The Effectiveness of Exercise Interventions on Coping with Stress: Research Synthesis

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Summary
Stress-related health issues are associated with mental and physical health decrements, and poor well-being. One intervention that may be useful for stress reduction is exercise. However, the research on exercise-interventions to reduce stress among non-clinical population is scarce. The purpose of the present paper was to systematically review the empirical work on the effectiveness of exercise as a treatment strategy for coping with stress. First, stress definitions and a stress-coping model are presented. Then, findings regarding the influence of exercise-interventions on stress among healthy populations are summarized. In the second half, the psycho-physiological mechanisms which underline the association between exercise and stress are reviewed. Finally, limitations, implications, and overall conclusion are presented. Altogether, the findings suggest that exercise-interventions may be effective in coping with everyday stress among non-clinical population. However, the role of the psycho-physiological mechanisms in the exercise-stress link and their interactions are yet to be established.

Key words: exercise, coping strategies, stress

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Introduction
A high prevalence of stress is evident in the current western societies. A recent survey obtained in the United States indicated that over two-thirds of the 2020 adult respondents from the general population experienced symptoms of stress such as irritability, anger, fatigue, and sleeping irregularities (American Psychological Association, 2013). Similarly, in Europe, the average prevalence of work-related stress in 2005 was 22% among the 27-member states, ranging from 12% in the United Kingdom to 55% in Greece (Milczarek, Schneider, & Rial González, 2009). Given the high prevalence of stress, there is a serious need for effective stress-reducing methods. In other words, there is a growing need for interventions “that can be easily utilized by large numbers of people that are readily available, inexpensive and have minimal side effects” (Henriques et al., 2011, p. 1).

Stress-related health issues are associated with increased healthcare costs, mental-health decrements, and poor well-being (Werneburg et al., 2011). Stress activates physiological responses encompassing changes in the nervous and immune systems, such as an increased level of cortisol, and increased heart rate and blood pressure (Schneiderman et al., 2005). When stress is persistent, these physiological changes can lead to chronic health conditions, such as an elevated blood pressure and a dysregulated immune system (Schneiderman et al., 2005), cognitive complications (McEwen & Sapolsky, 1995), and mental illnesses including depression (Hammen, 2004).

One intervention that may be useful for stress reduction is exercise. Converging evidence has consistently demonstrated the effectiveness of exercise and physical activity in reducing stress and its related symptoms (e.g., Conn 2010a, b; Guszkowska, 2004; Koschel, Young, & Navalra, 2017; McGale, Mc Ardle, & Gaffney, 2011; van der Zwan, de Vente, Huizink, Bögels, & de Bruin, 2015). Hence, it was suggested that exercise interventions, which consist of a subset of planned, structured, and repetitive physical activity (Shephard & Balady, 1999), may serve as an adaptive strategy to cope with stress (e.g., Garber, 2017; Firth, Rosenbaum, Stubbs, Gorczynski, Yung, & Vancampfort, 2016). We review the literature pertaining to the effectiveness of exercise as a treatment strategy for coping with stress. In the first part of this review, stress definition and manifestations, as well as a stress-coping model are presented. Then, findings regarding the influence of exercise interventions on stress and its related symptoms are summarized. In the second half, the psycho-physiological mechanisms related to stress, and several hypotheses concerning the underlining mechanisms of the exercise-stress link are reviewed. Finally, limitations, implications, and an overall conclusion, are presented.
**Stress and Coping**

Traditionally, stress has been defined as a stimulus, occurring in one’s life such as a loss of a job, or as a response accompanied by physiological arousal and negative affect (Folkman, 2013). The concept of stress is widely discussed in diverse health and behavioral science disciplines, including epidemiology, cognitive, personality, social psychology, and medicine. Early work focused on the physiological response to stressors, also described as the “fight-or-flight” reaction to stress (Cannon, 1932). Cannon’s work was later extended by Selye (1956) who assumed that all living organisms display nonspecific changes in response to stressful stimuli. Selye’s concept of stress was labeled as a 3-stage General Adaptation Syndrome (GAS), which comprises of an alarm reaction, resistance, and exhaustion (Selye, 1956). Each stage consists of both physiological and behavioral responses. Lacking restorative measures, results in physical and/or psychological deterioration.

Beginning in the 1960s and 1970s, stress was conceptualized as a transactional phenomenon dependent on the perceiver’s meaning given to the stimulus (Lazarus, 1966; 1979). The underlying idea is that different people may perceive a given event or situation differently and uniquely. These perceptions, rather than the objective stressors, determine the stress response, and in turn, the chosen coping strategy. This notion is regarded as the foundation of the stress and coping model (Lazarus & Folkman, 1992).

According to the stress and coping model, also known as the cognitive-evaluative model (Lazarus & Folkman, 1992), stress can be viewed as a response to a stressful event mediated by personal resources for coping, and cognitive appraisal of the event. Cognitive appraisal consists of three main phases; the primary appraisal, which serves to evaluate the potentially stressing event. The secondary appraisal, is a judgement concerning what might be done with respect to the availability of coping resources. Finally, a reappraisal, is a successive valuation that is based on new information obtained from the environment and/or the person during the occurring circumstances. The reappraisal and the individual’s psychological adjustments are determined by the effectiveness of the coping strategies chosen following the operation of the secondary appraisal.

Coping refers to the mental and behavioral efforts made to manage stress (Carver, Scheier, & Weintraub, 1989). Accordingly, successful coping result from a sufficient match between appraisal and coping strategy. In early formulations of the model, coping strategies were conceptualized along two dimensions: (1) problem-focused coping, and (2) emotion-focused coping. Problem-focused coping strategies target the origins of stress in practical terms which tackle the stressful situation that is causing stress. Examples of such coping strategies include active coping, problem solving, and information seeking. By contrast, emotion-focused coping strategies are aimed at altering the way one perceives the stressful situation or feels about it. Examples of these efforts include seeking social support and venting feelings, as well as avoidance, and denial. Lazarus and Folkmen’s (1992) model suggest that problem-focused coping strategies are most efficient when facing stressors that are changeable, while emotion-focused strategies are most adaptive when the stressor is unchangeable or when this strategy is used in conjunction with problem-focused coping efforts.

Taken together, the common conceptualization of stress postulates that equally important to the environmental demands is the way an individual reacts to the stressful experience and the strategy employed by the individual (Garber, 2017). Individuals can respond to stressful experiences in both adaptive and maladaptive behaviors, with maladaptive coping strategies being associated with less favorable outcomes (Skinner, Edge, Altman, & Sherwood, 2003). Examples of maladaptive coping include self-blame, venting, behavioral disengagement, substance use, and denial. In contrast, adaptive coping strategies include the use of humor, acceptance, planning, positive reframing, emotional support, and active coping (Garber, 2017; Jalbrzikowski, Sugar, Zinberg, Bachman, Cannon, & Bearden, 2014). One manifestation of active coping that was also referred to as an adaptive coping strategy is exercise.

**Exercise and Stress**

Exercise is considered an adaptive coping strategy. Exercise is a subset of planned, structured, and repetitive physical actions, aimed at improving or maintaining physical fitness (American College of Sports Medicine [ACSM], 2013). Exercise types include strength, endurance, functional, balance and flexibility. Of these, the most comprehensively studied in the stress and exercise literature have been endurance exercises, also known as aerobic exercise (Gillis & MacDonald, 2005). Examples of aerobic exercise include running, walking, dancing, and swimming. Traditional exercise recommendations suggest a threshold of activity that is necessary for health protection, while the ACSM’s (2015) position stand on the issue indicates that low to moderate-intensity exercise reduces blood pressure as much, or more, than higher intensity exercise (see Riebe et al., 2015 for a review).

According to the current ACSM (2015) recommendations for exercise participation, adults must undertake at least 150 minutes of moderate-intensity exercise per week to maintain their fitness and health. Moderate exercise increases one’s heart rate and breathing; specifically, it prompts 40%–60% of heart rate reserve. Examples include jogging and bicycle riding slower than 10mph (Weinstock, Farney, Elrod, Henderson, & Weiss, 2017). Low to moderate exercise intensity is associated with favorable status on coronary artery disease and other stress-related risk factors. In the domain of exercise and stress reduction, exercise interventions usually include at least three exercise sessions per week of at
least 15 minutes duration at moderate intensities (Riebe et al., 2015). In this vein, throughout this review, the term exercise intervention refers to an aerobic exercise program, performed for fitness purposes, and includes at least three exercise sessions per week at a moderate intensity.

The effectiveness of exercise was evident in the scientific literature as one which positively affects physical health and stress-reduction along with its related manifestations, such as anxiety and depression symptoms (e.g., Buckley et al., 2004; Conn 2010a,b; de Assis et al., 2008; Wipfli, Rethorst, Landers, 2008). Systematic reviews were targeted at examining the clinical evidence of the beneficial effects of exercise on various medical conditions, such as cancer (Knobf & Winters-Stone, 2013), hypertension (Pescatello, MacDonald, Lambert, & Johnson, 2015), diabetes (Koivula, Tornberg, & Franks, 2013), and chronic heart disease (Anderson et al., 2016). Specifically, people who exercise were less prevalent to mental abnormalities such as depression, negative affectivity, and anxiety (e.g., Conn 2010a,b; Wipfli, Rethorst, Landers, 2008).

Exercise is associated with reduced reported stress, a finding that has been evident in varied populations including athletes, students, elderly, and veterans with post-traumatic stress disorder (Buckley et al., 2004; de Assis et al., 2008; King, Taylor, & Haskell, 1993; McHugh & Lawlor, 2012; Taylor-Piliae et al., 2010). While it is equivocal whether those who exercise experience less stressful life events (Mooj, de Vries, & Grootenhuis, 2000; Stults-Kolehmainen & Sinha, 2014), an association between exercise and fewer daily hassles was noted (Nguyen-Michel et al., 2006). Several meta-analyses revealed that exercise is an effective treatment for depression (Schuch et al., 2016), and that regular physical activity reduces anxiety symptoms in non-clinical adult populations (Rebar, Stanton, Gerard, Short, Duncan, & Vandelanotte, 2015). In addition, it was recently suggested that exercise can serve as a treatment for coping with extremely stressful life events (Rosenbaum, Vancampfort, Steel, Newby, Ward, & Stubbs, 2015), and as a mean to increase the overall quality of life and psychological well-being (Gerber & Puhlse, 2009; Salmon, 2001).

Indeed, exercise has been demonstrated to promote positive changes in one’s mental health and the ability to cope with stressful encounters (Dunn, Trivedi, O’Neal, 2001; Edenfield & Blumenthal, 2011; Long, 1983; Salmon, 2001). A recent review concluded that exercise buffers the effects of stress on physical health (Gerber & Puhlse, 2009). For instance, exercise prevents stress-induced immunosuppression (Fleshner, 2005). Considering the seemingly noticeable effects of exercise on stress, it has been conceptualized as a method to inoculate individuals against the thores of stressful experience (Gerber, 2017; Salmon, 2001). Based on this notion, several studies were designed and performed to examine the effect of exercise interventions on stress reduction and consequently its associated symptoms.

Findings related to the relationship between exercise and stress-related symptoms were summarized in a considerable amount of meta analyses and systematic reviews (e.g., Hamer, Taylor, & Steptoe, 2006; McNeely, Campbell, Rowe, Klassen, Mackey, & Courneya, 2006; Peluso, & Andrade, 2005; Meier, 1994; Scully, Kremer, Meade, Graham, & Dudgeon, 1998). However, only a few of them focused on randomized controlled trials, and very few have dealt with non-clinical populations (Hamer, Taylor, & Steptoe, 2006). That is, the most systematic reviews concerning the influence of exercise interventions are selective in their choice of health groups considered, with main focus on depressive or anxious diagnosed population (e.g., Conn, 2010a,b; Dunn & Dishman, 1991; Dunn, Trivedi, & O’Neal, 2001 Lawlor & Hopker, 2001). In addition, we failed to locate a systematic review which have focused on exercise interventions as a treatment for daily stress in healthy people. The purpose of the current paper is to comprehensively review the body of literature which has examined the effectiveness of exercise as a treatment strategy for coping with stress in non-clinical populations.

Method

Search Strategy

Four electronic databases [Google Scholar, Web of Science ‘all databases,’ PsycINFO, and PsycARTICLES (combined search via EBSCOhost)] were used for the search of relevant literature. The present review searches for literature published from 2000 up to November 2017. The search terms ‘exercise intervention’, ‘physical activity intervention’, and ‘training program’, were combined with stress, anxiety, depressive symptoms, well-being, and coping strategies. For the databases, Google Scholar, Web of Science, and PsycINFO/PsycARTICLES, search terms were used successively (e.g., first search term: exercise intervention AND stress; second search term: physical activity intervention AND stress; third search term: exercise intervention AND coping strategies; etc.). The primary literature search resulted in a total of 1,320,000 articles (including duplicates between databases).

Study Selection

The search and screening process for relevant literature included an initial check of the titles of all retrieved studies, removing the duplicates, and excluding those studies, which were obviously related to other fields of research. Article titles not clearly signaling the field of research were excluded in this step. The initial screening resulted in 55 remaining articles, which were further screened for eligibility based on the following criteria: (a) the study must be published in full in English language in a peer-reviewed journal, (b) the study must be based on original data, (c) the study must be related to
exercise intervention aimed to reduce stress and its related symptoms (i.e., objective and subjective stress measures, affect and mood states, anxiety and depression symptoms, perceptions of quality of life, and psychological well-being). (d) the term exercise intervention refers to randomized controlled trials, which included over 3-days exercise program, operated in moderate intensity, (e) the intervention was carried out among a sample of adults (i.e., over the age of 18) with no clinical diagnosis, and (f) included aerobic exercise training (i.e., running, biking, jogging, dancing etc.).

Article abstracts, and full texts were used to perform a thorough check of these criteria. Following the selection procedure, 10 articles were identified. The reference sections of each of these 10 articles were then screened by hand to double check for studies, which have been potentially missed out on during the preceding steps of the selection process. As a result, two more articles were found and added to the list.

Findings: Exercise Interventions as a Strategy for Coping with Stress

Interventions which conducted randomized controlled trial have demonstrated that exercise programs resulted in reduction of perceived stress in real-world settings. For example, Eriksen and his colleagues (2002) found that an exercise intervention (comprised of aerobic dancing program) in the workplace positively influenced employees’ health. The intervention subjects (83 males, 27 females, age range: 36–45 years) exercised 13 weeks at leisure time in off-worksite training facilities. Results indicated that exercise training improved overall perception of quality of life and psychological and physical health sub-domains. The psychological benefits held steady only for those who continued to exercise on their own. Similarly, Thorne et al. (2000) found that a 16-week intervention (exercise four times per week, 40 min) improved stress reactivity in a group of firefighters.

Similarly, six-weeks of aerobic exercise intervention reduced cardiovascular activity levels during psychological stress and recovery in healthy young adults. In this study, forty-five sedentary young adults (18–30 years old) were engaged in either 6 weeks of aerobic training, weight training, or a control (no-treatment) condition. Following the intervention, participants were exposed to experimentally-induced psychological stress while their physiological reactivity was measured during rest, psychological stress, and recovery periods. Results indicated a better physiological response to stress among aerobically trained participants relative to anaerobic and control conditions marked by lower levels of heart rate and systolic blood pressure during psychological stress and recovery periods. The authors claimed that aerobic exercise holds a protective role against age-related increases in coronary heart disease for individuals who adopt aerobic exercise early in life and maintain exercising across the life span (Spalding, Lyon, Steel, & Hatfield, 2004).

Support for these findings was evident in other exercise-intervention studies using adults (e.g., Atlantis et al., 2004; Courneya, Mackey, Bell, Jones, Field, & Fairley, 2003; Hopkins et al., 2012).

Randomized controlled trials studies showed that exercise is an effective method for improving stress symptoms and quality of life also among students. For instance, a 20-week aerobic exercise training reduced psychological stress and physiological stress responses during the academic examination period (end of the semester) in sedentary students (von Haaren et al., 2016). In addition, exercise intervention significantly reduced study-related fatigue (emotional exhaustion, overall fatigue, and need for recovery), which is known as an outcome of prolonged study stress (de Vries, van Hooff, Geurts, & Kompier, 2016). Taken together, these findings suggest that regular exercise may be an accessible and inexpensive method for preventing or reducing study-related stress in university students, a population who is often facing stress.

Another population that may be exposed to continuous stress in everyday life is the elderly. More than half of the elderly aged over 60 years old in the US suffers from hypertension (Li et al., 2012), and other mental health problems, resulting from changes in age, living conditions, and physical conditions, such as loneliness, depression, anxiety, and fear (Banach & Aronow, 2011, Gao, Wang, & Yu, 2014). An appropriate exercise was suggested to serve as a safe guard form tension without causing side effects (Wenxin, Menglong, & Jiwei, 2016).

In a recent study, 12-weeks exercise intervention was conducted to evaluate the effectiveness of exercise on mental health outcomes and coping style (negative vs. positive) among elderly who suffer from high levels of stress. Following the intervention, participants reported significantly lower levels of mental health symptoms, such as somatization, interpersonal sensitivity, depression, anxiety, hostility, and paranoia, than the control subjects. Furthermore, the intervention participants reported significantly greater use of positive coping style than the control participants. According to the authors, exercise can effectively improve mental health levels and coping ability of elderly (Wenxin et al., 2016). This conclusion is consistent with other intervention studies reporting similar results among the elderly (e.g., Tarazona-Santabalbina et al., 2016).

Importantly, the positive effects of exercise on stress-related symptoms and quality of life may be attributed to various peripheral factors, as it is known that stress reduction often occurs when people indulge in activities they find pleasurable and satisfying (Sandlund & Norlander, 2000). To control for this potential effect, van der Zwan et al. (2015) compared the efficacy of a 3-weeks exercise intervention to a similar length interventions of mindfulness meditation intervention, and heart rate variability biofeedback. In this randomized controlled trial, non-significant advantage was found to exercise over the other interventions in reducing stress-related symptoms. All three interventions equally
contributed to participants’ well-being, reduced stress, anxiety and depressive symptoms, and improved psychological well-being and sleep quality (van der Zwan et al., 2015). In another study, the efficacy of aerobic exercise intervention was compared to the efficacy of yoga intervention, consisting of breathing technique and stretching through different body pose. Both active interventions produced similar improvement in stress-related symptoms including fatigue and vitality compared to the control participants (Oken et al., 2004). Similar findings were reported by Ross and Thomas, (2010).

These findings suggest that regular exercise enhances physical health and reduces stress, but these benefits may be mediated by various mechanisms, which are also common to other active interventions. These mechanisms are psychological and physiological (Peluso & Andrade, 2005).

Mechanisms Involved in the Exercise-Stress Link

Diverse psychological and physiological explanations were offered for the stress reduction effects of exercise training. Of the psychological theories, the most attention has been given to the distraction hypothesis which maintains that diversion from unfavorable stimuli improved mood during and after exercise (Morgan, 1985). Namely, the positive influence of exercise on stress is a result of distraction from negative thoughts (Morgan, 1985, 1987), and improved retrieval of positive thoughts (Clark, Milberg, & Ross, 1983). To test the distraction hypothesis, Saklofske et al. (1992) compared the effects of walking and relaxation. Both treatments led to reduced perceptions of stress levels. However, the walking subjects also showed an improvement in subjective energy. Thus, although exercise and relaxation have a similar effect on mood, exercise is superior for the energizing feeling.

According to the mastery hypothesis, the completion of an effortful task, such as exercise, may elicit a sense of mastery or achievement, thereby improving mood and reducing stress (Simons, Epstein, McGowan, Kupfer, & Roberrson, 1985). This assumption is in line with Bandura’s theory of self-efficacy. Specifically, since physical exercise can be perceived as a challenging and effortful task, being involved in such activity might enhance mood and stress reduction (North, McCullagh, & Tran, 1990).

Another explanation for the exercise-stress reduction linkage is driven from the self-expansion theory, claiming that individuals are fundamentally motivated to grow and improve the self by acquiring new identities, enhancing capabilities, developing new perspectives, and gaining resources (Aron, Aron, & Norman, 2001; Aron, Norman, & Aron, 1998). This broadening of the self with novel content can be achieved by participating in a new activity that is exciting, challenging, and interesting, such as exercise (Mattingly & Lewandowski, 2013). Accordingly, the positive influence of exercise on mental health can result from one’s participation in a new exciting activity which expands the self.

An alternative explanation to the beneficial effects of physical activity on mental health attributes it to the engagement in social interactions during exercise (Peluso & Andrade, 2005). According to the social interaction hypothesis (Ransford, 1982), the social relationships commonly inherent in physical activity, as well as the mutual support that occurs among individuals involved in exercise, play an important role in the effects of exercise on stress reduction and mental health in general.

Of the biological theories, the most attention has been given to (1) the alterations in monoamines, and (2) the activation of endorphins (Peluso & Andrade, 2005). The first approach relies on the findings that physical activity increases the synaptic transmission of monoamines, including serotonin, dopamine, and adrenaline (Kashihara, Maruyama, Murota, & Nakahara, 2009; Peluso & Andrade, 2005), which supposedly function as anti-depressive medications (Dunn & Dishman, 1991). However, it may be an oversimplification to claim that the effectiveness of anti-depressive substrates is attributed to increased synaptic transmission of monoamines. Therefore, although this explanation may be reasonable, it likewise seems too simplistic to explain the reduction of stress associated with physical activity (Morgan, 1985; Dunn & Dishman, 1991).

The second most common explanation refers to the action of endorphins within the central nervous system (Morgan, 1985; Nicoloff & Schwenk, 1995). Several studies consistently demonstrated that plasma level of endorphins is elevated following exercise (e.g., Dishman, & O’Connor, 2009; Grossman et al.,1984). Theoretically, the inhibitory effects of endorphins on the central nervous system (CNS) are accountable for the sensation of calm and improved mood experienced following exercise (Kashihara et al., 2009). In particular, beta-endorphin in the CNS act as a physiological modulator of the positive effects of exercise on mood (Anish, 2005). This hypothesis is supported by increased irritability, restlessness, nervousness, and feelings of frustration reported by physically active individuals when withdrawn from exercise, and in a state of endorphin abstinence (Peluso & Andrade, 2005).

Nevertheless, to date, there is no consensus regarding the relative importance of neither of both psychological and physiological claims for the association between exercise and stress reduction. Peluso and Andrade (2005) claims that a psychobiological framework is more comprehensive than each of them separately. Knowledge integration leads to a conceptual framework that sheds more light on the role of exercise as a treatment strategy for coping with stress. Alongside with the need to clarify the underlying mechanisms of the association between exercise and stress, and although most of the research findings show that exercise holds beneficial effect on stress levels, there are some issues which must be considered.
The Exercise and Stress link: Issues to consider

Although most studies’ findings provide evidence to the positive influence of exercise on stress levels, we note that in some cases the positive influence of exercise may not be applicable. For example, high intensity exercise, which exceeds individuals’ habitual level, is less likely to improve mood and, may even worsen it (Stepteoe, & Bolton, 1988). Similarly, exercise which involves competition can worsen mood in habitual exercisers (Stepteoe, Kearsley, & Walters, 1993). Additionally, habitual-active exercisers tend to exercise more in the face of stress than those in beginning stages of exercise. Consequently, stress may have differential influence on exercise adoption, maintenance, and relapse (Salmon, 2001).

Furthermore, although it appears that the physical activity itself and not fitness level, mollifies the effects of stress, there is no consensus on this claim (Stults-Kolehmainen & Sinha, 2014). People who are aerobically fit have less cardiac reactivity to stressors (Crews & Landers, 1987; Jackson & Dishman, 2006), and a better cardiovascular recovery (Chafin, Christenfeld, & Gerin, 2008; Jamieson, Flood, & Lavoie, 1994).

Another factor that must be considered in regard to the benefits and/or harms of exercise to combat stress, is the gender factor. Several gender differences in relation to both coping strategies and cardiovascular response to exercise are relevant to the scope of the current review. Although the literature examining the relation between gender and stress reveals several conflicting outcomes, numerous authors have determined that women tend to confront stressful situations more often than men. Furthermore, women have been found to suffer more chronic stress than men (e.g., McDonough & Walters, 2001) and are exposed to more daily stressful events (Kessler, 1987). People who are aerobically fit have less cardiac reactivity to stressors (Crews & Landers, 1987; Jackson & Dishman, 2006), and a better cardiovascular recovery (Chafin, Christenfeld, & Gerin, 2008; Jamieson, Flood, & Lavoie, 1994).

The benefits of exercise for stress reduction may be mediated by both psychological and physiological mechanisms (Kashira et al., 2009; Peluso & Andrade, 2005). However, the precise contribution of each mechanism to the relationship between exercise and stress, and the manner each mechanism interacts with other mechanisms, are yet to be clarified in future studies. Moreover, although the relationship between exercise and stress reduction was consistent in most studies, in some cases it was not supported (Hubbs et al., 2012; Jex, Spector, Gudanowski, & Newman, 1995; Yin et al., 2005; Zuzanek, Robinson, & Iwasaki, 1998). Hence, the benefits of exercise for mental health and stress must be viewed with cautious.

Discussion

We examined the effectiveness of exercise on coping with stress among adults thorough a review of exercise interventions in randomized controlled trials. The main findings presented here support the notion that exercise promotes positive changes in one’s mental health and ability to cope with stressful encounters (Atlantis et al., 2004; Courneya et al., 2003; de Vries et al., 2016; Eriksen et al., 2002; Hopkins et al., 2012; Throne et al., 2000; von Haaren et al., 2016). Moreover, exercise interventions appear to improve one’s depression and anxiety symptoms, which are recognized as extreme manifestations of stress (Hammen, 2004; Nicoloff & Schwenk, 1995; Rebar et al., 2015).

The benefits of exercise for stress reduction may be mediated by both psychological and physiological mechanisms (Kashira et al., 2009; Peluso & Andrade, 2005). However, the precise contribution of each mechanism to the relationship between exercise and stress, and the manner each mechanism interacts with other mechanisms, are yet to be clarified in future studies. Moreover, although the relationship between exercise and stress reduction was consistent in most studies, in some cases it was not supported (Hubbs et al., 2012; Jex, Spector, Gudanowski, & Newman, 1995; Yin et al., 2005; Zuzanek, Robinson, & Iwasaki, 1998). Hence, more scientific effort must shed light on the effectiveness of regular exercise for coping with stress.

Limitations and Future Directions

As might be expected, the current review holds several limitations. Some, are derived from methodological issues of the exercise intervention studies presented here, and other limitations are concerned with methodological issues of the current review. Regarding the first type
of limitations, designs of control groups in exercise intervention studies are often different from one another and limits the ability to compare the interventions’ outcomes. Similarly, although the exercise interventions presented in this review share similar objective (i.e., to explore the efficacy of exercise in reducing stress), in some cases, different measures of stress were operated. Thus, more consistency in the utilization of control groups and in the assessment of stress are required to clarify whether the changes in stress levels are due to the exercise intervention or due to other factors, such as participating in social activity.

Some limitations derive from the methodology of the current review. Although the current review followed specific inclusion criteria (e.g., exercise intensity and type, population characteristics, and study design), some variability still existed (e.g., length of interventions). That is, due to differences in the exercise regimen, stress assessment, length of intervention, and population characteristics such as gender and age. These limitations must be considered when one makes conclusions regarding the benefits of exercise on stress reduction.

Moreover, the current review included only interventions that were conducted as part of randomized controlled trials. Hence, some exercise-and-stress related findings that could shed more light on the effectiveness of exercise as a coping mechanism were not considered (e.g., Blumenthal et al., 2005; Kritz-Silverstein, Barrett-Connor, & Corbeau, 2001; Lawlor & Hopkins, 2001). Future systematic review and meta-analysis with a clearer inclusion and exclusion criteria, as well as a wider consideration of the findings relating exercise to stress reduction, may better account for the effect of exercise as a coping mechanism.

Although the data presented here suggest that improvements in cardio-vascular fitness due to participation in moderate exercise may play a significant role in reducing mental stress, the clinical significance of these findings must be prudently evaluated. We proposed that the association between exercise and stress reduction may be mediated by psychological and social factors (e.g., Morgan, 1985, 1987; Peluso & Andrade, 2005), thus, it is recommended to test the interaction between a given dose of exercise with various social and psychological factors. Also, most of the findings in relation to the underlining physiological mechanisms of the exercise and stress association were obtained in animal studies (e.g., Cotman & Berchtold, 2002; Cotman, Berchtold, & Christie, 2007; Voss, Vivar, Kramer, & van Praag, 2013). Hence, further studies must document the clinical benefits of regular aerobic training in humans, and to elucidate the mechanisms by which exercise alters psycho-physiologic stress response.

The present review raises the need for further investigation of the effects of exercise on stress and its related symptoms. For example, more research effort must examine questions concerning the appropriate dose of exercise required for stress-reduction. Particularly, we must determine the minimum threshold intensity, volume of exercise, increase in energy expenditure that benefit stress reduction. Similarly, we must determine the type of exercise and exercise environments useful for stress reduction. Specifically, may exercising in the nature hold unique benefits for stress reduction in comparison to exercising in an in-door environment?

In addition, the current review emphasizes the need for better understanding of the effectiveness of exercise in comparison to alternative treatments (e.g., pharmacotherapy, CBT, mindfulness, etc.) in affecting stress reactivity and coping efficiency among different populations. Such analysis may stimulate research on targeting exercise interventions to people who will benefit most from a given type of exercise, with an identification of those who will react better to alternative treatments when coping with stress.

Implications and Conclusion

The current review holds several important implications. Stress is widely prevalent and has repercussions for a wide range of mental and physical health issues (American Psychological Association, 2013; Milczarek et al., 2009). Hence, the potential to minimize its negative implications by a simple mean such as exercise is of significance for professionals in the health and exercise domains. The findings presented here, combined with consistent findings linking stress to depression, cardiovascular disease, and many other health endpoints (Anderson et al., 2016; Hopkins et al., 2012; Stults-Kolehmainen & Sinha, 2014), may encourage health policies to include provisions for integrated prevention and treatment of stress and its related symptoms by the promotion of physical activity.

Nevertheless, for this progress to occur, the well-identified associations between stress and exercise must be further recognized within the community of health and exercise researchers, practitioners, and other advocates. Furthermore, it seems that action must be taken to advance exercise interventions and have them considered as effective stress management techniques (Stults-Kolehmainen & Sinha, 2014). First, practitioners must use both objective and subjective assessments of stress for everyone to more reliably identify people who may be at risk for the negative impacts of stress. Moreover, a consideration of stress vulnerability across stages of change, as well as the impacts of exercise in different stages, may be useful for practitioners in choosing the appropriate exercise intervention for their client.

Importantly, new exercisers, especially those who are more dispose to stress, may find it hard to initiate and maintain physical activity as part of their daily life (Stults-Kolehmainen & Sinha, 2014). In such cases, it is even imperative to design a training program to fit the fitness level of the individual. This approach emphasizes that exercise interventions may be more effective when tailored to the individual (Garber et al., 2011). Hence, the interventionist must, as much as possible, allow the
people to choose which exercises they would like to be engaged with. By allowing this autonomy, practitioners may increase individuals’ enjoyment as well as their motivation to adhere exercising (Edmunds, Ntoumanis, & Duda, 2007; Firth et al., 2016).

In conclusion, exercise appears to be a practicable treatment for coping with stress and improving mental health among adults. Providing people with professional support to identify their exercise preferences and goals, as well as identifying their available stress coping strategies, may enable them to overcome psychological barriers, and maintain motivation towards regular physical activity. Moreover, it may encourage people to use simple and inexpensive strategy such as exercise, when facing stress in their daily life.

References


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