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Research Article

PHYSIOLOGICAL REACTIONS TO INTERNAL LOAD STUDY

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ABSTRACT

Internal load is the reaction of the body as a result of the physiological and psychological stress of athletes during training or competition. Response to training must be continually monitored by trainers and/or practitioners to ensure effective performance. There are many methods for assessing internal load monitoring. These methods can be used in the field and laboratory. With the rapid development of technology and sports science, new devices and ideas are emerging every day. Applications that were previously only run in a lab environment are now so simple that they can be run using an app on your watch or phone. These innovations bring many benefits to sports scientists and practitioners. Team and individual sports practitioners should develop training programs using these methods.

There may be individual differences, especially in team sports. During the same training session, athletes may exhibit different physiological responses. It is known that these differences can reduce the effectiveness of training and lead to injury and illness. Moreover, these assessments become even more important in sports such as football, where there can be periods of intense competition. Therefore, this review aims to assist sport scientists and practitioners by providing a comprehensive discussion on the formulation and assessment of internal loads during exercise.

KEYWORDS

Training monitoring, training load, internal load, performance monitoring, sports, individual.

INTRODUCTION

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Systematic monitoring of training loads provides important information for assessing and improving athletes' performance. Based on this important information, coaches and sports scientists can use these observations to achieve more effective training results, assess parameters such as overtraining and overexertion, and predict and prevent existing injuries and diseases that may occur. There are many objective and subjective assessment methods to monitor athletes' performance and bring it to the desired level. Internal training load is the physiological and psychological reactions that arise as a result of stress affecting the athlete's body during training or competition.

Physiological stress

When assessing physiological loads, which is one of the indicators of internal loads, methods related to heart rate and degree of difficulty are often used. In addition, biochemical, hormonal and immunological assessments are performed to determine the body's acute and chronic responses to training.

Heart rate

In the 20th century, heart rate monitors were only used in laboratory settings, but today, with the rapid advancement of technology, they have changed the situation. The ability to easily perform these assessments using devices such as phones and watch apps has made it one of the most commonly used training monitoring methods by coaches and sports scientists. The fact that studies on the use of heart rate in assessing training loads have shown mixed results suggests that this issue is open to debate. In addition, it is known that two athletes with the same average heart rate during training may have different physiological responses as a result of training. In this context, heart rate; These include temperature, dehydration, medications used, diurnal variables, level of training or competition, individual differences, circadian rhythms, and assessments in combination with various methods such as perceived level of difficulty, lactate concentration, exercise stimulation. Many factors can influence this. It was believed that effective results could be achieved by using TRIMP in assessing training loads.

Changes in heart rate

It has been noted that heart rate variability is a valuable measurement method that provides information about the athlete's training adaptation by assessing the autonomic function of the cardiovascular system at rest or after exercise. Heart rate variability is a measure of changes in RR intervals and can be assessed in a variety of ways. Among these methods, the arithmetic mean of the square root of the differences between the RR intervals is often used. These measurements can be taken using devices such as chest electrocardiography, electrocardiography, and smartphone photoplethysmography. However, chest

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cages are often preferred due to their ease of use in the field and more affordable price. Chronically elevated heart rate variability is associated with a positive response to exercise, while low levels of heart rate variability are associated with a negative response to exercise. For example, studies of swimmers and middle-distance runners used 3 weeks of extreme-intensity training and found that heart rate variability decreased by 22% (swimmers) and 38% (intermediate) as a result of this training. - long distance runners) respectively. After this training, the swimmers' load decreased by 69% and heart rate variability decreased by 7% within 2 weeks, and after 1 week, with a 40% decrease in training load, heart rate variability decreased by 38%. in long distance runners. In this regard, changes in heart rate are an important indicator in determining and regulating training loads in the order of periodic training of students.

Heart rate restoration

Heart rate recovery is primarily an acute and chronic response of the body to training loads. Research has shown that slow recovery of heart rate is an indicator of factors such as fatigue and inability to cope with training load, while rapid recovery is a positive sign of improved performance. However, results from studies examining the relationship between heart rate recovery and athletic performance are inconsistent. It is noted that the HRR alone does not provide information on all aspects of performance and should therefore be assessed in conjunction with non-invasive tests such as exercise, RPE and psychometric measures. Perceived difficulty is a subjective measurement method used by practitioners and sports scientists to assess the psychophysiological stress experienced by an athlete during training or competition. A variety of scales are used to assess perceived difficulty (Borg 6–20, CR-10, CR100).

The perceived training difficulty method is widely used to determine training load in team and individual sports. Practitioners using this method ask the athlete, within 30 minutes after competition or training, how difficult it was during training, using the Foster scale. The corresponding value represents the intensity in numbers and is multiplied by the total training duration to obtain the training load value. In team sports, this value is calculated by averaging the data of all athletes participating in the training. In most team sports, the average of these values, 300 to 500, is low intensity, and 700 to 1000 is high intensity. Some practitioners tend to exclude the warm-up and cool-down portions of the exercise. However, the estimated difficulty ratings cover the entire workout. Therefore, practitioners are advised not to discount the warm-up and cool-down sections when assessing the level of perceived difficulty.

Training loads of resistance exercises are determined by multiplying the number of repetitions performed in the exercise by the level of perceived difficulty. But

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these estimates may be wrong. Within the same exercise, there is a difference in perceived difficulty and the body's response to stress between repeated repetitions with a light load and repeated repetitions with a heavy load. At the same time, the level of difficulty is also affected by the duration of rest intervals between loads. For example, Kraft et al. In their study, there was a difference in perceived difficulty levels between 180-second and 90-second rest intervals between sets in strength training, and they noted that difficulty levels increased as rest intervals were shortened. They examined acute responses and strength gains at different training loads and rest intervals and noted that low-load training with short rest intervals (30 seconds) can induce high metabolic stress, high-load training and long rest intervals. will have more power. In this context, practitioners should also consider the parameters of training volume and internal training frequency when assessing the difficulty level of resistance training.

Hormonal, biochemical, immunological loads

Many studies, including hormonal, biochemical and immunological assessments, have been conducted to monitor the body's response to stress such as overload, overtraining, fatigue, stress and illness. In addition, the study of relevant literature mainly examines the parameters of testosterone, creatine kinase, cortisol, immunoglobulin A and blood lactate in hormonal, biochemical and immunological studies associated with internal exercise training.

Testosterone

Testosterone is an anabolic hormone responsible for many body functions, including growth, development and protein synthesis. It is said to be a parameter used to monitor fatigue during exercise and changes caused by fatigue. Monitoring testosterone levels in athletes suggests that it may help determine the types of training that should be used. For example, Beaven et al. In their study, they examined the hormonal responses of athletes to 4 different training protocols and found that the protocol that maximized testosterone response produced the greatest training gains. In another study, Michailidis looked at players' testosterone levels before, mid- and post-season and noticed an 11.6% increase in testosterone levels at the end of the pre-season compared to mid-season. During the season, this increase was 12.1%, but at the end of the season it was lower than the initial level, the difference is significant. season. Additionally, when planning exercises based on these observations, practitioners should consider factors such as the player's age, sleep, stress, diet, physical activity, circadian rhythm, and location.

Cortisol

Cortisol, a glucocorticoid released by the adrenal cortex in response to stress, is a catabolic hormone

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that plays an important role in metabolism and immune function. The release of cortisol depends on the intensity, duration and type of exercise. A review of the literature revealed numerous studies on cortisol release in athletes. For example, Cook et al. In their study, they examined cortisol levels in elite and non-elite athletes in various fields and found that elite athletes had higher cortisol levels than non-elite athletes. They studied cortisol levels in professional football coaches before, during and after play and reported that there was a significant increase. Research has shown that the release of cortisol is associated with increased workload and stress, and this release is similar to this increase.

Testosterone/cortisol ratio

The testosterone to cortisol ratio is often used by sports scientists to identify overtraining syndrome in athletes. In this syndrome, it may take weeks or months to reduce the cumulative stress levels caused by overtraining or undertraining. Athletes with symptoms of overtraining syndrome have been noted to have a decreased T/C ratio, and there is research showing that this condition is associated with increased proteolysis and decreased protein synthesis. Although many studies show that low T/C increases stress levels in athletes, some studies have conflicting results. In this context, practitioners should continually monitor the effects of the training programs they provide on athletes, rather than relying on a single parameter to assess these effects.

lactate

Lactate, widely used in sports science, was discovered and characterized in sour milk by Carl Wilhelm Scheele in 1780. About 70 years later, studies showing the formation of lactate in human blood were first reported by Johann Joseph Scherer, and in the early 20th century, English physiologists W. M. Fletcher and F. G. Hopkins observed that muscles continued to contract, producing lactate in the absence of oxygen. . . . Lactate estimates, which are actively used in sports science with the widespread use of portable measurement methods, are one of the important indicators of internal load. An increase in blood lactate levels occurs during supramaximal or maximal exercise during competition or training. Although most studies have adopted an aerobic threshold of 4 mmol/L, it has been noted that individual differences may exist and these individual differences should be taken into account when planning training. For example, Kawczynski et al. In their study, they noted that the mean post-race blood lactate value in elite 100-meter runners was 14.6 ± 1.5. Blood lactate levels are known to change at different times after exercise. Invasive methods are often used when measuring lactate levels. These methods create many difficulties for practitioners and the people they use. However, with the development of technology, innovative

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approaches in this area are emerging. With newly developed devices, lactate values can be assessed non-invasively. In this context, it is expected that these assessments will be used more frequently by sport scientists and practitioners in the near future.

Creatine kinase

Creatine kinase levels, assessed to identify biochemical responses to changes in exercise stress, have been shown to correlate with exercise-induced muscle damage. For example, Pascoal et al. In their study, they examined an 11-week training period in football players and noted that creatine kinase levels increased by 64 percent at the end of the training period. In a similar study, Meyer et al. studied creatine kinase levels in elite soccer players at the beginning and mid-season and found that creatine kinase levels increased mid-season. When testing creatine kinase levels, practitioners should be aware that values can vary depending on many variables. It is known that estimates may vary between individuals and depend on the type of training used and the structure of the sports network. Therefore, individual training load along with creatine kinase values should be taken into account and analyzed for better interpretation.

Immunoglobin A

Immunological measurements are taken to assess the effects of physiological stress in response to exercise. Excessive training can suppress the immune system and predispose athletes to such diseases. A review of the literature reveals that there are a limited number of immunological assessments and that assessment of immunoglobulin A antibodies is often included in immunological studies related to sports science. For example, Owen et al. In their studies, they noted that immunoglobulin A levels in elite football players are significantly reduced after high-intensity training, and emphasized that immunoglobulin A levels must be regularly monitored during training to prevent such diseases. upper respiratory tract infections and take precautions. In a similar study, Freitas et al.

DISCUSSION AND CONCLUSION

It is known that assessing the internal loads that arise during training or competition is very important for coaches and athletes. With these assessments, situations that negatively impact performance, such as injury, illness, stress and overload, can be predicted so that the athlete can participate most effectively in activities such as training and competition. It has been noted that different methods are used to assess internal loads. These methods used should be selected according to the characteristics of the sports field and the training being used. In addition, we should not forget that the load on the body is individual. Ignoring these differences, especially in team sports, can lead to insufficient training results. The cumulative effect of training can lead to decreased performance in the athlete, as well as injury and loss of motivation. In this

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context, athletes' internal monitoring of workload should be regularly assessed and the training structures performed should be adjusted in accordance with these assessments. In addition, we should not forget that psychological factors are another parameter that should be monitored along with physiological load. It is believed that the joint consideration of physiological and psychological stress when assessing the performance of athletes by coaches and medical practitioners gives more effective results.

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