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The Physiological and Psychological Connection:
The Body's Response to Ceased Exercise from Athletic Injury

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Abstract

While there is extensive research on both the physiological and psychological effects of exercise, there is limited research that draws connections between the two. One clear cut example of how these two intertwine is through an athletic injury. By exploring the previous research of others, this paper attempts to draw a connection that reveals the impact that physiological and psychological responses have on one another when exercise is ceased due to an athletic injury. First, this paper explores the physiological responses and effects from exercise. Next, it looks into both the short-term and long-term psychological effects of exercise. Then, it investigates the body's response to injury, as well as the overall physiological effects from ceasing exercise. The focus then shifts to the general psychological decline from the absence of exercise and hones in on the psychological response from an athletic injury. The paper ties together in the end by drawing a connection between both the physiological and psychological responses.

Keywords: athletic injury, physiological response, psychological response, ceased exercise

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When exercising, a person will experience both physiological and psychological effects. While the overall physiological aspects of exercise are generally backed by extensive, credible research, the psychological effects can tend to vary greatly from person to person, which can make it somewhat difficult to make generalizations from specific study results. Because of this, it is difficult to find research that makes a definite connection between the physiology and psychology of exercise. Athletes, who exercise on a regular basis, are a group of people that become accustomed to both effects over time. Therefore, when an injury occurs in this group of people, the body responds to the lack of exercise, both mentally and physically. By first focusing on the body's general physiological responses to exercise and the psychological effects that accompany it, and then exploring what happens both physically and mentally when regular exercise ceases, a connection can be drawn that relates the physiological changes occurring in an injured athlete to the cognitive thought process associated with injury.

While there are many specific and detailed physiological responses that occur during exercise, the major reactions come from the cardiovascular and respiratory systems. Chemical, mechanical, and thermal stimuli all influence the function of these two systems, and the response to each of these is reliant on the intensity, duration, and frequency of exercise (Burton, Stokes, & Hall, 2004). In general, metabolic processes speed up during exercise, creating more waste, and it is the job of these systems to help control and regulate the excess energy and other waste products (Willmore & Costill, 2005).

The cardiovascular system is a good starting point when examining the physiological responses during exercise. Overall, this system has five central functions during exercise:

distributes oxygen to working muscles, oxygenates blood, relocates heat from core to skin, distributes nutrients to active tissue, and transports hormones (McArdle, F. Katch, & V. Katch, 2000). As the intensity of exercise increases, a higher demand is placed on the cardiovascular system (Wilmore & Costill, 2005). In fact, there is a demand placed on the cardiovascular system before starting exercise. In anticipation to exercise, the body releases epinephrine and norepinephrine, which increase heart rate before physical exercise even begins (McArdle et al., 2000). As exercise begins and continues, heart rate will increase linearly with the intensity of the workout until a max heart rate is reached, and it is at this point where heart rate will plateau even if work rate continues to increase (Rowell, 1993). No matter how much training an individual has, the max heart rate will remain unchanged, and in fact, in elite athletes, max heart rate may even decrease slightly (Wilmore & Costill, 2005). In trained athletes, however, the heart rate will return back to its resting rate much quicker, and overall, trained athletes will tend to have lower resting heart rates (Wilmore & Costill, 2005).

Another important aspect of the cardiovascular system during exercise is stroke volume, or the how much blood is expelled per beat from the left ventricle in milliliters per beat (Wilmore & Costill, 2005). Stroke volume increases linearly with exercise intensity, and elite athletes will have higher resting and active stroke volumes (Wilmore & Costill, 2005). There are a few explanations as to why stroke volume increases with regular exercise. One reason is the Frank-Starling Mechanism, which is the mechanism that as the left ventricle fills with blood more completely during exercise, it stretches further, which causes it to recoil with a more forceful contraction, producing a higher stroke volume (McArdle et al., 2000). Stroke volume also increases because vasodilatation occurs in the blood vessels, reducing resistance (McArdle et al., 2000).

Heart rate and stroke volume are related through cardiac output, which is the amount of blood pumped by the heart in one minute and is measured in liters per minute (McArdle et al., 2000). The relationship is stroke volume multiplied by heart rate equals cardiac output, and if stroke volume, heart rate, or both increase, then cardiac output will increase as well (McArdle et al., 2000). Also, just like heart rate and stroke volume, cardiac output increases linearly with the intensity of exercise (McArdle et al., 2000). Even though max heart rate is often lower in highly trained athletes, they will still have a higher cardiac output due to an increased stroke volume because of hypertrophy in the left ventricle of the heart (Burton et al., 2004).

The flow of blood is also affected by exercise; the cardiovascular system redistributes blood to tissues with the highest immediate need for blood (McArdle et al., 2000). During exercise, blood flow is increased to the muscle, heart, and skin while it is decreased to other smooth muscles, such as the stomach and liver (Burton et al., 2004). At rest, only about 15-20% of the body's blood circulates through skeletal muscle and can increase up to 80-85% during strenuous activity (McArdle et al., 2000). As body temperature rises from physical activity, the cardiovascular system is responsible to help regulate a homeostatic temperature (McArdle et al., 2000). The extra heat generated is dispersed when blood supply is increased to the skin; this brings heat to the skin that is then cooled via the evaporation of sweat (Burton et al., 2004). Extra heat is also dissipated via expired air during ventilation (Burton et al., 2004).

Then ventilation system is also vital to the physiological response to exercise. When exercising at a submaximal level, ventilation increases in proportion to work rate, going from about 5-6 liters/min to 100 liters/min (Burton et al., 2004). The increase in pulmonary ventilation, which resembles the increase of oxygen uptake and carbon dioxide output, is due to the increase in tidal volume, as well as a higher respiration rate (Burton et al., 2004). The

respiration rate can even continue to remain elevated after heavy exercise for up to a possible 1-2 hours (Burton et al., 2004). One reason the respiratory rate increases from physical activity is because the requirement of oxygen by skeletal muscles vastly increases (McArdle et al., 2004). Just like ventilation, oxygen consumption increases in proportion to the increase of work at submaximal levels, and overall, elite athletes will also have a higher oxygen consumption rate than the average person (Burton et al., 2004). Eventually, oxygen consumption will be higher than oxygen input, causing the production of lactate. As enough lactate builds up, the lactate threshold is reached, which is the point when the clearing of lactate is no longer able to keep up with lactate production during physical activity (McArdle et al., 2004). When the lactate threshold is reached, the muscles begin to fatigue to the point of exhaustion (Farrell, Wilmore, Coyle, Billing, Costill, 1979). The higher a lactate threshold a person has, the better athletic performance they will have, so trained athletes on average have a significantly higher lactate threshold than untrained people (Farrell et al., 1979).

Regular exercise also results in physical changes that can be visibly seen. When someone exercises to the point where energy input is less than energy output, then the overall body composition changes, such as decreasing body fat and increasing muscle tone for an overall weight loss (Kravitz, n.d.). The increase in muscle tissue, or hypertrophy, is a result of an increase in muscle cell size; the fibers within the muscle also become larger and thicker (Wilmore & Costill, 2005). The fibers in the muscle increase for numerous reasons: greater number of contractile proteins, larger myofibrils in each fiber, more connective tissue, and a greater amount of enzymes and nutrients (Wilmore & Costill, 2005). According to Powell and Blair, as well as Hillsden and Thorogood, regular exercise can help prevent different somatic complains, as well as heart disease, hypertension, types of cancers, diabetes, and osteoporosis (as

cited in Scully, 1998). Also, according to Blair et al., obesity and all-cause mortality rates are decreased due to regular exercise (as cited in McAuley, Lox, & Duncan 1993).

While it is more than clear that there are many physiological advantages to consistent physical activity, there are also a plethora of psychological advantages. According to Smith et al., in actuality, the psychosocial advantages to exercise might even outweigh the physiological gains (as cited in Scully, 1998). Dishman, as well as Sallis and Hovel, also add that exercise is very dynamic, and as someone partakes in physical activity, they move through different phases of participation, where various aspects play different roles that overall help to create psychosocial benefits (as cited in McAuley, et al., 1993). Smith et al. also found that when general practitioners are asked about the health benefits of exercise, they usually bring up the psychological effects, including relaxation, more social contact, and an increase in both self-care and self-esteem (as cited in Scully, 1998).

The long term psychosocial advantages to consistent exercise are numerous. Dustman et al. found that it will lead to greater cognitive function, and McAuley et al. (1991) discovered that personal efficacy awareness is also increased (as cited in McAuley et al., 1993). Bandura defines self-efficacy as “the individual’s belief in his/her capabilities to execute the necessary courses of action to satisfy situational demands” (as cited in McAuley et al., 1993, p. 218). Bandura goes on to also say that self-efficacy could possibly influence the activities that individuals choose to approach, as well as the effort they put into these activities, and also the degree of perseverance in averse circumstances (as cited in McAuley et al., 1993). According to McAuley (1992) it has been shown that even short exercise sessions can boost self-efficacy (as cited in McAuley et al., 1993). While there is some controversy as to whether the type of exercise matters, in a paper reviewed by Rejeski, aerobic exercise is overall typically better than anaerobic exercise in

improving overall psychological function and enhancing one's general mood (as cited in Scully, 1998).

Not only has exercise been linked to improving self-efficacy, but it has also been linked to decreasing negative psychological functioning, and research done by Scully helps to support this. In 1992 the International Society of Sport Psychology backed findings by the American National Institute of Mental Health that found a link between physical activity and mental health, stating that depression, anxiety, and stress can benefit from exercise (as cited in Scully, 1998, p. 112). McAuley has backed this even further by showing through his work that there is a negative correlation between exercise and anxiety, stress, and depression (as cited in Scully, 1998). Clinical depression, according to research done by North et al., has even been shown to be reduced by both acute and chronic physical activity, although the longer length and higher frequency of exercise have a greater decrease of depression (as cited in Scully, 1998). In 1990, Martinsen did a study testing the effects of exercise on sedentary patients diagnosed with clinical depression and found some very interesting results. First off, his study showed that anaerobic exercise is just as effective as aerobic activity in reducing depression; second, the patients actually ranked physical activity as being the most important aspect in the treatment program for improving depression (as cited in Scully, 1998). Finally, Martinsen's study also revealed that the patients that continued to exercise regularly after the one year program reported having lower depression than those who did not continue exercise after the program ended (as cited in Scully, 1998).

Depression is not the only negative mental health dysfunction that exercise is shown to improve. A meta-analysis by Long and Stavel reviewed studies that distinguished between coping with stress versus not coping, and from this meta-analysis, they found that aerobic

training programs can help to diminish anxiety, especially work-related anxiety (as cited in Scully, 1998). To add to this, Landers and Petruzzello found that no matter what kind of anxiety measures were taken or what type of exercise routine, there was always a link between physical activity and the reduction of anxiety (as cited in Scully, 1998). What is surprising is that even one, quick workout session can implement an anxiolytic effect, with the longest exercise programs producing the greatest effect (Scully, 1998).

Interestingly enough, there has been a positive correlation between exercise and the reduction of pms symptoms, which brings a connection between the physiological and psychological effects of exercise. In a study done by Israel, Sutton, and O'Brien, participants were put on a twelve week exercise regime that included 30 minutes of jogging/walking for three times a week, and when compared to a control group, the participants in the exercise program had improvements in their PMS symptoms (as cited in Scully, 1998). In a similar study performed by Steege and Blumental, participants were put on training programs that included anaerobic and aerobic exercise for an hour three times a week for twelve weeks; the results concluded that both forms of exercise lessened premenstrual severity, but aerobic activity had a greater result on premenstrual depression (as cited in Scully, 1998). There are many theories as to why there is a connection between reduced PMS symptoms and exercise. One is that athletic women have lower levels of oestrogen when compared to women that do not exercise, and the decrease in this hormone, combined with the increased levels of progesterone help to reduce the severity of symptoms (Scully, 1998). According to Wells, however, the lower levels of oestrogen could be due to decreased body fat since adipose tissue is a source of oestrogen rather than directly related to exercise (as cited in Scully, 1998). Either way, the reduced adipose tissue is more than likely a result of the exercise, which still creates a link between the two. According to

others, however, the severity of PMS symptoms could be related to considerable changes in endorphin levels before menstruation, and regular exercise might actually help to stabilize endorphin levels, which reduces the severity of PMS symptoms (Scully, 1998). While it is uncertain why the link between the two exists, it seems fairly apparent that exercise does in fact reduce the symptoms of PMS. Because of this, there seems to be a relationship between how physiology (changes levels of hormones due to exercise that reduce physical symptoms) and psychology (reduction of PMS depression due to exercise) can be linked through physical activity.

Now that the positive effects of exercise have been explored, it is now important to examine how the body responds when an athlete suddenly stops exercising due to an injury. In this type of scenario, the body not only has to respond to the immediate injury but the overall physiological response due to ceased physical activity. The body's immediate response will be to deal with the injury at hand. One of the first reactions the body has to injury is the inflammatory response, which occurs immediately after any type of tissue is damaged ("Inflammation & Tissue Healing," n.d.). The article continues to explain that this response occurs for two reasons: to defend against harmful substances and to dispose of any dying or already dead tissue, which helps to allow for the regeneration of healthy tissue. There are five signs that are typical of the inflammatory response: heat as a result of increased blood flow to the injured area, from the vasodilatation of the blood vessels at the injured sight; pain caused by chemicals released which helps to prevent further tearing; swelling or edema attributable to an increase in fluid in the injured area; and finally, an overall loss of function in the area around the damaged tissue as a result of the swelling and pain, which also helps to prevent further injury to the tissue ("Inflammation & Tissue Healing," n.d.).

The inflammatory response can be divided into two stages: early and late inflammation, with the latter usually occurring around two to four hours after early inflammation begins (Kaiser, 2011). This early stage begins with the actual tissue injury, which can be caused by trauma or overuse of the tissue, which is sometimes referred to as microtrauma (“Inflammation & Tissue Healing,” n.d.). Followed by the injury is the release of chemicals that can cause greater sensitivity to pain; these chemicals, which include kinins, prostaglandin, and histamine, cause increased vasodilatation, as well as initiate chemotaxis, or the attracting of natural defense cells to the injured area (“Inflammation & Tissue Healing,” n.d.). This is when the second stage of the inflammatory response begins to kick in (Kaiser, 2011). In this stage, two types of leukocytes migrate to the injured area: neutrophils, which are the first to arrive to neutralize the effects of potentially harmful bacteria and macrophages, which engulf bacteria and dead cells; these white blood cells will arrive within 72 hours and will stay in the area for weeks, depending on the severity of the injury (“Inflammation & Tissue Healing,” n.d.). The actual healing of the injured tissue is the next process to occur in the inflammatory response and has four specific qualities: collagenation, which is the regeneration of new tissue by fibroblasts; angiogenesis, which is when new capillaries are produced to allow for blood flow to help cells grow; proliferation, which can last up to four weeks and is when scar tissue (leading to decreased functioning) begins to form in the more severe injuries; and finally remodeling, which can last from months to years as the newly generated cells are molded to the surrounding tissue (“Inflammation & Tissue,” n.d.).

Oftentimes athletics injuries also occur is harder, bone tissue. When a bone is fractured or broken, the affected limb or area is oftentimes placed in a hard cast for weeks or months, depending on the severity of the injury. When this happens, changes in the bone and muscle

occur almost immediately; atrophy occurs in the skeletal muscles as they decrease in size, causing a decline in muscular strength and power (Kenny, Wilmore, & Costill, 2012). Because the affected area is completely immobile, there is rapid loss in the functioning of the area (Kenny, et al., 2012). A study done by MacIntyre, Bhandari, Blimkie, Adachi, and Webber looked at the changes in the forearm bone after nine adults had a cast on for six weeks and then followed a yearlong strengthening program (2001). Since the sample size was so small, general conclusions cannot be drawn, but in this study the subjects had a decline in wrist mobility as well as the strength of their grip from their arm being in a cast, but these were regained after three months of following the strengthening program (MacIntyre et al., 2001). Another interesting pattern noticed was that the middle the radius bone had shrunk after six months of removing the cast, but was improved after a year of remobilization, and it is thought that this decrease in size was due to bone morphology in the cast since the actual bone density was never reduced (MacIntyre et al., 2001). While general conclusions may not be able to be made, based off this study, it appears that an injury to hard tissue can cause significant decrease in functionality that takes much longer to regain than it does to lose it.

Because many sports injuries can take several months or even years to recover from—if they ever fully recover at all—general changes in physiological fitness begin to occur due to a more sedentary lifestyle. In general when an individual has a higher fitness level, they tend to have a higher decline in fitness from the ceasing of exercise (Berlin, Kop, Deuster, 2006). In the study performed by McAuley et al., individuals participated in a 5 month regimented exercise program and were examined at a nine month follow up (1993). Those that failed to continue exercising after the program ended showed significant decreases in physiological functioning: general cardiorespiratory functioning declined, as well as muscular strength and flexibility

(McAuley et al., 1993). There was, however, little change in overall body composition (McAuley et al., 1993). In a study done by Berlin et al., they mention how the manipulation of physical activity levels by imposing bed rest can decrease a person's VO_2 max levels by anywhere from 11-17% depending on how fit the person is and how long they are subjected to bed rest (2006). Pfitzinger takes this even further by commenting on effects that occur when an endurance runner stops training (2004). In only 2-4 weeks of stopped endurance training, VO_2 max decreases up to 4-10%, blood volume reduces by 5-10%, stroke volume lessens by 6-12%, and heart rate increases 5-10%; overall flexibility and lactate threshold also reduce significantly (Pfitzinger, 2004). To put this in perspective as to how much this can affect ability, it was also shown that after three to four weeks of no training, athletic performance declines 3-5%; for example, a person who runs a 10K in forty minutes should expect to be one to two minutes slower after three weeks without running (Pfitzinger, 2004). It really is incredible how quickly physiological decline can occur due to lack of exercise, especially when considering how much training goes into achieving high athletic performance.

It should probably come as no surprise that there many psychological responses that tend to be associated with the cessation of exercise, and these can occur just about as quickly as the physiological effects. It has been noted that when behaviors become routine, such as regular exercise, cognitive control systems also become routine to the behavior (McAuley et al., 1993). Therefore, when a routine behavior becomes sporadic or is stopped all together, a higher demand is placed on the person's cognitive control, and systems such as self-efficacy are brought to higher attention (McAuley et al., 1993). McAuley et al.'s study actually showed that after a nine month break from five months of consistent biking and sit-up training programs, there were significant decreases in self-efficacy (1993). Therefore, this could possibly be due to the fact that

ending the regular exercise routine brought greater attention to self-efficacy and because the routine was ceased, it brought about worse feelings associated with self-efficacy. Their study also concluded that a single session of biking or completing performance tests increased self-efficacy back up to a level that no longer showed any significant difference (McAuley et al.; 1993). This would imply that positive feelings of self-efficacy are fairly easy to re-obtain by getting back into an exercise routine. In a study done by Morgan et al., they speculated that ending routine exercise could result in certain dysphoric states that include increased anxiety, depression, restlessness, and guilt (as cited in Scully, 1998). Although research on this limited, many different studies seem to coincide with these speculations. In fact, widespread clinical observations seem to concur that depressive symptoms tend to be very common once routine aerobic exercise is stopped (Berlin et al., 2006).

The study done by Berlin et al. has linked psychological responses to ceased physical activity. It has been consistently documented that the ending of regular physical activity can lead to low energy, fatigue, tension, confusion, lowered self-esteem, insomnia, and irritability (Berlin et al., 2006). While this seems to be pretty consistent, these symptoms are usually documented in a naturalistic setting, making it unclear as to if these are a direct result of the lack of exercise or if other factors contribute to this. To examine if these depressive symptoms are in fact due to the withdrawal of physical activity, Berlin et al. conducted a study where forty regular exercisers were randomly assigned to either continue exercise or withdraw for two weeks (2006). Their results conclude that somatic depressive symptoms, such as fatigue, increased after one week, with symptoms of depression occurring only after two weeks of ceased exercise (Berlin et al., 2006). Overall, exercise withdrawal led to a significantly higher negative mood as well as a general loss of vigor (Berlin et al., 2006). Not only does this prove in a clinical setting that these

somatic and depressive symptoms are in fact linked to lack of regular exercise, but it also shows how quickly these effects can begin to take place.

It has been found that even temporary periods of lowered physical activity that is due to injury results in depressive symptoms and fatigue (Berlin et al., 2006). Athletes that experience an injury are not only subjected to the general depressive symptoms due to ceased exercise, but they also have increased psychological responses due to the injury and lack of being able to participate in their sport. While different research varies on the emotional responses to an athletic injury, a critical review by Walker, Thatcher, and Lavallee does a good job at examining the different theories that have been crafted. Some research suggests that the athletes suffering from an injury go through the same grieving progression as people suffering from bereavement, illness, and disability (Walker, Thatcher, & Lavallee, 2007). In fact, sports psychologists during the 1980's and 1990's used the Kubler-Ross stage theory model almost religiously when examining injured athletes that states that grieving individuals go through five chronological stages: denial, anger, bargaining, depression, and acceptance (Walker et al., 2007). However, in more recent times, strictly using this model has been debated. Heil stated that it cannot be known how generalized how characteristic the grief response is in all injured athletes; he proposed that this grief process could be limited to only severe or traumatic injuries (as cited in Walker et al., 2007). To add to this, Udrey et al. found that there is only minimal support for the denial stage in injured athletes, and there is no support for that these athletes experience the bargaining stage; instead it is proposed that athletes do not deny the existence of their injury but are more than likely just trying to make sense of it and determine its severity (as cited in Walker et al., 2007). While athletes may experience the same emotions that occur in these grief models, there is no

actual documentation that proves there is a common sequence in which these psychological responses occur (Walker et al., 2007).

Wiese-Bjornstal, Smith, Shaffer, and Morrey proposed the Integrated Stress Process Model that states that the feeling of a sense of loss the athlete feels occurs after an appraisal, or assessment of individual coping, and it is this that causes the injured athlete to experience emotions similar with grief (1998). Therefore, in this model, grief is actually another emotional response to injury, as opposed to being the overall process an athlete goes through when coping with an injury; this is the most accepted and well-developed model to date (Walker et al., 2007). As suggested by Anderson and Williams, the first section of this model discusses the impact of different psychological variables on the likelihood of the onset of an injury (as cited in Walker et al., 2007). The remaining sections examine the degree of the stress response after injury occurs from cognitive appraisals, or the affected emotional responses of fear, anger, tension, etc., as well as the behavioral responses, such as how well the athlete follows rehabilitation (Walker et al., 2007). This model also takes into consideration the characteristics of the injury, situational factors specific to the sport in which the injury occurred, and general individual differences (Walker et al., 2007). When using their model, Wiese-Bjornstal et al. suggested that some athletes actually convey relief when they are injured because they no longer feel all the external pressures related to playing a sport, such as perfectionism, commitment, the coach and teammates, etc. (1998). Other athletes, on the other hand, feel an overwhelming sense of loss (Wiese-Bjornstal et al., 1998). They even found that some athletes may recover beyond their abilities before they were injured because oftentimes an athlete can become more dedicated and focused, as well as stronger mentally, after going through rehabilitation (Wiese-Bjornstal et al., 1998). Because there seems to be many different responses to injury and how an athlete responds

to it, it seems as if the Integrated Stress Process Model is in fact the most accurate because it takes all of these different factors into account, rather than some of the previous models used when assessing injured athletes.

In general, when asked to rank the typical emotional responses felt after injury, most athletes listed these as the most common: tension, anger, depression, frustration, and boredom (Walker et al., 2007). Many injured athletes also experience fear because they are afraid they will lose their spot on the team or re-injure themselves (Walker et al., 2007). While this is generally not the case, some studies have reported that 10-20% of injured athletes have extreme emotional responses, in particular depression, that are at a level that would necessitate clinical referral (Walker et al., 2007). Finally, another major emotion experienced when an athlete suffers from injury is the emotional trauma that occurs from feeling as if they have lost their sense of identity (Lockhart, 2010). Signs that an athlete feels they have lost their identity include: self-talk, lack of concentration, uncontrollable thoughts, and self-doubt (Lockhart, 2010). To measure the degree in which an athlete connects his or her identity to sports, the Athletic Identity Measure Survey (AIMS) has been created; those with a higher correlation between athletics and identity have more symptoms related to depression because these athletes feel as if they have lost their identity since they are no longer able to physically perform (Lockhart, 2010). Although athletes all have different emotional responses when coping with an injury, it is more than apparent that an athletic injury creates just as much of a psychological response as it does a physiological one.

By first exploring the positive physiological and psychological effects of exercise and then contrasting that with negative physiological and psychological responses due to ceased exercise from injury, it is possible to see how there is an interaction between the two and how each can affect the other. It is important to note that while it is possible to draw links between

physiological and psychological responses, there has not been a lot of research or studies conducted that directly link the two, so much of the connection is theoretical, rather than factual. One connection between the two is that there appears to be a relationship between low physical activity and depressive symptoms; it is possible that this has something to do with the physiological changes from reduced exercise levels, such as decreased VO₂ max (Berlin et al., 2006). In revisiting the study by Berlin et al., the results showed that level of somatic symptoms at week one predicted the degree of cognitive-affective symptoms at week two, and a possible explanation for this is that the somatic symptoms are due to an early onset of biological consequences of exercise withdrawal (2006). In this same study, cardiopulmonary measurements of fitness revealed the level of decreased fitness over the two week period was parallel to a decreased mood (Berlin et al., 2006).

General research has also shown that injured athletes that attend rehab with maximal effort, use psychological skills, and take advantage of any social support available are more likely to recover from an injury (Wiese-Bjornstal et al., 1998). This reveals that psychological well-being is just as important for recovery of an injury as rehab exercises. Another connection that can be made between physiological and psychological responses is the idea behind the “runner’s high.” While there is little evidence to support this, Steinberg et al. hypothesize that exercise releases endorphins in which the body becomes physiologically dependent on (as cited in Scully, 1998). If this were able to be proven through research, it would mean that the body can become physically dependent on the good mood effects from endorphins released during exercise. This notion of the “runner’s high” is backed by research done by Grossman et al. on the idea of exercise addiction, which is a contention being made that mood enhancing properties linked with exercise are influenced by chemicals in the brain similar to opiates (as cited in

Scully, 1998). If this were in fact the case, when regular physical activity is ceased, the body's physiological addiction to these chemicals could be associated with the depressive mood symptoms seen when exercise is ceased.

While there is debate on specific examples that link the physiological and psychological responses to exercise, one thing is for certain that they do exist. Even though more research is required, based off the studies reviewed in this paper, there seems to be a clear link between self-efficacy and physiological functioning. The decreased functioning that occurs in the body from lack of exercise can possibly lead to lower self-efficacy. This, in turn, decreases overall cognitive functioning, which helps to create a lowered self-esteem and allows for depressive mood symptoms to take over. If this link between physiological responses and psychological well-being is strengthened, then exercise could possibly be proven to be an effective, safe way to overcome depressive mood states. On the other side, if someone is depressed due to lack of exercise from an athletic injury, understanding the psychological connection to the injury could potentially help the patient accelerate in rehabilitation. Either way, it is imperative that the connection between the two be strengthened by further supportive research because it would lead to overall positive effects and better understanding between the correlation of the mind and body.

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