Psychology of Sport and Exercise 26 (2016) 14–23

Contents lists available at ScienceDirect

Psychology of Sport and Exercise

journal homepage: www.elsevier.com/locate/psychsport

Effects of exercise on mental health outcomes in adolescents: Findings from the CrossFit™ teens randomized controlled trial

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ARTICLE INFO

Article history:
Received 8 September 2015
Received in revised form
14 April 2016
Accepted 18 May 2016
Available online 24 May 2016

Keywords:
Mediators
Mental health
Adolescents
School intervention
Fitness

ABSTRACT

Objectives: To investigate the effectiveness of the CrossFit™ Teens resistance training program for improving mental health outcomes in adolescents, and to explore potential moderators and mediators.
Design: Assessor-blinded randomized controlled trial.
Methods: Ninety-six students (15.4 (0.5) years, 51.5% female) from one NSW secondary school, Australia 2013, were randomized into the 8-week CrossFit™ Teens intervention (n = 51) or control conditions (n = 45). Measures of mental health (psychological distress and self-esteem) were assessed using the Strength and Difficulties Questionnaire and Physical Self-Description Questionnaire. Hypothesized mediators were perceived body fat, strength and appearance; and general physical self-concept. Mediation was assessed using Preacher and Hayes' multiple mediation regression SPSS macro. Hypothesized moderators (sex and baseline levels of psychological distress) were assessed using linear mixed models and Cohen's d effect sizes were evaluated.
Results: There were no significant intervention effects on mental health or potential mediators in the full study sample. Intervention participants categorized as 'at risk' of psychological distress demonstrated improvements in self-esteem (d = 1.35); perceived body fat (d = 1.05), perceived appearance (d = 0.95); physical self-concept (d = 1.96); and total difficulties score (d = 0.70). A medium-large positive effect on perceived body fat was also observed in boys.
Conclusions: Participation in the CrossFit™ Teens resistance training program did not improve mental health outcomes in the full study sample. However, the results from this study provides preliminary evidence for improving mental health in adolescents 'at risk' of developing psychological disorders.
Trial Registration No: ACTRN12611000976987.

Mental health includes emotional, psychological, and social well-being, and affects how a person thinks, feels, and behaves (http://www.mentalhealth.gov). Mental health disorders rise sharply during adolescence and approximately 20% of adolescents worldwide have a diagnosed mental health illness (Patton et al., 2012). In Australia, the proportion of young people aged 16–24 years having high or very high levels of psychological distress is approximately 9%, and the prevalence of mental disorders is approximately 26% (including depression and anxiety) (Australian Institute of Health and Welfare, 2011). Mental disorders are now considered a leading cause of health-related disability in this age group and often have long lasting effects throughout adulthood (Kieling et al., 2011). Furthermore, poor mental health is strongly related to other health, behaviour and development concerns in young people, including higher rates of physical inactivity, lower academic achievement, substance abuse and violence, social problems, eating disorders, poor physical health and a heightened risk of suicide (Patel, Flisher, Hetrick, & McGorry, 2007; Patton et al., 2009; Rosenbaum et al., 2015; Sawyer et al., 2012). In addition there is a distinct gender pattern in mental health after the age of 13 years, with girls generally reporting more mental health problems than boys (Myrin & Lagerstrom, 2008). Consequently, there has been a call for the prioritization of the prevention and early intervention of mental health issues for young people worldwide (Patel et al., 2007; The Department of Health, 2011) and effective interventions addressing young people's mental-health needs are clearly needed (Brown, Pearson, Braithwaite, Brown, & Biddle,

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http://dx.doi.org/10.1016/j.psychsport.2016.05.008
1469-0292/

2013; Camero, Hobbs, Stringer, Branscum, & Taylor, 2012; Lubans, Plotnikoff, & Lubans, 2012).

The causes of mental health illness in adolescents are complex and varied. In many cases, mental health illness emerges as a consequence of biological status (e.g., genetic predisposition for disorders such as bipolar disorder and depression) and/or environmental/social interactions (such as exposure to abuse, stress, discrimination, bullying, death or relationship issues) (Anyon, Ong, & Whitaker, 2014; Whitlock & Schantz, 2008). Although researchers are only beginning to explore ways to prevent and treat mental health disorders, participation in regular physical activity and developing high levels of physical fitness in adolescence have shown to have a positive impact on mental health (Ortega, Ruiz, & Castillo, 2013; Penedo & Dahn, 2005; Reiner, Niermann, Jekauc, & Woll, 2013; Smith et al., 2014). Evidence suggests that physical activity stimulates widespread neurobiological, hormonal and physiological adaptations, which may alleviate some symptoms, treat or even prevent mental health disorders such as anxiety and depression (Carek, Laibstain, & Carek, 2011; Gerber et al., 2012; Jerstad, Boutelle, Ness, & Stice, 2010; Lindwall, Ljung, Hadzibajramovic, & Jonsdottir, 2012; Lubans et al., 2012; Motl, Birnbaum, Kubik, & Dishman, 2004; Nabkasorn et al., 2006; Ruggero, Petrie, Sheinbein, Greenleaf, & Martin, 2015).

There is a dearth of studies reporting the impact of physical activity interventions on mental health outcomes in adolescents; and although they have shown potential for positively affecting mental health and well-being, these studies have generally recruited small samples of specific adolescent groups (such as overweight/obese, low SES, females, or at-risk) (Brown et al., 2013; Camero et al., 2012; Lubans et al., 2012).

Studies now also show that vigorous physical activity and high levels of physical fitness (particularly cardiovascular fitness and muscular fitness) are most important for achieving substantive health gains, yet there is a large proportion of youth who do not participate in physical activities of sufficient quantity or intensity to accrue the associated health benefits; and a decline in fitness levels in youth has been reported worldwide (Armstrong, 2012; Bai et al., 2015; Jansseen & LeBlanc, 2010; Smith et al., 2014). In many countries up to 80% of adolescents are not meeting physical activity guidelines (Hallal et al., 2012); up to 62% of boys and 74% of girls are not meeting cardiorespiratory fitness recommendations; approximately 48% of adolescents are not achieving recommended levels in muscular fitness, flexibility and measures of adiposity; and significantly lower achievement in fitness levels are evident in the middle school years (Bai et al., 2015). Given that physical activity and physical fitness declines sharply during adolescence (Dumith, Gigante, Domingues, & Kohl, 2011), and that physical activity and fitness have a role in the treatment and prevention of mental health disorders, there is a clear need for novel physical activity programs that meet the needs and motivations of young people (Armstrong, 2012; Dumith et al., 2011; Stratton et al., 2004).

Schools are uniquely positioned to play a valuable role in the promotion of physical and mental health in young people (Hills, Dengel, & Lubans, 2015; Theron, Liebenberg, & Malindi, 2014; Whitelaw, Teuton, Swift, & Scobie, 2010). Consequently, a variety of physical activity programs that specifically target improvements in the health-related fitness levels of adolescents have been trialled in the school setting and have reported varied levels of success (Costigan, Eather, Plotnikoff, Taaffe, & Lubans, 2015; Eather, Morgan, & Lubans, 2015; Faigenbaum, McFarland, & Keiper, 2007; Faigenbaum, McFarland, Johnson, et al., 2007; Kriemler et al., 2011; Lubans, Sheaman, & Callister, 2010; Meinhardt, Witassek, Petrò, Fritz, & Eiholzer, 2013; Sun et al., 2013). However, limited studies have investigated the impact of school-based physical activity programs on mental health outcomes in adolescents (Biddle & Asare, 2011; Camero et al., 2012) or investigated the specific factors responsible for influencing psychological change associated with participation in physical activity programs in this age group (Camero et al., 2012; Pickett, Yardley, & Kendrick, 2012). Of the few available studies, Bonhauser et al. (2005) demonstrated significant improvements in anxiety levels and self-esteem in a sample of low-income adolescents who participated in a one-year school-based sports program (Bonhauser et al., 2005); Annesi et al. (2007) demonstrated an improvement in mood and physical self-concept in 9–12 year old children participating in the school-based Youth Fit for Life program (Annesi et al., 2007); and Norris found an improvement in measures of well-being in adolescents participating in a 10-week school-based high intensity aerobic program (Norris, Carroll, & Cochrane, 1992). None of the available studies have implemented a fitness program that targets multiple components of health-related fitness for adolescent girls and boys in the school setting.

CrossFit™ is a form of training that targets multiple components of fitness and has emerged as a popular and effective lifetime physical activity choice for adults worldwide (Heinrich, Patel, O'Neal, & Heinrich, 2014; M. M.; Smith, Sommer, Starkoff, & Devor, 2013). The CrossFit Teens™ program was designed specifically for improving fitness and resistance training skill competency in adolescents (ages 12–18 years) and incorporates combinations of nine core strength exercises in a group training setting (Glassman, 2010). The short duration, high intensity focus and station-based organisation also draws from existing training methods that have proven to be effective and engaging for adolescents (such as circuit training and high intensity interval training)(Costigan et al., 2015), and equip them with the necessary skills to be physically active within and beyond the school setting (Lubans, Morgan, Aguiar, & Callister, 2011). This novel program requires minimal equipment, aligns with physical education and sport objectives in secondary schools, and adheres to international physical activity and resistance training recommendations for young people (Pate & O'Neill, 2012). Concerns have been raised regarding the potential injury risks associated with the intense and repetitive nature of CrossFit ™ training and the technique requirements needed to perform some core exercises safely (Hak, Hodzovic, & Hickey, 2014). Despite these concerns and the growing popularity of CrossFit™ Teens training programs, to the authors' knowledge, there are no published studies supporting elevated injury risk in adolescent participants, nor have there been any studies evaluating the psychological impact of this specific training method. We recently reported the efficacy and feasibility of the CrossFit Teens™ resistance training program for improving health-related fitness and resistance training skill competency in adolescents. The 8-week intervention resulted in statistically significant effects on body composition (waist circumference, BMI and BMI-Z), flexibility (sit and reach), muscular fitness (standing jump), and cardiorespiratory fitness (shuttle run) in a sample of adolescents (Eather et al., 2015).

The aim of the current study was to investigate the impact of the CrossFit ™ Teens resistance training program on mental health outcomes in adolescents and to explore potential mediators and moderators of intervention effects. And although only a small percentage of adolescents may suffer from mental health problems, they are a segment of the adolescent population that may be especially likely to benefit from engaging in physical activities like CrossFit training. Consequently, an investigation of the impact of the CrossFit ™ Teens resistance training program on participants identified as 'at-risk' of developing a mental health disorder was added as a secondary focus of this study. Mediation analysis can be used to expand our understanding of the mechanisms responsible for influencing change in targeted outcomes (Cerin, 2010) and the results can be used to guide future intervention development,