



THE RELATIONSHIP BETWEEN EXERCISE INTENSITY AND STRESS LEVELS IN ATHLETES AT THE STUDENT SPORTS EDUCATION AND TRAINING CENTER IN NORTH SUMATRA

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ABSTRACT

Stress is one of the factors that affect mental health and athletic performance. In student athletes, the demands of intensive training and academics can increase the risk of severe stress. This study aims to analyze the relationship between training intensity and stress levels in athletes at the North Sumatra Student Sports Education and Training Center. The study uses a quantitative approach with a descriptive analytical design and cross-sectional method. The study population consisted of 142 active athletes, with purposive sampling technique. The sample size was determined using the Slovin formula with a 5% error rate, resulting in 90 respondents. Data were collected using the Perceived Stress Scale (PSS-10) and International Physical Activity Questionnaire-Short Form (IPAQ-SF) questionnaires. The instruments were tested for validity through item-total correlation (all items were valid) and reliability using Cronbach's Alpha (>0.70), which showed good internal consistency. The results showed that most athletes were involved in high-intensity training and experienced high levels of stress, both in cardiorespiratory sports (56.8% high-intensity training; 73% high stress levels) and martial arts (67.9% high-intensity training; 75.5% high stress levels). Statistical analysis shows a significant relationship between training intensity and stress levels, with odds ratios (OR) of 6.42 for cardiorespiratory athletes and OR 8.58 for martial artists. These findings emphasize the importance of managing training intensity, monitoring stress levels, and implementing coping strategies to maintain athletes' mental health and performance.

Keywords: athletes; exercise intensity; north Sumatra; stress levels; student sports education and training center (PPLP)

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INTRODUCTION

Modern developments, with all their conveniences, have led to unhealthy lifestyles in society. One impact is a decrease in physical activity, including exercise. This has resulted in a drastic decline in public health and fitness (Burtscher et al., 2023). Meanwhile, exercise and physical activity are fundamental principles of daily life. The implications of regular exercise are palpable, with positive benefits for physical health and a satisfying quality of life (Vaqar, 2023). The definition provided by the WHO emphasizes that exercise is not limited to recreational or competitive activities, but includes all types of physical movement performed with the help of skeletal muscles and requiring energy (Caponnetto et al., 2021). Furthermore, international recommendations from the WHO and ACSM emphasize the importance of aerobic exercise, both moderate and high intensity, as this type of activity has been proven to provide real benefits to physical fitness and health recommended for adults.

Physical exercise is categorized based on its intensity. Moderate-intensity exercise, such as brisk walking or leisurely cycling, typically involves oxygen consumption at around 75% of maximum capacity, or approximately 3–6 METs, with a recommended duration of 30 minutes per day for 5 days a week. Meanwhile, high-intensity exercise, such as sprinting or High-Intensity Interval Training (HIIT), involves greater effort, reaching 90–95% of maximum heart rate and oxygen consumption above 75%, or more than 6 METs, with a recommended duration of about 20 minutes

per day, five times a week. The importance of regular physical activity lies in its benefits for maintaining organ function, improving fitness, and enhancing quality of life. Conversely, a sedentary lifestyle or lack of exercise has been shown to increase the risk of serious health issues, including death from various diseases, the onset of depression symptoms, decline in brain and cognitive function, and a deteriorating quality of life (Vaqaar, 2023).

Better quality of life too is closely related and has a positive relationship with a person's mental health. In this case, when discussing the mental health of an individual, it means referring to the working order of a person's mind which is related to the problem of how he thinks, feels and behaves (Kaur & Bashir, 2016). Mental health is often influenced by various factors, and one of the most dominant is stress (Ward et al., 2023). Stress occurs when individuals feel overwhelmed by demands, whether from their environment, work, or personal life, while their capacity or resources are considered insufficient to cope with these demands. Stress originates from any event or thought that causes feelings of distress, frustrated, angry or nervous (Kumar & Bawthra, 2020).

Exercise at either moderate or high intensity as recommended by WHO and ACSM can significantly reduce the hemodynamic response to various stressors (Burg et al., 2017). Stress triggers can come from a variety of psychological disorders, such as excessive anxiety, panic attacks, compulsive behavior due to obsessive-compulsive disorder, extreme fear of social interaction or social phobia, and various other stress-related disorders (Herbert et al., 2020). These conditions can reduce a person's quality of life if not properly addressed. One approach that has been proven to help is regular exercise.

Physical activity not only promotes physical health but also has a positive impact on the brain by enhancing its ability to adapt, known as neural plasticity. In the elderly population, exercise plays a crucial role in slowing down cognitive decline, which typically occurs as people age. Therefore, exercise is not only viewed as a means of maintaining physical fitness but can also be utilized as a form of therapy in the management of psychological disorders (psychopathology), degenerative brain diseases, and as a complement or alternative to conventional medical therapy (Ward et al., 2023). This is also in line with the European Psychiatric Association (EPA) guidelines on increasing physical activity in people with mental illness as an intervention in treating stress and major depressive disorder (Schuch & Vancampfort, 2021). Therefore, sports and a person's mental health are closely related and have a positive relationship.

On the other hand, in the reality of competitive sports, stress is an almost unavoidable factor. Athletes are required to always perform at their best, whether during preparation, competition, or after the competition is over. Such pressure stems from various sources, such as coaches' expectations, audience support or criticism, competition with opponents, and personal demands to achieve success. As a result, many athletes experience excessive mental strain, making them more vulnerable to psychological issues, including chronic stress, anxiety disorders, and even depression (Reardon et al., 2020). Research results (Ward et al., 2023) revealed that the majority of athletes, around 91%, experience stress as a consequence of training and competitive preparation. The level of stress experienced varies; some athletes experience mild to moderate stress, while a small number face severe or extreme stress. This data shows that stress is a common phenomenon in the lives of athletes, although its intensity varies. The study also highlights the impact of stress on performance, with approximately one-third of athletes reporting that the stress they experience affects their ability to compete, while others report that their performance remains stable despite experiencing stress (Ward et al., 2023).

This is caused by various reasons stressor an athlete experiences stress throughout their career. The stressors they experience and endure include a demanding professional lifestyle and training schedule, following a rigorous diet, and attending numerous competitions. This often puts a strain on athletes, both physically and mentally. In addition, athletes' stress levels are not only influenced

by training or competition, but also by various factors throughout their careers. For young athletes, emotional support from parents and coaches is crucial for mental health, as they are still in a developmental stage and easily influenced by their surroundings. However, as athletes enter the high-performance phase, their focus shifts; while interaction with coaches remains important, demands from the competitive environment, performance expectations, and the intensity of training become more dominant factors in determining stress levels (Purcell et al., 2019).

In literature, exercise is often said to have psychological benefits, one of which is the prevention of mental health disorders through its antidepressant effects (Reardon et al., 2020). In other words, exercise is seen as a way to boost mood, reduce symptoms of depression, and improve overall psychological well-being. However, athletes experience different conditions. During periods of intense training and competition, athletes face high levels of physical and mental stress, making them more vulnerable to stress and other psychological disorders (McLoughin et al., 2021). The contradiction between the theory that exercise reduces stress risk and the fact that athletes experience higher stress levels has prompted further research, particularly to explore how high-intensity training affects stress levels in student athletes. The researcher compiled and analyzed all the information obtained as a basis and valuable findings for further research. On that basis, the researcher wrote a thesis entitled "The Relationship Between Training Intensity and Stress Levels in Athletes at the North Sumatra Student Sports Education and Training Center."

METHOD

Employing a quantitative approach, this research aims to measure and analyze numerical data to assess the connection between variables. The chosen descriptive-analytical design provides a clear representation of real-world conditions while simultaneously evaluating the relationship between training intensity and stress levels in young athletes. Through a correlational method, researchers can quantify the strength of this relationship and potentially forecast future conditions based on identified patterns. The use of a cross-sectional design involves a one-time measurement of variables, offering a snapshot of the athletes' state at a specific moment rather than observing long-term trends. This methodology is efficient for rapidly obtaining pertinent data and establishing a preliminary understanding of the link between high-intensity training and stress in college athletes.

The research was scheduled to take place over three months, from September to November, at the North Sumatra Student Sports Education and Training Center, which is the main location for student athlete training activities in the Medan area. The target population for the study consisted of all athletes who were registered and actively training at the center, totaling 142 people. Respondents were selected based on specific criteria to ensure that the data obtained is relevant and representative of the actual conditions of the athlete population. The sample in the study was a subset of the population that reflects and describes the entire population. The sample that was part of this study were athletes who entered the research inclusion criteria, namely:

1. Active athletes at PPLP SUMUT
2. The selected sports, including soccer, athletics, wrestling, judo, karate, pencak silat, and taekwondo, were considered because each has varying levels of training intensity, ranging from low to high.
3. Voluntary participation is a requirement so that the athletes involved are truly willing to contribute to the research.

This study used a purposive sampling technique, meaning the researcher selectively selected samples from the population without using probability methods. The required sample size was calculated using the Slovin Formula. Based on the formula, the required sample size for this study was 90 athletes. In this study, data collection focused on two main instruments, namely the PSS-10 to measure the stress levels experienced by athletes and the International Physical Activity Questionnaire-Short Form to assess their physical activity levels. These two instruments have been widely used in various international studies and are considered to have good validity and reliability.

The PSS-10 has been proven to have construct validity with item-total correlations > 0.30 and adequate internal reliability with Cronbach's Alpha values ≥ 0.70 . Data from the questionnaires were collected simultaneously in one session to ensure efficiency and consistency, then processed and analyzed statistically to explore the relationship between training intensity and stress levels in student athletes. The results of this analysis are expected to produce scientifically accountable findings.

RESULT

Table 1.
Distribution of sample characteristics by gender and age

Demographic Characteristics	Number (n)	Percentage (%)
Gender		
Man	62	68,9
Woman	28	31.1
Age		
15	19	21,1
16	30	33,3
17	41	45,6

The sample's demographic characteristics, as presented in Table 1, were categorized according to gender and age. Gender was divided into two groups: male and female. There were 62 males (68.9%) and 28 females (31.1%) in the total sample. Meanwhile, in terms of age, the sample was divided into three groups: 19 samples (21.1%) were 15 years old, 30 samples (33.3%) were 16 years old, and 41 samples (45.6%) were 17 years old.

Table 2.
Distribution of Frequency of Exercise Intensity in Cardiorespiratory Athletes

Exercise intensity	f	%
Low	0	0
Currently	7	18,9
High	30	81,1

The data in Table 2 shows that of the total number of cardiorespiratory athletes studied, 30 (81.1%) underwent high-intensity training, indicating the dominance of heavy training in this sport. In contrast, only 7 athletes (18.9%) underwent moderate-intensity training.

Table 3.
Frequency Distribution of Exercise Intensity in Martial Arts Athletes

Exercise intensity	f	%
Low	0	0
Currently	9	17
High	44	83

The data in Table 3 reveals that the majority of athletes in martial arts, namely 44 people (83%), chose high-intensity training. This indicates that training that demands maximum physical effort is more dominant among martial artists. Meanwhile, only 9 athletes (17%) performed moderate-intensity training.

Table 4.
Frequency distribution of stress levels in cardiorespiratory athletes

Stress Level	f	%
Light	0	0
Currently	10	27,0
Heavy	27	73,0

From the data in Table 4, it can be seen that the majority of cardiorespiratory athletes experienced high levels of stress, namely 27 people (73%). This shows that high-intensity training carried out by cardiorespiratory athletes is likely related to increased psychological pressure. Conversely, only 10 athletes (27%) experienced moderate levels of stress, indicating that a small proportion of athletes were able to manage their stress better.

Table 5.
Frequency distribution of stress levels in cardiorespiratory athletes

Level stress	f	%
Light	0	0
Currently	11	20,8
Heavy	42	79,2

Data from Table 5 shows that most martial artists, namely 42 people (79.2%), are at a high level of stress. This indicates that high-intensity training, which is common in martial arts, has the potential to cause significant psychological pressure. Conversely, only 11 athletes (20.8%) experienced moderate stress, indicating that a small proportion of athletes are able to maintain a more controlled stress level.

Table 6.
Relationship between exercise intensity and stress levels in cardiorespiratory athletes

Exercise intensity	Level stress			Total f (%)	p	(95% CI)
	Light f (%)	Currently f (%)	Heavy f (%)			
Low	0	0	0	0		
Currently	0	6 (85,7)	1 (14,3)	7 (100)	0,001*	6,42
High	0	4 (13,3)	26 (86,7)	30 (100)		

*P value (0.001) indicates significance

The data in Table 6 shows that in cardiorespiratory sports, low-intensity and low-stress training was not found. Among athletes engaged in moderate-intensity training, the majority, namely 6 out of 7 athletes (85.7%), were at a moderate stress level, while 1 athlete (14.3%) experienced severe stress. This indicates that even at moderate training intensity, athletes tend to experience significant psychological pressure. Meanwhile, among athletes undergoing high-intensity training, the majority experienced severe stress levels, with 26 out of 30 athletes (96.7%) at severe stress levels, while only 1 athlete (4.8%) was at moderate stress levels. This percentage emphasizes that an increase in training intensity correlates with an increase in stress levels, indicating a strong relationship between high physical load and psychological stress in cardiorespiratory athletes.

Statistical analysis indicates that there is a significant relationship between exercise intensity and stress levels in cardiorespiratory athletes, as indicated by a p-value of 0.001, which is less than the significance threshold of 0.05. This means that differences in exercise intensity have a significant effect on athletes' stress levels. A PR value of 6.42 indicates that athletes engaging in moderate to high-intensity training are more than six times more likely to experience moderate to severe stress compared to athletes at low intensity levels or reference conditions. This finding reinforces that the higher the training intensity, the greater the risk of psychological stress experienced by athletes, making stress management a critical component in cardiorespiratory training programs.

Table 7.
Relationship between exercise intensity and stress levels in martial arts athletes

Exercise intensity	Level stress			Total f (%)	p	(95% CI)
	Light f (%)	Currently f (%)	Heavy f (%)			
Low	0	0	0	0		
Currently	0	7 (77,8)	2 (22,2)	9 (100)	0,000*	8,58
High	0	4 (9,1)	40 (90,9)	44 (100)		

* P value (0.000) indicates significance

The data in Table 7 shows that in martial arts, low-intensity training and low stress levels were not found. Among athletes who performed moderate-intensity training, the majority, namely 7 out of 9 athletes (77.8%), were at a moderate stress level, while 2 athletes (22.2%) experienced high stress levels. This shows that even though the training was not too strenuous, some athletes still experienced psychological pressure. Among athletes engaged in high-intensity training, the majority, 40 out of 44 athletes (90.9%), experienced high stress levels, while only 4 athletes (9.1%) experienced moderate stress.

Statistical analysis shows a significant relationship between training intensity and stress levels in martial artists, with a p-value of 0.000, which is less than the significance threshold of 0.05. This indicates that training intensity has a significant effect on athletes' stress levels. A PR value of 8.58 indicates that athletes engaging in moderate to high-intensity training are more than eight times more likely to experience moderate to severe stress levels compared to athletes at low intensity or reference conditions.

DISCUSSION

The distribution of the characteristics of the research sample can be seen in table 1. The division of sample characteristics categories based on gender, males dominate the research sample with 62 athletes and females with 28 athletes. Then based on the age of the research sample, 17 years old dominated with 41 athletes, followed by 16 years old samples with 30 athletes, and 15 years old samples with 19 athletes.

Table 2 outlines the frequency distribution of exercise intensity among cardiorespiratory athletes. The data shows that the highest number of athletes engaged in high-intensity exercise (30), followed by 7 athletes engaged in moderate-intensity exercise. Furthermore, Table 3 outlines the frequency distribution of exercise intensity among martial arts athletes. Based on the data, 44 athletes engaged in high-intensity exercise dominated, followed by 9 athletes engaged in moderate-intensity exercise. The data in Table 4 indicates that the majority of cardiorespiratory athletes, namely 27 athletes, experienced high levels of stress, while 10 athletes experienced moderate levels of stress. This high stress level is associated with intensive training loads, a packed competition schedule, and additional responsibilities such as dealing with injuries and undergoing rehabilitation. Social support factors also play a significant role; athletes who receive support from teammates and coaches tend to be better able to manage stress, while a lack of support can worsen psychological conditions. Playing status, such as being a starter or sitting on the bench, can also add mental pressure due to feelings of insecurity or lack of confidence. Additionally, ineffective training methods can hinder mental skill development, disrupt concentration, cause discomfort, and potentially reduce team cohesion. Overall, the combination of these factors explains why many cardiorespiratory athletes experience high stress levels (Lopes et al., 2020; Afiq et al., 2020).

When student athletes face pressure from multiple sources simultaneously, including academic obligations and athletic demands, they can reach the limits of their physical and psychological capacity. Factors such as excessive training, a packed competition schedule, lack of social support, and inappropriate training methods can add to the mental burden on athletes. When this pressure persists without effective stress management, athletes risk developing mental health issues, declining physical condition, and reduced athletic performance. In other words, prolonged stress accumulation not only impacts psychological well-being but also an athlete's ability to perform at their best (Lopes et al., 2020; Afiq et al., 2020). The data in Table 5 shows that most martial artists, namely 42 people, experienced high levels of stress, while 11 other athletes experienced moderate stress. This high level of stress can be explained by the characteristics of martial arts themselves, which require maximum physical and mental readiness. According to Anggara ARD et al. (2022) state that athletes must be able to manage psychological pressure, focus, and physical responses optimally to face their opponents. Therefore, martial arts training tends to cause significant mental pressure, which is reflected in the high number of athletes with severe stress. Martial arts sports and competitions are important for maintaining physical condition, focus, and self-confidence to maintain performance according to the established strategy to achieve victory (Anggara & Laksmiwati, 2020). Being a student athlete involves various challenges, including carrying out responsibilities in both sporting and academic aspects. This includes balancing social life and sporting responsibilities, managing emotional stability when faced with success or failure, maintaining physical health to meet the demands of competition, and focusing on sports career goals.

Stress in student athletes often arises due to the accumulation of pressure from various sources. In addition to the physical and mental demands of sports, they also face academic and social pressures that can affect their psychological well-being. Physiological conditions, such as fatigue or injury, can also add to mental strain. Additionally, social factors such as support from peers, coaches, or family and the ability to manage time between school, training, and other activities, are key determinants of stress levels (Anggara & Laksmiwati, 2020; Park et al., 2020).

Athletes often face psychosocial pressures from various sources, such as the demand to perform well in competitions and interactions with coaches, teammates, or other social environments. These pressures can increase the risk of stress. Every athlete has goals they aim to achieve, so they set expectations for themselves to meet those targets. When this pressure or expectation exceeds an athlete's physical and mental capacity, it can create an imbalance that triggers stress symptoms. Thus, stress in athletes does not only stem from physical factors or training but also from psychosocial dynamics and personal achievement demands, all of which must be considered in managing athletes' mental health (Anggara & Laksmiwati, 2020; Park et al., 2020).

Athletes also face pressure at school, caused by assignments and the need to achieve good grades. Martial arts athletes have a daily routine of attending school activities from morning to afternoon. In the afternoon, they return to training with a break before practice. Although sometimes this break is used to work on assignments or group projects. Meeting the demands of an academic context can be a burden for student athletes, as they must balance their time, energy, and thoughts to succeed both academically and in their careers as athletes. Sometimes, student athletes struggle to maintain this balance. Most of them have experienced stress, both physical and psychological (Anggara & Laksmiwati, 2020; Park et al., 2020).

In this study, although various factors other than training, such as academic demands, social support, or physiological conditions, can affect athletes' stress levels, training intensity remains a highly influential factor. To test the relationship between training intensity and stress levels, researchers used a bivariate chi-square test. This test helps researchers assess whether the distribution of stress levels differs significantly between groups of athletes undergoing moderate- and high-intensity training. Through this approach, a clear understanding can be gained of the extent to which training intensity contributes to the stress experienced by student athletes.

Chi-square analysis of cardiorespiratory athletes revealed a significant relationship between exercise intensity and stress levels, as indicated by a p-value of 0.001, which is less than the significance threshold of 0.05. This means that exercise intensity plays a significant role in influencing the psychological condition of athletes. A PR value of 6.42 confirms that athletes undergoing moderate to high-intensity training are more than six times more likely to experience moderate to severe stress compared to athletes at low intensity or reference conditions. These results are consistent with previous research findings, which also indicate that the higher the intensity of cardiorespiratory training, the greater the risk of stress experienced by student athletes.

One of the main factors strengthening this relationship is time management, which has proven to be a major challenge for student athletes. Their busy schedules include mandatory 4 hours of training per day during the competitive season and 8 hours per week during the off-season, as well as a total of up to 34 hours of additional athletic activities per week, including weight training, meetings with coaches, tactical training, and competitions. On the other hand, they must also complete academic tasks for 38.5 to 40 hours per week. This combination of high physical and academic demands can lead to time imbalance and increase the risk of stress, explaining why most cardiorespiratory athletes experience moderate to high stress levels (Lopes et al., 2020).

When training loads are not managed properly, athletes lose sufficient time for recovery and adaptation to training, leading to the accumulation of fatigue. This excessive fatigue not only affects

physical abilities, such as coordination, but also mental abilities, including decision-making and emotional stability. This condition can lead to overtraining, a state where the athlete's body and mind are subjected to excessive stress due to continuous training without adequate recovery. Additionally, periods of increased academic pressure add mental stress, accelerate fatigue, and increase the risk of severe stress (Lopes et al., 2020).

Chi-square analysis of martial artists showed a significant relationship between training intensity and stress levels, with a p-value of 0.000, which is less than the significance threshold of 0.05. This confirms that training intensity affects the psychological condition of athletes. A PR value of 8.58 indicates that athletes engaging in moderate to high-intensity training are more than eight times more likely to experience moderate to severe stress levels compared to athletes at low intensity or reference conditions. This high risk of stress can be explained by the nature of martial arts training, which demands continuous and intense training to achieve optimal fitness. This creates social pressure, whether from coaches, teammates, or personal expectations, thereby increasing the likelihood of mental health issues (Park et al., 2022; Nugroho et al., 2022). In addition, student athletes not only face the physical demands of training, but are also at risk of psychological distress. This risk increases when they prioritize their athletic careers over their academic education, creating additional pressure to achieve optimal athletic performance. The high intensity of training, such as six days a week and four training sessions per day, adds to the physical and mental strain, which can potentially worsen the psychological condition of athletes. In other words, during training, martial arts students are exposed to the additional pressures of an educational system centered on grades and exams. Therefore, this psychological pressure is expected to impact mental health, leading to significant stress (Park et al., 2022).

Martial artists face additional pressures that differ from other student athletes, primarily because they must follow a special training program that involves weight control. This requires them to maintain strict physical health, continuously hone their technical skills and strategies, and ensure that their body care and nutrition are well managed. The combination of physical, mental, and nutritional discipline demands can lead to higher stress levels compared to athletes who do not have such strict weight requirements and training programs. This is due to the ongoing assessment of athletes with the aim of improving their abilities during training and competition. Furthermore, intense training and monotonous training programs can lead to boredom, fatigue, and stress, leading to athletes training less enthusiastically. Therefore, this ongoing situation can be burdensome for athletes and potentially negatively impact their psychological well-being. The psychological impact on athletes is increased stress hormone levels, leading to significant stress and feelings of hopelessness (Park et al., 2022).

An athlete undergoes intense and strenuous training every day, striving for success. Therefore, athletes often face demands from both coaches and parents. These demands require athletes to maintain optimal performance. This factor also contributes to significant stress in athletes. Furthermore, stress in athletes can occur when they face pressure during rigorous training, feel uncomfortable in their environment, and experience disharmony in their relationships with teammates or coaches (Anggara & Laksmiwati, 2022).

Stress occurs when the body encounters physical or psychological stimuli that disrupt its internal balance. These stimuli, known as stressors, trigger a complex response involving the nervous system, hormones, and the immune system. For example, the sympathetic-adrenomedullary axis (ALONE) and the hypothalamic-pituitary-adrenal axis (HPA) work to mobilize energy and prepare the body to face threats. The stress response is fundamentally adaptive, helping the body respond to challenges and protect tissues from damage. However, if stressors occur repeatedly or persistently, this response can become maladaptive. Chronic stress accumulation can disrupt physiological and psychological functions, increasing the risk of conditions such as depression, anxiety, and cognitive impairments (Ayers BCKMTSD, 2022).

Stress has a significant impact on brain health, including triggering conditions such as depression, anxiety, and post-traumatic stress disorder. The body responds to stress through the stress system, which involves brain networks that can detect and interpret events as threats. This mechanism is complex because it integrates brain and body functions to adjust physical and mental responses. Stress triggers can be physical or psychological, and the body's response adapts based on the type of trigger. When a stress trigger is detected, two main systems are activated: the sympathetic-adrenomedullary axis (ALONE), which releases the hormones norepinephrine and epinephrine, and the hypothalamic-pituitary-adrenal axis (HPA), which releases glucocorticoids. The activation of these two axes produces a rapid response that allows the body to adapt to stress, take adaptive actions, and restore internal balance. This process is crucial for maintaining homeostasis, but if stress persists, the system can become overactive and contribute to mental disorders.

The body's response to stress is not only local, but involves the entire body system. The body adjusts energy flow and metabolism to cope with challenges, activates the immune system to protect itself, and modulates the functions of the digestive and reproductive systems. In the brain, stress triggers a complex response that occurs through non-genomic mechanisms (rapid responses without genetic changes), genomic mechanisms (changes in gene expression), and epigenetic mechanisms (modifications that affect gene expression over the long term). This activation is also associated with increased pro-inflammatory signaling, which affects cellular activity and neuronal plasticity, thereby altering how synapses function. The end result of all these processes is physiological and behavioral changes that enable individuals to adapt to challenging environments and increase their chances of survival (Godoy et al., 2018).

When the body encounters stressors, information from the environment or internal body is processed and triggers rapid activation of the stress system. The SAM axis provides an initial response through the release of catecholamines such as adrenaline and noradrenaline, which prepare the body to face threats through a “fight or flight” response. This activation then stimulates the HPA axis, involving the hypothalamus and anterior pituitary gland to release CRH and ACTH. ACTH stimulates the adrenal cortex to produce glucocorticoids, primarily cortisol, which helps the body cope with stress by adjusting metabolism, blood pressure, and immune system function. Cortisol is also regulated by a negative feedback mechanism; the hippocampus monitors cortisol levels and inhibits the release of CRH and ACTH if hormone levels are too high, thereby maintaining stress system balance and preventing excessive responses. This system ensures the body can respond effectively to stress without damaging organs or long-term physiological functions (James et al., 2023).

Glucocorticoids such as cortisol and corticosterone are important hormones produced by the HPA axis in response to stress. These hormones act as intercellular signals to adjust bodily functions to challenging environmental or psychological conditions. When individuals face stressful situations, CORT secretion increases, making this hormone a physiological indicator of stress. Interestingly, it is not only negative stress that increases CORT levels; physical activities such as exercise can also stimulate the secretion of this hormone as part of the body's adaptive response. The magnitude of this hormonal response is not uniform but is influenced by individual factors such as gender, age, type of stressor, as well as the duration and intensity of the stress experienced. Thus, CORT helps the body adapt to environmental changes while facilitating physiological adaptation, but excessive or prolonged responses can have negative effects on physical and mental health (Spencer & Deak, 2017).

When the body is constantly exposed to stressors, the HPA axis adapts through adaptive changes that occur at the cellular and tissue levels. The effects of stress are not limited to hormonal responses but also influence neurons and glial cells in the brain. The limbic system, which plays a crucial role in regulating emotions, learning, memory, and executive function, is highly sensitive to

chronic stress. Long-term accumulation of stress can alter the structure and function of limbic circuits, which may impair an individual's ability to manage emotions, make decisions, and recall information (Roberts & Karatsoreos, 2021). Prolonged exposure to stress can disrupt the balance of the HPA axis, resulting in an unsynchronized hormonal and neurological response to stress. This imbalance leads to ineffective coping strategies and can damage mental health and adaptive abilities. Dysregulation of the HPA axis is correlated with a high risk of developing mental disorders, such as depression, schizophrenia, and anxiety disorders. In depression, cortisol levels increase significantly, particularly in acute or severe subtypes of depression, as the adrenal glands overwork, damaging the hippocampus and increasing vulnerability to the condition. HPA axis dysregulation also affects circadian rhythms, thereby impacting mood, cognitive function, memory, and academic performance. This means that chronic stress not only has physiological effects but also disrupts mental health and cognitive capacity through hormonal mechanisms and structural changes in the brain, particularly in the hippocampus (James et al., 2023).

CONCLUSION

The results of the study indicate that the majority of the sample were male (68.9%) aged between 15 and 17 years old, and most athletes underwent high-intensity training, both in cardiorespiratory sports (56.8%) and martial arts (67.9%). The stress levels experienced by athletes were also relatively high, with 73% of cardio-respiratory athletes and 75.5% of martial arts athletes experiencing severe stress. Statistical analysis revealed a significant association between training intensity and stress levels in both groups of athletes. Cardiovascular athletes who underwent moderate to high-intensity training had a 6.42 times higher risk of experiencing moderate to severe stress, while martial arts athletes had an 8.58 times higher risk of experiencing moderate to severe stress.

These findings emphasize the importance of managing training intensity and monitoring stress in athletes, especially students who face academic and athletic demands simultaneously. Coaches and sports support staff are advised to design training programs that take into account athletes' physical and psychological capacities, including adequate recovery time and stress management interventions. This is crucial to prevent the negative effects of excessive stress on mental health, athletic performance, and cognitive development. The limitations of this study include the use of a cross-sectional design, so that the causal relationship between exercise intensity and stress cannot be confirmed, and data collected from only one training center, limiting the generalizability of the findings. Further research is recommended to use a longitudinal design to monitor changes in stress levels over time, expand the sample population across multiple training centers, and explore moderating or mediating factors such as social support, time management, and athletes' coping strategies.

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