present study has several strengths. First, cardiorespiratory fitness and fatness were measured objectively. In comparison with self-reported methods of estimated physical activity, cardiorespiratory fitness is a more objective measure.\(^{40}\) Moreover, it has been found that self-reported methods of BMI are influenced by under reporting for weight and over reporting for height.\(^{41}\)

In conclusion, the present study suggests a link of cardiorespiratory fitness and fatness with positive health indicators, suggesting that improving both cardiorespiratory fitness and fatness could exert a favourable effect on positive health during childhood and adolescence.

### References


### Funding

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### Key points

- Positive health is likely a buffer against physical and mental illness. Positive health may explain some of the health benefits associated with increasing cardiorespiratory fitness and decreasing fatness in youth.
- We examined the association of cardiorespiratory fitness and fatness with positive health indicators in children and adolescents.
- The present study indicates that cardiorespiratory fitness is associated with positive health indicators in children and adolescents, so that those with a high cardiorespiratory fitness also reported a better positive health.
- We also observed that adiposity status appears to be inversely associated with indicators of positive health, so that those with lower levels of BMI and body fat percentage reported better positive health.
- Taken together, these findings suggest that improving both cardiorespiratory fitness and fatness could exert a favourable effect on positive health during childhood and adolescence.
Policy measures and the survival of foster infants in Stockholm 1878–1925

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Background: At the end of the 19th century, infant mortality was high in urban and rural areas in Sweden. In Stockholm, the mortality rate was particularly high among foster children. This study addresses the importance for health of targeted public policies and their local implementation in the reduction of excess mortality among foster children in Stockholm at the turn of the 19th century. In response to public concern, a law was passed in 1902 on inspections of foster homes. Stockholm city employed a handful of inspectors who visited foster

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