

Overtraining in Sports and its Impact on Athletes

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Victoria Allocco

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Cathy Houston-Wilson

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Cathy Houston-Wilson

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Abstract

Athletic participation has increased across the country for individuals of all ages. There are more opportunities to join organizations competitively, which can consist of intercollegiate or travel teams. There is pressure in society to be the best at the individual's selected sport, which can cause some concerns. To perform at a higher level than their teammates, athletes may feel obligated to train and practice excessively. Several hours of training and practice can result in injuries or illness. These conditions could result in physical impacts, which can affect an individual's body functions. In addition, a significant number of hours engaged in sport participation is linked to influencing one's mental well-being. If the necessary steps aren't taken when an athlete is overtrained, this may result in long-term or chronic damage.

Keywords: athletic participation, physical impacts, mental well-being, chronic damage

Chapter 1: Introduction

Overtraining is an issue that individuals at all levels of sport participation might encounter at some point in their career. It can be defined as extreme stress on one's body which can have several effects on the health and sports performance at any level (Guimaraes et al., 2017). In many circumstances, these effects can be short-term and can be resolved within a timely manner. However, there are instances where in more serious cases, these impacts can be long-term. Signs and symptoms must be recognized as soon as possible to give the best chance to prevent severe problems. It is significant to treat an athlete at any of these levels with the same degree of urgency, as this could be detrimental to their long-term health. These effects can differ in severity depending on how the injury was caused (Guimaraes et al., 2017).

Coaches and coaching personnel must be educated on the effects of overtraining and the impact of it on an athlete's well-being. An administrator or coach must acknowledge there is more to overtraining effects than just the physical aspects. Overtraining can lead to issues with an individual's mental well-being in some situations. Some of the signs and symptoms of overtraining include decreased appetite, inability to sleep, anxiety disorders, and depression (Guimaraes et al., 2017). It is also known that decreased performance, fatigue, and mood changes can be additional signs of overtraining (Cadejani & Kater, 2019). Main and Landers (2012) have stated that in extreme situations overtraining can make an individual devalue their sport.

Research explains the theories behind the reasoning behind why an athlete might overtrain. According to research, one of the reasons an athlete might overtrain is because they are trying to prevent the possibility of losing a game (Tuncel, 2015). In ancient times losing a

game could cause feelings of shame for an athlete, some believe this is carried into the way individuals think today (Tuncel, 2015). Athletes may feel like they need to engage in numerous hours of conditioning, strength training, and practicing in efforts to prevent the possibility of losing. At the collegiate level, athletes may feel pressured or obligated to train because they are competing at a high level. The goal of intensely training is to eliminate the feelings of anger, despair, or sadness that losing a game may cause an individual (Tuncel, 2015).

Many individuals argue over who is responsible for overtraining athletes. They may make the argument that it is the coach's job to monitor their team's practice and conditioning hours every week (Horvath & Birrer, 2021). Individuals may disagree with this and believe other athletic personnel are at fault. It is at question who is responsible for overtraining these athletes. The debate continues for who can be blamed for excessively training these individuals.

Statement of the Problem

Athletes are training and practicing numerous hours a week to be the best they can be for their team. Several hours of practice will assist each athlete in improving their skills and performance. One of the reasons the athletes engage in a significant amount of practice and training is to improve their athletic abilities, subsequently increasing their chances of winning more games. Research has shown that losing games can cause unwanted feelings to an athlete. Performing poorly and losing may cause the individual to become upset and encounter feelings of outrage and irritation (Tuncel, 2015).

Intense practices and training sessions can be detrimental to the health of an individual. Repetitive training actions can impact the physical and mental well-being of athletes. This can lead to feelings of exhaustion and fatigue if the proper precautions aren't taken. Overtraining is an aspect that athletes might encounter during their experiences as an athlete. According to a

study, overtraining can cause stress, fatigue, decreased physical health, and lower energy levels (Piacentini & Meeusen, 2015). It is significant for athletic administrators and medical professionals to identify the signs and symptoms of overtraining as early as possible.

Overtraining can influence the functions of an athlete in many additional ways if they are involved in intense training measures.

Purpose of the Study

The purpose of this synthesis project is to review the literature on the impact of overtraining on athletes.

Operational Definitions

1. Overtraining – A condition of adjusting poorly to a period of extreme stress caused by physical exertion which affects the health and sports performance of an individual (Guimaraes et al., 2017).
2. Overtraining Syndrome (OTS) – This syndrome can arise when an athlete excessively practices, does not intake the recommended number of calories, and does not receive the desired hours of sleep every night. (Cadegiani et al., 2021).

Research Questions

The following research questions will be explored during this literature review:

1. What are the physical impacts of overtraining on athletes?
2. What are the mental impacts of overtraining on athletes?
3. What are the long-term consequences for an athlete who has encountered overtraining impacts?

Delimitations

1. The articles used in the literature review of the synthesis were peer reviewed.

2. The articles used were published between the years of 2011-2021.
3. The literature review uses articles which are solely based on information regarding why athletes overtrain, the impacts caused by overtraining, and the long-term consequences of injuries that occurred during sport participation.

Chapter 2: Methods and Procedures

The purpose of this synthesis project is to review the literature on the impact of overtraining on athletes. The articles collected for this synthesis project were located using the EBSCO database from The SUNY Brockport's Drake Library. Within the EBSCO database, the SPORTDiscus database was searched. When exploring the EBSCO database, thousands of articles resulted as a result of my searches and 11 were used for the purpose of this project.

Keywords were used to narrow down the search and focus on retrieving articles which are significant to the purpose of this synthesis. These keywords include *overtraining within sports, effects, athletes, overtraining, mental health, performance, collegiate, overtraining syndrome, study, excessive training, male athletes, performance study, recovery, burnout in athletes, and physical training*. *Collegiate* was identified as a keyword because this is the level of sports that is focused on for the project. The keyword *overtraining* was used because this could be a result of an athlete who trains excessively within a designated period.

The first search within the SPORTDiscus database used the keywords *overtraining within sports*. This search resulted in 76 articles. To limit the number of articles, the search used only peer reviewed journals and sources with a published date from 2011-2021. Another keyword that was used is *effects*. This search resulted in seven results, three of which were used for the synthesis literature review.

The second search within the SPORTDiscus database used the keyword *overtraining*. This search resulted in 2,740 articles. Similar to the previous search, a limiter was to use only scholarly journals which were published within the years 2011-2021. The second keyword that was used is *mental health*. This resulted in 34 articles. The third, and final keyword, used in this

search was *performance*. This resulted in 20 articles, of which, two were used for this literature review.

The third search within the SPORTDiscus database used the keyword *collegiate*, and resulted in 39,599 articles. Since this was a significant number of articles found with the use of one keyword, more limiters were utilized. The search was then refined by only using those published within the years 2011-2021 and that were peer reviewed. An additional keyword that was used was *overtraining*. This resulted in six articles, three of which were used for this literature review.

The fourth search within the SPORTDiscus database used the keyword *overtraining syndrome* and resulted in 392 articles. The search then used the limiters of only peer reviewed articles and those published within the 10-year time frame, 2011-2021. Another keyword which was used for this search was *study*. By using these two keywords, this resulted in 243 articles. After this second keyword, another word was used which was *excessive training*. This final search resulted in nine articles, one of which was used for the purpose of this literature review.

The fifth search within the SPORTDiscus database used the keyword *overtraining syndrome* and resulted in 822 articles. Next, peer reviewed articles were selected as one of the limiters, as well as scholarly journals from 2011-2021. The second keyword used was *male athletes*, which refined the search down to 86. The third keyword used was *performance study*, and this narrowed the search to 40 articles. The fourth, and final, keyword used for the article search within this database was *recovery*. This limited the search down to six articles, one of which was used for this synthesis project.

The sixth search within the SPORTDiscus database used the keyword *overtraining*. This resulted in 2,741 articles. Two limiters were then put into place to refine the search, which were

only peer reviewed articles and those published within the 2011-2021 timeframe. The second group of keywords used was *burnout in athletes*. This refined the search to 36 athletes. The third keyword used was *physical training*. This resulted in 10 articles, one of which was used for this literature review.

Within the SPORTDiscus database, articles were obtained from several different journals. The titles of these journals are: *Scandinavian Journal of Medicine and Science in Sports*, *Journal of Exercise Physiology*, *Journal of Athletic Training*, *International Journal of Sports Science and Coaching*, *European Journal of Applied Physiology*, *Journal of Sports Physiology and Performance*, *The International Journal of Sport and Society*, *International Journal of Sports Physiology and Performance*, and *Journal of Physical Education and Sport*. *The International Journal of Sports Physiology and Performance* provided three articles which were used for this synthesis project. The others listed provided one article for the literature review.

These articles focused on participants who were athletes and engaged in sports. The type of participants many of these focused on were college athletes between the ages of 18-23. There were a few which focused on young adult athletes, which would be concerning individuals within the 18-40 age group. This included information for athletes at both the collegiate and professional level. Throughout the 11 articles used in this synthesis project, 961 athletes were involved in these studies. More specifically, 459 males and 35 females were included in these studies, while there were 467 athletes whose gender was not revealed.

The articles used in this literature review were analyzed in several different ways. These 11 articles utilized both quantitative and qualitative methods. More specifically, there were nine quantitative articles and two qualitative articles used for this literature review. These methods consisted of descriptive analysis, statistical analysis, nonparametric analysis, parametric

statistics, and one-way analysis. Means and standard deviations were also calculated, and the results were displayed in a few articles. Also, linear regressions and scales as well as mixed model effects were utilized within these articles for this synthesis project. In addition to these quantitative methods, there were qualitative approaches as well. Training logs were evaluated throughout various times of the season to determine the athletes physical and mental well-being. Lastly, online training diaries were evaluation based on notes the athletes recorded after their practice or conditioning sessions. This diary was used to record objective or subjective data from the study.

Chapter 3: Review of Literature

The purpose of this chapter is present a review of literature on the impact of overtraining on athletes. In particular, the following topics will be explored: physical impacts from overtraining, mental impacts from overtraining, and how athletics can impact an individual's future. When individuals think of overtraining, they might think of a cut on their knee or a blister on their foot. This is incorrect as there is much more to this syndrome than what individuals think. Athletes physical and mental well-being are two aspects which may be in jeopardy when they encounter symptoms of overtraining. These impacts can be detrimental to an athlete's health if they do not seek help once they are overtrained. For teams to have success athletes must receive proper treatment to avoid harm to their body. The first topic which will be addressed is physical impacts from overtraining.

Physical Impacts from Overtraining

It is evident from reviewing the literature on the topic of overtraining that it can cause physical impacts on an athlete's body. Individuals associated with intercollegiate athletes must understand if an athlete's training program is insufficient or excessive. Smith et al (2011) studied the relationship between changes in one's ability and changes in physiological and psychological aspects during and after a period of high-intensity training. Twenty athletes engaged in 12 aerobic sessions and two weight training sessions each week. A 30-minute maximal rowing ergometer test was performed every week during the four-week period of increased intensity and duration. Saliva samples were taken from the athletes every morning and were evaluated. In addition, capillary and performance blood tests were performed on all twenty athletes. The blood lactate samples were collected to determine if the athletes fell within or outside of the normal blood glucose concentration. Lastly, the athletes were asked to record the number of hours they

slept every night as well as the number of times they woke up during the night. The results showed that there were minor improvements in 30-minute mean power in the overload for the athletes. Also, the blood glucose concentration levels were determined to be normal. Lastly, one of the athletes encountered mild fatigue symptoms and performed at a satisfactory level during their rowing tests.

In addition, Nicoll et al (2018) provided insight on how thyroid hormones control energy production and metabolism and could affect overtraining syndrome in individuals. The purpose of this study was to analyze the correspondence between thyroid hormones and symptoms of overtraining syndrome in track and field runners. Thyroid hormones are used for controlling metabolism, mood, and an athlete's energy levels. A group of female runners who participated on a Division I NCAA track and cross-country team were used for this study. Measurements were taken at three different times during the study during the preseason, pre-season and post-season, or weekly. There were several characteristics measured such as height, body composition, blood levels, aerobic capacity testing and their daily food intake. The results of the study showed that fatigue was lower at the second week compared to after the season. In addition, at the pre-season stage more than half of the athletes were not eating the recommended amount of protein. By post-season, 75% of the athletes met the recommendations for the levels they should meet.

The study conducted by Cadegiani and Kater (2019) describes the repercussions of receiving an inadequate amount of nutrition and recovery time. The focus of this study was to compare muscular, hormonal, and inflammatory variables within overtrained athletes, healthy athletes, and sedentary individuals. There were 51 men recruited to participate in this study who were classified in one of the three participant groups, and these individuals were chosen through

social media website based on their physical ailments. The individuals selected for this study were between the ages of 18-50 years old and did not have any known medical conditions. The overtrained and sedentary athletes recorded the sport being performed, training intensity, number of minutes participating in this activity, and the number of rest days they had per week. The individuals who were classified as encountering overtraining syndrome were clearly identified due to their signs and symptoms. The impacts included increased estradiol, decreased testosterone, an altered immune system, and an overreaction of muscle tissue compared to the healthy participants.

In addition, Brink et al (2012) validates the physical impacts excessive sport participation can have on an athlete. An imbalance between stress and recovery in athletes can result in the inability to train their best, which can eventually lead to overtrained athletes. The purpose of this study was to observe the performance and determine the stress-recovery balance in overreached soccer players. Male athletes were evaluated during two soccer seasons to determine their impacts from the training programs. A prospective cohort design was utilized to track stress and recovery in these male soccer athletes ages 15 to 18. These programs consisted of aerobic, speed, agility, technical, and tactical training. The athletes who showed decreased performance were evaluated by professionals. This study showed that some of the individuals who engaged in these practices had an increased heart rate. These fatigued athletes encountered difficulty sleeping and were labeled as sleep deprived.

Furthermore, Piacentini and Meeusen (2015) have stated that issues with physical abilities may arise because of excessive physical activity. The purpose of this study was to determine the achievement of an online training-monitoring system in efforts of eliminating nonfunctional overreaching. A track and field athlete was asked to complete a training diary

every day as well as a profile of mood state (POMS). This diary consisted of this athletes' feelings, which were evaluated to determine the level of overreaching. After analyzing this female track athletes' feelings, it was determined that she encountered physical impacts. The profile of mood state (POMS) determined that this athlete's fatigue increased by 167% as compared to the baseline at the beginning of the study. Other than decreasing levels of performance, this training diary did a sufficient job of determining the athletes overreaching level.

Similarly, Main and Landers (2012) have stated the impacts overtraining can have on the physical well-being of a 22-year-old male triathlete. This individual had symptoms of overtraining because of intense physical activity in their sports. The purpose of this study was to show that overtraining does not always end with the individual encountering athlete burnout from participating in their desired sport. Athlete Burnout Questionnaires (ABQ) and The Multi-Component Training Distress Scales (MTDS) were used by the triathlete to provide information relative to the symptoms the athlete was experiencing. The results showed the athlete had an increased resting heart rate, a suppressed maximal heart rate, and spatial orientation.

Romano et al (2019) mentions the relationship between swimming and fatigue is crucial and it can have a significant impact on the abilities of an athlete. It is important to have programs which are specific to the needs of the swimming athletes to give them the best possibility of being successful. This study looked to determine the strength of the correlation for using chronic fatigue syndrome self-assessments and typical overtraining evidence factors. Data were collected from 19 collegiate NCAA division I swimmers. There were 11 male and eight female participants who were between the ages of 18-23 years old, and several tools were utilized to determine an athlete's chronic fatigue syndrome. All athletes who were involved in this study

had several measurements taken including resting blood pressure, resting heart rate, oxygen saturation level, and resting blood lactate. These were calculated two hours after their practice to determine their fatigue levels. Athletes did not show any differences by their gender, age, height, weight, body mass index, or swim stroke. Pearson's correlations of blood pressure were measured independently and were not associated with other signs of fatigue. Pulse oximetry and resting heart rate were within normal ranges for this study. However, resting blood lactate levels were found to be higher than normal resting blood lactate levels.

Mental Impacts from Overtraining

Research has shown that overtraining can have a severe impact on the mental well-being of athletes. Main and Landers (2012) have validated this through their study conducted on overtraining and burnout in a 22-year-old collegiate athlete. This individual was a swimmer who participated in this study to determine his levels of burnout. The purpose of this study was to show that overtraining does not always end with the individual encountering athlete burnout from participating in their desired sport. The two tools that were used to evaluate his levels of overtraining were Athlete Burnout Questionnaires (ABQ) and The Multi-Component Training Distress Scales (MTDS). The athlete was asked to complete five training logs during different points of the season which gave specifics related to the activity they engaged in. Results showed that the athletes had increased levels of depression and stress from excessive physical activity. The findings also described that overtraining caused decreased feelings of accomplishments, emotional exhaustion, and devaluing the athletes desired sport.

The mood of an individual can be altered if their training becomes more intense causing mental health issues and worsened health. Zanini et al (2018) validated this statement through their research. The focus of this study was to identify and assess stress levels, mood state, as well

as the stress and recovery level of swimmers. These male and female athletes were analyzed at different points of the beginning, middle, and end of the season. Recovery-Stress Questionnaires were used to document the well-being of the athletes during specific parts of the season. The male and female participants were asked to give their answers on a Likert Scale from zero to six. The study found that the depression factor increased within specific participants who were involved in the research. The results also showed that the anger factor increased while the vigor of these athletes declined.

Although the study completed by Piacentini and Meeusen (2015) contributed to the validation that overtraining has a significant impact on the physical health of athletes, it also displayed how they can be mentally affected. The purpose of this study was to determine the success of an online training-monitoring system to prevent non-functional overreaching. A female track and field athlete was asked to participate in this study by completing a daily training diary and a weekly profile of mood state (POMS). The diary collected feelings of the participants during their training sessions and conclusions were made based off these emotions. These conclusions determined whether the athlete would fall within the classification of nonfunctional overreaching. The findings of this study showed that there was a 38% decrease in vigor and a 62% increase in depression.

In addition, Anderson et al (2021) took a closer look at the effects overtraining syndrome can have on an athlete's body. This study looked at the impact of overtraining on the cortisol awakening response, which plays a role with the monitoring of an athlete's training status. Some theories propose that the cortisol awakening response may be impacted if an athlete encounters overtraining because of their sport participation. The purpose of this study was to compare the cortisol awakening response and the daily cortisol slope between healthy, sedentary, and

overtrained athletes. This study was a secondary cross-sectional analysis which focused solely on male athletes. The male athletes who participated in this study provided saliva samples to determine the cortisol concentration. These samples determined if the athlete was part of the healthy, sedentary, or overtrained group. Cortisol concentrations were collected for every athlete who was classified in the sedentary and overtrained group. However, only 22 of the 25 healthy athletes were successfully studied for this study. The variance models displayed that there was no difference in awakening time between the different groups.

How Can Athletics Impact an Individuals Future?

Studies have shown there are health benefits to exercising consistently at a moderate intensity. Brooks (2021) states that there is a decreased risk of heart disease, cancer, stroke, and diabetes associated with normal activity. The benefits of physical exercise begin to decline when the individual overtrains or engages in high-intensity activity. An athlete's body might be more prone to injuries and chronic stress on the body can be because of vigorous training. One of the purposes of this study was to determine the effect playing a collegiate sport had on an athlete and how that injury impacted their physical capabilities five or more years after they graduated from college and stopped playing varsity sports. The second purpose was to see if those athletes who encountered difficulties from these injuries were at an increased risk for a chronic disease. The subjects for this study were alumni from three division I institutions who played a variety of different sports teams. The study looks at 435 previous athletes from three division I institutions. These athletes could be male or female and must have been a member of one of their intercollegiate athletics teams. The athletes completed surveys which asked about their medical history and injuries related to their sport. After the initial survey was completed, each of the athletes needed to give consent to completing another survey five years after they completed

their college sport. The second survey asked questions regarding their exercise habits and asked about their current health conditions. The results showed that 79% of athletes reported that they encountered an injury during practice. In addition, 54% of the athletes had major injuries and 56% reported a chronic injury during college athletics.

Athletes should understand how they can prevent or reduce their overtraining symptoms. The study conducted by Cadejani et al (2021) describes the methods which can be used for athletes of many ages. The focus of this study was to learn more about the recovery process of overtraining syndrome since there is little known about this process. This was a 12-week interventional protocol for athletes who had been labeled as overtrained. These athletes have had an increase in their calorie consumption, an interruption of their training or sleep patterns, or differing levels of stress. This study evaluated 50 parameters related to insulin tolerance tests and body composition. The findings of the study verified that overtraining syndrome is difficult to overcome. The athletes that participated in the 12-week nutritional, exercise, sleeping, and social interventional were able to fully or almost fully recover in specified areas, such as the testosterone and estradiol levels. Body metabolism and competition did not fully recover in the overtrained athletes. This study has also shown that several of the athletes who had overtraining syndrome did not recover. This included fatigue that cannot be recovered from, changes in immunity, low energy levels, and an increased risk of developing severe injuries. These are several of the aspects an athlete might encounter as they get older because of overtraining in their younger age.

Summary

Research has verified that overtraining in a sport can cause significant impacts to an athletes physical and mental health. These effects can arise from excessive physical activity at

any level of sport participation. Individuals believe that athletes encounter these impacts during specific ages or levels of athletics. These articles invalidate these theories due to the ages of the athletes who were involved in these studies. Both the mental and physical impacts should be taken seriously as this could significantly influence the athlete's quality of life. If these individuals do not seek help from professionals, these effects could result in long-term or permanent conditions. The proper steps must be taken to avoid these impacts which could result in chronic injuries or illness. Every sign and symptom should be taken seriously to prevent permanent damage to an individual.

Chapter 4

Results, Discussion and Recommendations for Future Research

The purpose of this chapter is to present the results of the review of literature on the impact of overtraining on athletes and how these results align with the purported research questions which guided this synthesis project. In addition, recommendations for future research as it relates to overtraining impacts on athletes are presented.

The results of this review of literature displayed similar themes throughout the research retrieved from the databases. These articles showed that athletes can encounter severe consequences because of excessive physical activity. A few of the mental impacts consisted of decreased feelings of accomplishment, increased feelings of anger, and devaluing one's sport. In addition, several of these individuals encountered physical effects due to athletic participation. Several of these conditions consisted of an increased resting heart rate, altered immune system, and higher resting blood lactate levels.

The literature review has also shown that these physical or mental impacts can be permanent depending on the severity of the condition. The research has shown the long-term injuries athletes can suffer for several years after competing on an intercollegiate athletic team. In some extreme circumstances, chronic injuries or illnesses can arise due to excessive physical activity.

Discussion

Interpretations

As part of this literature review, several research questions were posed. The first research question examined was, what are the physical impacts of overtraining on athletes? The results of this question showed that there were several physical impacts associated with overtraining. The

study by Smith et al (2011) displayed that mild fatigue symptoms and satisfactory performance can arise due to inadequate rest in-between exercise. Similarly, Nicoll et al (2018) described the athletes fatigue levels between pre-season, mid-season, and post-season. The article stated the athletes felt more fatigue during the second week compared to the other weeks. They were not receiving the recommended amount of protein intake which contributed to their feelings of exhaustion. The participants in the Cadegiani and Kater (2019) literature review, validated that overtraining leads to physical impacts in athletes. These included increased estradiol, decreased testosterone, an altered immune system, and an overreaction of muscle tissue compared to healthy individuals. The study by Brink et al (2021) described the overtrained athletes had sleep deprivation. Piacentini and Meeusen (2015) examined participants and determined the athletes had increased fatigue rates of 167% compared to their baseline test. The physical impacts stated in Main and Landers (2012) were an increased heart rate, a suppressed maximal heart rate, and spatial orientation. Lastly, the study conducted by Romano et al (2019) determined resting blood lactate levels were higher than normal levels in overtrained athletes.

The second research question was, what are the mental impacts of overtraining on athletes? The results found in the Main and Landers (2012) study stated the athletes have increased levels of depression and stress from sport participation. In addition, they had decreased feelings of accomplishment, emotional exhaustion, and devalued feelings towards their sport. The study conducted by Zanini et al (2018) determined the athletes had increased feelings of anger and declined vigor. This article stated some of the participants encountered significant feelings of depression throughout the study. Piacentini and Meeusen (2015) had similar results because they found the participants had decreased vigor and increased depression among the athletes. Lastly, Anderson et al (2021) determined that out of the 25 athletes, 22 had been

successfully studied and concluded that overtraining had no significant impacts on the awakening time of individuals in three control groups. The saliva samples used were collected from healthy, sedentary, and overtrained individuals.

The final research questions examined was, what are the long-term consequences for an athlete who has encountered overtraining impacts? The results showed overtraining can cause life-long or chronic injuries to an individual. The study by Brooks (2021) stated that 79% of the athletes reported they were injured during practice. This article also stated 54% of the athletes had a major injury and 56% reported a chronic injury during collegiate sports. Cadegiani et al (2021) showed several of the overtrained athletes did not recover. The article stated these individuals encountered fatigue they could not recover from, changes in immunity, lower energy levels, and an increased risk of developing severe injuries. There are numerous health issues these athletes might experience as they age due to overtraining when they were younger.

Implications

Previous research on the impact of overtraining athletes shows validation that there can be a significant effect on an individual's well-being. The conclusions associated with this topic are agreed upon within the research focused on overtrained athletes. This synthesis project offers relevant information regarding the specific impacts an individual can encounter as well as the long-term effects one can experience.

The findings are like other studies relevant to the topic of this synthesis project. The studies conducted on the topic of overtraining within sports has validated the fact that athletics can significantly influence an individual's life. The findings of this literature review are consistent with those complete previously in other studies. These findings consist of information related to the mental and physical impacts athletes can encounter through sports participation.

One of the differences detected through the examination of several different articles, is some may target one area instead of both physical and mental. For example, Main and Landers (2012) discuss both the physical and mental impacts while Romano et al (2019) solely stated the physical effects and Zanini et al (2018) described those that were mental.

The results discovered from this synthesis project have confirmed existing theories about this topic. The articles validate that it is essential to receive an adequate amount of rest between practice sessions to prevent overtraining. It is important to consume the recommended number of calories when participating in games or practice sessions frequently. The necessary amount of rest is essential for an athlete who engages in physical exercise regularly.

The research found for this literature review has contributed significantly to the studies that have previously been completed on this topic. It is important for an athlete to receive the adequate amount of rest between training session to prevent overtraining symptoms. This can result in severe injuries or illness which can differ in length. The impacts from overtraining can be resolved in a short period of time, but in more serious situations these effects can be chronic.

Recommendations for Future Research

In reviewing the database on overtraining impacts on athletes the following limitations were noted regarding the studies under review. The studies were limited by the number of overtrained athletes who completed a questionnaire after their sport participation. These individuals were asked to truthfully complete these based on their feelings. Depending on if the athletes felt comfortable with the conditions of the study, they may have recorded false information on these questionnaires. Another limitation is some of these articles focus on athletes who have a broad age range. Several of these documents looked specifically at collegiate athletes. A few of these studies looked at the impacts of athletics on high school individuals.

Lastly, the remainder of these articles studied a wide range of individuals at both the high school and college level, as well as prior to graduating from an institution.

Based on these limitations and other insights related to the literature, the following recommendations for future research should be considered:

1. The individuals who conduct the study should avoid using opinion-based athlete evaluations and keep their information to factual statistics.
2. The studies should focus specifically on one group of athletes, such as high school, college, or professional, instead of combining all age groups into one article.
3. A few of the articles gathered data from one participant, it would be ideal to gather data from a statistically significant number of athletes.

Summary

The purpose of this literature review was to determine the impacts of overtraining on athletes. Delimiting variables were used to do an exhaustive data-based search which yielded 11 articles. These articles were then systematically used to determine the impacts of overtraining on athletes. Research revealed throughout every level of athletics, impacts can occur due to excessive physical activity. These can include an altered immune system, sleep deprivation, overreaction of muscle tissue, and a suppressed maximal heart rate. In addition, athletes can encounter mental impacts because of overtraining as well. These included decreased feelings of accomplishments, emotional exhaustion, depression, and decreased vigor in several athletes. Both the physical and mental effects can significantly impact the well-being of an individual who is engaged in athletics.

The articles have shown the importance of taking the necessary steps needed to prevent significant effects from sport participation. The studies have shown the importance of receiving

the necessary caloric intake depending on the needs of one's body. Consuming the necessary amount of protein has shown to influence the abilities of an athlete. If these preventative aspects are not completed by the individuals, they are at a greater risk of becoming overtrained. Once they are identified as overtrained, they must take the necessary steps to remedy the injuries or illness they encountered. Through this synthesis project it has been learned that chronic issues can arise from physical activity. Every sign and symptom should be taken seriously to prevent permanent damage to an individual.

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Appendix A

Author	Title	Source	Purpose	Methods & Procedures	Analysis	Findings	Discussion/ Recommendations Research Notes – Commonalities/Differences
Anderson, T., Wideman, L., Cadegiani F. A., & Kater, C. E. (2021)	Effects of overtraining status on the cortisol awakening response-endocrine and metabolic responses on overtraining syndrome (eros-car)	International Journal of Sports Physiology and Performance	To compare the cortisol awakening response and diurnal cortisol slope between athletes with overtraining syndrome, healthy athletes, and sedentary athletes.	This study analyzed data from the Endocrine and Metabolic Responses from overtraining. Male athletes participated in this study who were in the overtrained, healthy, and sedentary group. The athletes produced saliva samples that were tested to determine the control group they were classified in.	Linear regressions tested if there were relationships between the cortisol concentrations found in the saliva samples. Mixed-effects models were used to assess the effect of the overtrained, healthy, and sedentary group,	Cortisol concentrations were successfully collected for sedentary and overtrained athletes. Only 22 of the 25 healthy athletes were successfully analyzed during this study. The analysis of variance models demonstrated no difference in awakening time between the different groups.	The physiological course of overtraining has been linked to result in a chronic state of energy decline which can affect repair processes. This study has stated that adapting to a harsh environment can lead to a worsened athletic performance and negative health outcomes. In addition, this article emphasizes the importance of continuing research on athletes who encounter overtraining syndrome.

<p>Brink, M. S., Visscher, C., Coutts, A. J., & Lemmink, K. A. P. M. (2012)</p>	<p>Changes in perceived stress and recovery in overreached young elite soccer players.</p>	<p>Scandinavian Journal of Medicine and Science in Sports</p>	<p>The purpose of this study is to observe one's sport performance and determine the stress-recovery balance in overtrained male soccer players.</p>	<p>This study examined stress, recovery, and athletic performance during two sport seasons. 94 of the best male athletes were monitored during the 2006-2007 and 2007-2008 seasons. The training program consisted of aerobic, speed, agility, technical and tactical training. The athletes with decreased performance were sent to the laboratory to be evaluated. They were studied to</p>	<p>Means and standard deviations were calculated for determining the stress and recovery for the players.</p>	<p>This study shows the increased heart rate due to the activities and practices the players engaged in. In addition, this article describes the impacts of the performance tests relative to their overtraining levels. Some of these impacts included increased heart rate as well as sleep deprivation. Those who have altered results were labeled as overreached.</p>	<p>It is important to monitor nonfunctional overreaching because it could reduce a player's risk and improve the performance of the player. It is significant to have baseline tests at the start of the season when the players were somewhat free from fatigue in case they are labeled as overtrained during the season.</p>
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				determine their impacts because of their performance tests.			
Brooks, K. (2012)	Collegiate athletic participation, physical limitations, and chronic disease risk.	Journal of Exercise Physiology	One of the purposes of this study was to determine the effect playing a collegiate sport had on an athlete and how that injury impacted their physical capabilities five or more years after they graduated from college and stopped playing sports. The second purpose was to see if those athletes who encountered	The subjects for this study were alumni from three division I institutions who played on a variety of different sports teams. The athletes completed surveys which asked about their medical history and injuries related to their sport. After the initial survey was completed, each of the athletes needed to give consent to completing	Statistical analysis was used during this study which includes descriptive statistics and frequency distributions.	The results showed 79% of athletes reported that they encountered an injury during practice. In addition, 54% of the athletes had a major injury and 56% reported a chronic injury during college athletics.	This study concludes that some athletes sacrifice their future quality of life for college sports. It is important to remember the decisions made by an athlete are not surrounding the fact that their participation may impact their quality of life for their future. Competing on an intercollegiate athletic team could increase one's possibility of having a chronic disease or illness.

			difficulties from these injuries were at an increased risk for a chronic disease.	another survey five years after they completed their college sport. The second survey asked questions regarding their exercise habits and about their current health conditions.			
Cadegiani, F. A., & Kater, C. E. (2019)	Basal hormones and biochemical markers as predictors of overtraining syndrome in male athletes: The eros-basal study.	Journal of Athletic Training	To compare muscular and hormonal aspects in overtrained and healthy athletes.	The participants consisted of 51 men aged 18 to 50 years old. 14 of the participants were affected athletes of overtraining syndrome, 25 were healthy, and 12 were sedentary. All 39 of the athletes engaged in a sport and then their outcomes	The results were presented as means and standard deviations when normally distributed. When nonnormally distributed, the results were presented as medians and confidence intervals.	Overtraining syndrome in males resulted in increased estradiol, decreased testosterone, an altered immune system, and an overreaction of muscle tissue compared to the healthy participants.	According to the findings of this study, the overtrained athletes had more similarities with the sedentary individuals compared to the healthy athletes. Overtraining did not cause inflammatory changes in the male athletes used in this study.

				were measured.			
Cadegiani, F. A., Silva, P. H. L., Abrao, T. C. P., & Kater C. E. (2021)	Novel markers of recovery from overtraining syndrome: The eros-longitudinal study.	International Journal of Sports Physiology and Performance	The purpose of this study was to learn more about the recovery process of overtraining syndrome since there is little known about this process.	This study included 12 overtrained athletes who participated in a 12-week interventional protocol. The intervention consisted of consuming more calories, transitory training, increased sleep quality, and stress management, followed by the evaluation of 50 aspects.	Nonparametric analysis of variance was used when there was no means of normality. One-way analysis was used when normality was met.	Athletes who encountered overtraining syndrome and engaged in a 12-week intervention presented a full or partial recovery. This intervention focused on nutrition, exercise, sleeping and social changes. They had a full recovery while biochemical markers only had partial recovery. This study has also shown that several of the athletes who had overtraining syndrome did not recover. It was determined that recovering from overtraining	Overtraining syndrome is a difficult condition to overcome due to many reasons. This condition can occur to any athlete and everyone that has this syndrome can encounter different symptoms. There are no predictable signs of this condition, therefore, it is difficult to find ways to improve an individual's health.

						syndrome is a difficult process.	
Main, L.C., & Landers, G. J. (2012)	Overtraining or burnout: A training and psycho-behavioural case study.	International Journal of Sports Science and Coaching	The purpose of this study is to show that overtraining does not always end with the individual encountering athlete burnout from participating in their desired sport.	The participant in this study is a 22-year-old triathlete who previously attended college. The two instruments which were used was an Athlete Burnout Questionnaire (ABQ) and The Multi-Component Training Distress Scale (MTDS). The athlete was asked to complete a weekly training log and include the type of training, volume, and intensity of the	Training logs were used for each of the training phases. The five phases included, (1) general preparation, (2) specific preparation, (3) early competition season, (4) mid-competition season, and (5) end of competition season.	The athlete completed in several training sessions and events. According to The Multi-Component Training Distress Scale (MTDS), the athlete had depression, stress, fatigue, and physical signs during the fourth phase. A doctor stated he was experiencing burnout. The athletes season ended earlier than expected, and felt decreased levels of accomplishment, devalued his sport, and had feelings of tiredness.	This study showed an athlete who has been overtrained and becomes burned out as a result. As the season continued, the athlete was not able to get the correct recovery he needed. Not receiving adequate recovery can result in lower levels of performance which can cause one to lose motivation when it comes to their sport. It is significant for overtraining and burnout to be understood to ensure an athlete gets the proper treatment. The individuals who are associated with sports should be aware of the signs and symptoms of overtraining to prevent the problems from worsening.

				activity. They also included if they had any signs of infection or injury.			
Nicoll, J. X., Hatfield, D. L., Melanson, K. J., & Nasin, C. S. (2018)	Thyroid hormones and commonly cited symptoms of overtraining in collegiate female endurance runners.	European Journal of Applied Physiology	The purpose of this study is to analyze track and field endurance runners and determine if there is a correlation between thyroid hormones and overtraining syndrome. Thyroid hormones control metabolism, mood and an athlete's energy levels.	16 female mid- and long-distance runners who participated on a Division I NCAA indoor and outdoor track and cross-country team were used for this study. Measurements were taken at three different times during the preseason only, pre-season and post-season, or weekly. There were several aspects measured such as height, body	The thyroid hormones are displayed as non-parametric statistics because they are not normally distributed. Spearman's rho correlation coefficient was used to determine relationships between different aspects. Data was recorded as a mean and standard deviation.	The results of the study showed fatigue was lower at the second week compared to after the season. In addition, at the pre-season stage more than half of the athletes were not eating enough protein that was recommended. By the end of the season, 75% of the athletes met the recommendations for the levels they should meet.	This study showed the more common symptoms of overtraining syndrome in athletes. In addition, it showed that lower levels of thyroid hormones can cause issues with skill levels. It is significant to regulate the thyroid hormones in athletes because this can impact their performance. Another aspect which is important to understand is the athletes' abilities to perform are significantly impacted by their nutrition patterns and how many calories they consume.

				composition, blood levels, aerobic capacity testing and their daily food intake.			
Piacentini, M. F., & Meeusen, R. (2015)	An online training-monitoring system to prevent nonfunctional overreaching.	Journal of Sports Physiology and Performance	The purpose of this study is to determine the success of a training-monitoring system to prevent nonfunctional overreaching.	A female track and field athlete completed a training diary and a weekly profile of a mood state (POMS). The diary includes personal feelings reported on a scale. Calculations were completed to determine if nonfunctional overreaching occurred.	The training diary includes a section where data can be recorded. A baseline test is performed during the first four weeks of regular training. To evaluate the mood state of the runner, there is a questionnaire which asks about the individuals mood.	Data from the profile of a mood state shows there was a 167% increase in fatigue, a 38% decrease in vigor, a 62% increase in depression, and a total mood increase of 22%.	Before noticing an athlete's performance was decreasing, the feelings recorded in the training diary predicted overreaching symptoms. One of the early signs of overreaching is an athlete's performance decreasing. There are more signs and symptoms that should be monitored to prevent more severe and permanent injuries.
Romano, V., Arnold, M., & Johnson, J. L. (2019)	A feasibility study: Using chronic fatigue syndrome (CFS) self-	The International Journal of Sport and Society	This study looked to determine the strength of correlation of	Data was collected from 19 collegiate NCAA division I	Descriptive analysis includes mean, median, mode, standard	Athletes did not show any differences by their gender, age, height, weight,	Fatigue can be made worse if the athlete continues to practice and condition. It is important athletes understand their limits in

	<p>assessments in collegiate swimming to determine overtraining.</p>		<p>using chronic fatigue syndrome self-assessments and signs that display overtraining.</p>	<p>swimmers. There were 11 male and eight female participants who were between the ages of 18-23 years old. This feasibility study uses self-assessment tools to determine an athlete's chronic fatigue syndrome. All athletes who were involved in this study had several measurements taken including resting blood pressure, resting heart rate, oxygen saturation level, and</p>	<p>deviation, and range. In addition, Microsoft Excel was utilized for the analysis process.</p>	<p>body mass index, or swim stroke. Pearson's correlations of blood pressure were measured independently and were not associated with other fatigue indicators. Pulse oximetry and resting heart rate were in the normal range for this study. However, resting blood lactate levels were found to be higher than normal resting blood lactate levels.</p>	<p>attempts to prevent overusing their bodies. Sometimes it can be difficult for athletes to get the necessary recovery time needed due to the pressured training schedule. Overtraining syndrome will occur within an athlete if they do not receive the proper recovery time. When a body is constantly tired, it is more likely to get injured.</p>
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				resting blood lactate. These were calculated two hours after their practice to determine their fatigue levels.			
Smith, T. B., Hopkins, W. G., & Lowe, T. E. (2011)	Are there useful physiological or psychological markers for monitoring overload training in elite rowers?	International Journal of Sports Physiology and Performance	To examine the correlation between changes in performance and changes in physiological and psychological factors during and following training.	20 athletes from the New Zealand elite rowing team participated in this study. The rowers had 12 aerobic rowing sessions and two weight training sessions every week. Saliva samples were taken every morning immediately before and after the 30-minute ergometer test. A capillary blood sample	The relationships between changes in performance and changes in markers were examined. Then the changes in performance were plotted on a linear scale while those markers were plotted on a log scale.	The blood glucose concentration levels were normal. Both the male and female athletes had an increase in the 30-minute mean power. One of the rowers who was a participant for this study was diagnosed as overtrained due to his sleep patterns and psychological state. One of the athletes encountered mild fatigue symptoms and performed at a	The head coach of this team leads his players through a difficult program. It was expected that some of the rowers would show signs of functional overtraining. There is a possibility that some of these rowers would display signs and symptoms of nonfunctional overtraining due to the intensity of the training programs.

				<p>was taken three times a week and carefully examined. Performance tests were conducted on the first day of the study and on the last day of the training block. During the final training session, the participants were asked to record the number of hours of sleep and the number of times they woke up over the course of the previous week.</p>		<p>satisfactory level during their tests.</p>	
<p>Zanini, G. D. S., Filho, D. M. P., Neiva, C.</p>	<p>Stress and mood states monitoring in a swimming team during a</p>	<p>Journal of Physical Education and Sport</p>	<p>The purpose of this study is to identify and analyze stress levels,</p>	<p>32 male and female swimmers were asked to participate in</p>	<p>The data was displayed using statistical analysis</p>	<p>The study stated the depression factor increased its mean values. When analyzing</p>	<p>This article mentions the relationship between mood and sports performance. Athletes who are in a state of mood with major</p>

<p>M., Silva, D. P., D., Ciolac, E. G., & Verardi, C. E. L. (2018)</p>	<p>competitive period.</p>		<p>mood state, as well as the perception of stress and recovery of swimmers.</p>	<p>this study. The swimmers were assessed at different times which were at the beginning of the competition, during, and at the end of the season. Recovery-Stress Questionnaires were used to document the mental, emotional, and physical well-being of the participants. The responses were given on a Likert Scale from 0-never to 6-always.</p>	<p>including several descriptive statistics. The calculations were performed using a statistics program using SPSS 15.0.</p>	<p>the anger factor, an increase in average values was seen. In addition, vigor showed a reduction in the mean values when looking at the chart.</p>	<p>changes may not be able to achieve the best sports performance. In addition, it is significant to understand that if the levels of physical demands are high and there is little to no rest, this can lead to injuries or the possibility of the athlete becoming overtrained.</p>
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