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Exercise and Cortisol Stress Levels: How Does Exercise Decrease Cortisol Stress Levels?

The purpose of this research is to review whether or not exercise can be used as a successful coping mechanism for stress. The way stress will be measured is by the bodily chemical cortisol. Low levels of cortisol are associated with low stress levels. In some instances, low levels of the chemical cortisol are also associated with high levels of exercise. However, on the opposite end of the spectrum high levels of exercise are not always correlated with a low stress level. Exercise does not always result in lowered levels of the chemical cortisol. Excess exercise can be unhealthy and may cause health problems; however, optimal amounts of exercise for a college age person have been shown to decrease cortisol stress levels (West, Otte, Geher, Johnson, & Mohr, 2004).

Stress is a condition that every person encounters in some way, shape, or form throughout their lives. Although stress can be an unavoidable aspect of life, there are many useful ways to cope and manage it. Stress can be defined as a person's state of mind that is influenced by stressors, any external or internal force that triggers or causes stress. A person's homeostasis is threatened under stress. When changes to homeostasis occur, they can be both behavioral and physical. This is the beginning of the stress response system. Exercise can also be considered a stressful situation for the body (Mastorakos, Pavlatou, Diamanti-Kandarkis, & Chrousos, 2005). Stress is positively correlated with contributing to or exacerbating many psychological disorders, especially depression. Exercise has been shown to have positive effects on depression and is often used as a treatment (Nabkasorn et al., 2005).

Cortisol is a chemical that is released during the human stress response, regulated by the hypothalamic-pituitary-adrenal (HPA) axis (Harbach et al., 1999). The stress model is important in understanding how hormones relating to stress are released into the bloodstream. When a stressor is encountered, cortisol is released from the brain and is regulated by the HPA axis (de Vries, Bernards, de Rooij, & Koppeschaar, 2000).

According to Harbach et al (1999) exercise can be defined as any type of physical activity outside of a person's normal daily activities. For the purpose of this paper, exercise includes treadmill running, playing sports, hiking, yoga, and walking. Exercise and cortisol are directly related. During physical activity cortisol is released; however, the amount and time of the cortisol release depend on the situation, type of physical activity, and the duration of physical activity (de Vries et al., 2000).

Although exercise has shown to be an effective way to decrease stress, this is not always true. Too much exercise can be problematic, so it is important for an individual to find their optimal level of exercise. This can be done by monitoring their activity and heart rate, as well as frequency and duration of vigorous activity. Over-exercising has been shown to create more stress on the body, causing fatigue and exhaustion. This is especially true for professional athletes who exercise everyday at maximum output (Gonzalez, Moya, Martinez, & Salvador, 2002).

The current healthcare system is mainly focused on simply managing acute medical and mental conditions. The medical model is insufficient against the increasing prevalence of chronic diseases, primarily as a result of poor lifestyle choices. Although it is important to manage stress in regard to chronic disease, stress is not the only contributing factor. It is important to note that susceptibility to chronic diseases can be caused by biological (genetic predisposition), psychological (effective coping mechanisms), and social factors (stress) (West et al., 2004).

Implications of Exercise and Cortisol Stress Levels

Healthcare professionals could utilize exercise as an effective mechanism for coping with stress, and for preventing and treating both psychological and physical disorders. Depression, for example, is a very common psychological disorder of which stress is a contributing factor. Research has shown that a decrease in psychological stress of depressed patients could be attributed to exercise and physical activity. On average,

exercise lowers cortisol stress levels in people with depression. Regular exercise has been shown to have anti-depressant effects on depression (Nabkasorn et al., 2005).

Chronic disease is a growing problem in America and has many stress-related difficulties. Primary, secondary or public health approaches have not always been the best approach to dealing with these stress-related difficulties. These approaches were built around the bio-medical model. They focus mainly on biological treatments for disease, such as medication and surgery. According to West and his colleagues (2004), the increasing number of people who are now using alternative medicine and complementary medicine can be attributed to the need for care that is developed from modern life stress. Some of these alternative and complementary forms include exercise such as yoga or dance, meditation, and herbal remedies. These complementary and alternative approaches have been proven to be successful at lowering stress levels, treating depression, increasing positive moods, and helping cancer patients cope. Although it is true these approaches are gaining popularity within society, they are typically not used alone. People are using them in combination with primary health approaches for the best possible outcome.

Exercise and Cortisol Stress Levels

Exercise may increase stress levels

In regard to the negative effects of exercise, too much can be unhealthy. There is a point in which training and exercise become a risk. Exercise is physically a stress situation for the body. During exercise the body must adapt with the equilibrium. This process requires adaptive responses of the hormonal systems such as the HPA axis. When looking to control stress through exercise, it is important for people to regulate and find the right amount of exercise for them personally (Mastorakos et al. 2005).

A study conducted by Gonzalez et al. (2002) was designed to examine a four-month training period of two different male basketball teams. They examined the effects of training on the salivary testosterone (Tsal), salivary cortisol (Csal) responses, and differences in the salivary testosterone/cortisol ratio (Tsal/Csal ratio) after acute physical training. Tsal and Csal were measured by collecting saliva samples. The professional athletes were chosen from the National Spanish Basketball League. The participants were drug free and healthy.

The baseline levels of Tsal and Csal were measured before the basketball season had started, and the participants had not engaged in training for at least 6 weeks. Participants took part in an incremental graded exercise (GXT). This GXT consisted of riding an exercise bicycle in three phases. The first phase was a warm up with light cycling. The second phase was the test phase. The test phase started out at 30 watts of cycling and increased 30 watts until exhaustion. This was followed by a recovery phase of light cycling. Tsal and Csal levels were measured 20 minutes after cycling. This same test was performed 4 months later after the season had started and participants were engaging in normal training. Team 1 engaged in the highest amount of training during the season, and team 2 engaged in a lower amount of training (Gonzalez et al., 2002).

The results show that neither team had differences among Tsal levels from the pre-test to the post-test. The Csal levels of team 1 did not show any changes; however, team 2 did show an increase in Csal. For team 2, training caused an increase of cortisol instead of a reduction. This could reflect that team 1 adapted better to the training than team 2 due to the possibility of over-training. At the end of this study, Gonzalez et al. (2002) ultimately concluded that exercise did not work as a successful stress coping mechanism for team 2.

The correct amount of exercise is needed to reduce stress

A person's response to stressors is typically a reaction of the organism trying to compensate for the stress. This reaction activates the HPA axis, which releases the chemical cortisol into the blood stream. De Vries et al. (2000) investigated if incremental exercise could be used as a model stressor to disclose a pattern of activation in the HPA axis. Eight healthy men (ages 19-26 years old) fasted overnight and then cycled at 40, 60, 80, and 100% of power output. For the purpose of this study,

power output relates to the amount of energy exerted during exercise (de Vries et al., 2000). This was done in successive time increments of 10 minutes each up to exhaustion. Blood was drawn before the exercise, at the end of each time increment, and during the exhaustion state 5 and 30 minutes after the exercise in order to measure cortisol, endorphin, and prolactin levels. These were markers of workload-related responses.

This study concluded that cortisol was a delayed response to the stressor. This may be the result of a drop in blood glucose levels. Cortisol increased for a short time period only during or after intense exercise. It could be considered to be the body's way of preparing muscles and protecting against muscle damage. The researchers concluded that the activation of these stress hormones occurred at different time points. It seems that these hormones play different roles in preparing for physical activity and recovery. This shows that exercise can actually be a stressor on the body rather than decreasing the stress of a person (de Vries et al. 2000).

Exercise affecting stress levels varies from individual to individual

In a study done by Harbach et al. (1999) cortisol levels were not the same for every individual after exercise. Fourteen male volunteers participated in a study in which cortisol levels were measured. All participants were drug free including alcohol and medication. Three of the men smoked, but less than 10 cigarettes a day. They had no history of disease or psychological disorders. All of the volunteers participated in 2 to 6 hours a week of physical activity.

For the study, participants ran 3 km outdoors at their own comfort level. After this task was completed participants ran up 8 floors of a building. The exercise lasted roughly 20 minutes. Blood samples were collected from the participants before and after the workout. Cortisol levels were measured from the plasma samples. The findings indicate that cortisol levels were different for individuals undergoing the same workout. After the workout cortisol levels increased slightly or decreased in some participants. This study shows that there is individual variation in how exercise can impact cortisol levels. Stress is not strictly a biological concept including hormones. It encompasses a person's unique psychological makeup (Harbach et al., 1999).

Exercise can reduce cortisol stress levels

A study by West et al. (2004) found positive effects of exercise on stress. In this study participants were healthy college students who were enrolled in classes of Hatha yoga, introductory biology, and African dance. A total of 69 participants were divided into three groups: 21 were enrolled in African dance, 30 from biology, and 18 from Hatha yoga. The student's age range was from 17 to 24 years of age, (M = 19). All classes were promptly 2 hours in length. At the beginning and end of each class, salivary cortisol levels were measured. Students were also asked to fill out the Perceived Stress Scale (PSS). The findings of this study confirmed that participants in the African dance and Hatha yoga class reported decreased perceived stress compared to participants in the biology class. Cortisol levels increased in African dance, decreased in Hatha yoga, and did not change in biology class (West et al., 2004).

West et al. (2004) concluded that the incongruence between cortisol levels and the PSS results could be attributed to changes in physiological arousal and its different effects on cortisol. Both the Hatha yoga and African dance groups showed lowered perceived stress; however, there was not a significant relationship between perceived stress and cortisol levels. Both Hatha yoga and African dance reduced perceived stress, even though they are different physiologically. Cortisol is a steroid that is a regulation of physical arousal. This could be why African dance produced higher levels of cortisol, yet a lowered perceived stress level. Over time, however, both Hatha yoga and African dance showed reductions in baseline cortisol levels that contributed to the students' overall health. The results of this research are consistent with findings that have shown exercise as a way to decrease stress levels (West et al., 2004).

Exercise and depression

Nabkasorn et al. (2005) investigated exercise as a coping

mechanism for stress in patients with depression. The participants for this study included 266 female volunteers whose ages ranged from 18 to 20 years old. All participants were recruited from the Chronburi, Thailand university nursing program. Participants were screened for depression using the Center for Epidemiologic Studies Depression (CES-D) rating scale. Out of 266 participants, 152 did not meet the criteria for clinical depression, leaving an eligible sample size of 114 participants with depression. Participants were excluded from the study if they had ever taken anti-depressant medication, had health problems that interfered with physical activity, or had participated in strenuous physical activity in the prior 6 months. Only 59 of the 114 participants agreed to the study and provided informed consent.

Participants were divided into two groups. The treatment group took part in an 8-week physical exercise program. The control group continued with their daily routines. All participants were asked to complete the CES-D every four weeks in order to measure depression levels. Urinary secretions of cortisol were measured every 24 hours in order to measure psychological stress levels. Of the 59 original participants, five failed to complete the exercise program. Three dropped out because of lack of motivation, and two participants attended less than three sessions per week. The results were based on the remaining 49 participants (Nabkasorn et al., 2005).

The treatment group, who completed the exercise regime, was able to lower their levels of cortisol. They also had lower CES-D scores compared with the control group. In contrast, the control group showed no change in cortisol levels and no significant change in CES-D scores. Researchers concluded that exercise was beneficial to lowering stress and decreasing depressive symptoms. These findings directly support the idea that exercise can decrease the stress cortisol levels of college age students (Nabkasorn et al., 2005).

Conclusions

Research has shown that exercise can be successful in decreasing the cortisol stress levels of college age people. The research by West et al. (2004) suggests that in some cases cortisol stress levels are lowered as a result of exercise. The research conducted by Nabkasorn et al. (2005) also showed that cortisol can be decreased as a result of exercise in patients with depression. After completing an exercise regime, patients demonstrated lower levels of depressive symptoms in addition to lowered levels of cortisol. Harbach et al. (1999) found the effects of exercise on cortisol stress levels can vary from individual to individual. Stress not only encompasses the biological components such as cortisol levels, but also a person's psychological make up.

Although appropriate exercise has positive effects on stress levels, the health benefits of exercise are mediated by an individual's temperament for an optimal level of exercise. De Vries et al. (2000) concluded that exercise can actually be a stressor on the body. Cortisol stress levels could also be related to the amount of physical exercise being performed. Gonzalez et al. (2002) concluded that cortisol levels of basketball players differed at baseline depending on how much training the players were undergoing at a certain time.

Implications

These findings show many implications for using exercise as a means of stress management. It is important for people to understand both the positive and negative effects of exercise. Exercise is certainly healthy for individuals; however, finding the appropriate exercise regime is important. Every person is unique and needs to find an exercise regime that works best for them as an individual. Stress can cause many different health problems, and it is important to find an appropriate way to cope with stressful situations, including psychological health problems as well as physical health problems. This is why it is important to learn the right strategy for coping with stress. Too much exercise is not good for a person's stress level. With this being stated, too little exercise is not good for a person's stress level either. The correct amount is needed to successfully reduce stress, and finding the correct moderation between the two can be useful for reducing stress levels (de Vries et al., 2000).

Limitations and Future Directions

Limitations to this area of research include the limited age range of participants and baseline activity levels. Age could be a factor that

could cause problems generalizing these studies to the general population as the studies reviewed in this literature were conducted using college age people. College age people might have a higher base level of cortisol than other age groups because of their lifestyles. College can be stressful, creating higher stress levels compared to people who are older, or not in college. This could affect the measurement of baseline cortisol. Different baseline levels of cortisol would make it very difficult to generalize this information to the general public (West et al., 2004).

The amount of physical activity people perform on an everyday basis may also change their level of cortisol. For example, a person with a very physically strenuous job might have higher levels of cortisol making it harder to generalize to the larger population as well. The strenuous workout of African dance increased cortisol levels, so it could also be possible for a physically strenuous job to affect the amount of cortisol in a person's body (West et al., 2004).

Areas of future study might include the effects of exercise on stress in an older adult population. Being able to replicate these results with multiple populations would support the hypothesis of exercise as a stress moderator. Knowledge of these results could possibly educate people better about the importance of exercise as a coping mechanism for stress. People should be encouraged to find an exercise regime that works best for them individually. It not only reduces acute stress, but also long-term stress as well (de Vries et al., 2000). The knowledge of exercise and stress levels could also be applied more often as a treatment for depression and other psychological disorders, decreasing dependence on medication. Exercise has been shown to be a powerful protective factor against depression, with people who exercise regularly being at a reduced risk for developing depression. Research on the correlation between exercise and depression could also be expanded to other psychological disorders as well. In the future, exercise could be used as a prevention and treatment mechanism (Nabkasorn et al., 2005).

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