LATVIAN ACADEMY OF SPORT EDUCATION

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EFFECT OF OUTDOOR RECREATION ACTIVITY ON STRESS LEVEL AND MENTAL TOUGHNESS ON TAEKWONDO ATHLETES IN THE COMPETITION PERIOD

Summary of the Doctoral Thesis

To obtain the Doctoral (*Ph.D.*) degree in Health and Sports Science in the Sub-branch of Sport Pedagogy

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GENERAL CHARACTERISTICS OF THE DOCTORAL THESIS

Contact with nature may influence our thoughts, feelings, and actions to function more effectively. People are inspired by nature, and nature and natural systems are used as a resource to create new products or solutions (Kim, Kim, Pegard, Oh, Kagan, Fleischer, and Loo, 2012). Research has demonstrated that various contact forms with nature benefit us differently (Bowler, Buyung-Ali, Knight, and Pullin, 2010; Capaldi, Dopko, and Zelenski, 2014; Grinde, and Patil, 2009). However, some researchers (Collado, Staats, and Sorrel, 2016; Von Lindern, Bauer, Frick, Hunziker, and Hartig, 2013) have shown that some people reported more significant restoration effects of being in nature than others. This evidence suggests that contact with nature may be affected by other factors associated with natural environments (e.g., a sense of being away from daily routine).

Research on the cognitive impacts of contact with nature is on attentional processes. Ohly, White, Wheeler, Bethel, Ukoumunne, Nikolaou, and Garside (2016) have argued that it is unclear which precise attentional processes explain the observed therapeutic effects. Regarding the potential cognitive functions, there needs to be more clarity about whether other mental products are used. Atchley, Strayer, and Atchley (2012) mentioned that it is not clear that positive creativity effects are due to exposure to the natural environment or other factors associated with such an environment. The ability to express emotions and apply professional skills in stressful situations makes a difference between strong and weak athletes. Kallus and Kellmann (2000) stated that stress, coping with it, and recovery determine the athlete's state, which determines the athlete’s reaction to subsequent stressors and influences performance. Not only is the intensity of the stress an essential factor, but the duration, distribution over time, and the nature of the stress play important roles.

According to Gucciardi, Daniel, Sandy Gordo, James, and Dimmock (2009), if the athlete's physical, technical, and tactical training is at the same level, these mental factors play a crucial role in victory or loss. By increasing their mental toughness, athletes with good physical qualities and the skills necessary for their sport can increase their chance of achieving stable success in competitions. In scientific literature, mental toughness is one of sports psychology's most widely used but least understood terms. Some sports psychologists associate an athlete's mental toughness during competitions with psychic regulation – an athlete's ability to relax and regulate both the effects of mental stress and one's own psycho-emotional state and behavior (Weinberg, Joanne Butt, and Culp, 2011).

As an Olympic sport, Taekwondo is a combat sport involving scientific and technological aspects. Countries seek information from the different variables involved in the sport process to achieve the best international results. Present-day taekwondo follows a philosophy like its ancient predecessor's (Park, and Gerrard, 2000), with psychological, physical, and spiritual aspects often incorporated into training (Lee, 2010). Practitioners expect to display respect for themselves and others, humility, perseverance, self-control, and honesty to better refer to the guiding principles of martial art (Park et al., 2000). The research focusing on taekwondo's impact on psychological health, suggests it is associated with several positive outcomes. These include increased cognitive and affective self-regulation and prosocial behavior in children (Lakes, and Hoyt, 2004) and reduced aggressive behavior in youth and teenager's population (Harwood, Lavidor, and Rassovsky, 2017). Studies have also shown improvements in mood (Yang, Ko, and Roh, 2018) and enhanced strategies for coping with and managing stress (Petrovic, 2017) in taekwondo athletes. However, taekwondo has not been widely examined in psychological research.

Gas Discharge Visualization (GDV) based on the Kirlian effect is a scientific method to assess individual stress (Korotkov,2017). The measurement through GDV is performed by stimulation of electrons at the fingertips. It is the flow of electrons from a conducting object under the influence of a high-frequency (1024 Hz) electromagnetic pulse of high intensity, which creates photon radiation (glow) in the gas air (Hacker, 2005). This glow results from ionizing gaseous molecules in the surrounding air through the discharged electrons from the fingertips. A charged-coupled device (CCD) camera's glow is captured (Korotkov, Williams , and Wisneski, 2004). The GDV image is obtained from ten fingers of both hands in two ways, with and without a filter. A filter is a thin plastic film placed between the finger and the dielectric plate during the measuerment. The filter removes the effects of sweating on sympathetic and psychosomatic responses and gives the physiological state (Korotkov, Shelkov , Shevtsov , Mohov , Paoletti, Mirosnichenko, 2012). Comparison of these images with and without filter forms an Activation Coefficient, a quantitative assessment of a person's stress level based on the evaluation of autonomic balance (Korotkov, 2002). The data findings of GDV measures suggest that GDV can be used to measure the activity of autonomic response.

Moss, 2012 points out that the relationship between nature and adolescents in recent years got a great deal of attention and shows that adolescents have a declining relationship with nature. On the other hand, the time they spend indoor increses. Many studies have examined the detrimental effects of adolescents' increased engagement with technology (Von Marees, and Petermann, 2012). However, some

studies try to understand why adolescents spend time on cell phones and playing computer games. Cell phones keep them primarily indoors when they might be engaging in other activities in natural environments. Some research in this area was in laboratory settings, with images and videos of unusual backgrounds presented to participants and self-report questionnaires used to evaluate their preferences and measure their affective responses (Valtchanov, and Ellard, 2010).

Besides, researchers have documented the beneficial effects of mental toughness on sports performance. Still, Truelove's research (2014) mentioned that only 5-10% of athletes' training time is for developing essential psychological skills such as mental toughness. Also, psychological variables have been one of the crucial facilitators in terms of sports performance. Mental toughness has been considered very important. The other reason to study the mental toughness of taekwondo athletes is the absence of studies. When the results are not successful regarding the competition and performance, many athletes and their coaches plan to work more on the physical or technical fitness routine. They neglect the psychological aspect as less critical. Athletes in heavy physical training and competition may be limited to non-training stress in taekwondo and many sports. Adding psychological, social, or non-athletic physical stress may result in an allostatic load over the adaptation threshold, leading to physical maladaptation and an accumulation of stress and fatigue (Polman, and Houlahan, 2004). Therefore, for optimum stress recovery and adaptation and ultimately improved performance, taekwondo athletes must train specifically to adapt selected capacities relevant to event performance and minimize the impact of non-specific psychosocial stressors with appropriate recovery; the athlete can train at the required intensity and or complete the load at the next training session for optimal competition performance.

Taekwondo is an indoor sport, and athletes prefer to do all kinds of training inside the club, for example, if there is cardio training, they like to do it on the treadmill inside the club but not go outdoors for jogging or walking and after training they go home and play computer games or spend their time on cell phones. Cell phones keep them primarily indoors when they might be engaging in other activities in natural environments. Stress, coping with it, and recovery determine the athlete's state, which determines their reaction to subsequent stressors and influences performance. Increased stress demands and insufficient recovery lead to the athlete experiencing more stress. If recovery demands cannot be met, the athlete will be stressed beyond the point of failure and may need to find other ways of coping with the stress. Imbalances between stress and recovery can lead to short-term and long-term reductions in the athletes' performance. If recovery is not adequate and increased stress may result in overtraining syndrome. The overtraining syndrome results from insufficient recovery, excessive high-intensity training, increases in

training load, and non-training stressors. Overtraining can increase susceptibility to injury and illness, increase negative mood states, and decrease performance.

Based on the above, the doctoral thesis topic, "Effect of outdoor recreation activity on stress level and mental toughness on taekwondo athletes in the competition period," was studied.

The object of the research: outdoor recreation activity (walking in nature) impacts on performance in the competition period in taekwondo athletes.

The research subject: outdoor recreation activity (walking in nature) and taekwondo athlete's stress level, mental toughness, and performance, in the competition period.

The base of the research: Latvian taekwondo athletes (17-23 years old, international level).

The research aim: the study of the effects of outdoor recreation activity (walking in nature) on stress level, mental toughness, and performance in taekwondo athletes during the competition period and recommendation development for taekwondo coaches to increase the performance of athletes in the competition period.

The hypothesis of the research: by applying outdoor recreation activity (walking in nature) as a recovery means in the competition period, taekwondo athletes' stress level will be reduced, and mental toughness components (confidence, control, and constancy), and performance will be increased in the competition period.

The objectives of the research:

1. To theoretically study outdoor recreation activity (walking in nature) taekwondo athletes' stress level, mental toughness, performance, and their importance in the taekwondo competition period.
2. To identify the stress level, mental toughness, and performance of taekwondo athletes before the experiment.
3. To develop and apply the content of outdoor recreation activity in the practice of the taekwondo athlete's competition period.
4. To study and analyze the effect of outdoor recreation activity on the stress level, mental toughness, and performance of taekwondo athletes in the competition period and to develop recommendations for taekwondo coaches to increase the performance of athletes in the competition period.

The methods of the research:

1. Analysis of scientific literature sources in sports science, outdoor recreation activity (walking in nature), stress level, mental toughness, recovery, taekwondo training, and competition protocol.

2. Practical quantitative method of data collection: document analysis of the competitions' protocols in Belgium and Sweden, survey – questionnaire (Sports Mental Toughness Questionnaire, DASS: stress scales), Testing (Gas Discharge Visualization (GDV) Technique to measure stress level, Determination Test (DT)), detection experiment.

3. Practical data process and analysis methods: mathematical statistics (Microsoft Office Excel and the IBM SPSS version 26, descriptive statistics - mean, standard deviation, coefficient of variation, Paired sample T-test, the Shapiro-Wilk test, and Wilcoxon test.

The methodological basis for the research consists of the following:

The biophilia theory: states that an innate connection exists between people and the natural world and that we might get benefit from contact with nature (Wilson, 1984; Falk and Balling, 2010; Ulrich, Simons, Losito, Fiorito, Miles, Zelson, 1991; Kaplan, 1995; Herzog, Maguire, and Nebel, 2003; Lückmann, Lagemann, and Menzel, 2013; Pigram and Jenkins, 2007; McLean, Hurd, and Rogers, 2008; Korpela, Borodulin, Neuvonen, Paronen, and Tyrväinen, 2014).

Two famous theoretical statements of how nature might affect athletes' performance and individuals' health, or cognition related to the recovery effects of the natural surrounding are **Attention Restoration Theory** (ART) (Kaplan, 1995) and the second theory is **Stress Reduction Theory** (SRT) (Ulrich, 1983, 1993; Ulrich, Simons, Losito, Fiorito, Miles, and Zelson, 1991). They suggest that exposure to nature helps individuals recover their psychological capacity (e.g., positive well-being) and mental references (improved attention). The SRT claims that non-threatening natural surroundings promote psychophysiological stress recovery after stressful events and that such recovery occurs naturally rather than in non-rural surroundings (Ulrich et al., 1991)

The Stress and General Adaptation Syndrome theory (GAS) states that the interactive effects of stress and recovery on performance capacities and performance readiness are determined by an individual's capacity to adequately manage stress (Selye, 1936, 1956; Selye, 1978; Lazarus, 1966; Cannon, 1929; Martens, 1987; Spielberger, 1983; Ewert and Chang, 2018; Cox, 1994; Kaplan, 1996; Jones, and Bright, 2001; Miller, and McCool, 2003; Tenenbaum, 1984; Tenenbaum, Jones, Kitsantas, Sacks, Berwick, 2003; Polman, and Houlahan, 2004; Van Dijk, and Swaen, 2003).

Kellmann's scissors model of stress and recovery is a psychological model based on the idea that optimal performance in athletes is achieved when there is a balance between stress and recovery. According to the model, stress and recovery can be represented as two sides of a pair of scissors, with optimal performance occurring when the two sides are balanced. Performance suffers when stress levels are too high, and recovery is insufficient. On the other hand, performance can improve when recovery is abundant, and stress is low. The model has been widely used in sports psychology to understand the role of stress and recovery in athletic performance (Kellmann, 2002a, and b, Kellmann 2001, Kellmann 2010, Kellmann 2000).

Depression Anxiety Stress Scales (DASS) questionnaire is based on Classical Test Theory (Lovibond and Lovibond, 1995; Traub, 1997; Shea, Tennant, and Pallant, 2009; Crawford, and Henry, 2003). It is based on the assumption that the total score on a test is a combination of a person's valid score (their actual level of the construct being measured) and measurement error (random variability in the measurement process).

The inverted-U theory is regarding stress's effects on performance, and it proposes that as the complexity of a skill increases, the amount of arousal required for peak performance decreases. Irrespective of the type of skill involved, optimal performance occurs when the performer reaches an optimal level of arousal (Yerkes and Dodson, 1908; Easterbrook, 1959; Sonstroem and Bernardo, 1982; Srivastava and Krishna, 1991).

Positive psychology focuses on studying a person's feelings, behavior, and thoughts, emphasizing the person's strengths rather than the negative aspects of life. The center of the theory is the positive potential of a person as an individual, where **mental toughness** in sports is explained as a factor contributing to the optimal functioning of a person (Loehr, 1986; Jones, Hanton, and Connaughton, 2002; Golby and Sheard, 2004; Sheard, Golby, and Wersch, 2009; Gucciardi, 2011). Mental toughness consists of several components:

- **Confidence** is closely related to athletes' ability to interpret stressful situations as a positive opportunity to achieve higher results (Moritz, Feltz, Fahrbach and Mack, 2000; Vealey & Knight, 2002);

- **Constancy** is the ability to overcome failure, return after a loss and continue the fight, learn from one's mistakes, and improve (Gould, Finch, and Jackson, 1993; Fletcher and Sarkar, 2012; Rees, Hardy, Güllich, Abernethy, Côté, Woodman, and Warr, 2016).

- **Control** is the ability to focus one's attention on the performance of a task, successfully resist temptations, follow one's goals, as well as work productively in

high-stress situations (Baumeister, Heatherton and Tice, 1994; Baumeister, and Vohs and Tice, 2007; Englert, and Bertrams, 2015).

Reactive stress tolerance about determination test, and it is defined as an individual's ability to react effectively, quickly, and appropriately to a given circumstance, even in a stressful setting (Schuhfried, 2001, 2013; Sadowski, Gierczuk, Miller, Cieśliński, and Buszta, 2012; Gierczuk, Bujak, Rowiński, and Dmitriyev, 2013; Sadovski, 2003).

The theory of power in taekwondo suggests that specific characteristics like speed, agility, concentration, and self-esteem are essential for success in taekwondo competitions. These characteristics are related to stress and mental toughness in taekwondo athletes. For example, an athlete with high self-esteem can be more confident in their abilities and better able to cope with the demands of competition, while an athlete with lower self-esteem can be more attached to stress and anxiety. Additionally, the ability to react quickly and effectively to a given circumstance is related to mental toughness, which involves maintaining focus and control under pressure. It is possible that outdoor recreation activity, by providing a stimulating and calming environment, can help to improve these characteristics and finally enhance stress resilience and mental toughness in taekwondo athletes (Choi, 1965, Park et al., 2000; Lee, 2010; Lakes et al., 2004; Harwood et al., 2017; Yang et al., 2018; Petrovic, 2017).

The scientific novelty of the research:

In this research, the author used three instruments to measure the stress level in taekwondo athletes. The instruments are the Stress scale of the DASS questionnaire, the Determination test, and the Gas Discharge Visualization.

The research contributes to the body of knowledge in sports science by providing evidence for the potential benefits of incorporating outdoor recreation activity (walking in nature) in taekwondo athletes' training and performance during the competition period, it demonstrates the effectiveness of outdoor recreation activity in reducing stress levels and improving performance according to GAS theory, and Kellmann's scissors model which describes the relationship between stress, recovery, and performance, providing concrete strategies for reducing stress levels and improving recovery, which coaches and athletes in training and performance contexts can implement.

The Kirlian principle is the underlying principle behind Gas Discharge Visualization (GDV) technology. By using GDV technology, researchers can obtain objective data that can be used to study the effects of outdoor recreation activity on stress levels in taekwondo athletes.

Additionally, using GDV technology can provide new insights into the effects of stress on the body, including information about the body's energy balance, which can help improve our understanding of the mechanisms underlying stress. This can be of particular interest to sports science because it can give more specific information about the energy status of the athlete in the competition period, which can help to develop better recovery and performance enhancement methods.

The practical significance of the research:

This study is significant for taekwondo athletes, taekwondo coaches, taekwondo clubs, and the Latvian Taekwondo Federation.

For taekwondo athletes, it is evident: If walking in nature in the training process of the competition period is effective, then the performance of the individuals and team performance increases. Enhanced performance for athletes can increase self-confidence, self-control, self-constancy, and stress reduction. They receive a medal in different taekwondo tournaments. Also, the results of the present study may have implications to provide a reference of the effectiveness of outdoor recreation activity, enabling athletes to engage in activities that are beneficial to their stress- recovery in the training process and competition period.

The second group is the coaches, the Latvian Taekwondo Federation, and other Taekwondo clubs. The developed recommendations for increased performance in the competition period can help taekwondo coaches prepare athletes in the competition period. The content of outdoor recreation activity in the practice of the taekwondo athlete’s competition period can be a successful program intervention to reduce stress and enhance performance, translating into more wins. Winning is the most visible and easily measured criterion of coaching competence. At the same time, the coaches are concerned with many more areas to develop their athlete's abilities. Coaches’ job often depend on the number of wins and losses they experience. While teams can improve without increasing their win-loss ratio, winning is the most visible marker. Also, if the taekwondo team were to earn a medal in the international taekwondo competition, it would confirm that the program was highly successful.

Theses for defense:

Outdoor recreational activities (walking in nature), included as a means of recovery in the training process during the competition period, reduce the stress level of taekwondo athletes.

Outdoor recreational activities (walking in nature), included as a means of recovery in the training process in competitions, stabilize the mental toughness of taekwondo athletes.

Recreational activities in the nature (walking), applied immediately after taekwondo training during the competition period during a one-month mesocycle (4 weeks, 3 x a week), reduces the stress level of athletes, promote the stability of mental toughness and improve the performance of taekwondo athletes.

The gas discharge visualization (GDV) testing method can be practically used by taekwondo coaches to determine the stress of athletes during the training process of athletes.

Type of research. The Doctoral thesis "Effect of outdoor recreation activity on stress level and mental toughness on taekwondo athletes in the competition period" is a quasi-experimental and quantitative approach to research.

Limits of the research:

Many factors affect athletes' performance, such as physiological and psychological. Also, taekwondo training needs physiological (strength, flexibility, speed) and psychological parts. In this research, the author focuses on psychological preparation for stress level and mental toughness and its components as confidence, constancy, and control, in taekwondo athletes in the competition period.

Mental toughness has different programming that can help athletes as mindset programs. However, this research used the effect of exposure to nature as a program and planned to help taekwondo athletes increase mental toughness.

Another limitation of this research is the small size of subjects. In Latvia, eight taekwondo clubs and less than 400 athletes at all levels are training in taekwondo. However12 taewondo athletes according to the criteria: 17 to 23 years old, 10 year experience of participation in the international competition.

Another limitation of this research is the preparation time and the research, and it was just four weeks before the competition.

Terms and concepts used in the research:

The term *outdoor recreation* is a voluntary activity or experience that includes games or other activities in an individual's free time for pleasure and physical, mental, and emotional well-being (Veal, 2011).

The term *nature* is the nonhuman origin that includes plants, animals, the landscape, trees and greenery, and other features and products of the earth, as

opposed to humans or human creations (Hartig, Evans, Jamner, Davis, and Gärling, 2003).

Stress is a multidimensional phenomenon that disturbs the body's homeostatic balance and is caused by physical, psychological, or social conditions. (Selye, 1956).

Stress level. Based on the DASS questionnaire, the stress level is between normal till extremely severe, and scores range from 0-34 (Lovibond and Lovibond,1995).

Mental toughness is "congenital or established psychological dominance over one's opponent, which helps to maintain perseverance, self-confidence and act effectively in high-stress situations during the most responsible moments of competitions" (Jones, Hanton, and Connaughton, 2002, p. 209).

The term *confidence* is closely related to athletes' ability to interpret stressful situations as a positive opportunity to achieve higher results (Moritz, Feltz, Fahrbach and Mack, 2000).

The term *constancy* is the ability to overcome failure, return after a loss and continue the fight, learn from one's mistakes, and improve (Gould, Finch, and Jackson, 1993).

Self-control is the ability to focus on the performance of a task, successfully resist temptations, follow one's goals, and work productively in high-stress situations (Baumeister, Heatherton and Tice, 1994).

The term *Gas Discharge Visualization (GDV)* is the flow of electrons from a conducting object under the influence of a high-frequency (1024 Hz) electromagnetic pulse of high intensity, which creates photon radiation (glow) in the gas air (Hacker, 2005).

The term *taekwondo* is a combat sport involving various techniques such as punches, kicks, and blocks to defeat an opponent (Park et al., 2000).

Recovery is an active process of regaining physiological resources and re-establishing psychological states to allow the athlete to use these resources in training and competitions (Kellmann, and Kallus, 2001).

1. THEORETICAL BASIS OF TAEKWONDO ATHLETES' TRAINING, STRESS LEVEL, MENTAL TOUGHNESS, AND OUTDOOR ACTIVITY (WALKING IN NATURE)

The theoretical part of the Doctoral Thesis consists of analysis of the scientific literature. The theoretical part of the research consists of four subchapters.

In the subchapter of the Doctoral Thesis **1.1** "**Martial arts, taekwondo sport, and training periodization**," the literature about martial arts, taekwondo sport, and training periodization were studied and analyzed. The principal values promoted in

the martial arts classroom are honor, loyalty, courage, and humility. For hundreds of years, martial arts supporters talked about their capacity to assist the personal development of the practitioner. The Japanese concept of budo illustrates the connection between personal development and mind-body training practices, which generally applies to martial arts with a combat dimension. While physical training is like other forms of fighting, it is the philosophical basis of the movement. *Bud* is a word used to explain the philosophical basis of those martial arts related to personal and inner progress through training. *Do* refers mainly to the western way of an inner life path and the specific philosophical orientation of the traditional martial artist. Martial arts, specifically taekwondo, is a combat sport involving various techniques such as punches, kicks, and blocks to defeat an opponent. For taekwondo athletes, maintaining peak physical condition during a competition is vital. They must deal with pressure, control stress and anxiety before a competition, and deal with thoughts of previous losses, injuries, or knock-out experiences. The more critical the competition, the more stress the athlete experiences. With all these strains, an athlete may find it difficult to enter the flow state and, thus, be unable to react to an opportunity and miss the timing of a critical technique. In taekwondo, recovery is essential for high performance, which may provide numerous benefits during repetitive high-level training and competition. It is well known that athletes train to increase performance and win. Performance can be achieved with different factors. Training periodization is the systematic planning of athletic or physical training. It involves the manipulation of various training variables, such as volume, intensity, and frequency, over a given period. The goal of periodization is to maximize performance and prevent overtraining. In taekwondo, training periodization involves dividing the training year into different periods, such as an off-season, pre-season, and competition, and focusing on specific goals and techniques during each period. It is crucial for taekwondo athletes to properly plan and periodize their training to improve their performance and prevent burnout.

The second subchapter of the Doctoral Thesis **1.2. "Stress, the relationship between stress, recovery, and performance, stress disorders, stress, and energy management,"** describes the concept of stress, connection between stress, athletes recovery and performance, describes stress disorders and body energy management. Selye (1956) defined stress as a multidimensional phenomenon that disturbs the body's homeostatic balance and is caused by physical, psychological, or social conditions. He proposed the General Adaptation Syndrome (GAS), which has its foundation in activating the adrenal cortex in answer to stress. Selye furthered the stress literature in his proposition that changes in homeostasis were not just a response to environmental alterations but that an animal's physiological systems could be trained to maintain adaptive defenses against potential exposure to stress.

He suggested that conditioning factors, such as previous exposure and controllability of a stressor, could alter the GAS.

Furthermore, he proposed that stressors, including physical exercise, could lead to cross-stressor adaptations that would develop resistance to psychosomatic and neurotic diseases. He defined the three stages of GAS: alarm reaction, resistance, and exhaustion. A coach wants the athlete to perform to the best of his ability, and for optimal performance, athletes need to recover after competition and between training sessions. Thus, balancing training stress and adequate recovery is essential for ideal performance. Apart from training load, psychological stress factors play a role in the development and performance of an athlete. Many coaches do not believe that events outside the sporting environment are relevant to performance, but what happens in the athlete's private life can add to the stress the athlete experiences. Stress, coping with it, and recovery determine the athlete's state, which determines their reaction to subsequent stressors and ultimately influences performance. Not only is the intensity of the stress an essential factor, but the duration, distribution over time, and the nature of the stress play important roles. Increased stress demands and insufficient recovery lead to the athlete experiencing more stress. If recovery demands cannot be met, the athlete will be stressed beyond the point of failure and may need to find other ways of coping with the stress. Recovery is an active process of regaining physiological resources and re-establishing psychological states to allow the athlete to use these resources in training and competitions. The complexity of the recovery process led researchers to propose recovery as a general psychophysiological concept. Recovery sessions must be included in the training and competition schedule, but an interdisciplinary approach may be the key to a more effective diagnosis of the recovery-stress state of an individual. Kellmann's scissors model explains the relationship between stress and recovery. As athletes are subjected to stressful life events, psychological and physical stressors accumulate along the same pathway, and without adequate recovery, it can lead to elevated stress levels. With adequate recovery, however, the athlete can react accordingly and cope successfully with the stress, re-establishing an optimal performance level. Any imbalances in the recovery-stress state that are not immediately taken care of can result in under-recovery, overtraining, and possible burnout. Stress disorders resulting from predominantly psycho-social and physiological excessive stress and under-recovery are characterized by chronic fatigue, most likely associated with hypothalamic dysfunction, regardless of the predominant source of stressors.

Stress disorders promote physiological maladaptation and psychological dysfunction, which may have a detrimental effect on performance capacities. Unexplained underperformance syndrome is considered a more precise term for

athletic stress disorder, as it describes the defining characteristic of the syndrome without inappropriately implying the cause. Energy management is the practical usage of personal energy, which involves learning to recognize, develop, and refill it. Energy management includes stress management, the most significant proportion of energy management. Other energy management components are task/time management, proper nutrition, and physical training and exercise. Coaches want their athletes to have plenty of energy, so they will tolerate the relaxation that accompanies a guided visualization session when they are confident. It will lead to increased energetic output and postponement of fatigue during competition.

The third subchapter of the Doctoral Thesis **1.3**. "**Mental toughness and its significance in sports and taekwondo**" examines mental toughness in sports and taekwondo. The term *mental toughness* has been regularly used in the sporting arena for over 25 years. The term is such that it can have distinctly different meanings for every individual, whether it is athletes, coaches, commentators, or the media. Practicing sports psychologists are often asked to develop mental toughness within a team environment or with individual athletes. However, working towards strategies for developing this mental toughness is challenging without defining and operationalizing the construct. It could be argued that mental toughness and hardiness are the same, with different labels. However, in response to such a claim, it could also be argued that hardiness is inadequate to address the unique characteristics essential in a sporting domain and regarding sporting performance. Specifically, hardiness does not account for the unique context in which sport occurs. We can see the growing research on mental toughness in martial arts and combative sports. The number of papers focusing on mental toughness in martial arts and taekwondo is deficient.

Nevertheless, many authors highlighted that mental toughness is essential and wanting. Mental toughness may be even more crucial in martial arts, not only if the pressure of competitions and performance is assumed, like many other sports. More critical, contact fighting, sometimes extended life-term learning, and negative energy control during the fight when the focus is critical may be very demanding. The aspects of full contact practice, body to body, and dealing with violence and negative energy make martial arts a fruitful area for testing mental toughness and its development and exploring the application and influences of cognitive skills training.

The fourth subchapter of the Doctoral Thesis **1.4.** "**Nature and outdoor recreation activity**" described the aspect of exposure to nature and outdoor recreation activity (walking in nature). The individual-nature connection refers to the relationship between an individual and the natural environment. It is believed that being in nature or engaging in activities in nature can positively affect an

individual's physical and mental well-being. Some theories, such as the Biophilia Theory, suggest that the natural environment has restorative properties to help individuals recover from stress. The biophilia theory suggests that humans have an innate preference for natural surroundings and that exposure to nature has restorative effects. Two well-known theories in psychology, Attention Restoration Theory (ART) and Stress Reduction Theory (SRT), provide insights into the positive effects of nature on humans. ART suggests that natural surroundings promote simple attention, which requires little mental effort and can resist fatigue, thus helping to restore mental capacity. SRT suggests that non-threatening natural surroundings promote psychophysiological stress recovery, improve mood, decrease negative thoughts, and reduce stress more effectively than artificial environments. Studies have shown that exposure to natural environments reduces stress, as indicated by lower blood pressure and increased positive affect. Natural surroundings and outdoor activities are associated with novel stimulation and relaxation, and factors such as feeling away and goals related to the surroundings may also explain the restorative effects. Outdoor recreation is a voluntary activity or experience that includes games or other activities in an individual's free time for pleasure and physical, mental, and emotional well-being. Some studies suggest that training in a natural environment can help improve taekwondo performance.

2. RESEARCH OBJECTIVES, METHODOLOGY, AND ORGANIZATION

Analysis of Scientific Literature Sources

The theoretical substantiation of the dissertation was based on literature research and analysis. The literature research and analysis process obtained information from scientific literature sources in sports science, psychology, stress level, mental toughness, recovery, taekwondo training, and competition. An extensive theoretical investigation and analysis of empirical research findings were performed on the relationship between stress level, performance, recovery, mental toughness components, outdoor recreation activity, physiological processes related to stress level in different theoretical contexts, results, and significance in martial arts and taekwondo competition period. The study of stress level, performance, recovery, mental toughness, and outdoor recreation activity was based on an analysis of literature sources. The study uses two hundred seventy-two literature sources: English (271) and Russian (1).

Survey – Questionnaire

Two questionnaires were used in the Doctoral Thesis.

1. Stress Scale of DASS questionnaire. The stress scale of the Latvian version of DASS (Lovibond and Lovibond,1995) was used and validated by (Ozoliņa et al., 2015). The stress scale of DASS is a self-respond scale that measures stress. The answer options are ranked on a Likert scale from 0 to 3. The 0 stands for "Did not relate to me at all" and 3 for "Related to me most of the time or very much."

The stress scale is described: Stress: chronic nonspecific arousal, difficulty relaxing, nervous arousal, easily upset/agitated, irritable / over-reactive, and impatient, and scores range from 0-14 (normal), 15-18 (mild), 19-25 (moderate), 26-33 (severe) and 34+ (extremely severe). The Stress scale was used in the Doctoral thesis to identify the stress level of taekwondo athletes.

2. Sports Mental Toughness Questionnaire (SMTQ). The Latvian version of a questionnaire, the Sports Mental Toughness (Sheard et al., 2009), was validated by Astafičevs; Vazne; Fernate (2020). The SMTQ consists of 14 statements divided into three components of mental toughness- Confidence, Constancy, and Control. The Confidence Scale is characterized as a positive interpretation of threats and stress by the athlete. Belief in oneself is the athlete's unshakable confidence in one's abilities, the athlete is firmly convinced of what he/she can do, and this view is unchangeable. A confident athlete believes in having the necessary skills and abilities to perform well in stressful situations. Self-confident athletes can make decisions with determination and confidence in stressful situations. Athletes who believe in themselves recover quickly after moments of losing composure. The Constancy scale provides insight into how strong you are as an athlete's commitment to complete the set and planned tasks to the end. The scale results show an athlete's ability to set challenging goals and inspire and encourage others to continue to fight. It reveals the extent to which an athlete takes long-term responsibility for themselves and the consequences of one's actions in the training and competition process. The Control scale shows how well or poorly an athlete can control herself when he/she begins to worry about poor performance and when the athlete starts to doubt himself. Athletes who have developed this skill do not worry about events they cannot control or sudden situations. Self-control is an athlete's ability to control oneself when something does not happen the way one would like, and it is the control of one's anger and other emotions. Self-control is an athlete's belief that they can influence events to cope with or manage stress. The answer options were ranked on a Likert scale from A to D. The A scale stands for "Very true," and the D stands for "Not at all." The doctoral thesis used the SMTQ to identify and analyze taekwondo athletes' mental toughness components (control, confidence, constancy).

Testing

The Determination test (DT) and Gas Discharge Visualization (GDV) were used in the doctoral thesis to gain deeper insight and objectively assess athletes' stress level. The Vienna test system can detect and analyze various psychophysiological processes, such as Determination tests.

The Determination Test (DT)

The determination test is used to measure reaction time and reactive stress tolerance. Since this is a fundamental ability required in many everyday situations, the areas of application of the DT are vast. Since the DT measures reactive stress tolerance, experiencing stress is inherent to testing. The ability to react is defined here as responding to one or more environmental stimuli as quickly and accurately as possible. The occurrences of the stimulus and any manner of reaction that can be observed are reaction time. Reactive stress tolerance is a particular case of the ability to react and describes the ability to respond quickly and correctly under stressful conditions. Stress tolerance is the degree to which a person can resist stress and keep their impact on power and mental state as low as possible. *The test* presents all the stimuli (colors, tones, foot signals). The percentile ranks indicate what percentage of a particular comparison group obtained the same or a lower score on the variable in question. The ranks are 0-24 (below average), 25-75 (average), and 76-100 (above average). DT was used to assess the stress levels of taekwondo athletes.

Gas Discharge Visualization (GDV)

The Gas Discharge Visualization technique (Kirlian effect) is a scientific method to assess individual stress. A bio-electrography tool illustrates the state of a person's stress and energy amounts. All ten fingertips of the subjects were measured. By scanning, high intensity electrical field activates the discharge of photons and electrons from human skin, which creates gas discharge photographed by a video camera. The assessment through GDV is performed through stimulation of electrons at the fingertips by applying a short electric pulse of a high voltage (10 kV), high frequency (1024 Hz), and a glow occurs. This glow results from ionizing gaseous molecules in the surrounding air through the discharged electrons from the fingertips. A camera captures the glow. GDV parameters, the scale of stress level are from 0-2 (calm or chronic depression), 2-4 (normal), 4-6 (excited state), 6-7 (reaction to a previously stressful situation), 7-10 (very high-stress level). In the doctoral thesis, the GDV test was used to assess the stress levels of taekwondo athletes.

Detection Experiment

The detection experiment was conducted to determine the effect of outdoor recreation activity (walking in nature) on taekwondo athletes' stress level and mental toughness in the competition period.

The group in the detection experiment consisted of twelve taekwondo athletes from the 17-23 age groups. The sample was selected according to the following criteria: participation in competitions organized by the Latvian taekwondo has represented Latvia in international competitions and is eligible for the International Sweden Taekwondo Championship, and at least ten years of experience in taekwondo. These criteria were selected to minimize other factors' impact on the research results. The Latvian taekwondo athletes (n=12) took part in the detection experiment, which took place in three stages. The experiment took four weeks before the international Sweden taekwondo competition. It was twelve sessions, including 40 minutes in zone 1 and 2 (101-141 bpm). In the first stage of the investigation, all athletes were introduced to the tests (DT and GDV), and the protocol of each test was explained to them under the supervision of specialists; how, when and where it would be conducted. All participants received verbal and visual explanations of them. In the second stage, all athletes completed the Determination Test, gas discharge visualization, and questionnaires (Stress scale of the DASS and SMTQ). In the third stage of the detection experiment, all athletes completed the Determination Test and gas discharge visualization after four weeks of outdoor recreation (walking in nature). They conducted and responded to the stress scale of the DASS and SMTQ questionnaires.

Comptition protocol anaalysis

Analyzing of performance was performed where taekwondo athletes performed in the international Belgium and Sweden taekwondo championships.

Mathematical Statistics

The purpose of mathematical statistics is to perform statistical processing of the obtained data. The results obtained in the experiment were processed using Microsoft Office Excel and the SPSS version 26 mathematical statistics software. Primary and secondary mathematical statistics methods were used in the research:

- Descriptive statistics: mean, standard deviation, coefficient of variation
- The Shapiro-Wilk test
- Paired sample T-test
- Wilcoxon test.

Organization of Research

The research lasted four years, from its launch in 2019 to its conclusion in 2023. The doctoral thesis study was carried out in several stages (Figure 1).

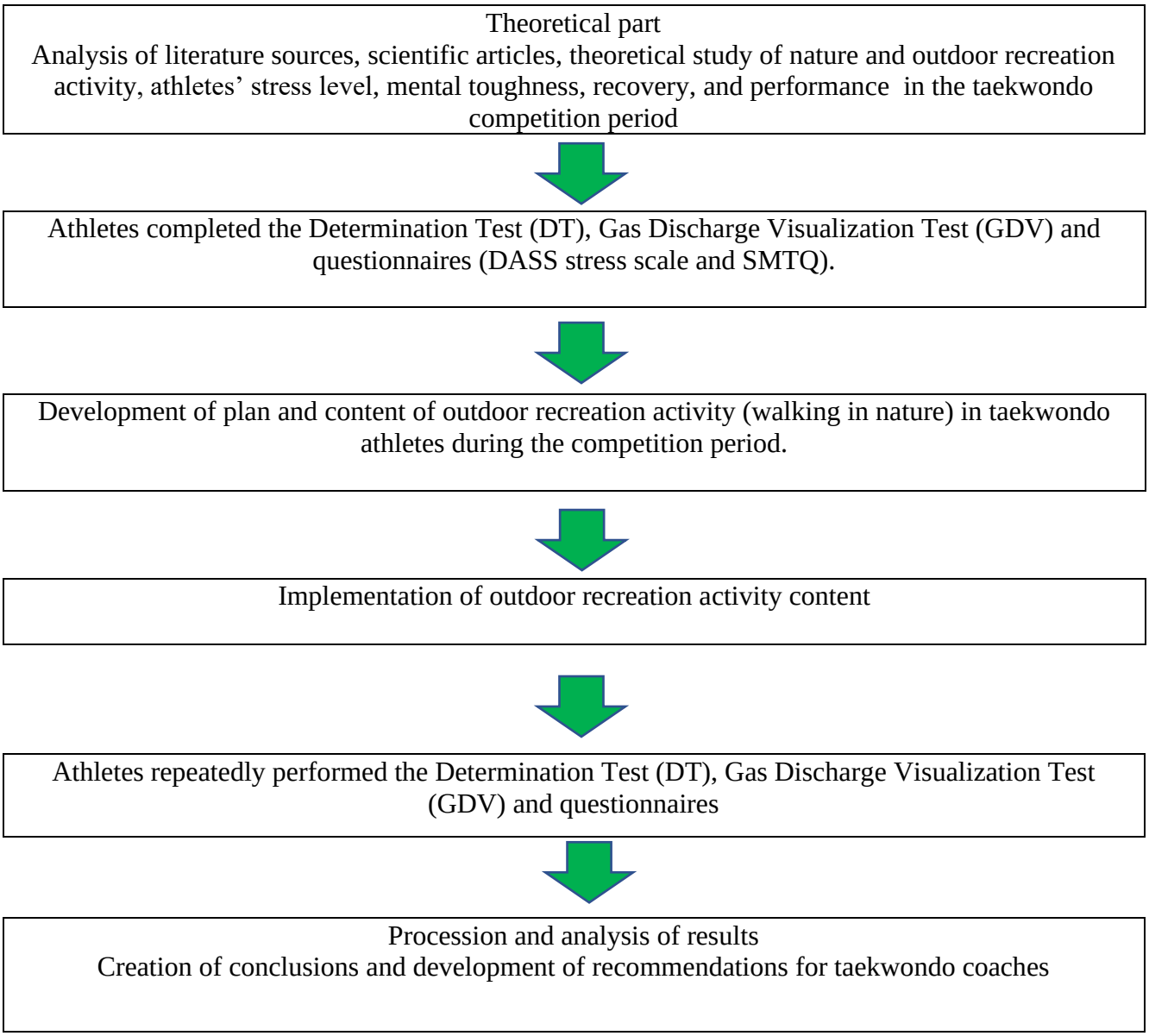

Figure.1**. Research Organization Scheme**

The first stage. In the theoretical part, the scientific categories were determined, analysis of scientific literature was made. Theoretical study of athletes' stress level, mental toughness, recovery, and performance, and the role of them in the taekwondo competition period, and the main objectives for solving the problem of doctoral thesis research were set.

The second stage. In the second stage of the study, a detection experiment was conducted. The experiment took place four weeks before an international

taekwondo competition in Sweden. Before the experiment, all athletes were introduced to questionnaires and tests (DT and GDV), and also explained the protocol of each test under the supervision of a specialist - how, when and where it will be performed. All participants received verbal and visual explanations about them. Athletes completed the Determination Test (DT), Gas Discharge Visualization (GDV) and questionnaires (DASS Stress Scale and SMTQ).

The third stage. In the third stage of the research, the content of outdoor recreation activity (walking in nature) program for four weeks period for taekwondo athletes in the competition period was developed.

The forth stage. The implementation of the outdoor recreation activity content took place during the competition period within one month (4 weeks). Each week there were 5 taekwondo 90-minute training sessions, and three training sessions were followed by a recreational activity of 40-minute outdoor walking. Walking in the nature, mostly in the forest and on the plain, took place within two heartbeat intensity zones: very light intensity (Z1: 101-121 beats/min.) and light intensity (Z2: 121-141 beats/min.) zones. Latvian taekwondo athletes (n=12), aged between 17 and 23, took part in the implementation of outdoor recreation activities.

The fifth stage. After the implementation of the content of outdoor recreational activities, practically all athletes took the Determination Test (DT) and the Gas Charge Visualization (GDV) test again. They answered the questions of the DASS stress scale and the SMTQ questionnaires. An analysis of the performance of taekwondo athletes at the International Competition in Sweden was carried out.

The sixth stage. Mathematical processing and analysis of the results was carried out and recommendations were developed for taekwondo coaches in working with athletes during the competition stage.

3. RESULTS OF THE EFFECT OF OUTDOOR RECREATION ACTIVITY (WALKING IN NATURE) ON STRESS LEVEL, MENTAL TOUGHNESS, AND PERFORMANCE, IN TAEKWONDO ATHLETES

The subchapter 3.1. "**Identification of stress level, mental toughness, and performance of taekwondo athletes before the experiment,**" describes the practical research about taekwondo athletes' stress level, mental toughness, and performance before the experiment, as well as its results.

First the stress level of Latvian taekwondo athletes was stated. The **Stress scale** of DASS (www2.psy.unsw.edu.au/Groups/Dass/Latvian/Ozolina.htm) was completed by taekwondo athletes, n=12. The Stress scale of the DASS questionnaire is a self-respond scale that measures stress, and scores range from 0-14 (normal),

15-18 (mild), 19-25 (moderate), 26-33 (severe), and 34+ (extremely severe). Table 1 shows the descriptive statistics of a sample of taekwondo athletes (n=12). The results are presented in terms of Mean (M) and Standard Deviations (SD). The mean stress level for the sample of n=12 taekwondo athletes is M=28.917, with a standard deviation of SD ± 1.084. It suggests that the average stress level for the sample falls within the severe range of the stress scale, as the mean score falls between 26 and 33. A small standard deviation suggests that there is small variation and the athletes are in the range "severe".

Table 1

Descriptive Statistics for taekwondo athletes (n=12, stress scale of DASS before the experiment)

	N	Mean	SD
Stress	12	28.917	1.084

The stress levels for each gender (n=6 male and n=6 female) were measured using a stress scale questionnaire, and the results are presented in terms of mean and standard deviations for each group (table 2). The mean stress score for male athletes is M=28.167, with a standard deviation of SD ± 0. 408; for female athletes, the mean stress score is M= 29.667, with a standard deviation of SD ±1.033. The results of this table indicate that, on average, the female athletes in the sample had slightly higher stress levels than the male athletes.

Table 2

Descriptive Statistics for taekwondo athletes (n=12, stress scale for gender before the experiment)

	Group	N	Mean	SD
Stress	Male	6	28.167	0.408
	Female	6	29.667	1.033

However, as shown in figure 2, the standard deviation for the female group (±1.033) is much higher than the standard deviation for the male group (±0.408), which shows that the female group has bigger dispersion around the mean.

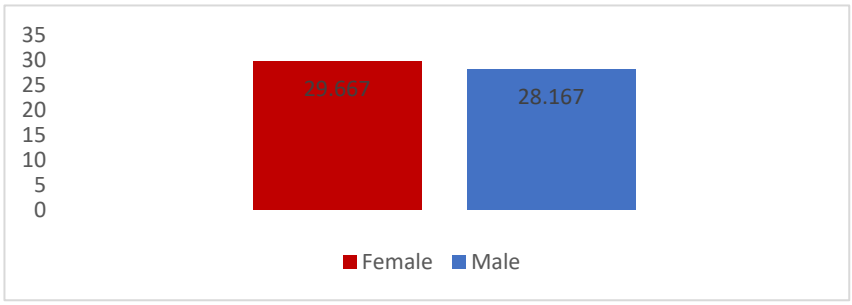

Figure 2. **Mean for taekwondo athletes, stress scale (DASS), by gender (n=12)**

The results of the stress scale for the twelve athletes in figure 3 show that the majority have a severe stress level, with scores ranging from 28 to 31. According to the given range, scores between 26 and 33 are considered severe stress, while scores above 33 are considered severe stress.

Based on the stress range, all male athletes (S1-S4, S6, and S5) have a severe stress level with a score of 28 or 29. S5 has the highest stress level among male athletes, scoring 29. In the female group, female athlete S7 has the lowest stress level with a score of 28, which is in the severe range. Female athlete S10 scored 29, also in the severe range. Female athletes S9, S11-S12 have the same stress level with a score of 30, which is still in the severe range. Female S8 has the highest stress level among all the athletes, with a score of 31, which is still in the severe range.

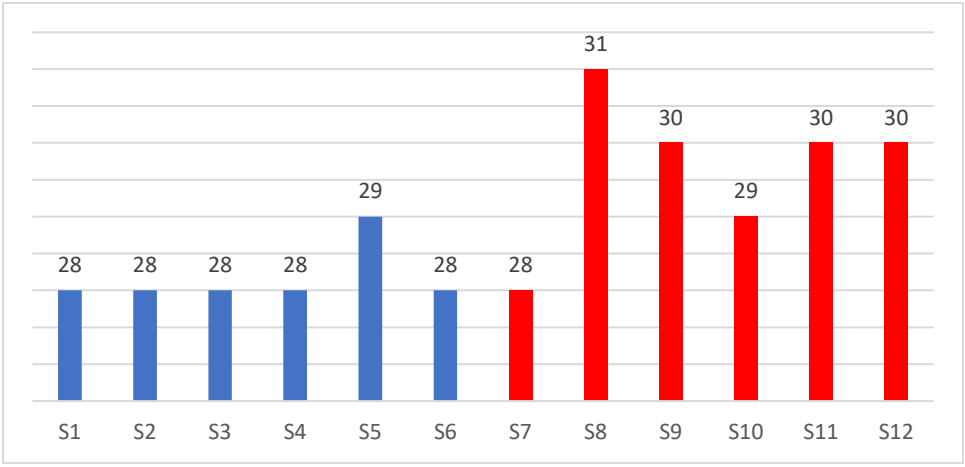

Figure 3. **Stress score (DASS) for individual taekwondo athletes before the experiment (n=12)**

The stress level before the experiment was measured with a **GDV** camera for taekwondo athletes (n=12). The range of stress level for GDV is from 0-2 (calm or chronic depression), 2-4 (normal), 4-6 (excited state), 6-7 (reaction to a previously

stressful situation), 7-10 (very high-stress level). Before the experiment, the descriptive statistics for stress level based on GDV for taekwondo athletes (n=12) is presented in terms of mean and standard deviations (table 3).

The mean stress level for the sample of n=12 athletes is M=4.820, with a standard deviation of SD ± 0.968. According to the GDV range, a score of 4.820 falls within the excited state range of 4-6, characterized by emotional excitement and tense activity. The standard deviation of 0.968 indicates that the stress level of the athletes in this sample is relatively consistent, with most of the scores falling within one standard deviation of the mean. It suggests that while the athletes have high-stress level, the stress levels are somewhat similar across the group.

Table 3

Descriptive Statistics for taekwondo athletes (n=12, GDV before the experiment)

	N	Mean	SD
Stress	12	4.820	0.968

The stress levels for each gender (n=6 male and n=6 female) were measured using GDV, and the results are presented in terms of mean and standard deviations for each group (table 4).

The mean stress score for male athletes is M= 4.835, with a standard deviation of SD ±1.005, while for female athletes, the mean stress score is M=4.805, with a standard deviation of SD ± 1.025. The results indicate that the stress level for both male and female athletes are relatively high, with mean scores close to the excited state range of 4-6.

Table 4

Descriptive Statistics for taekwondo athletes (n=12, GDV for gender before the experiment)

	Group	N	Mean	SD
Stress	Male	6	4.835	1.005
	Female	6	4.805	1.025

The results of the Gas Discharge Visualization (GDV) test before the experiment for twelve athletes in figure 4 show that the stress level scores range from 3.72 to 5.98. The scores of 3.72 fall within the normal range of 2-4, and scores of 5.38, 5.74, and 4.96 falls within the excited state. The results show some variability in the stress level of the athletes in this sample, with some athletes having low levels of stress and others having higher levels. The fact that some athletes score in the excited state range highlights the potential impact of stress and tension. In male groups, S1 and S2 have a score (of 3.72), which falls under the range of 2-4, meaning the athlete is in a normal condition. Athletes' S3-S6 scores (4.47-5.98) fall

under 4-6, meaning the athlete is in an excited state of stress. In female athletes, S8 and S12 have the same score (3.72), which falls under the range of 2-4, meaning the athlete is in a normal condition, but athletes S7, S9-S11 score (4.96-5.98), which falls under the range of 4-6, meaning the athlete is in an excited state of stress. The results show that some of the athletes in this sample face higher stress and tension levels.

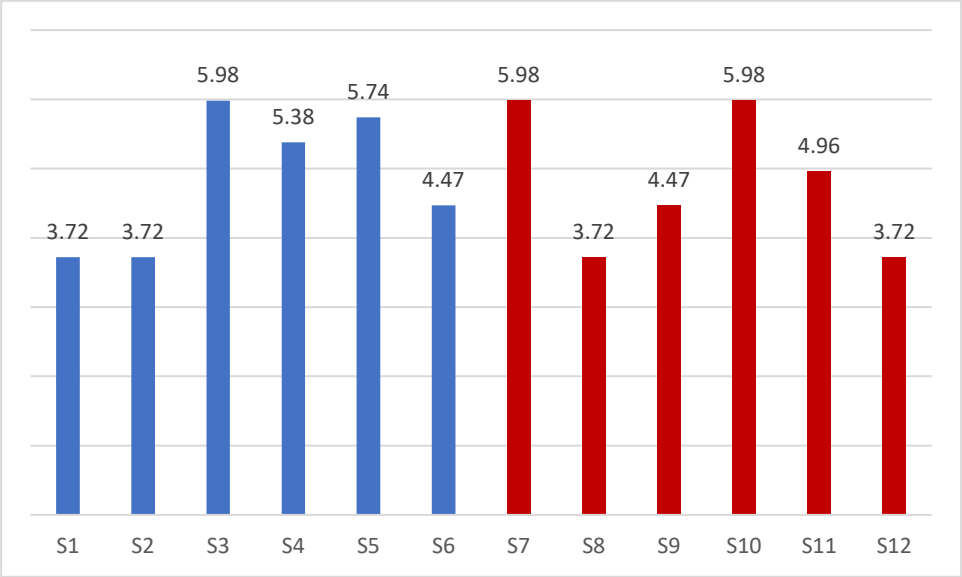

Figure 4. **GDV for individual taekwondo athletes before the experiment (n=12)**

The stress level before the experiment was measured by **Determination Test** (DT) for taekwondo athletes (n=12). The stress rank for DT scores is 0-24 (below average), 25-75 (average), and 76-100 (above average).

Before the experiment, the descriptive statistics for stress levels based on DT for taekwondo athletes (n=12) were presented in terms of mean and standard deviations (table 5). The mean stress level for the sample of n=12 athletes is M=50.917, with a standard deviation of SD ± 22.817. This score falls within the average range of the rank.

Table 5

Descriptive Statistics for taekwondo athletes (n=12, determination test before the experiment)

	N	Mean	SD
Stress	12	50.917	22.817

The stress levels for each gender (n=6 male and n=6 female) were measured using DT, and the results are presented in terms of mean and standard deviations for each group (table 6).

The mean stress score for male athletes is M= 55.00, with a standard deviation of SD ±29.455, while for female athletes, the mean stress score is M=46.833, with a standard deviation of SD ± 15.420.

Table 6

Descriptive Statistics for taekwondo athletes (n=12, determination test for gender before the experiment)

	Group	N	Mean	SD
Stress	Male	6	55.000	29.455
	Female	6	46.833	15.420

Based on the DT percentile rank, the mean score of M=55.00 for male athletes falls into the "average" range of 25-75, indicating that the stress levels for male athletes were moderate.

It is in line with the standard deviation of SD±29.455, which suggests that the stress levels of male athletes in this sample are inconsistent, with some athletes having higher stress level and others having lower levels. On the other hand, the mean score of M=46.833 for female athletes falls within the average range of 25-75, indicating moderate stress levels. The standard deviation of SD±15.420 suggests that the stress levels of female athletes are relatively consistent, with most of the scores falling within one standard deviation of the mean.

The results of the Determination Test for twelve athletes, with six male and six female participants, were collected (fig 5). According to the percentile rank, scores from 0-24 are below average, 25-75 are average, and 76-100 are above average. Male athletes' scores range from 19 to 93, with a mean score of M=55.00 and a standard deviation of SD±29.455. It indicates that the stress level for male athletes are variable, with some athletes having below-average scores, S5 (score 19), and others having above-average scores, S4 (score 88), and S6 score (87). The scores for female athletes range from 32 to 75, with a mean score of M=46.833 and a standard deviation of SD±15.420. It suggests that the stress level for female athletes is relatively consistent, with most scores falling within the average range (S7-S12). Overall, the results indicate a range of stress levels among the twelve athletes, with some athletes having above average and others having average or below average.

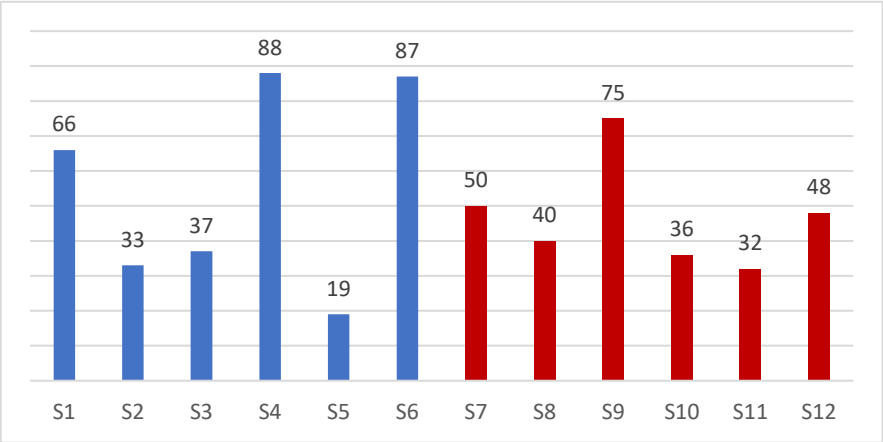

Figure 5. **Determination test for individual taekwondo athletes before the experiment (n=12)**

This part analyzes the components of **Mental Toughness** (Confidence, Constancy, and Control) in Latvian taekwondo athletes before the experiment described. The Latvian version of the Sports Mental Toughness Questionnaire (SMTQ) was used. The SMTQ was given to 12 Taekwondo athletes (female n=6 and male n=6). The SMTQ consists of 14 statements divided into three components of mental toughness- confidence, constancy, and control.

The descriptive statistics were generated (Table 7) for n=12 taekwondo athletes for the gender of the athletes (male and female). The mean confidence, constancy, and control scores are M=16.833, M=13.083, and M=11.167, respectively. The standard deviation for confidence, constancy, and control are SD ± 3.614, SD ± 1.379, and SD ± 1.801, respectively.

Table 7

Descriptive Statistics for taekwondo athletes (n=12, mental toughness components before the experiment)

	Confidence	Constancy	Control
Athletes	12	12	12
Mean	16.833	13.083	11.167
Std. Deviation	3.614	1.379	1.801

The mean score for **confidence** is relatively high, indicating that the athletes in this sample generally have a high level of confidence in their abilities. The standard deviation for confidence is also relatively high, indicating a wide range of scores for this mental toughness component among the sample athletes. The mean score for **constancy** is also high, indicating that the athletes in this sample generally

maintain their focus and commitment to their goals over time. The standard deviation for constancy is relatively low, indicating that the scores for this component of mental toughness are relatively consistent among the athletes in the sample. The mean score for **control** is low, indicating that the athletes do not have a high level of control over their emotions and thoughts during training and competition.

Descriptive Statistics for the mental toughness components (confidence, constancy, and control) in terms of gender (n=6 Male and n=6 Female) are shown in table 8.

Table 8

Descriptive Statistics for taekwondo athletes (n=12, mental toughness components before the experiment)

	Confidence		Constancy		Control	
	M	**F**	**M**	**F**	**M**	**F**
Athletes	6	6	6	6	6	6
Mean	17.500	16.167	13.500	12.667	11.333	11.000
Std. Deviation	3.564	3.869	1.761	0.816	2.066	1.673

The results show that the mean confidence score is higher for male athletes (M=17.5) compared to female athletes (M=16.167). The standard deviation for male athletes is slightly lower (SD ± 3.564) than for female athletes (SD ± 3.869). This suggests less variation in the confidence scores among male athletes compared to female athletes. The mean constancy score is also higher for male athletes (M=13.5) compared to female athletes (M=12.667). The standard deviation for male athletes is higher (SD ± 1.761) than for female athletes (SD ± 0.816). This suggests that female athletes have less variation in constancy scores than male athletes.

Lastly (figure 6), the mean control score is similar for male and female athletes (M=11.333 for males and M=11 for females). The standard deviation for male athletes (SD ± 2.066) is higher than for female athletes (SD ± 1.673). This suggests more variation in the control scores among male and female athletes. The results show that male athletes generally have higher confidence and constancy scores than female athletes. However, the scores for control are similar for both male and female athletes.

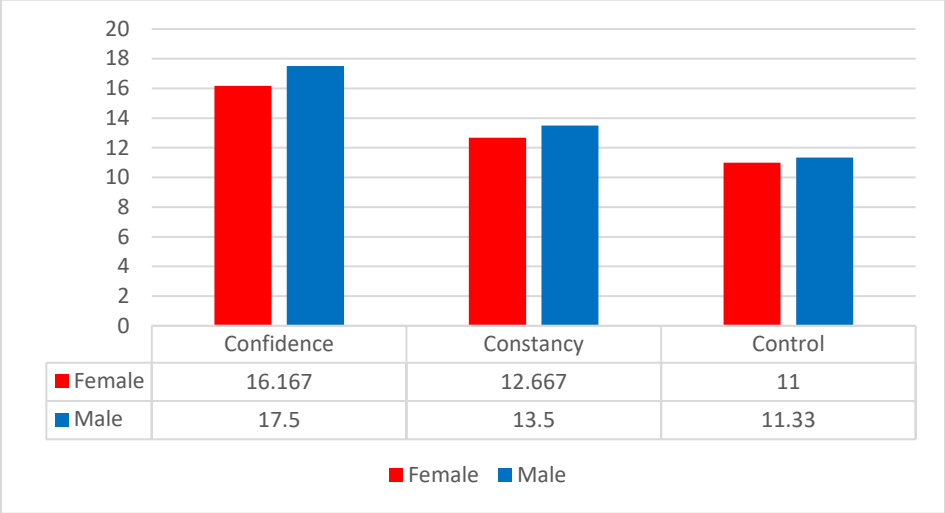

Figure 6. **Mental toughness components for taekwondo athletes (n=12) before the experiment**

The **performance** of the Latvian taekwondo team at the International Belgium taekwondo competition in 2022 was unsuccessful. The Latvian team was composed of 5 athletes: 2 male athletes, one in the Senior division (-80 kg) and another in the Junior division (-78 kg), and three female athletes in the Junior division, 2 of them in the -63 kg category and another in the +68 kg category. The competition had a total of 1200 participants from different countries. Unfortunately, all the Latvian athletes lost in the first round of competition, except for the female athlete in the +68 kg category, who won one match. The competition results are on the European Taekwondo Union website at https://europeantaekwondounion.org/event/belgian-open-2/.

When considering the poor performance of the Latvian taekwondo team, a combination of factors likely contributed to this outcome. Some athletes' high-stress levels may have negatively impacted their performance, while the differences in mental toughness components between male and female athletes may have also played a role. Additionally, the team may have lacked the necessary skills and preparation to compete at this level or had issues with strategy and tactics.

In the subchapter 3.2. "The content of outdoor recreation activity in the taekwondo athlete's competition period" describes the task - **t**o develop the content of outdoor recreation activity in the practice of the taekwondo athlete's competition period.

In the research done, describe in the subchapter 3.1., it was stated that the mean stress level for male and female taekwondo athletes is high. With the purpose to decease taekwondo athletes' stress level for their better performance in the

competitions, outdoor recreation activity (walking in nature) content was developed. The content included the period of four weeks, during which taekwondo athltes walked in nature as an outdoor activity. It consists of twelve sessions – recreation activity in nature (table 9)

Table 9

Outdoor recreation activity (Walking*) plan

(Intensity zones: Zone 1: Very light, heart rate 101-121 beats per minute, Zone 2: Light, heart rate 121-141 beats per minute)

Week 1	Week 2	Week 3	Week 4
Session 1 Taekwondo Walking * Intensity: Z1 Duration: 40 minutes Pages:41-48 in the Promotion work	**Session 6** Taekwondo Walking * Intensity: Z2 Duration: 40 minutes	**Session 11** Taekwondo Walking * Intensity: Z1 Duration: 40 minutes	**Session 16** Taekwondo Walking * Intensity: Z2 Duration: 40 minutes
Session 2 Taekwondo	**Session 7** Taekwondo	**Session 12** Taekwondo	**Session 17** Taekwondo
Session 3 Taekwondo Walking * Intensity: Z2 Duration: 40 minutes	**Session 8** Taekwondo Walking * Intensity: Z1 Duration: 40 minutes	**Session 13** Taekwondo Walking * Intensity: Z2 Duration: 40 minutes	**Session 18** Taekwondo Walking * Intensity: Z1 Duration: 40 minutes
Session 4 Taekwondo	**Session 9** Taekwondo	**Session 14** Taekwondo	**Session 19** Taekwondo
Session 5 Taekwondo Walking * Intensity: Z1 Duration: 40 minutes	**Session 10** Taekwondo Walking * Intensity: Z2 Duration: 40 minutes	**Session 15** Taekwondo Walking * Intensity: Z1 Duration: 40 minutes	**Session 20** Taekwondo Walking * Intensity: Z1 Duration: 40 minutes

The sessions plan for outdoor recreation activities (walking) provides for each session a specific task, which included the duration of walking, intensity (Intensity zones: zone 1: very light, heart rate 101-121 beats/min, zone 2: light, heart rate 121-141 beats/min), route. Recreational activities in the nature (walking) are intended to be used immediately after taekwondo training during the competition period of a one-month mesocycle (4 weeks, 3 x a week), thus reducing the stress level of athletes, promoting the stability of mental toughness, which is expected to improve the performance of taekwondo athletes.

In the subchapter 3.3. "**The effect of outdoor recreation activity on the stress level, mental toughness, and performance of taekwondo athletes in the competition period and recommendations for taekwondo coaches for perrformance in the competition period"** the effect of outdoor recreation activity on the stress level, mental toughness, and performance of taekwondo athletes in the competition period was stated and recommendation was developed for taekwondo coaches.

To find out if the results of the **Stress Scale of the DASS questionnaire** for athletes (n=12) are different in terms of walking (before and after the experiment), the Shapiro-Wilk test indicates that the assumption of normality was not satisfied; therefore, the Wilcoxon signed-rank test to analyze data was used (table 10).

Table 10

Stress scale of DASS for taekwondo athletes (n=12, before and after the experiment)

	Time	N	Mean	SD	P
Stress	before the experiment	12	28.917	1.084	0.002*
	after the experiment		18.750	3.279	

(*Significant)

The sample results for taekwondo athletes (n=12) show that the mean stress level before the walking in nature program was M=28.917, with a standard deviation of SD ±1.084. The stress levels of these athletes were severe, and there was a wide range of stress levels among the athletes. After the experiment, the mean stress level had significantly reduced to M=18.750 with a standard deviation of SD ±3.279. The results of the Wilcoxon test, $W = 78.00$, indicate that the difference is significant as the p-value 0.002 is < 0.05 at the 5% level. It indicates that the outdoor recreation activity (walking in nature) effectively reduced the athletes' stress levels.

To find out the results of the stress scale of DASS for male and female athletes (before and after the experiment), the Shapiro-Wilk test indicates that the normality assumption was not satisfied. Therefore, the Wilcoxon signed-rank test was used

(table 11). The results show that male and female athletes' mean stress levels before the experiment were M=28.167 and M= 29.667, with a standard deviation of SD ±0.408 and SD ±1.033. The stress levels of these athletes were severe, and there was a wide range of stress levels among the athletes. After four weeks of walking, the mean stress level significantly reduced for males to M=17.833, and for females, M=19.667 with a standard deviation of SD ±3.601 and SD ±2.944. The results of the Wilcoxon test, $W = 21.00$, indicate that the difference is significant as a p-value of 0.031 for males and female p-value of 0.034 is < 0.05 at the 5% level. It indicates that the outdoor recreation activity (walking in nature) effectively reduced the athletes' stress levels. However, the standard deviation of after the experiment is high, indicating a wide range of mild stress levels still among the athletes.

Table 11

Stress scale of DASS for male and female taekwondo athletes (n=12, before and after the experiment)

	N	Time	Mean	SD	P
Male	6	before the experiment	28.167	0.408	
		after the experiment	17.833	3.601	0.031*
Female	6	before the experiment	29.667	1.033	
		after the experiment	19.667	2.944	0.034*

(*Significant)

Figure 7 shows the relative changes in the **Stress scale** (DASS) for 12 athletes (six males (S1-S6) and six females (S7-S12)) before and after the experiment. The mean stress level for the 12 athletes before the experiment was 28.6, ranging from 28 to 31. The mean stress level for the 12 athletes after the activity was 18.75, ranging from 16 to 25. On average, the stress level for all athletes reduced from before the experiment to after that. The male athletes had a mean stress level of M=17.833 after the program, while the female athletes had a mean stress level of M=19.667. Athletes with the most considerable percentage decrease in stress levels are S1-S3 and S6-S7, with a relative change of 75%. It means that their stress levels were reduced by 75% before the experiment score of 28 to a score of 16 after the experiment. The athlete with the lowest percentage decrease in stress levels is S5, with a relative change of only 16%. It means his stress level was reduced by 16%, from a score of 29 before the experiment to 25 after the experiment. Athletes S9 and S11 showed a 66.66% decrease in stress levels, from a score of 30 to 18. The athlete S4 showed a 55.55% decrease in stress levels, from a score of 28 to 18. The athlete

S12 showed a 50% decrease in stress levels, from a score of 30 to 20. The athlete S10 showed a 31.81% decrease in stress levels, from 29 to 22. The athlete S8 showed a 29.16% decrease in stress levels from 31 to 24. Athletes showed a significant decrease in stress levels as measured by the Stress scale of the DASS questionnaire.

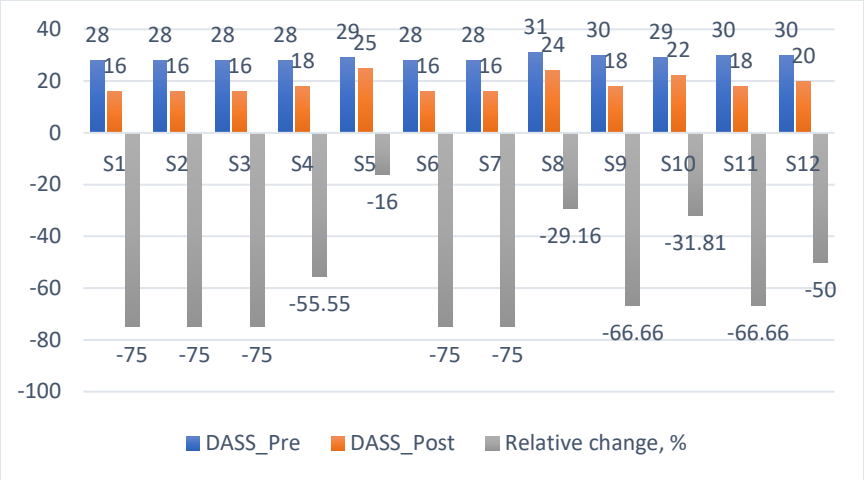

Figure 7. **Relative changes in the stress level of taekwondo athletes (n=12) before and after the experiment**

To investigate if the results of **Gas Discharge Visualization (GDV)** for athletes (n=12) are different in terms of walking (before and after the experiment), the Shapiro-Wilk indicates that the assumption of normality was satisfied. Therefore, the Paired sample T-Test was used (table 12). The sample results for taekwondo athletes (n=12) show that the mean stress level before the experiment was M=4.820, with a standard deviation of SD ±0.968. The results indicate that the stress level is high, with mean scores close to the excited state range of 4-6.

Table 12

GDV taekwondo athletes (n=12, before and after the experiment)

	Time	N	Mean	SD	P
Stress	before the experiment	12	4.820	0.968	0.001*
	after the experiment		2.881	0.470	

(*Significant)

After the experiment, the mean stress level was significantly reduced to M=2.881 with a standard deviation of SD ±0.470. The Paired sample T-Test showed $t(11) = 8.420$, indicating that the difference is significant as the p-value 0.001 is < 0.05 at the 5% level. It indicates that the outdoor recreation activity (walking in nature) effectively reduced the athletes' stress levels.

To investigate whether the results of GDV for stress levels in male and female athletes were different regarding walking (before and after the experiment), the Shapiro-Wilk test indicates that the normality assumption was satisfied for male athletes. However, it was not satisfactory for female athletes. Therefore, to analyze the results, the Paired sample T-Test for males and Wilcoxon signed-rank test for female athletes were used (table 13). The results show that the mean for male stress level before the experiment was M=4.835 with a standard deviation of SD ±1.005, and the mean for female athletes was M= 4.805 with a standard deviation of SD ±1.025. The results indicate that the stress levels for both male and female athletes are high, with mean scores close to the excited state range of 4-6. After the experiment, the mean stress level had significantly reduced for males to M=3.123 with a standard deviation of SD ±0.196, and for females, M=2.638 with a standard deviation of SD ±0.553. The paired sample T-Test for males showed that t (5) = 4.622, indicating that the difference is significant as the p-value 0.006 is < 0.05 at the 5% level. The results of the Wilcoxon test, W = 21.00, indicate that the difference is significant for female p value 0.036 is < 0.05 at the 5% level. It indicates that outdoor recreation (walking in nature) effectively reduces athletes' stress levels. Both male and female participants had a stress level in the excited state before the experiment. After the experiment, the stress level of female participants decreased more than male athletes under normal, calm conditions.

Table 13

GDV of male and female taekwondo athletes (n=12, before and after the experiment)

	N	Time	Mean	SD	P
Male	6	before the experiment	4.835	1.005	
		after the experiment	3.123	0.196	0.006*
Female	6	before the experiment	4.805	1.025	
		after the experiment	2.638	0.553	0.036*

(*Significant)

According to figure 8, for every athlete, overall, the GDV results show a decrease after the experiment, indicating a decrease in stress levels for the athletes. The results indicate a decrease in the stress levels for all athletes, as shown by the decrease in GDV scores. The athlete with the largest decrease in stress levels is S11, with a 57.86% relative change from 4.96 to a score of 2.09. The athlete with a minor decrease in stress levels is S2, with a relative change of 12.63% from 3.72 to 3.25.

Athletes S3, S7, S10, S4, S5, S6, S8, S9, and S12 decreased stress levels from 22.85% to 57.86%. Their scores decreased from 2.28 to 5.98 and ranged from 2.09 to 3.25.

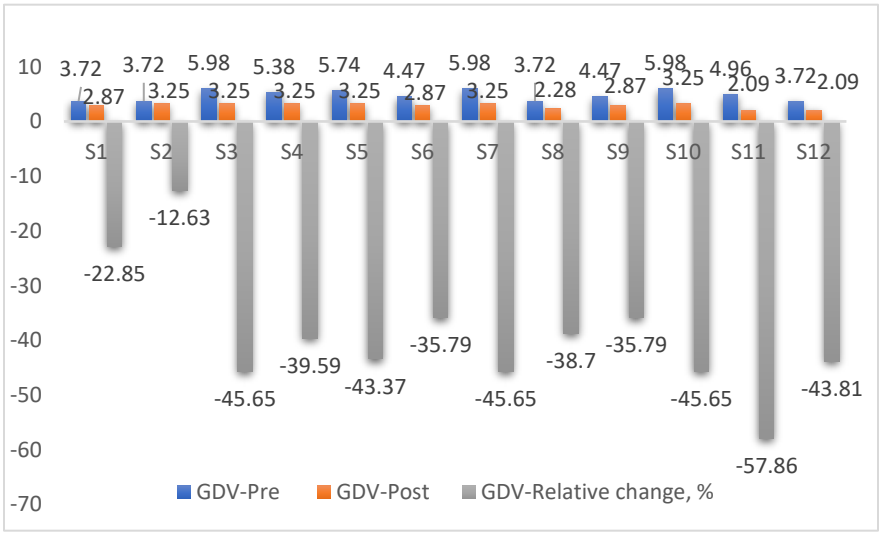

Figure 8. **Relative changes in GDV of taekwondo athletes n=12 (before and after the experiment)**

To investigate if the results of the stress level of the **Determination test (DT)** for taekwondo athletes (n=12) are different in terms of walking (before and after the experiment). The Shapiro-Wilk test indicates that the assumption of normality was satisfied. The Paired sample T-Test to analyze the data was used (table 14).

Table 14

Determination test taekwondo athletes (n=12, before and after the experiment)

	Time	N	Mean	SD	P
Stress	before the experiment	12	50.917	22.817	0.001*
	after the experiment		73.167	15.625	

(*Significant)

The sample results for taekwondo athletes (n=12) show that the mean stress level before the walking activity was M=50.917, with a standard deviation of SD ± 22.817. This score falls within the average rank range for the Determination test. The standard deviation of SD±22.817 shows that the athletes' stress levels differ. After four weeks of walking, the mean stress level significantly increased to M=73.167 with a standard deviation of SD ±15.625. The standard deviation that became smaller, indicating that the stress levels of the athletes became more tightly grouped around the mean score of M=73.167. The Paired sample T-Test results indicate that t (11) = -5.116, the difference in stress levels between before and after

the experiment is significant, with a p-value of 0.001, which is less than 0.05 at the 5% level.

To investigate whether the results of the Determination test for male and female taekwondo athletes differed in walking (before and after the experiment), the Shapiro-Wilk test indicates that the normality assumption was satisfied. Therefore, the Paired sample T-Test was used to analyze the results (table 15). The results show the mean stress level for males before the walking activity was M=55.000 with a standard deviation of SD ±29.455, and for female athletes, M= 46.833 with a standard deviation of SD ±15.420. Based on the percentile rank of the Determination test, the mean score of M=55.00 for male athletes falls into the average range of 25-75, indicating that the stress levels for male athletes were moderate. It is in line with the standard deviation of SD±29.455, which suggests that the stress levels of male athletes in this sample are inconsistent, with some athletes having higher stress levels and others having lower levels. On the other hand, the mean score of M=46.833 for female athletes falls within the average range of 25-75, indicating moderate stress levels. The standard deviation of SD±15.420 suggests that the stress levels of female athletes are relatively consistent, with most of the scores falling within one standard deviation of the Mean.

After four weeks of walking, the mean stress level significantly increased for males to M=71.500, with a standard deviation of SD ±20.423, and the mean for females was M=74.833, with a standard deviation of SD ±10.647. The standard deviation (SD) for females was lower after the experiment (10.647) compared to before the experiment (15.420), which suggests that the stress response was more consistent among female participants after the activity. Meanwhile, the SD for males was lower the after the experiment (20.423) than before the experiment (29.455), indicating more variability in stress response among male participants after the activity. The results of Paired T-test for male athletes, $t(5) = -2.680$ and for females showed that $t(5) = -4.945$, indicating that the difference is significant as the p-value for males 0.044 and p value 0.004 for the female is < 0.05 at the 5% level. This indicates that the outdoor recreation activity (walking in nature) was influential in the determination test results of the athletes.

Table 15

Taekwondo athletes' Determination test (n=12, before and after the experiment)

	N	Time	Mean	SD	P
Male	6	before the experiment	55.000	29.455	0.044*
		after the experiment	71.500	20.423	

Female	6	before the experiment	46.833	15.420	0.004*
		after the experiment	74.833	10.647	

(*Significant)

According to figure 9, the Determination Test (DT) results, 12 athletes were tested, with an ID ranging from S1 to S12. The results show each athlete is before and after the experiment scores and the relative changes. Athlete S5 had the most significant relative increase, with a 157.89%, from 19 to a score of 49. Athlete S2 had the second-highest relative change, with an increase of 87.87%, from 33 to 62. Athletes S1, S3, S7, S8, S10, and S12 also showed increases in their determination test, with relative changes ranging from 43.93% to 52.08%.

Athlete S4 had the smallest increase, 2.27%, from 88 to 90, and athlete S6 slightly decreased with a relative change of -4.59%. The results of the DT indicate an improvement, and it shows a significant increase in their scores after the experiment.

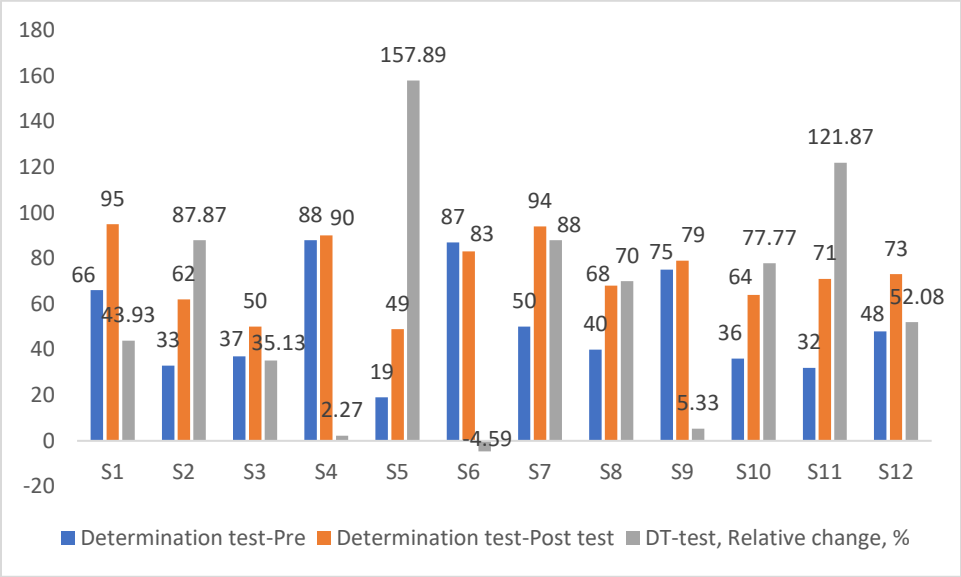

Figure 9. **Results of stress Determination test for taekwondo athletes (n=12) before and after the experiment**

To investigate if the results of the **Sports Mental Toughness Questionnaire (SMTQ)** for athletes (n=12) are different in terms of walking (before and after the experiment) on the components of mental toughness (Confidence, Constancy, and

Control), the Shapiro-Wilk test indicates that the assumption of normality was satisfied for all components, therefore the Paired sample T-test to analyze data was used (table 16).

Table 16

Confidence component for taekwondo athletes (n=12, before and after the experiment)

		Time	N	Mean	SD	P
Confidence		before the experiment	12	16.833	3.614	
		after the experiment		16.417	2.937	0.661

The results of taekwondo athletes (n=12) show the mean for **confidence** before the walking activities was M=16.833, which is high, indicating that the athletes in this sample have a high confidence level in their abilities with a standard deviation of SD ±3.614. The standard deviation before the walking for confidence is relatively high. After four weeks of outdoor recreation activity (walking in nature), the mean was M=16.417, with a standard deviation of SD ± 2.937. The Paired sample T-test results indicate that $t(11) = 0.451$. The difference is insignificant as the p-value 0.837 is > 0.05 at the 5% level. The T-test results further support that the walking activity did not significantly affect the confidence component.

To investigate whether the results of Confidence for male and female athletes differed in walking (before and after the experiment), the Shapiro-Wilk test indicates that the normality assumption was satisfied. Therefore, a paired sample T-test was used to analyze the data (table 17). The results show that the mean for confidence before the walking program for male and female athletes was M=17.500, with a standard deviation of SD ±3.564, and the mean for female athletes M= 16.167, with a standard deviation of SD ±03.869. The Paired sample T-test indicates that for male athletes, $t(5) = 1.083$, and for females, $t(5) = -0.216$, showing that the difference is not significant as p-value 0.328 and p-value 0.837 is > 0.05 at the 5% level.

Table 17

Confidence component for athletes (n=12, males and females before and after the experiment)

	N	Time	Mean	SD	P
Male	6	before the experiment	17.500	3.564	
		after the experiment	16.333	3.077	0.328
Female	6	before the experiment	16.167	3.869	0.837

		after the experiment	16.500	3.082	

To investigate if the results of the **Sports Mental Toughness Questionnaire (SMTQ)** for athletes (n=12) are different in terms of walking before and after the experiment on the component of **constancy**, the Shapiro-Wilk test indicates that the assumption of normality was satisfied; therefore the Paired sample T-test to analyze data used (table 18).

Table 18

Constancy for taekwondo athletes (n=12, before and after the experiment)

	Time	N	Mean	SD	P
Constancy	before the experiment	12	13.083	1.379	0.661
	after the experiment		13.167	0.937	

The sample results for taekwondo athletes (n=12) show that the mean for **constancy** before the walking program was M=13.083, which is high, indicating that taekwondo athletes can maintain their focus and commitment to their goals over time. The standard deviation SD ±1.379 for constancy is low, indicating that the scores for this component of mental toughness are relatively consistent among the athletes. After four weeks of outdoor recreation activity (walking in nature), the mean was M=13.167, with a standard deviation of SD ± 0.937. Standard deviation also decreased. The Paired sample T-test results indicate that $t(11) = -0.233$, the difference is insignificant as the p-value 0.820 is > 0.05 at the 5% level. The T-test results further support that the walking activity did not significantly affect the constancy component.

To investigate if the results of **Constancy** for male and female athletes differ regarding walking (before and after the experiment), the Shapiro-Wilk test indicates that the normality assumption was satisfied. Therefore, a paired sample T-test was used to analyze the data (table 19). The results show that the mean constancy score is higher for male athletes (M=13.5) than for female athletes (M=12.667). The standard deviation SD ± 1.761 for male athletes is lower than for female athletes SD ± 0.816. This suggests that male athletes have bigger difference in the constancy scores than female athletes. After four weeks, the mean for males decreased slightly to M=13.000, with a lower standard deviation of SD±0.894. The mean for female athletes increased slightly to M=13.333, with a slightly higher standard deviation of SD± 1.033. The Paired sample T-test indicates that for male athletes, $t(5) = 0.889$, and for females showed, $t(5) = -2.000$, indicating that the difference is not significant

as the p-value 0.415 is > 0.05 at the 5% level. The results for females showed that $t(5) = -2.000$, indicating that the difference is insignificant as the p-value for males is 0.415 and the p-value for females 0.102 is > 0.05 at the 5% level.

Table 19

Constancy for taekwondo athletes (n=12, male and female athletes before and after the experiment)

	N	Time	Mean	SD	P
Male	6	before the experiment	13.500	1.761	
		after the experiment	13.000	0.894	0.415
Female	6	before the experiment	12.667	0.816	
		after the experiment	13.333	1.033	0.102

To investigate if the results of the **Sports Mental Toughness Questionnaire (SMTQ)** for athletes (n=12) are different in terms of walking (before and after the experiment) on the component of **Control**, the Shapiro-Wilk test indicates that the assumption of normality was satisfied; therefore the Paired sample T-test to analyze data used (table 20).

Table 20

Control for taekwondo athletes (n=12, before and after the experiment)

	Time	N	Mean	SD	P
Control	before the experiment	12	11.167	1.801	
	after the experiment		11.083	2.234	0.909

The sample results for taekwondo athletes (n=12) show the mean for **Control** before the walking program M= 11.167 with a deviation of SD ±1.801, indicating that the athletes do not have a high level of control over their emotions and thoughts during training and competition.

After four weeks of outdoor recreation activity (walking in nature), the mean was M=11.083, with a standard deviation of SD ± 2.234. While there is a slight decrease in the mean score and an increase in the standard deviation, the result of the Paired sample T-test indicates that $t(11) = 0.117$; the difference is insignificant as

the p-value 0.909 is > 0.05 at the 5% level. The T-test results further support that the walking activity did not significantly affect the control component.

To investigate whether the results of the Control component for male and female athletes differed in walking (before and after the experiment), the Shapiro-Wilk test indicates that the normality assumption was satisfied. Therefore, a paired sample T-test was used to analyze the data (table 21). The mean before the walking is similar for male and female athletes, M=11.333 for males and M=11 for females. The standard deviation for male athletes SD ± 2.066 is higher than for female athletes SD ± 1.673, suggesting more variation among male athletes than female athletes. The mean stress score after an experiment for male athletes is M=10.500, with a standard deviation of SD ± 1.378. After an experiment for female athletes, the mean score is M=11.667, with a standard deviation of SD ± 2.875.

Table 21

Control for taekwondo athletes (n=12, male and female athletes before and after the experiment)

	N	Time	Mean	SD	P
Male	6	before the experiment	11.333	2.066	
		after the experiment	10.500	1.378	0.402
Female	6	before the experiment	11.000	1.673	
		after the experiment	11.667	2.875	0.566

Although there is a change in the mean scores, these changes are not statistically significant as the Paired sample T-test indicates that, for males athletes, $t(5) = 0.916$, and for females showed that $t(5) = -0.614$, indicating that the difference is not significant as the p-value for male is 0.402> 0.05 and p-value for the female are 0.566 > 0.05 at the 5% level. The T-test results further support that the walking activity did not significantly affect the control component for both male and female athletes.

Performance of athletes in the competition. Four taekwondo athletes from a sample of the detection experiment participated in the Sweden International Taekwondo Championship in May 2022 in Stockholm. The competition has an E2 European ranking for the Juniors division. All Latvian taekwondo athletes were representatives of the 17 years age group (Junior division) who have recognized success in taekwondo, have experience in Latvian and international competitions, and have been involved in taekwondo for more than ten years. According to the world taekwondo website worldtkd.simplycompete.com, the registration was online,

and more than 1066 taekwondo athletes in the Cadet, Juniors and senior divisions participated. The Latvian team participated with four athletes in the Junior division (3 females that 2 of them in the weight category of -63 kg and one athlete at +68 kg, and one male athlete in the weight category – 78 kg), the author of the research was the coach of the team. According to the competition draw sheets, 1 out of 4 athletes did not have an opponent (Female +68 kg), 2 out of 4(both Female -63 kg) had an opponent in their group (n=12), and another athlete (Male -78 kg) had an opponent (n=5). The competition started at 8:30 in the morning. The first taekwondo athlete (F -63 kg) was unsuccessful and lost the competition against Finland, but she fought very well, and the team administration was satisfied with her performance. The male (M-78 kg) lost the game against Great Britain. The second female athlete (F-63 kg) won against Norway, Serbia, and Bulgaria, and she qualified for the final competition. However, an hour before the competition, she got a stomach pain, and the doctor came and said it was all about the stress of the competition, so immediately we went for a walk out of the competition arena for 40 minutes, and we talked about different topics and competition as we had enough time before the final. In the final, the athlete (F-63 kg) had an opponent from Bosnia Herzegovina, and she won the competition and the gold medal.

Recommendations for taekwondo coaches

Recommendations for taekwondo coaches for athlete performance in the competition period based on the research findings included incorporating outdoor recreation activity (walking in nature) as a regular part of the training schedule. It could involve setting aside specific times for the athletes to engage in nature walks, such as during active recovery or as a warm-up or cool-down activity.

The intensity and duration of these nature walks could be tailored to the individual needs and goals of the athletes, and coaches could encourage the athletes to focus on relaxation techniques, deep breathing, during the walks to maximize their stress-reducing benefits. It may also be helpful for coaches to educate and support the athletes on the importance of maintaining a healthy balance between training and rest and to help them develop strategies for managing stress and maintaining mental toughness during the competition period.

Following the results of the effect of outdoor recreation activity on stress levels, and mental toughness, there are some recommendations for taekwondo coaches:

1) Incorporate outdoor recreation activity (such as walking in nature for 40 minutes) into the training schedule for taekwondo athletes during the competition period, with a frequency of three sessions per week, zone1-2 (heart rate 101-141).

2) Consider individual factors such as age, gender, and prior experience with outdoor recreation when determining the duration and intensity of outdoor recreation activity for each athlete.

3) Monitor taekwondo athletes' stress levels and mental toughness during the competition period and adjust the frequency and content of outdoor recreation activity as needed (give the questionnaire to the coaches).

DISCUSSION

Recreation is generally considered an evaluation of leisure time with various activities. These activities can be grouped under general topics such as musical activities, sporting activities, games, artistic activities, activities that require skills, nature activities, and social and cultural activities. Some sources describe outdoor recreation as an activity or experience that includes games or other activities in an individual's free time for pleasure, physical, mental, and emotional well-being (Veal, 2011), and mental and physical healing activity (McLean et al., 2008). Sport is the most comprehensive, diverse, and drawn attention area of recreation. Many studies have shown that being in nature can affect stress level (Nisbet et al., 2011; Hattie et al., 1997; Higgins, 2002; Van den Berg et al., 2010; Adevi and Mårtensson, 2013; Diette et al., 2003; Lee et al., 2011; Ward Thompson et al., 2012). Participation in recreation activities to allow and develop physical health but also benefits by reducing stress (Asztalos et al., 2009). It can help decrease cardiovascular disease, metabolic complications, and some cancer risks and improve physical capacity (Garber, 2011). Furthermore, several studies have observed the positive effects of nature on health, stress, and recovery (Kruize, 2020). According to Ilhespy (2009), individuals' outdoor recreation involvement is vital to developing their self-confidence, positive thinking, and excellence. Outdoor recreation helps promote academic achievement, work commitment, analytical thinking, and preventing violations. Based on international research conducted by Garst, Schneider, and Baker (2001), which studied adolescents who participated in outdoor recreation activities, found out that the individuals positively impacted their perception while participating in outdoor activities.

The research results from the Determination Test and the Gas Discharge Visualization showed that after walking in nature stress was reduced in taekwondo athletes. The DASS questionnaire had a significant result, but athletes still had mild stress.

Scientific literature research indicates the benefits to mental health, stress, and well-being associated with exposure to natural environments. In scientific research,

stress is the condition manifested by a specific syndrome that includes all the nonspecifically caused changes inside a biological system (Selye, 1978). The relationship between exposure to natural environmental settings and stress reduction has been extensively demonstrated. Tyrväinen et al. (2014) also confirm that even a short visit to a natural area significantly benefits stress reduction compared to a non-natural area. A recent experimental study by Ewert and Chang (2018) found out that visitors to natural environments had noticeably reduced both physical and psychological stress level after the visit, in contrast to those who visited a more built-up outdoor setting or indoor sports center. Several experiments have shown physiological stress-releasing effects of forest environments, such as reduced blood pressure, pulse rate, and cortisol level. The results of the physiological responses suggest that participating in outdoor activities induces relaxation and reduces the adverse effects of stress (Park et al., 2010; Lee, J., Park, B., Tsunetsugu, Y., Ohira, T., Kagawa, T, and Miyazaki, 2011). Natural environments may not only influence stress directly but may also have indirect results by serving as a buffer, contrary to the adverse health-related effects of stress. For example, Brown et al. (2013) found that participants who viewed the natural environment before being subjected to a mental stressor demonstrated more remarkable recovery than those who had a view of the built environment. Shin et al. (2011) showed that walking in the nature, incredibly meditative walking, has a more significant effect on certain psychological aspects, such as happiness and self-esteem, compared to walking in the gym. Song et al. (2015) also showed that combining nature visits with other relaxation activities (e.g., breathing and focusing on an object) supports people with mental illness in dealing with stress and speeds up their recovery.

The data obtained from the doctoral thesis research also indicates that walking in nature effectively reduces taekwondo athletes' stress. The changes seen can be explained by Attention-restoration theory. This theory posits that attention is recovered from exposure to the natural environment, which begins when observing small natural components like grasses. It further suggests that taekwondo athletes activity in the natural environment can likely help improve the quality of the training exercise and competition effect. Other studies support these results, one study reports that stress and anxiety dropped after exercising in the natural environment, another study reported that the mood state of a nature-walking group changed positively in the post-test (Pretty, 2005; Shin, 2011). Hartig, Evans, Jamner, Davis, and Gärling (2003) report that participants who were exposed to a natural condition (sitting in a room with tree views, followed by walk-in a nature reserve) reported more significant stress reduction, in lower blood pressure than participants who sat in a room without views and then took a walk in an urban setting comprising office and retail buildings. Participants in the nature condition also reported increased

positive affect and reduced anger, while those in the urban condition reported opposite emotional effects. Additionally, participants performed slightly better on an attentional test at the midpoint of the walk in the nature reserve than they had done in their pre-test performance.

While exposed to the natural environment, taekwondo athletes have positive benefits it helps maintain a positive mood state and decrease stress level. Of relevance here is Kandels (1991) study that showed an increase in alpha waves in the temporal lobe in response to olfactory stimulation by essential oil components, which represented extracts of odors that we experience in the natural environment. Olfaction is closely related to emotion, odors can reduce stress and change mood. Additionally, Psychophysiological stress recovery theory suggests positive thinking replaces negative thinking while watching the natural environment (Ulich, 1984; Hartig T,2004). Stress reduction theory (SRT) (Ulrich, 1993; Ulrich et al., 1991) examines emotional restoration, suggesting that contact with nature helps a person to recover his or her psychological capacity (e.g., positive well-being) and cognitive resources (e.g., increased attention). The SRT states that after stressful experiences, non-threatening aspects of the natural environment promote psychophysiological stress recovery and that such recovery occurs more readily in a natural than in an urban environment (Ulrich, 1993; Ulrich et al., 1991). This recovery is driven by attentional responses evoked by the natural environment (i.e., affective responses to certain visual stimuli). Natural environments, for instance, often possess qualities such as moderate complexity and depth and natural contents (e.g., water and greenery) (Ulrich, 1983). From an evolutionary standpoint, Ulrich et al. (1991) posit that humans have an automatic tendency to respond positively to elements of the natural environment instead of elements in human-made settings, which enables stress recovery and attention responses. Following a stressor, the restorative effects of the natural environment, accompanied by sustained attention responses, may therefore induce an automatic increase of positive affect, limit negative thoughts, and reduce negative physiological responses in a way that urban environments will not (Ulrich, 1993; Ulrich et al., 1991).

The current study results suggest that walking in nature can positively affect stress and mood, and the training environment is also an important factor in the psychological state of exercise. Parks' (2007) study shows that pulse rate and blood pressure were lowered, and the autonomic nervous system stabilized while looking at the natural environment. Further, exercising in unpolluted outdoor settings positively affects physical activity (Li, 2010). Hines (1993) in his research poists out that indoor air is 100 times more contaminated than outdoor air, and prolonged exposure to such pollution can cause dizziness and severe respiratory illness. Various methods to measure stress level in taekwondo athletes have been described

in detail in doctoral thesis research. The stress scale of DASS adapted to the Latvian language, the GDV camera, and the determination test from the Vienna Test System were used to study the stress level. The study by Sadowski et al. (2012) used determination test to identify the factors that differentiated between medal and non-medal winners in taekwondo. Taekwondo juniors were split into a medal-winning group and a non-medal-winning group based on their performance at the Polish Junior Championship. The results indicated that the medal-winning group had a significantly faster complex reaction time than the non-medal-winning group.

In the study by Gierczuk et al. (2013), 25 Greco-Roman wrestlers and 24 taekwondo athletes were compared using four VTS tests: RT and DT for complex reaction (stress). The results indicated no differences between Greco-Roman wrestlers and taekwondo athletes in any VTS test, except for one part of DT where there was a significantly greater number of incorrect and omitted responses from the taekwondo group as compared to the wrestling group. The article's authors suggested that the similar demands and training styles of wrestling and taekwondo might have contributed to athletes from both sports having similar psychometric profiles. In contrast with the previous study, Gierczuk et al. (2013) found very different results. Their study compared 11 taekwondo champions of the international master class with 13 taekwondo champions of a national master class. DT for complex reaction (stress), SIGNAL for spatial orientation, and MLS for movement coupling and frequency. In contrast with the results obtained by Sadowski et al. (2012), who showed that there was no difference in simple reaction, but a significant difference in complex reaction (stress), Gierczuk et al. (2013) found out the exact opposite, that there was a significant difference in simple reaction, but no difference in complex reaction. In addition to these results, they also found that high-level taekwondo athletes were better regarding correct responses in DT. A possible explanation for the discrepancy in results could be the age of the taekwondo exponents used in each study. Sadowski et al. (2012) used taekwondo juniors, while Gierczuk et al. (2013) used senior national team members. Age could have had an effect as older taekwondo athletes would have had more time to train and improve their abilities, which might have resulted in a more remarkable contrast between high- and low-level athletes. Zwierko et al. (2010) analyzed the response time and peripheral sight of volleyball players with non-athletes, and they found significant differences that showed athletes have a better response time and visual field of view than people who are not athletes. Moreover, there is no consensus on whether the results can be applied to athletic careers as the tests are not developed in a sport-specific manner. Overall, however, there are more pros than cons considering VTS as it is a unique objective assessment tool that can study the different psychological constructs of athletes, thus including the efficiency and speed of decision-making, as well as the

quantitative and qualitative aspects of attention and concentration, which are vital areas of study in the case of Taekwondo athletes.

Mental toughness, in scientific literature, is described as one of the most widely used but least understood terms in sports psychology. "Congenital or established psychological dominance over one's opponent, which helps to maintain perseverance, self-confidence and act effectively in high-stress situations during the most responsible moments of competitions" (Jones, Hanton, and Connaughton, 2002, p. 209). The result of outdoor recreation activity on mental toughness components was not significant. Bull (2005) reported that there are different kinds of mental toughness, not only one applicable to everyone and every sport. For example such sports as golf, and car racing require different skills.

There could be absolute control in a critical moment versus being mentally tough enough to take risks; as was also mentioned, not only the discipline of sports matters. Another difference could be, for example, sport or athlete level with one peak performance (Olympics) and, in contrast, an athlete with a season full of important competitions. In terms of enduring the normal pressure during the training, different skills may be needed. Therefore, Bull et al. (2005) suggested further examining mental toughness not only as a general construct but also as a specific one for the kind of sport or athlete. According to this assumption, there is nothing like one suitable type of mental toughness. Crust (2007) note that this might be important in future research to clarify the definition of mental toughness.

The researchers Singh and Solanki (2015) were interested in the differences in mental toughness between judo and Taekwondo athletes. In their study, 40 athletes were randomly selected (50% male and 50% female). Nevertheless, there was no significant correlation between the style and the mental toughness score. It may suggest that the martial arts style is not so important in improving mental toughness. Nevertheless, choosing one balanced with an individual's opinion and philosophy is necessary to achieve appropriate conditions. The authors accordingly appeal for further research on mental toughness in martial arts and the inclusion of mental toughness training into the workouts. Since 2013, the mainstream in researching mental toughness has gone in different directions. Even though it is still novel in the field of martial arts, in other sports, mental toughness is researched frequently. One study is focused on negative or positive youth sports experiences and their contribution to mental toughness. Gucciardi (2011) stated that a positive relationship exists between time (years of training, hours of training per week) to the desire to achieve, attentional control, and mental toughness attribute.

The interaction between mental toughness and stress in athletes demonstrated a benefit in that those individuals with higher mental toughness reported fewer mental health issues when in high-stress situations, and mental toughness was shown

to offset some of the adverse effects of the stress in these young elite athletes (Gerber et al., 2018). The number of papers focusing on mental toughness in martial arts and taekwondo is deficient. Minnix's (2010) research shows that the need for mental toughness is essential. We can also admit there is insufficient research in this field to determine the needs and outline mental toughness in martial arts. Nevertheless, many authors highlighted that mental toughness is critical and wanting. Mental toughness may be even more crucial in martial arts, not only if the pressure of competitions and performance is assumed, like many other sports. Nevertheless, more importantly, contact fighting (or even complete contact), sometimes long-term fighting, and negative energy control during the fight when the focus is critical may be very demanding. The aspects of full contact practice, body to body, and dealing with violence and negative energy make martial arts a fruitful area for testing mental toughness and its development and exploring the application and influences of mental skills training.

Our environment can affect our mental and physical health and impact our health-related behaviors and choices in many different and conflicting ways. Some places/spaces can promote good health and well-being, while others may have the opposite effect. Natural environments support mental health and well-being and represent a crucial element in the physiological mechanism behind preventing and treating mental illnesses (Lachowycz and Jones, 2013). Gucciardi (2015) indicated that mental toughness functions more like a state (Gucciardi et al., 2015) than a trait. It also provides expanded insights on how that functional state can be optimized through specific steps taken by the individual either independently or via a coach or other trusted advisor. Bowler et al. (2010) have commented that most research on restorative environments only examines relatively short-term effects, and this was also the case in our studies. Respondents walked only briefly, we do not know the effect of more prolonged exposure to environments.

Organized group walks enable individuals to visit a natural environment they may not have gone to (Wendel-Vos,2007), thereby enhancing their likelihood of restoration (Staats, 2004). While the restorative benefits of being in nature with others might be reduced (compared to being alone) (Johansson, 2011), the results in the present study show there is still a mental health benefit. In this way, group walking schemes could be a non-medical community activity to which GPs could provide social prescriptions (Lovell, 2017). Social prescribing to nature-based programs, such as group walks in nature, allows local commissioners of health services to bring people into contact with nature for mental health benefits (Cook, 2019).

In the doctoral thesis, the stress scale of the DASS questionnaire for stress level was used. The SMTQ questionnaire, adapted to the Latvian language, was used

to study taekwondo athletes' mental toughness. Unfortunately, this study has several limitations, such as having no control group and a small sample size.

CONCLUSIONS

1. In the theoretical study about the effect of the outdoor recreation activity (walking in nature) on taekwondo athletes' stress level, mental toughness, recovery, and performance, it was concluded:

Based on biophilia theory (Wilson, 1984), humans have an innate preference for natural surroundings, and exposure to nature has restorative effects. Outdoor activities refer to physical activities engaged during exposure to natural settings (Pretty et al., 2007). Taekwondo is a combat sport involving punches, kicks, and blocks to defeat opponents (Park et al., 2000). For taekwondo athletes, maintaining peak physical condition during a competition is vital. They must deal with pressure, control stress and anxiety before a competition, and deal with thoughts of previous losses, injuries, or knock-out experiences. The more critical the competition, the more stress the athlete experiences. According to Stress Reduction Theory (SRT) (Ulrich, 1993; Ulrich et al., 1991), natural surroundings promote psychophysiological stress recovery, improve mood, decrease negative thoughts, and reduce stress. Selye (1956) defines stress as a multidimensional phenomenon that disturbs the body's homeostatic balance and is caused by physical, psychological, or social conditions. Studies report reduced stress after outdoor recreation activity in the natural environment (Shin, 2011; Hartig et al., 2003; Song et al., 2015; Dadvand et al., 2015; Olafsdottir et al., 2018). Mental toughness and its components (confidence, constancy, and control) are crucial in martial arts. Contact fighting sometimes extends life-term learning, and negative energy control during the fight when the focus is critical may be very demanding. The aspects of full contact practice, body to body, and dealing with violence and negative energy make martial arts a fruitful area for testing mental toughness and its development. Balancing training stress and adequate recovery is essential for ideal athlete performance (Kellmann, 2002). General Adaptation Syndrome Theory (Selye, 1956) and the Scissors Model of Stress and Recovery (Kellmann, 2002) explain the nature of stress and its effects on the body and mind and show that athletes need to manage their stress levels to maintain optimal performance.

2. Having studied taekwondo athletes' stress levels, mental toughness, and performance before the experiment, it was concluded that: The stress level before the experiment was measured by the DASS questionnaire scale, showing that taekwondo athletes have a high and severe range of stress. According to the GDV,

taekwondo athletes have an excited state and a high-stress level. The results of the DT show that taekwondo athletes have an average range of stress.

2.1. Stress level by **Stress scale** for Latvian taekwondo athletes (n =12) before the walking activity was M =28.917 (SD ±1.084). It suggests that the average stress level for the sample falls within the "Severe" range of the stress scale, as the Mean score falls between 26 and 33. The Mean stress score for male athletes is M= 28.167 (SD ±0.408), while for female athletes, the mean stress score is M=29.667 (SD ± 1. 033). It indicates that, on average, the female athletes in the sample had slightly higher stress levels than the male athletes. However, the standard deviation for the female group (SD±1.033) is much higher than the standard deviation for the male group (SD±0.408), which there is a broader range of stress levels among the female athletes in the sample. The athletes need support and resources to help them manage their stress levels and improve their athletic performance.

The stress level by **GDV** for Latvian taekwondo athletes (n =12) before the walking program was M=4.820 (SD ± 0.968). According to the range table, a score of 4.820 falls within the "excited state" range of 4-6, characterized by emotional excitement and tense activity. The stress levels of the athletes in this sample are similar across the group. The mean stress score for male athletes is M= 4.835 (SD ±1.005), while for female athletes, the Mean stress score is M=4.805 (SD ± 1.025). It indicates that the stress level for both male and female athletes are relatively high, with Mean scores close to the "excited state" range of 4-6. It is essential to monitor and manage stress levels in this population.

The stress level by applying the **Determination test** for Latvian taekwondo athletes (n =12) before the walking program was M=51.417 (SD ± 23.727). This score falls within the average range of the rank. The stress levels of the athletes in the sample are relatively different. The mean score of M=56.00 for male athletes falls into the "average" range of 25-75, indicating moderate stress levels for male athletes. It is in line with the standard deviation of SD±30.829, which suggests that the stress levels of male athletes are different, with some athletes having higher levels of stress and others having lower levels.

On the other hand, for female athletes, the mean score of M=46.833 falls within the "average" range of 25-75, indicating moderate stress levels. The standard deviation of SD±15.420 suggests that the stress levels of female athletes are relatively consistent. It showed a need to develop future interventions to improve stress tolerance in athletes.

The mean score for taekwondo athletes' confidence and constancy is relatively high, but the mean score for control is low, indicating that the athletes do not have a high level of control.

2.2. The Mean (M) score for **mental toughness components** of confidence, constancy, and control for a sample of n=12 athletes before the experiment are for confidence M=16.833 (SD ± 3.614), constancy M=13.083(SD ± 1.379), and control M=11.167 (SD ± 1.801).

The mean **confidence** score for male athletes is M=17.5, which is higher than for female athletes (M=16.167). The standard deviation for male athletes is slightly lower (SD ± 3.564) than for female athletes (SD ± 3.869). This suggests less variation in the confidence scores among male athletes compared to female athletes.

The mean **constancy** score is also higher for male athletes (M=13.5) compared to female athletes (M=12.667). The standard deviation for male athletes is lower (SD ± 1.761) than for female athletes (SD ± 0.816). This suggests that male athletes have less variation in the constancy scores than female athletes.

The mean for the **control** score is similar for male and female athletes (M=11.333 for males and M=11 for females). The standard deviation for male athletes (SD ± 2.066) is higher than for female athletes (SD ± 1.673), suggesting more variation in the control scores among male and female athletes. It can be concluded that there are some differences in the mental toughness components of confidence, constancy, and control between male and female Latvian taekwondo athletes. It appears that male athletes have higher mean scores for confidence and constancy, while scores for control are similar for both male and female athletes. There is less variation in the scores for confidence and constancy among male athletes compared to female athletes. But there is more variation in the control scores among male athletes. These findings provide a starting point for further investigation into Latvian taekwondo athletes' mental toughness and how it relates to their performance in competition.

2.3. The **performance** of the Latvian taekwondo team at the International Belgium taekwondo competition was unsuccessful. The Latvian team was composed of 5 athletes: three female athletes in the Junior division, 2 of them in the -63 kg category, and a total of 19 contestants, both of whom got the 18^{th} and 19^{th} place. Another female in the +68 kg category, and a total of 9 contestants, got the 6^{th} place. 2 male athletes, one in the Junior division (-78 kg) and a total of 7 contestants, got 7^{th} place, and another in the Senior division (-80 kg) and total 19 contestants, he got the 19^{th} place.

3. The content of outdoor recreation activities aimed at reducing the stress level of taekwondo athletes during the competition period was developed. It includes 12 walking sessions, and the duration of each session is 40 minutes at a certain walking intensity (Intensity zones: zone 1: very light, heart rate 101-121 beats per minute; zone 2: light, heart rate 121-141 beats per minute). Recreational activities in the nature (walking) were applied immediately after taekwondo training during the

competition period during a one-month mesocycle (4 weeks, 3 x a week) to reduce the stress level of athletes, promote the stability of mental toughness and improve the performance of taekwondo athletes.

4. After four weeks of outdoor recreation activity (walking in nature), it can be concluded that: The stress level of taekwondo athletes after the experiment for stress scale and GDV was significantly reduced. For DT, the differences were significant.

4.1.The **Stress scale** for male and female athletes shows a significant reduction in stress levels after the walking activity. The Mean score for Female athletes after walking was M=19.67(SD±2.944), and the Mean score for Male athletes after walking was M=17.833 (SD±3.601). The results indicate that the difference in stress scores before and after the walking activity is significant (p 0.031< 0.05 for males and p 0.034< 0.05 for females). It suggests that the walking activity effectively reduced the stress level of both male and female athletes.

In conclusion, the study found that outdoor recreation (walking in nature) can reduce stress levels in taekwondo athletes. It was determined through **Gas Discharge Visualization (GDV)** before and after the experiment. The results showed a significant decrease in stress levels for the whole group of 12 athletes and male and female athletes separately. The mean score for female athletes after walking was M=2.638(SD±0.553), and the mean score for male athletes after walking was M=3.123 (SD±0.196). The results indicate that the difference in stress scores before and after the walking activity is significant (p 0.006 < 0.05 for males and p 0.036< 0.05 for Females). The findings suggest that walking in nature can effectively reduce stress levels for taekwondo athletes.

In conclusion, the results showed that the stress level of the athletes changed after the activity. It was indicated by a significant increase in the mean score on the **Determination test (DT)** from M= 50.917 to M=73.167. The standard deviation of the stress score was also lower after the activity, suggesting a more consistent stress response among participants. The results also showed a significant difference in stress levels before and after the activity (p 0.044 for males and p 0.004< 0.05 for females). The mean stress scores for the males were M=71.500(SD±20.423), and for females, M= 74.833 (SD±10.647).

After four weeks of outdoor recreation activity (walking in nature), it can be concluded that there was no significant change in the mental toughness components (confidence, constancy, and control) of taekwondo athletes.

4.2. It can be concluded that for components of **Mental toughness** (Confidence, Constancy, and Control), the differences in **confidence** scores before and after the activity was not significant for both male and female athletes, as indicated by a p-value of greater than 0.05 (p = 0.661 for all athletes and p = 0.837

for female athletes and p = 0.328 for male athletes). This suggests that walking in nature did not significantly change taekwondo athletes' mental toughness, specifically on the confidence component of mental toughness.

There was no significant effect on **constancy** in male and female athletes after walking. The pre-walk scores for the total sample (M=13.08, SD±1.379) and the post-walk scores (M=13.167, SD±0.937) are not significantly different, with a p-value of 0.820. The same results were obtained for female athletes with a Mean pre-test score of M=12.667 (SD±0.816) and a Mean post-test score of M=13.333 (SD±1.033) with a p-value of 0.102. For male athletes, the pre-walk score was M=13.500 (SD±1.761), and the post-walk score was M=13.000 (SD±0.894) with a p-value of 0.415.

The **control** component in athletes shows that walking does not significantly impact it. This conclusion is supported by the results from both the overall and the subgroups of female and male athletes. The pre-walk scores (M=11.17, SD±1.80) and post-walk scores (M=11.08, SD±2.23) are not significantly different from each other, as indicated by the results of the paired sample t-test (t(11) = .117, p = .909). Similarly, the results for the female athletes also show that walking did not significantly impact the control component of the mental toughness of female athletes, as indicated by the paired sample t-test (t(5) = -0.614, p = 0.566). The mean stress score after the experiment for female athletes was M=11.667(SD ± 2.875). Male athletes also show that walking did not significantly impact the control component of the mental toughness of male athletes, as indicated by the results of the paired sample t-test (t(5) = 0.916, p = 0.402). The Mean stress score after the experiment for male athletes was M=10.500(SD ± 1.378).

4.3. The **performance** of athletes was the Sweden International taekwondo championship. The Latvian team consisted of four athletes in the Junior division. Three female athletes, 2 of them in the -63 kg category, and 12 contestants, one of them got the first place and another the 12th place. Another female in the +68 kg category did not have any contestants. The male athlete in the Junior division (-78 kg) and five contestants got the third place.

4.4. Following the results of the Stress scale, GDV, determination test, and performance of athletes, **three main recommendations for** taekwondo coaches have been developed:

1) Incorporate outdoor recreation activity (such as walking in nature for 40 minutes) into the training schedule for taekwondo athletes during the competition period, with a frequency of three sessions per week, zone1-2 (heart rate 101-141).

2) Consider individual factors such as age, gender, and prior experience with outdoor recreation when determining the duration and intensity of outdoor recreation activity for each athlete.

3) Monitor taekwondo athletes' stress levels and mental toughness during the competition period and adjust the frequency and content of outdoor recreation activity as needed.

- The aim of the Doctoral thesis was partly achieved by realizing the research tasks and based on the obtained results.
- The research hypothesis was partly confirmed. Applying outdoor recreation activity (walking in nature) as a recovery means in the competition period reduced taekwondo athletes' stress levels. It has a statistically significant impact on the following: the stress scale of DASS, GDV, and DT ($p<0.05$) and the performance of taekwondo athletes in the competition (first and third places), but does not statistically significantly affect the components of mental toughness: confidence, constancy, and control ($p>0.05$).

LIST OF SCIENTIFIC PUBLICATIONS

1. Boobani, B; Grants, J; Boge, I. (2022). The investigation of mental toughness components of taekwondo athletes of Latvia. *LASE journal of sports science* vol. 13, no. 1, pp. 78-89. http://journal.lspa.lv/

2. Ulme, G; Boobani, B; Grants, J; Bernāns, E. (2022). The relationship between recreational physical activity and state and trait anxiety. *LASE journal of sports science* vol. 13, no. 1, pp. 64-77. http://journal.lspa.lv/

3. Ulme, G; Boobani, B; Arne, D; Grants, J. (2021). Evaluation of the emotional state in the outdoor recreational activities. *LASE journal of sports science* vol. 12, no. 1, pp. 48-56. http://journal.lspa.lv/

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5. Boobani, B; Grants, J; Boge, I. (2020) Recreation activity for Taekwondo athletes' physical recovery. *Lithuanian Sports University, theory and practice: problems and prospects,* pp. 23-29. *http://dspace.lsu.lt/handle/123456789/78*

PARTICIPATION WITH REPORTS IN INTERNATIONAL SCIENTIFIC CONFERENCES

1. Boobani, B; Grants, J; Boge, I. (2023). *Effects of walking in nature on stress level and mental toughness on taekwondo athletes in the competition phase.* The

15th Scientific International Conference of Doctoral and Master students of the Latvian Academy of Sport Pedagogy. Riga, Latvia.

2. Boobani, B; Grants, J; Boge, I; Litwiniuk, A. (2023). *Effects of walking in nature on stress level in the competition phase.* LASE International scientific conference Sports science and health in sport in 2023, Riga, Latvia.

3. Boobani, B; Grants, J; Boge, I (2022). The *effect of outdoor activity on stress level in taekwondo athletes*. The 11th International Recreational Sports Summer School "Outdoor sports and leisure activities." Universita di Verona, Verona, Italy.

4. 2. Boobani, B; Grants, J; Boge, I (2022). *Effects of outdoor activity and gas discharge visualization techniques on stress level in taekwondo athletes*.14th International Scientific Conference "Sports science and health care in sports in 2022". Latvian Academy of Sport Education, Riga, Latvia.

5. Boobani, B; Grants, J; Boge , I. (2021). *Comparison of mental toughness in Latvian martial arts athletes*. 14th conference of the baltic society of sports sciences. "Sports Science and Health at a Time of Change" Riga, Latvia.

6. Boobani, B. (2021). *Monitoring stress-recovery in Taekwondo athletes.* International scientific conference „sports science and health in sport in 2021". Latvian Academy of Sport Education, Riga, Latvia.

7. Boobani, B; Grants, J; Boge , I. (2021). *Monitoring in Taekwondo athletes*. (2021). LASE 13th International Master and Ph.D. Students Scientific Conference "Sport in changing environment" Riga, Latvia.

8. Boobani, B; Grants, J; Boge , I. (2020). *Recreation activity for recovery in Taekwondo athletes.* The 12th Scientific International Conference of Master and Doctoral students of the Latvian Academy of Sport Education. Riga, Latvia.

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SCIENTIFIC RESUME – CV

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Scientific research activities

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