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Physical fitness and psychological health in overweight/obese children: A cross-sectional study from the ActiveBrains project

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ABSTRACT

Objectives: To examine the associations of physical fitness (i.e. cardiorespiratory fitness, muscular strength, and speed/agility) with psychological distress and psychological well-being in overweight/obese pre-adolescent children.
Design: 110 overweight/obese children (10.0 ± 1.1 years old, 61 boys) from the ActiveBrains project (http://profith.ugr.es/activebrains) participated in this cross-sectional study.
Methods: Physical fitness was evaluated by the ALPHA battery test. Cardiorespiratory fitness was additionally evaluated by a maximal incremental treadmill. Stress was assessed by the Children's Daily Stress Inventory, anxiety by the State-Trait Anxiety Inventory, depression by the Children Depression Inventory, positive affect and negative affect by the Positive and Negative Affect Scale for Children, happiness by the Subjective Happiness Scale, optimism by the Life Orientation Test, and self-esteem by the Rosenberg Self-Esteem questionnaire. Linear regression adjusted for sex and peak height velocity was used to examine associations.
Results: Absolute upper-body muscular strength was negatively associated with stress and negative affect ($\beta = -0.246$, $p = 0.047$; $\beta = -0.329$, $p = 0.010$, respectively). Furthermore, absolute lower-body muscular strength was negatively associated with negative affect ($\beta = -0.301$, $p = 0.029$). Cardiorespiratory fitness, expressed by the last completed lap, and relative upper-body muscular strength were positively associated with optimism ($\beta = 0.220$, $p = 0.042$; $\beta = 0.240$, $p = 0.017$, respectively). Finally, absolute upper-body muscular strength was positively associated with self-esteem ($\beta = 0.362$, $p = 0.003$) independently of sex and weight status (p for interactions >0.3), and absolute lower-body muscular strength was also positively associated with self-esteem ($\beta = 0.352$, $p = 0.008$).
Conclusions: Muscular strength was associated with psychological distress (i.e. stress and negative affect) and psychological well-being (i.e. optimism and self-esteem) as well as cardiorespiratory fitness was associated with optimism. Therefore, increased levels of physical fitness, specifically muscular strength, could have significant benefits for overweight/obese children psychological health.

1. Introduction

Mental disorders are expected to be the most pervasive type of all-cause disorders in developed countries in 2020.[1] In fact, mental disorders are estimated to affect around 35% of children in Europe. Bearing in mind that childhood is a crucial period of life

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when many physiological and psychological changes occur, psychological health at this age may be determinant for later periods of life.[2] Psychological health is understood as the absence of psychological distress with the presence of psychological well-being. Specifically, psychological distress is understood as unpleasant feelings or emotions that impact the level of functioning (e.g. anxiety, depression, stress, mood disorders). However, psychological well-being is defined as some combination of positive affective states and functioning with optimal effectiveness in individual and social life (e.g. happiness, self-esteem, optimism).[3] Previous studies have suggested that better psychological well-being is expected to increase qualities and source of resilience, prevent pathologies, and emotional disorders.[4] Hence, strategies to increase psychological well-being and decrease psychological distress in children are needed.

Another common worldwide health issue is the high rate of overweight/obesity; according to the World Obesity Federation, around 30% of children are overweight or obese. Importantly, overweight/obesity status is associated with poorer physical and mental health.[5] For instance, overweight/obesity is bidirectionally associated with a higher risk of depression.[6] Additionally, it is known that overweight/obese children have worse self-esteem and physical appearance, as well as higher levels of depression and mood disorders than normal-weight children.[5] Thus, examining the association of protective risk factors, such as physical fitness, with psychological health is particularly important in overweight/obese children.[7]

Physical fitness has been shown to be a powerful marker of health in early years and later in life.[8] Physical fitness is defined as the capacity to perform physical activity and is composed of a set of physical components such as cardiorespiratory fitness (i.e. the capacity of the cardiovascular and respiratory systems and the ability to carry out prolonged strenuous exercise), muscular strength (i.e. the capacity to exert work against a resistance), and speed/agility (i.e. the ability to move the body as fast as possible).[9] Numerous benefits of physical fitness for physical and cognitive health are well known in children and adolescents.[9,10] Likewise, being physically fit might be associated with different psychological health indicators.[2,11] Importantly, recent studies showed that improvements in physical fitness, especially cardiorespiratory fitness, were associated with reductions in levels of depression and anxiety in adolescents.[12,13] Similarly, muscular strength was related to better self-esteem and self-perception,[11] as well as a reduced risk of any future psychiatric diagnosis and suicide mortality.[2] However, to the best of our knowledge, there are no studies examining the influence of speed/agility on psychological health. It is relevant to differentiate which components of physical fitness may be more strongly associated with different aspects of psychological health in overweight/obese children since no previous studies examined this association in that target population.

Therefore, the aim of the present study was to examine the associations of physical fitness components (i.e. cardiorespiratory fitness, muscular strength, and speed/agility) with psychological distress indicators (i.e. stress, anxiety, depression, and negative affect) and psychological well-being indicators (i.e. positive affect, happiness, optimism, and self-esteem) in overweight/obese children.

2. Methods

The present cross-sectional study was developed within the ActiveBrains project framework (http://profith.ugr.es/activebrains?lang=en). A detailed description of the study design and methods has been published elsewhere.[14] A total of 110 overweight/obese children (10.0 ± 1.1 years old; 65% boys) from Granada (southern Spain) were recruited and evaluated from November 2014 to February 2016. The study protocol was approved by the Review Committee for Research Involving Human Subjects at the University of Granada and was registered in ClinicalTrials.gov (Identifier: NCT02295072).

Body weight (kg) was measured with an electronic scale (SECA 861, Hamburg, Germany), while *height* (cm) was assessed using a precision stadiometer (SECA 225, Hamburg, Germany). We calculated *body mass index* (*BMI*) by dividing the weight (kg) and height (m^2). The participants were classified into BMI categories (i.e. overweight, obesity type I, and obesity type II), according to Cole et al. [31] cut-offs. *Peak height velocity* (*PHV*) is the most commonly used indicator of maturity in studies of children and adolescents.[15] PHV was calculated from the Mirwald et al. [33] equations for boys and girls.

The different components of *physical fitness* (i.e. cardiorespiratory fitness, muscular strength and speed/agility) were assessed following the ALPHA (Assessing Levels of Physical fitness and Health in Adolescents) health-related fitness test battery for youth,[16] which is valid, reliable, feasible, and safe for the assessment of health-related physical fitness in children.[16] Additionally, cardiorespiratory fitness was evaluated by a laboratory fitness test.[17] *Cardiorespiratory fitness* from the ALPHA battery was assessed by the 20 m shuttle run test.[16] The two metrics used from the 20 m shuttle run test were: the last completed stage recorded and translated into an estimated maximal oxygen consumption measure (VO_2max, ml/kg/min) using the Léger equation,[18] and the last completed lap. We evaluated *cardiorespiratory fitness* from laboratory conditions using a gas analyzer (General Electric Corporation) while performing a maximal incremental treadmill (hp-cosmos ergometer) test modified for unfit children. Maximal oxygen consumption (VO_2max, ml/kg/min) was then obtained.[16]

Upper and *lower-body muscular strength* were evaluated by the handgrip strength test (kg) and the standing broad jump test (cm), respectively.[16] The handgrip test evaluates absolute upper-body muscular strength. Additionally, relative upper-body muscular strength was expressed per kg of body weight. The standing broad jump test evaluates relative lower-body muscular strength; the distance in cm was multiplied by the weight in order to obtain absolute lower-body muscular strength.[16] Lastly, *speed/agility* was assessed by the 4×10 m shuttle run test.[16] The fastest time was recorded in seconds.

Stress was evaluated by The Children's Daily Stress Inventory (CDSI). The CDSI evaluates the daily impact of relatively minor stressful events in four areas: health, school, peers, and family. The final version includes 30 dichotomous items. Possible answers were yes/no and the answers were summed (The score ranges from 0 to 30). The higher scores in the CDSI indicate the higher stress levels. The inventory was reliable and validated in primary school students from Spain.[19]

Childhood *trait anxiety* was evaluated by the State-Trait Anxiety Inventory for Children (STAIC-T). The STAI is among the most widely used measures of general anxiety. The STAI evaluates worry, tension, apprehension, and nervousness, although it is used as a global anxiety measure.[20] It is a 20 trichotomous item self-administered instrument categorized from 1 (almost never) to 3 (often). The score ranges from 20 to 60. The higher scores show the higher trait anxiety levels. It is widely used, reliable (Cronbach alpha = 0.94), and extensively validated.[19]

Depression was evaluated by the Children's Depression Inventory (CDI), which assesses rates of symptoms related to depression or dysthymic disorder in children.[21] The 27 items of the CDI are grouped into five factor areas: negative mood, interpersonal problems, ineffectiveness, anhedonia, and negative self-esteem, although a global score was used for analysis in that study. Response options range from 0 to 2. The final score was obtained from the

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