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## Pain tolerance in sport

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### Abstract

Pain is an inseparable element of the sports experience, regardless of the chosen discipline. The saying “no pain, no gain” perfectly describes the risk of an injury in sport as well as the expectations of high tolerance of pain. Sociologists note the connection between sport norms and values and the pain and behaviours related to an injury. While competing an athlete is under pressure of the coach, activists and supporters who expect him or her to continue and perform despite pain. However, pain in sport is not always a negative factor as it also plays an informative role indicating physical limitations of the body. It is especially relevant when the body is at risk of an injury or when an athlete puts in maximum effort required during competitions. The authors present the phenomenon of experiencing pain related to sport at the highest level, competitors’ coping strategies, as well as selected mental techniques used by athletes to increase their tolerance of pain.

### Keywords

psychology, sports, pain, pain tolerance, mental training

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# Pain tolerance in sport

## Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

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## abstract

Pain is an inseparable element of the sports experience, regardless of the chosen discipline. The saying "no pain, no gain" perfectly describes the risk of an injury in sport as well as the expectations of high tolerance of pain.

Sociologists note the connection between sport norms and values and the pain and behaviours related to an injury [1, 2]. While competing an athlete is under pressure of the coach, activists and supporters who expect him or her to continue and perform despite pain [3]. However, pain in sport is not always a negative factor as it also plays an informative role indicating physical limitations of the body. It is especially relevant when the body is at risk of an injury or when an athlete puts in maximum effort required during competitions.

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## INTRODUCTION

Effective physical activity in every discipline requires a competitor to use both biological and mental resources at the optimum level. Since ancient times physical abilities and training have been considered as the most important factors in achieving athletic performance. However, proper mental attitude, which is considered to be of crucial importance while preparing for competitions, is not a discovery of recent years. It was already known in the ancient times [4], when the players were recommended to calm down and focus on the upcoming competition. It is currently believed that athletes are approaching the end of their physical abilities, and what decides about the final result is more often their mental attitude [5]. It is the strong psyche that can help to finish the race when the body fails. When Justyna Kowalczyk won a gold medal at the Olympic Games in Sochi, rumours appeared that her foot injury was not real. Many people could not believe that it is possible to race at that pace for 10 kilometres with a broken bone, as the pain that accompanies this kind of injury would prevent gaining a good result. But it is a fact that during every Olympic Games there are athletes who win not only with their rivals but also with the pain they experience.

In this paper, the authors will focus on the experience of pain which is ubiquitous in sport. The pain is understood as “an unpleasant feeling of physical or mental nature causing the reaction which usually consist of evasion”. Pain is a signal, a body defence method to eliminate the dangerous arousal [6]. According to the International Society for the Study of Pain, pain is “an unpleasant sensory and emotional experience associated with the currently occurring or potential tissue damage or described in terms of such damage.” Although pain is undoubtedly an unpleasant sensory experience, it has a very important signalling function that enables us to survive in the external environment [7]. Pain makes it possible to locate and identify the disease process or tissue damage, thereby facilitating a selection of an appropriate remedial response. In addition, through learning, both humans and animals acquire avoidance or escape behaviours when faced with stimuli that cause pain sensations [8].

Scientists have distinguished two types of pain: receptor-nociceptive pain, which is a result of stimulation of sensory nerve fibres or a reduction of the reactivity of nociceptors (pain receptors); and a non-receptor, neuropathic pain, resulting from damage or disease within the nervous system structures or occurring as a result of a negative emotional state and mental processes, i.e. psychogenic pain [7]. The sensation of pain itself arises as a result of brain neuronal activity, which can be confirmed by diagnostic methods such as visualization techniques, e.g. positron emission tomography (PET).

Nociception (a process in which receptor pain appears) consists of four stages [9]. In the first one, called transduction, a chemical, mechanical or thermal stimulus is transformed into an electrical impulse which then goes to spinal cord receptors, where neurokinins and peptides performing modulating function are released. The information about pain is subsequently transmitted to other structures of the nervous system by the excitatory aminoacids and leads to the perception of pain in the encephalon. It is only at this point that a person realizes the meaning of pain and can respond accordingly. The pain sensation affects the central nervous system resulting in increased breathing and heart rate and greater blood flow in the brain and muscles. The aim of all these pro-

cesses is to maintain homeostasis. The final result of the pain sensation are pain behaviours observable on the outside, i.e. what the person says, does or avoids doing because of the discomfort. The expression of pain depends on cultural factors and psychological characteristics of an individual, for example on one's temperament [10].

Domżał [11] distinguishes three components of pain: a somatic element, that is a sensual feeling; a cognitive element, which determines how pain is experienced by an individual; and an emotional component, which translates into a feeling of distress. The pain sensation itself is subjective by nature, experienced differently by every person. What is more, the sensation can be experienced differently by the same person in various situations. This is primarily due to the current emotional state of the individual and the cognitive processing of a stimulus, which consists of identification of the cause of pain, evaluation of its source and concentration on the feeling [12]. Apart from the factors mentioned above, the intensity of the experience depends on processes such as memory, because perception depends on previous experience, beliefs and locus of control, as the suffering person can frequently control their surroundings [13]. In various cultures people perceive pain differently because different patterns of pain response were presented to them by people among whom they were brought up [10]. In addition, the psychological response to pain is connected with a somatically conditioned sensory threshold of pain, which indicates the smallest intensity of a stimulus causing pain and a pain tolerance threshold, indicating the highest intensity of the pain stimulus that the person is able to endure. The former characteristic remains constant for an individual; however, the latter one can be increased through proper training [14]. Women experience pain more intensely; they also have a lower pain threshold; therefore, in the case of chronic pain, they are more prone to mental disorders [15]. Interestingly, the pain tolerance in women is significantly increased during menstruation, as compared to other moments of the cycle. During menstruation pain is also seen as less cumbersome, which might lead to the conclusion that at this time, a greater training load may be planned [16].

#### **PAIN SENSATIONS EXPERIENCED BY ATHLETES**

Expectations of athletes' higher pain tolerance are firmly embedded in the culture of sport. Athletes, more often than people not connected with sport, must ignore pain sensations or continue their physical activity for a long time despite the pain [17]. However, the perception of pain in sport, beyond the obvious discomfort, is also very useful. When an athlete trains in appropriate conditions and is given specialized medical, psychological, physiotherapeutic and coaching care, he or she perceives the pain as less nagging and feels safe. Experiencing pain also depends on its interpretation; therefore, greater understanding of pain and the realization that it is an inseparable (and necessary) element of the training process allows the athlete to gradually accept the discomfort. [18]. In sport, pain serves an adaptive function, warning of impending or already present trauma, as well as an informative function, signalling that one has achieved or exceeded the level of optimal load [19]. The ability to distinguish between the two types of pain is learnt during childhood. The first type requires the person to stop the exercise immediately, while the second indicates the limit which should not be exceeded for exercise to remain safe and thus it is a very useful phenomenon in sport (e.g. stretching exercises are always accompanied by slight pain; however, too strong pain

sensations indicate that the muscle is not ready for that range of motion, and the exercise should be changed to a different one) [20].

A sport discipline characterized by above-average frequency of pain sensations (more or less intense) as well as commonly occurring injuries is artistic gymnastics [21]. This kind of gymnastics is a highly difficult sport, requiring great technique and training. Its continuous development is associated with ever larger loads, which result in more frequent injuries, renewal of previous traumas and pain in various parts of the body [22]. When performing gymnastic routines of high complexity, the hand performs various types of work: it can grab bars or be a fulcrum in floor exercises or while jumping over a vaulting table. In these cases, wrists are exposed to various kinds of pressure and torsional forces [23]. Young gymnasts often suffer from chronic wrist pain due to constant hand load. During the process of intensive training, when the gymnast's body is constantly subjected to multiple types of stress and joint overload, many micro-injuries of hands can occur [23]. The study on a group of Canadian artistic gymnasts, both male and female, has shown that the majority of participants, regardless of age, minimize the seriousness of unpleasant sensations coming from the body during intense workouts. For example, a six-year-old girl when asked about pain responded that she feels pain but carries on practicing because she knows that it is good for the muscles and thus it is a contributing factor to her sports development. Another eight-year-old competitor added that if there was pain, she would try to overcome it, because "if you give up and start to cry it means that you are weak, and if you are weak, what's the point of doing gymnastics?" [20; p. 622].

In sport, the fight with pain has yet another dimension - a competitor demonstrates his or her strong character and in this way gains respect of the opponents and achieves success [24, 25]. Bill Koch, a silver medallist at the 1976 Olympic Games in 30km Nordic skiing said that 90% of his success can be attributed to his ability to tolerate pain [26]. Another discipline, in which a sportsperson has to cope with a lot of physical discomfort while competing is cycling. O'Conner [27] mentions the Tour de France as one of the most difficult tests of human athletic endurance. A typical distance for the cycling race varies between 50 and 250 km and can last from one (50 km) to six hours (250 km). Weather conditions may differ dramatically: from low temperatures and snow to hot and humid conditions. Cyclists must effectively deal with the unpleasant effects of dehydration, cold, heat, fatigue, increase in lactate concentration and the depletion of muscle glycogen, while pursuing the right racing strategy [28]. Participants of long-distance races complain about a burning sensation in their legs and lungs as well as many other symptoms which an exhausted body gives. Taking control over those feelings is the only helpful method of coping with them. Basically, cycle races require both physical and mental effort [29]. One of the elements of a runner's training involves increasing the individual tolerance of suffering, that is, increasing the threshold of pain tolerance. When a long-distance runner crosses the finish line he or she has not used 100% of their physical abilities and energy. The runner only uses as much of his/her capabilities as their personal pain tolerance allows for. The best athletes are not only well trained physically, but also well prepared to experience discomfort during the race [30]. Egan [31] tried to answer the question whether the pain tolerance level of competitors practicing various disciplines is different. Therefore, he involved in his study

competitors practicing various disciplines (football, boxing, karate, fencing, cross-country skiing). All of them were subjected to a Cold-Pressor Test (immersing feet in water with ice). It turned out that more than a half of the participants withstood the maximum time of 12 minutes, but football players and cross-country skiers had significantly higher pain tolerance when compared to other discipline competitors and the control group, which consisted of people not practicing sport.

## **COPING WITH PAIN IN SPORT**

Physiological endurance tests performed on athletes do not explain all the differences in their physical efficiency [32,33,34,35]; therefore, it is believed that these are psychological factors that play a prominent role in achieving outstanding endurance levels [27]. Morgan and Pollock [36] have identified two strategies for dealing with pain: the dissociative and the associative strategy. The first one involves distracting one's attention from pain and own body by focusing on external factors (e.g. listening to music). This method is effective rather on a short-term basis, because after a while pain starts to break through other sensations and it is increasingly difficult to control. Thus, this method is effective only when pain appears at the very end of the sports competition. Moreover, drawing attention away from pain sensations reduces the ability to control one's own body, which increases the risk of injury. The associative strategy, on the other hand, involves complete monitoring of pain. The athlete is focused on the information coming from his or her own body and fully controls it. By doing so, the athlete reduces the risk of injury. This method provides increased tolerance of pain sensations and is very effective especially among the athletes who are more experienced and aware of their own body. The dissociative strategy is more often used by women whereas men tend to use the associative strategy more frequently [15]. The associative strategy is particularly often used by the best athletes who, by applying it, can monitor their body, control the temperature, hydration, movements, pain sensations and other factors [37]. This means that athletes do not fight the pain, but rather fraternize with it. According to Raglin [37], even half of long-distance Olympic runners use both of these strategies during their trainings, which makes the time of long and arduous training sessions more diverse. Compared to other athletes, Olympians are able to assess the effort needed to complete the exercise much more accurately, and through the consistent use of associative strategies they increase their pain tolerance. During races none of the Olympians used the dissociative strategies. Endorphins are hormones which also help athletes to relieve pain. Endorphins are peptide hormones that allow for a feeling of happiness and satisfaction; they are responsible for euphoria and the suppression of pain [38]. Endorphins are produced during intense physical activity, especially during strenuous endurance exercises. It is likely that these hormones are produced in oxygen debt which arises in the body during prolonged physical activity. The increased secretion of endorphins mainly occurs in those parts of the brain that play an important role in the perception of pain. Recent studies [39] have led to the identification of two other substances which alleviate pain: phenylethylamine and endocannabinoids [40], both produced by the body during intense exercise. These compounds, apart from the previously mentioned endorphins, are associated with the phenomenon of the "runner's high" [41], that is a euphoric state, created as a result of long-distance running, which is characterized by greater resistance to fatigue. All of these substances can cause analgesia, i.e. a pain suppression state in



people who are physically active. To confirm that endocannabinoids (in this case, anandamide, AEA) are connected with the “runner’s high” scientists from the University of Arizona have tested the relationship between the level of endocannabinoids and the runners’ mood. The relationship was evident – the better the mood observed in the participants, the more endocannabinoids were present in their bodies [40]. In sports practice, this means that the combination of these substances makes an exhausted marathon runner come to the finish line despite the muscle pain which is growing with every kilometre, and a climber is able to reach the summit in conditions of acute oxygen hypoxia. The pain sensation appears only some time after completing the task, e.g. crossing the finish line, which is why basically at every major sporting event we can observe competitors who win seemingly effortlessly and a few hours later have a problem with getting to the medal ceremony.

#### MENTAL TECHNIQUES USED TO INCREASE PAIN TOLERANCE

In order to reach the highest level in sport, athletes should not concentrate on developing only one particular skill, but a whole set of psychological skills that are associated with optimal performance [42]. One of the methods of improving sport performance is mental training [43], which can also be used to increase pain tolerance of a competitor. It is possible because, in contrast to the threshold of pain sensation, which is conditioned by somatic factors, pain tolerance depends on psychological factors (e.g. concentrating on pain, the current physical condition). For this purpose, various techniques of mental training are used, for example visualization, goal setting, internal dialogue, relaxation techniques, mindfulness training, changing cognitive patterns, or a multimodal program that includes a combination of these techniques [44]. Relaxation techniques not only improve the effectiveness of rehabilitation after trauma, but also enhance pain tolerance; when pain occurs, one can use simple relaxation and calming exercises. In addition, the use of various relaxation techniques gives different results, e.g. concentrating on breath helps to complete the race despite unpleasant sensations, and progressive relaxation increases the resistance to the currently experienced pain; however, this should not be applied directly after the training to speed up regeneration of the body. In the latter case self-hypnosis gives the best outcome [45]. Herris and Hebert [46] have demonstrated that the effectiveness of visualization in increasing tolerance of pain is dependent on the relaxation preceding it. When competitors used only visualization, the pain sensations were even greater than before using this method. What is more, the researchers found particular effectiveness in pain reduction of visualization consisting in imagining movements of joints located close to the place susceptible to an injury. Another effective technique is visualization during which competitors imagine not only the approaching beginning of the race, but also the times of crises that may occur during the race. Knowing when to expect the difficulties makes it easier for the competitor to prepare and overcome them [29]. The method based on goal setting involves planning and then implementation of the plans [45]. The technique is especially effective during races, because the concentration on the result and the process necessary to achieve the best possible outcome help to overcome the difficulties and increase resistance to pain distractions. Other researchers [47] note that the mere setting of goals strengthens the relationship between intention and behaviour and thus increases the determination to continue one’s efforts also when faced with pain. A positive attitude and internal dialogue are very significant in increasing pain tolerance [48]. For-



mer Olympic cyclists used positive and reassuring sentences in their internal dialogue – they reminded themselves that they had appropriately prepared for the competition, their pain is only short-term and that they will certainly cope with it as every moment brings them closer to the desired finish line [29]. It is worth noting that negative thoughts, such as “I cannot stand it,” result in a lower tolerance of pain, while an internal dialogue based on such statements as “I can do it” alleviates pain sensations and increases pain tolerance [45]. The use of mindfulness training and meditation is recommended to people suffering from chronic pain, depression, hypertension and other medical complaints, because they positively influence the parasympathetic nervous system and the immune system, and they increase the density of the grey matter [49]. La Cour and Petersen [50] noted in their study a reduction in the general level of anxiety and depression, an improvement in the quality of mental functioning (psychological well-being), increased pain control and pain acceptance in people using a standardized program of Mindfulness Based Stress Reduction (MBSR). Such effect was much smaller (insignificant) in the case of using painkillers.

The Mindfulness Based Stress Reduction (MBSR) program positively contributes to the treatment of pain, including patients with chronic pain. The results of a study conducted by Kress and Statler [29] on cyclists showed that the former Olympians used a variety of cognitive strategies to cope with pain during endurance training and racing. In the critical moments of competition, the cyclists focused on very specific aspects of their racing. They focused on a pedalling technique, maintaining or adjusting the position of the body, the strategy of the race, cyclists ahead of them, or simply on enduring the race. They noticed that when pain grew, the best way to deal with it was to focus on those aspects of cycling which allowed them to reach the finish line in the most effective way [29]. Cyclists stressed that thinking about the pain was a waste of energy, which moved the chances of success away from them. Another important strategy mentioned by the cyclists involved preparing of an action plan and sticking to it. Participation in the competition, endurance training and other forms of preparation, all set appropriate objectives to be achieved by the cyclist. The vision of the objective helped the cyclists in critical moments to do their best and put even more effort in cycling.

There is also a close relationship between the beliefs about one's effectiveness in pain tolerance and a release of endogenous opioids [51]. The findings suggest that the assessment of the pain level and its interpretation are key to pain tolerance. Athletes can actively develop their tolerance in this regard; however, it is recommended to do so gradually. Whitmarsh and Alderman [52] have shown that athletes who changed their cognitive patterns greatly improved their time efficiency and increased tolerance to pain during training sessions. Pain experienced during physical effort can be interpreted as a threat to the somatic integrity of an individual and associated with an increased arousal and anxiety [49], which make it even more unpleasant. The athlete's body becomes more strained, making the effort less effective and more painful. However, research in the field of pain in sport indicate that the cyclical exposure to pain can directly lead to getting used to it by reducing surprise, insecurity and a sense of danger. This means that an athlete can, to a certain degree, prepare for pain. What is more, to improve athletic performance, one can use mental training based on at least a few key aspects, such as anxiety

management, goal setting, strengthening of the attention span, imaginative training and various techniques of building and increasing self-confidence [53].

## CONCLUSIONS

Psychological skills can be the key factor that determines whether an athlete will end the competition as a winner or a loser [45]. In order to increase their maximum possibilities, athletes must train their psyche, just as they train their body. Nowadays, the competitor's pain tolerance frequently determines the result of the competition; therefore, it is very important for an athlete to be able to continue the efforts despite the unpleasant symptoms. Developing knowledge in this field is of paramount importance when it comes to the very process of training, especially that athletes are exposed to ever greater loads in all disciplines. Also amateurs, who, unlike professional athletes, are less well prepared physically and are not under specialized medical care, are more prone to injuries [3]. Moreover, apart from standard training, athletes also learn to distinguish the pain signalling trauma from load-caused pain and, therefore, they have many opportunities to test different strategies for coping with pain. As a result, they progressively become more resistant to unpleasant sensations, which ensures both comfort and safety. For these reasons, physical activity is also recommended for patients suffering from chronic pain, as regular workouts improve the quality of life, for example, by altering the perception of pain and increasing pain tolerance [3]. Studies also confirm that ignoring pain may reduce the extent to which pain interferes with the ability to engage in everyday work and social relationships [54].

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