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Physical fitness as a moderator of neuroticism and depression in adolescent boys and girls

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ABSTRACT

Introduction: Individuals who exhibit high levels of neuroticism are more likely to experience depressive symptomology. Symptoms of depression generally emerge during adolescence, making it a critical time for the establishment of psychological well-being. Improved physical fitness may be associated with lower symptoms of depression. Therefore, the purpose of the current study was to examine the moderation effects of physical fitness variables on the relationship between neuroticism and depression during adolescence.
Methods: Adolescents completed fitness assessments, including evaluations of cardiorespiratory fitness (CRF), muscular strength and endurance, and body composition. Additionally, participants responded to survey items assessing levels of neuroticism and depression. Separate hierarchical regression analyses were conducted to determine each fitness variable's moderation effect on the relationship between neuroticism and depression.
Results: Results of the regression analyses indicated that CRF was a statistically significant moderator among both boys and girls. Post hoc testing indicated that CRF demonstrated a meaningful moderation effect on the neuroticism-depression relationship.
Conclusions: The findings of this study support the psychological health benefits associated with physical fitness. Specifically, the relationship between neuroticism and depression was weaker among those with higher levels of CRF. Promoting physical fitness may be exceptionally important for adolescents with higher levels of neuroticism.

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1. Introduction

Major depressive disorder (MDD) is a significant mental health problem, effecting about 17% of adults in the United States (Kessler et al., 2005). Depressive symptomology has been shown to relate to several health risks including coronary heart disease, weight gain, inactivity, and alcohol and drug abuse (Barth, Schumacher, & Herrmann-Lingen, 2004; Penedo & Dahn, 2005). Symptoms of depression generally emerge during adolescence, making it a critical time for the establishment of psychological well-being (Birmaher et al., 1996). Components of health-related fitness (i.e., cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition) may guard against the development of depressive symptoms (Ruggero, Petrie, Sheinbein, Greenleaf, & Martin, 2015), though the protective mechanisms have yet to be clearly established. Neuroticism, a fundamental personality trait, is a risk factor for depressive symptoms during this developmental period (Kercher, Rapee, & Schniering, 2009). Therefore, additional research is necessary to explore the relationships between physical fitness, neuroticism, and depression.

As part of the five factor model of personality (Costa & McCrae, 2010), neuroticism represents a stable personality trait that contrasts emotional stability with maladjustment (John & Srivastava, 2001). Higher scores on neuroticism are characterized by anxiety, fear, moodiness, worry, envy, frustration, jealousy, and loneliness (Costa & McCrae, 1992). Individuals who score high on measures of neuroticism tend to respond more poorly to stressors, feel more hopeless and are at higher risk for developing mood disorders and substance addiction (Aleksandrova et al., 2012). During adolescence, neuroticism has been shown to increase the likelihood of experiencing depressive symptomology one year later (Kercher et al., 2009), making it a fundamental risk factor (American Psychiatric Association, 2013; Beck & Alford, 2009).

The trait of neuroticism has a strong genetic foundation (Eysenck, 1967) and is established during early childhood (Barlow, Ellard, Sauer-Zavala, Bullis, & Carl, 2014). MDD, on the other hand, is a complex disorder that depends more significantly on environmental influences and can occur at any age, with the average age of onset in the mid-twenties (Kendler, Hettema, Butera, Gardner, & Prescott, 2003). Cognitive theories of psychopathology offer a framework for understanding

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how neuroticism may lead to the experience of depressive symptoms. Beck (1967) proposed that the manner in which individuals process stressful life events can lead to negative thoughts and affects. Neuroticism, therefore, serves as a lens through which individuals experience and understand the events around them. Individuals who exhibit high levels of neuroticism tend to display biased negative cognitions in response to stressful situations (Lakdawalla & Hankin, 2008), which are associated with feelings of inadequacy, self-blame, and more severe levels of depression. In addition, individuals high in neuroticism are more likely to ruminate on negative cognitions, which in turn is associated with higher levels of depressive symptomology (Lam, Smith, Checkley, Rijsdijk, & Sham, 2003). Physical fitness may impede or protect against this cognitive process.

1.1. The role of physical fitness

Regular physical activity is associated with lower levels of depressive symptoms (Brosse, Sheets, Lett, & Blumenthal, 2002; Janssen & Leblanc, 2010). Increasing daily physical activity has been shown to be an effective treatment for reducing depressive symptoms (Conn, 2010). Positive mood states produced upon the completion of exercise inhibit negative cognitive processes that characterize Beck's model of depression (North, McCullagh, & Tran, 1990). By changing overt behavior (i.e., physical activity habits), negative thought processes may be interrupted. Several mechanisms that may facilitate the reduction of depressive symptoms include increased self-efficacy (Bandura, 2004) and improvements in self-esteem and self-perception (White, Kendrick, & Yardley, 2009). Furthermore, daily physical activity interrupts continued bouts of sedentary behavior.

Physical fitness, which results from continued physical activity, may also lead to the reduction of depressive symptoms. While physical activity refers to any bodily movement that results in energy expenditure, physical fitness represents a set of attributes that people have, or strive to achieve (Caspersen, Powell, & Christenson, 1985). Increasing evidence suggests that higher levels of physical fitness relate to psychological benefits including higher self-esteem and positive body-image (Mitchell, Petrie, Greenleaf, & Martin, 2012). Attributes of physical fitness include cardiorespiratory fitness (CRF), muscular strength and endurance, body composition, and flexibility. Physical activity that leads to improvements in CRF may protect against the development of depressive symptoms during adolescence (Ruggero et al., 2015). Furthermore, CRF has been shown to protect against the potential depressive effects of obesity (Becofsky et al., 2015). Muscular strength and endurance represents a component of physical fitness that has received less research attention in comparison to CRF. Preliminary evidence indicates that resistance training (e.g., weightlifting) has the potential to significantly reduce depressive symptoms (Beniamini, Rubenstein, Zaichkowsky, & Crim, 1997; LeCheminant et al., 2014).

1.2. Purpose

Individuals who exhibit high levels of neuroticism may be more likely to experience stress in their environment, and respond to negative events by developing depressive symptoms (Beck, 1967). Given that the prevalence of depression increases during adolescence (American Psychiatric Association, 2013), it may be informative to explore this relation during the adolescent developmental timeframe. Based on literature demonstrating the potentially protective effect that CRF can have against the development of depressive symptoms, research is needed to determine if that effect occurs in relation to adolescents' level of neuroticism. Therefore, this study examined the relation of neuroticism and depressive symptomatology among boys and girls to determine the extent to which components of physical fitness served as a moderator. It was hypothesized that components of physical fitness (i.e., CRF, muscular strength and endurance, and body composition) would (a) negatively relate to depressive symptoms, and (b) moderate the neuroticism-depression relation such that adolescents' who were more physically fit would demonstrate a weaker relationship between neuroticism and depression.

2. Methods

2.1. Participants

The sample included 1625 (789 males, 836 females) middle school students attending public schools in the southern United States. Participants were recruited during physical education classes with the assistance of physical education teachers. Participants had a mean age of 12.23 ($SD = 0.96$). The majority of participants were white (53.8%), followed by Hispanic (29.6%), Black (12.9%), Asian (2.9%) and American Indian (0.7%). The participants in the current study were representative of the composition of the school district (e.g., race, ethnicity, and socioeconomic status). Regarding socioeconomic status, 38.0% of the students received full-reduced lunch, 5.4% received partial reduced lunch, and 56.6% did not qualify. Informed consent was obtained from both parents/guardians and adolescent participants.

2.2. Instrumentation

2.2.1. Fitness assessment

As part of daily physical education classes, participants completed fitness testing based on FITNESSGRAM® protocol (Plowman & Meredith, 2013). The procedure included assessments of CRF, muscular strength and endurance, and body composition. The progressive aerobic cardiovascular endurance run (PACER) was used to measure CRF. The test involved running 20 meter laps at a progressively faster cadence. The total number of successfully completed laps served as an indication of CRF (Burns, Hannon, Allen, & Brusseau, 2014). PACER test results have demonstrated good reliability and validity against gold standard criterion measurement for VO_{2max} (e.g., graded exercise test with direct oxygen consumption measurement) in a sample of adolescent boys and girls (Mahar, Guerieri, Hanna, & Kemble, 2011). The multiple correlation between measured and estimated VO_{2max} was $R^2 = 0.75$. Body mass index (BMI) was used to assess body composition. Height and body weight were objectively measured and recorded in feet/in. and pounds. Values were later transformed into individual BMI scores (kg/m^2). Curl-up and push-up tests were used to assess muscular strength and endurance. Individual scores indicated the number of successful successive repetitions.

2.2.2. Center for Epidemiological Studies – Depression Scale for Children (CES-DC)

The 20-item CES-DC (Faulstich, Carey, Ruggiero, Enyart, & Gresham, 1986) was used to assess depressive symptomology. For each item (e.g., "I felt sad" or "I felt like something good was going to happen"), participants indicated how they had been feeling during the past week using a scale that ranged from 0 (*Not at all*) to 4 (*A lot*). Response scores were summed to attain an individual's overall score which ranged from 0 (*No symptoms*) to 60 (*Highest level of symptoms*). The CES-DC has demonstrated adequate internal consistency ($\alpha = 0.89$) and demonstrated concurrent validity by associating with DSM diagnoses of MDD (Fendrich, Weissman, & Warner, 1990). Internal consistency of CES-DC scores in the current sample was $\alpha = 0.91$.

2.2.3. NEO personality inventory

As part of the five-factor model of personality, neuroticism was assessed using 12 items from the NEO Personality Inventory-Revised (NEO PI-R; Costa & McCrae, 1992). For each item (e.g., "I rarely feel lonely or blue" and "I am not a worrier"), participants indicated how much they agreed or disagreed with each statement using a scale ranging from 0 (*Strongly disagree*) to 4 (*Strongly agree*). Response scores were summed to attain an individual's overall score. Previous studies using