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Physical activity and stress resilience: Considering those at-risk for developing mental health problems

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ABSTRACT

Introduction: Physical activity (PA) has been shown to benefit mental health. While research on non-human animal species indicates that PA may confer protective effects on mental health by increasing resilience to stress via regulation of the stress response, the human literature offers inconsistent evidence regarding this idea. To help reconcile these inconsistencies, the present study of human adults tested the hypothesis that PA's protective effects, as indexed by self-perceived resilience, vary according to individual differences in trait anxiety, which has been linked to a dysregulated stress response and risk for developing mental health problems. Specifically, we predicted that individuals reporting high trait anxiety (and thus presumably more stress response dysregulation) would show a stronger association between PA and self-perceived resilience, than would peers with lower reported trait anxiety.
Methods: Undergraduate students ($n = 222$) completed online self-report measures regarding their PA level, trait anxiety, and self-perceived resilience.
Results: Hierarchical linear regression analyses yielded evidence of a significant interaction between trait anxiety level and PA, such that PA and self-perceived resilience were significantly and positively associated among individuals with high trait anxiety, but not among individuals with low and moderate trait anxiety.
Discussion: In conclusion, individuals with high trait anxiety, which may be a risk factor for developing clinically significant mental health problems, may preferentially show psychological, as well as physiological, benefits from PA.

1. Introduction

According to the Centers for Disease Control and Prevention (CDC), over 50% of adults in the United States fail to engage in recommended levels of physical activity (PA; CDC, 2012). This statistic is striking, given ample evidence that PA yields physical and mental health benefits, as well as potential protective effects. For instance, physically active individuals report reduced incidence of mental health problems and a dose-response relationship appears to exist between PA and mental health (Goodwin, 2003; Ströhle et al., 2007).

Substantial evidence links PA and psychological well-being; however, the path from PA to its notable psychological benefits is complex (Crone, Smith, & Gough, 2006). As the prevalence of stress-related mental health problems continues to surge (i.e., anxiety and depression; Kessler et al., 2005), much attention has focused on whether PA influences the stress response, or one's resilience to stress [see A to C in Fig. 1, which depicts associations among PA, mental health, and study specific variables referred to throughout the introduction], as a means of promoting mental health [Fig. 1, D] (Tsatsoulis & Fountoulakis, 2006). That is, does PA improve an individual's stress resilience, in turn, providing protection against stress-related mental health problems? Of note, we define resilience as the ability to respond and adapt successfully to acute or chronic adversity as a function of adaptive physiological/psychological stress responses (Feder, Nestler, & Charney, 2009). This definition is important to keep in mind, because researchers operationalize resilience in diverse ways.

Research using animal models lends ample support to the hypothesis that stress resilience at least partially accounts for the commonly observed negative association between PA and stress-related mental health problems. For example, the introduction of habitual PA prior to stress exposure (e.g., footshock, social defeat) attenuates the activation of, as well as changes in, physiological stress response systems that are typically observed in stressed

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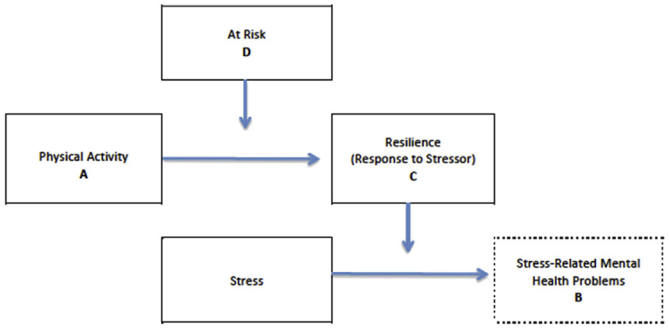

Fig. 1. Model showing the relationship among variables considered in the study. Stress-induced mental health problems are not assessed. Future research is needed that incorporates variables that measure these important outcomes.

sedentary rodents (Dishman et al., 2006; Greenwood & Fleshner, 2011; Stranahan, Lee, & Mattson, 2008). Similarly, habitual PA appears to protect rodents against negative behavioral consequences of stress that resemble human anxiety or depression symptoms (e.g., social avoidance, exaggerated conditioned fear, and interference with instrumental learning) (Greenwood & Fleshner, 2011, 2013). In essence, the non-human literature suggests that habitual PA increases physiological and behavioral resilience to stressors, which may help prevent stress-related mental health problems.

Generally, the human literature indicates that people who exercise regularly have lower risk for developing stress-related mental health disorders than do sedentary peers (Gerber & Pühse, 2009). Human studies have investigated whether PA confers such resilience by examining varied effects of PA on the stress response. For example, studies of physiological responses to laboratory stressors (e.g., mental arithmetic, public speaking, and cognitive interference tasks) have found that fitness and/or exercise training predict regulated cardiovascular activity, which is commonly identified as a marker of physiological resilience (e.g., Forcier et al., 2006). The literature also indicates that PA reduces self-reported psychological (i.e., anxious) responses to stressors. Rimmele et al. (2009) found that, compared to untrained males, elite male athletes not only showed significantly lower cortisol levels and heart rates, but also reported less state anxiety in response to psychosocial stress (i.e., public speaking). Additionally, Smith (2013) reported that PA attenuates the anxious response (i.e., state anxiety) to emotional stimuli (arousing pleasant/unpleasant/neutral images), which further suggests that PA may help people to better endure or manage daily anxieties and stressors.

Despite relatively coherent evidence of a positive association between PA and stress resilience, some human studies have yielded less consistent findings. For example, one literature review found the evidence for PA-induced augmentation of neuroendocrine stress reactivity in response to laboratory-based stressors to be inconclusive (Sothmann, 2006). Further, at least one study has shown that PA-induced changes in the physiological stress response do not extend to psychological responses to stress, defined as state anxiety (Klaperski, von Dawans, Heinrichs, & Fuchs, 2013).

Notably, much of the extant literature has focused on main effects, measuring associations between PA and stress resilience [see Fig. 1, A to C]. Limited research, in contrast, has examined moderators of such main effects. Therefore, there could be value in investigating individual differences that may serve as moderators, influencing the degree to which PA offers protective effects for different individuals. Findings from such research would help inform efforts to personalize prevention/intervention for mental health problems.

One potential moderator is the predisposition to respond with anxiety, a characteristic that places individuals at risk for developing stress-related psychological disorders [See Fig. 1, D]. Although some conceptualizations define risk and resilience as opposite sides of the same coin, the absence of risk factors does not necessarily confer resilience (Manyena, 2006). Further, research suggests that mechanisms of risk, like the predisposition to experience anxiety, are not always the opposite of those mediating resilience to stress (Poirier, Cordero, & Sandi, 2013).

Smits, Tart, Rosenfield, and Zvolensky (2011) conducted the only published study to date that examines individual differences in risk factors for the development of mental health problems or predisposed anxious responding, as a potential moderator of the impact of PA on resilience. For this study, predisposed anxious responding was defined as high levels of anxiety sensitivity, or the fear of somatic arousal. This characteristic is an established risk factor for anxiety and its disorders (Schmidt, Zvolensky, & Manor, 2006). Resilience was operationally defined as an individual's subjective distress rating following recurrent inhalation of 20% carbon dioxide (CO_2) enriched air (psychological response to physiological stressor). The researchers found that anxiety sensitivity moderated the association between PA and resilience, such that PA protected against elevated distress only in those who reported both high anxiety sensitivity and high levels of PA.

Smits and colleagues' findings suggest that PA's protective effects may be specific to those at elevated risk for psychological disorders. However, the conclusions that can be drawn on the basis of this study are of limited generalizability for two key reasons. First, anxiety sensitivity is a strong predictor of panic disorder (McNally, 2002), but less reliably predicts fear-based anxiety disorders (Naragon-Gainey, 2010). Second, the laboratory-based stressor used to elicit a measured stress response can only provide a proxy for individuals' responses to routine stressors (Kamarck & Lovallo, 2003; van Doomen & Turner, 1992). Accordingly, there is value in extending Smits and colleagues' research by examining whether and how different risk factors for stress-related mental health problems interact with PA to predict responses to daily life stress.

To this end, the present study examined trait anxiety as a potential moderator of the association between PA and stress resilience, defined as self-perceived ability to cope with daily stress. Trait anxiety is a broad risk factor for mental health problems that marks a tendency to pervasively experience anxiety and worry

Table 1
Descriptive statistics, Cronbach's alpha, and correlations in and between covariates and study variables ($N = 222$).

Variable	M (N)	SD (%)	α	1	2	3	4	5	6
1. Age	21.24	5.38		–	.06	−.05	−.17*	−.12	.14*
2. Gender[a]	171	77%			–	.04	.15*	−.12	−.03
3. Race						–	.12	−.003	−.19**
Caucasian	66	30%				–			
African American	105	47%				–			
Asian	34	14%				–			
Other	17	8%				–			
4. STAI-T Score	43.96	10.95	.91				–	−.05	−.63**
5. GPAQ	2159.01	2806.80						–	.08
6. CD-RISC 10	26.40	7.93	.92						–

Note: GPAQ = Global Physical Activity Questionnaire–Recreational Activity; STAI-T = State Trait Anxiety Inventory-Trait Form X; CD-RISC 10 = Connor Davidson Resilience Scale 10. The GPAQ α is not reported because the score comprises two items that are designed to measure different constructs.
*$p < .05$; **$p < .01$.
[a] Descriptive statistics are for the women in the sample.