



Research article

An exploration of the antecedents and mechanisms causing athletes' stress and twisties symptom

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ABSTRACT

Research background: Twisties symptoms have attracted the world's attention in the sports field since the 2020 Tokyo Olympics.**Aim:** However, studies on the symptoms and causes, inducing mechanisms, and relationships between DP/DR (Depersonalization/Derealization Disorder) and anxiety and depression for athletes have been sparse for both the general population and athletes. The literature on the twisties issue of athletes is quite scarce in the past.**Research method:** Adopting the criteria appealing to PRISMA Items to review the subject twisties in a broader mode and combining with the IPO (Input-Process-Output) model for triangulation testing purpose, this study categorized the literature to explore input variables causing athletes' twisties and identified process variables in psychological mechanisms bridging suppression and finally discussed the existing possible ways in helping athletes to solve problems caused by twisties.**Results:** The authors formed 6 propositions in summarizing twisties' influential factors and mechanisms and tried to propose solutions to reduce the stress and the relevant twisties symptom of athletes. (1) Promotion of Athletes' Mental Toughness to Resist Stressors. (2) Interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR. (3) Monitoring the athlete's HRV test results to ensure the Athlete's ability to resist pressure. (4) Avoid organizational stressors. (5) Written Emotional Disclosure method. (6) Improve various support systems for athletes: dual career paths. (7) Athletes' Stressful Awareness about the impact of gender, seniority, and environment.**Conclusion:** Through the theoretical dialogue on the symptom of twisties, this study helps promote the development of the research of "twisties" and depersonalization-derealization symptoms (DDS); both have been under-researched.

1. Introduction

Population-based studies investigating the impact of DP/DR symptoms on the course of depression and anxiety and empirical research are sparse (Michal and Beutel, 2009). Not even to mention the least number of studies on the symptoms and causes of related research of relationships among Depersonalization-derealization disorder (DDD) and anxiety (Michal and Beutel, 2009) and depression for athletes (Schlax et al., 2020).

Stress is unavoidable for athletes; athletes' psychological status is like the interaction results between body and mind - interaction between exhausted physical situation and psychological anxiety and worry about

the performance related to their future salary, employment contracts, and even fans' interactions. Although appropriate stress helps players improve their performance, over-stress can easily cause players' performance to drop or make mistakes (Yang et al., 2015). For athletes, to have a great performance during the contest and physical training in the long run, the ability to resist stress is a critical factor.

Athletes' ability to resist stress includes the emotional factors of resistance, such as stress, anxiety (Millman et al., 2021), nervousness, and worries, which could be leading to poor performance of athletes during the contest. That is to say, the psychological status of athletes has played a critical role in regulating emotions and coping with stress. And the training of psychological status takes time, as stress level may not

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only be from outer factors such as a requirement from the team and contest but from the athletes inherited personality in terms of sensitivity towards outer stressor, which make training of stress coping capability even harder.

From 2015 to 2016, the NCAA launched a mental health campaign to arouse the public's attention to the mental health of athletes. Famous cases are like: (1) American swimming legend "Flying Fish" Michael Phelps also publicly talked about his personal depression experience through "ESPN" in 2016. (2) Simone Biles, a well-known American gymnast at Tokyo Olympics on Jul 27, 2021, is said to have twisties in mid-air, which is caused by psychological stress, and then drop out of competitions. Twisties is like Athletes who lose control of awareness about their positions in the air and did not know which part of the body to land. This means that athletes need to spend a period of time to decompress and regulate their psychological status. In addition to the original stress, athletes also need to avoid further fear about the losing control feeling will take place again when they make the next attempt. In short, stress from twisties, anxiety (Schlax et al., 2020), and worries about coming back from the twisties are double stress on athletes. (3) In March 2018, an American professional basketball player for the Cleveland Cavaliers of the National Basketball Association (NBA) disclosed at The Player Tribune about his panic attack experience during a game in November 2017 and the relevant psychological experiences afterward. (4) In May of 2021, Japan's internationally famous tennis athlete Naomi Osaka ever refused to attend the press conference of the French Open (Les Internationaux de France de Roland-Garros) due to mental health problems (anxiety) and announced his retirement after being fined. Naomi Osaka said that she has been suffering from depression for a long time. Sponsors, including the American sports brand Nike, publicly expressed their support for Naomi Osaka and affirmed her courage to disclose that she suffered from depression.

We can see that since the NCAA's promotion of psychological care for athletes from 2015 to 2016, the psychological problem of athletes is no longer a problem that should be hidden, but a mental health issue that can be publicly inspected, that we all should pay attention to.

Therefore, the research of sports psychology has gradually risen. Many sports psychology professionals, consultants, and psychologists have begun to discuss how to avoid, protect, and take care of the psychology of athletes and promote athletes to achieve sports performance at the same time. The contest of exercise should be able to be continued healthily. Thus, sports psychology health has begun to gain attention.

For example, sometimes, sports psychologists use cognitive reconstruction methods such as image training (Lagos et al., 2008) and interventions correcting cognitive misinterpretations (Colic et al., 2020) to simulate athletes in competition situations, so that athletes are mentally prepared and experienced and become less anxious. Thus, athletes can concentrate faster and quickly recover from frustrations (Peper and Aita, 2017).

This also formed the motivation of this research for finding good stress coping methods for athletes. By using a traditional qualitative literature review method combining with the Input-Process-Output Model way of reviewing antecedents of twisties via appealing to the PRISMA Items' checklist, this study aims to explore and categorize influential factors in causing twisties of athletes to help construct models among relevant stress management skills of athletes in conquering stress. This study contributes to summarize stressors causing twisties of athletes, proposes six propositions for the test of future studies, and a conceptual framework on antecedents that cause twisties.

2. Literature review strategy

The authors use the traditional literature review mode, and adopting the criteria appealing to PRISMA Items to review the subject twisties in a broader mode. Systematic reviews play an important role in many areas of research, necessitating revision to the guidelines. Research synthesis can provide a summary of current knowledge in a field, which may lead

to identifying future research priorities; they might answer questions that individual studies could not; they might point out shortcomings in primary research that need to be addressed in subsequent studies, or it might provide theories about why phenomena occur (Gurevitch et al., 2018).

PRISMA, a statement published in 2009, also known as Preferred Reporting Items for Systematic Reviews and Meta-Analyses, is a list of evidence-based items used to evaluate health care interventions and their costs. An article review stage involved searching and removing irrelevant articles. The articles are analyzed using predefined categories (Regona et al., 2022).

The authors use the traditional literature review mode and adopt the criteria appealing to PRISMA Items to review the subject twisties in a broader mode. PRISMA extension is good for scoping reviews (Tricco et al., 2018), containing 22 items to include on the checklist. The PRISMA checklist serves as a standard and assurance of quality in provisions of evidence to evaluate the appropriateness of the scope of literature review for the selected research topic (Please see Appendix A for reference). PRISMA 2020 covers a discussion on the criteria for review, including the sections of title, abstract, introduction, methods, results, discussion, and funding. The criteria of PRISMA are set up for identifying, screening, deciding on the studies' eligibility and scope, and then finalizing the list of studies to be included, during the systematic review process. Appendix A (Concepts of the Preferred Reporting Items for Scoping Reviews of PRISMAscr Checklist Being Applied) shows this study's procedures for identifying, screening, deciding on the studies' scope, and then finalizing the list of studies to be included, according to PRISMA criteria in different sections, including title, abstract, introduction, methods, results, discussion, and funding.

2.1. Analysis of the references characteristics of this study

Analysis on the references characteristics of this study includes:

3 books, 1 doctor thesis, 31 journal papers for general IPO-structured literature review, and 8 journal papers are adopted as references of this study. They are all English-written publications.

Keywords for selection of the information source include 18 terms: anxiety, athletes, athletes' mental toughness, depersonalization, depersonalization-derealization disorder, derealization, dissociative disorders, emotional labor, organizational stressors, PTSD, self-efficacy, sports performance, stress, stress management, stress release, suppression, system 1, twisties.

Except the 3 expertise books, one doctoral thesis, 39 references are mainly from 38 journals: Ann. Clin. Transl. Neurol., Int. J. Event Festiv. Manag., Int. J. Sport Exerc. Psychol., BMC medicine, International Journal of Mental Health Promotion, Am. J. Clin. Hyp., Ann Intern Med, Appl. Psychophysiol. Biofeedback, Biofeedback, Consciousness Cogn., Curr. Psychol., Curr. Psychiatry Rep., Depersonalization. Br. J. Psychiatry, Depress Anxiety, Front. Neurol., Frontiers in psychology, Int. J. Clin. Exp. Hypn, Int. J. Psychophysiol, Int. J. Stress Manag., International Journal of Stress Management, J Clin Psychiatry, J. Affect. Disord, J. Leisure Sports Manag., J. Trauma Dissociation, J. Traumatol, J. Anxiety Disord, J. Clin. Psychol, Journal of Open Innovation: Technology, Market, and Complexity, Multisensory Res, Nature, Physical therapy, PLoS, PLoS Medicine, Psychiatric Med., Psychology, Psychosom. Med. Psychother, and Systematic reviews.

Except for 8 journal papers referred for PRISMA items, 31 journal papers were referred specifically for the development of the propositions and suggestions of the solutions are the end of the study. However, from the link of the topics/literature showing up in different sections, we can see that one theoretical variable has been extensively discussed among different sections, or say, connections between literature reviews for development were clearly constructed.

For example, Cox et al. (2002) discussion on the topic of depersonalization has been shown in the section of 3.1. Suppression and sources of stress of athletes/3.5. Proposition Development and conceptual

framework of this study. Michal et al. (2009) discussion on the topic of depersonalization-derealization disorder has been shown in the section of 1. Introduction/3.1. Suppression and sources of stress of athletes/3.2. Twisties/3.5. Proposition Development and conceptual framework of this study/5.1. Theoretical Implication. Casiglia et al. (2021) discussion on the topic of depersonalization-derealization disorder has been shown in the section of 3.4. DDD (Depersonalization-derealization disorder)/5.1. Theoretical Implication, and the like.

Finally, the years of the sources of information has distributed as: 1 cited article's publication year is from 1972; 4 cited article's publication year are from 1990 to 1997; 7 cited article's publication year are from 2002 to 2009; 6 cited article's publication year are from 2012 to 2015; 25 cited article's publication year are from 2016 to 2022. Please kindly see Appendix B for details of the analysis.

2.2. Prospective Categorization of literature via IPO model

There has been very little research about twisties in the past, not to mention the relevant theoretical dialogue and discussions about the twisties symptom of athletes. Therefore, the authors did their best to collect as much available information as possible to give readers a comprehensive concept of the phenomenon of athletes' twisties in terms of its antecedents and possible influential outcomes psychologically.

Concerning classification, this study uses the concept of the IPO model (Shih, 2009) to examine the collected literature and categorize the variables according to input, process, and output variables to examine the gap in the literature review in the field of athletes' twisties. As relevant literature is still sparse in this field, IPO categorization should help promote the development of the literature as the concepts in development become clearer. The conceptual framework of the IPO literature review model is illustrated below (Figure 1).

Within the model, input variables represent the influential factors influencing either mediator (process variables) or output variables (perceptual, psychological status of athletes). For example, coaches and psychological professionals can manipulate the input variables to try to reduce the perceptual stress level of the athletes and maintain their performance at the same time.

2.3. Triangulation test

Based on the IPO model, this study proceeds with the triangulation test framework (Figure 2), and the contents of the test in each IPO step are as follows:

- Input variables: Finding Antecedents causing Athletes' Twisties, involving papers discussing the direct influential factor: depersonalization and derealization in various databases to bridge the inferential literature on the causal relationship between DDD and Twisties.
- Process Variables: Finding psychological mechanisms bridging suppression, PTSD, DDD, and Twisties through collecting practical information from athletes' interview results posted on social media. The authors analyze the descriptions of depression, anxiety, twisties, and maladaptive symptoms mentioned in major social media newspapers and magazines during interviews with the famous Tokyo Olympic athletes.

- Output Variables: The literature review aims to find possible solutions for twisties.

3. Analysis: input and process

3.1. Suppression and sources of stress of athletes

The psychological stress sources of athletes are different from the general public. Therefore, the general public's psychological stress management theory has to be updated to illustrate athletes' psychological stress management methods. For example, famous athletes usually have many fans who focus on and follow them as movie stars; they become role models in front of social media, which tracks their daily lives. Therefore, athletes need to wear a mask to live in front of the public (surface acting) (Shih, 2009); surface acting forces athletes to pretend they are tough and strong.

Moreover, athletes have to go through harsh physical training every day – similar to physical abuse, which may cause trauma and PTSD. According to research results of Michal and Beutel in 2009, in terms of neurobiological and psychological models, a disordered body schema (the harsh physical training) and emotional and autonomic blunting (PTSD) are essential components of DDD disorder, and relevant in panic disorder (Cox and Swinson, 2002). Athletes' hard physical training differs from the general population's exercise and fitness. Under continuous and heavy daily physical training, combined with suppressed stressors, athletes may have disordered body schema and emotional and autonomic blunting leading to DDD disorder if the suppressed stressors cannot be released on time. From the perspective of autonomic nerves, exercise tends to easily stimulate the parasympathetic nerves. Excessive exercise can be inferred to cause autonomic blunting. Depersonalization and Derealization are characterized by a general emotional numbness (Dewe et al., 2018), which could be related to emotional suppression, as Dewe et al. (2018) also indicated the fact that autonomic suppression in response to threats delivered to the self is correlated to increases in trait-based depersonalization-type experiences.

Moreover, the environment faced by athletes is not the environment of ordinary families and office workers. Therefore, the antecedents of the source of stress for athletes cannot be compared with the general public's stress management theory and should be discussed in a distinguished direction. For example, the well-known Hindrance-Challenge Stressors Model (Fan et al., 2021; Flinchbaugh et al., 2015; Gerich, 2017) suggested that the general public will regard stress as a challenge or way for escaping, but it is not suitable for athletes here. Why? Because athletes have no way to escape. In the work (sports) environment, the benefits involved by sports are huge; pressure for competition and being fast replaced are at a high level. Sport is an extremely competitive industry. There is no room for mistakes. Athletes must listen to instructions from coaches, experts, and managers daily - intensive guidance instructions from expert group: no control feeling upon their motions (there is no feeling of control of their own lives daily. Self-efficacy helps increase people's feeling of control in the buffer of negative stress, as a feeling of losing control induces stress (Bandura, 1992, 1997). That is to say, losing control of their living environment could cause their feeling of no confidence and control over their lives. Also, the pressure to retire due to the growing age and reduction of physical strength, as well as the stressor from the continuous joining of younger athletes (competition and

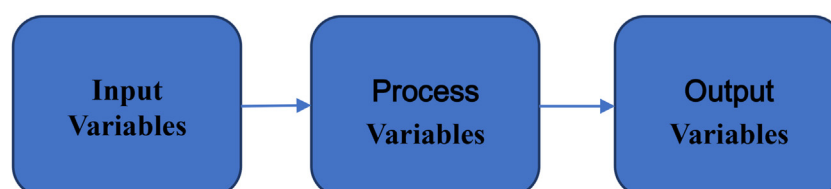


Figure 1. Prospective Categorization of literature via IPO model in terms of Athletes psychological stress coping strategies.

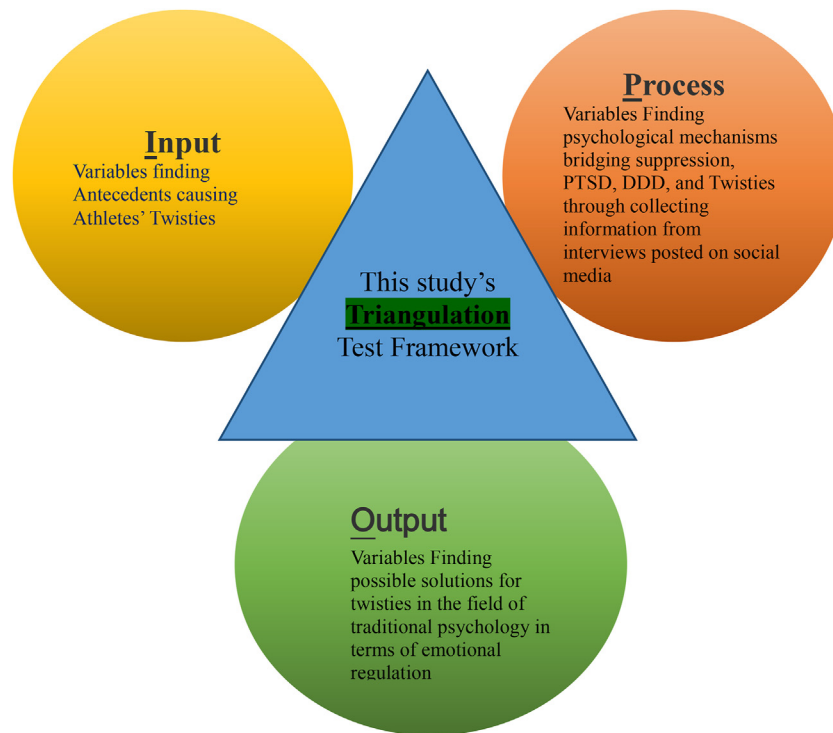


Figure 2. The triangulation test framework of this study.

replacement from the continuous joining of young athletes), examination of and follow-up on social media, and intensive training and frequent and travel for contests all-cause athletes' stress. And the chances for social support from a family with family members have become less, so the huge pressure on athletes has become the norm; Figure 3, indicated the distinguished stressful work environment. In short, this study suggested that suppression and harsh physical training lead to disordered body and emotions of athletes.

3.2. Twisties

According to the literature, not only “twisties”, a mental disorder, have not been curiously mentioned in the medical literature (Casiglia and

Tikhonoff, 2021), but also depersonalization-derealization symptom (DDS) is a scant and under-researched clinical area (Michal et al., 2016). Furthermore, treatment-related to dissociative disorders has not developed well compared to other major diagnostic disciplines (Bailey and Brand, 2015).

“Twisties” is considered a gymnastic phenomenon or mental block which causes a sudden loss of sense or spatial awareness loss while performing and hence, fails to control the body position (Casiglia and Tikhonoff, 2021; Philadelphia, 2021). Medgym (2021) also stated that it is the unexpected inability to do the required spins or any spins sometimes for a particular position. It is an occurrence in which an athlete suddenly forgets his/her mind while displaying their performance (Knudsen, 2021). Presumably, it might be caused by the heavy pressure

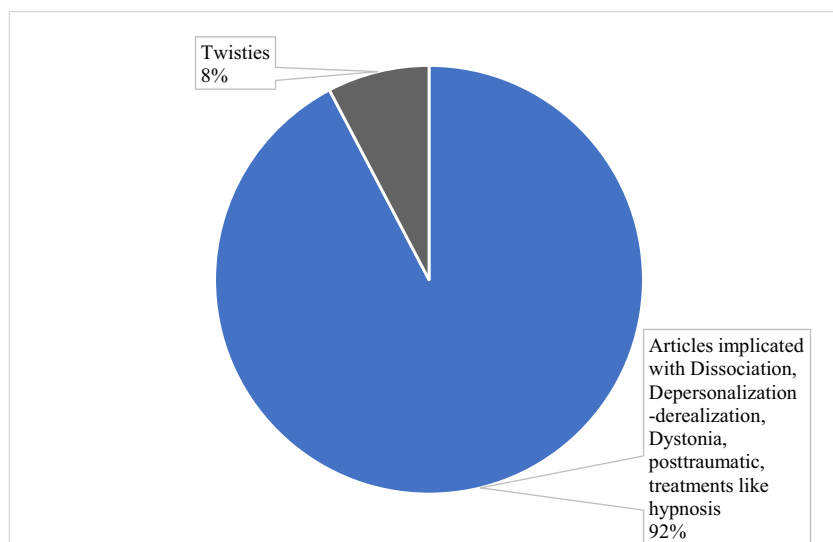


Figure 3. Statistical distributions of articles founded with implications of dissociation, depersonalization-derealization, dystonia, posttraumatic, treatments like hypnosis.

and stress of the competition. This is a dysfunction of a sensory mismatch between the mind and body (Renaud, 2015). It is a disconnectedness between one's self-perceptions and the external world (Carlson et al., 2018; Gold and Quiñones, 2020). Gupta and Basu (2021) also explained that it is generically rooted in mental health issues. This kind of disorder frequently happens in adolescent athletes due to high pressure, whereas it is rarely caused in adult athletes, and this hazardous disorder can lead to severe physical trauma (Casiglia and Tikhonoff, 2021). Therefore, gymnasts should be aware of this mental disorder.

Valdez and Lilly (2021) and Weiner and McKay's (2013) study also indicated that this dissociative symptom is commonly experienced by a person who suffers from panic disorder or PTSD. PTSD is a mental disorder caused by extremely stressful anxiety, which affects at least 10% of patients who have experienced traumatic events (Kessler et al., 1995). The symptom evolves into trance-like disorders, out-of-body control (depersonalization), and unrealistic sense (derealization) (Schiafone et al., 2018). Depersonalization is defined as a condition wherein an individual suffers his/her feelings, thoughts, bodily sensations or memories as not belonging to himself/herself (Grigsby and Johnston, 1989; Hollander, 2009; Mishra et al., 2021; Sarlin, 1962; Trueman, 1984). Mishra et al. (2021), Sarlin (1962) and Trueman (1984) documented that derealization is an abnormal alteration in the sensitivity of one's surroundings so that a real sense of the external environment is lost. According to (Lenka and Jankovic, 2021), a phenomenon of Task-specific dystonia (TSD) or a form of focal dystonia relative to sport is named "twisties," which impairs sensitivity of position in space.

Although symptoms of "twisties" are rarely tested through research, some researchers relative to yips/dystonia discovered the symptoms, such as jerks, spasms, and tremors (Lenka and Jankovic, 2021; Revankar et al., 2021). The jerk was the most frequent symptom in the study of McDaniel et al. (1989), whereas tremor represents the majority of Psychogenic Moment Disorder (PMD) (Peckham and Hallett, 2009). Additionally, twisties are characterized by abnormal, involuntary twitching and spasms (Revankar et al., 2021).

On the other hand, depersonalization-derealization disorder (DDD) demonstrates the disruptions of self-awareness of the body (Sommer et al., 2021). DDD symptoms seem to be revealed in the sense of panic disorder and may manifest a more serious clinical course (Cassano et al., 1989). Therefore, twisties are found when the chronic sense of self-detachment and unreality sense of external surroundings suddenly occur. Dissociation disrupts usual integrated operational functions of consciousness, memory and environmental discernment (American Psychiatric Association, 2013). The construct of dissociation involves an alteration in awareness which is the disconnectedness from one's self (emotions, thoughts, memories, sensations and beliefs) and its surrounding (Gold and Quiñones, 2020; Heydrich et al., 2019; Schimmenti and Caretti, 2016).

Dissociation Symptoms generally consist of psychogenic amnesia, sudden terror, zoning out, spaciness, trance, identity disorder, and a sense of detachment (American Psychiatric Association, 2013; Cardaña and Carlson, 2011). The American Psychiatric Association (2013) stressed that dissociative disorders (symptoms) may or may not be anticipated by the exposures to the traumatic cases or may or may not be arising PTSD symptoms. However, as the PTSD subtype, dissociative signs should be concerned when a full set of PTSD criteria are faced/occurred.

The following charts (Figures 3 and 4) show the publication databases and articles which have implications with twisties, dissociation, depersonalization-derealization, posttraumatic, etc. We found that most of the dissociation research papers have implications with depersonalization-derealization, posttraumatic, dystonia and so on, whereas very few articles mentioned twisties.

3.3. Post-traumatic stress disorder of athletes (PTSD)

Mental health awareness related to mental disorders and symptoms amongst athletes has received huge attention and has become a growing

public concern nowadays (Gorczyński et al., 2020; Muir and Munroe-Chandler, 2020; Schinke et al., 2021). Athletes also experience mental disorders such as post-traumatic stress disorder (PTSD) symptoms like general people (Poucher et al., 2021) because it can occur in all trauma experienced people at any age (Lynch, 2021). PTSD is the state of mental health provoked by a serious event (Bender et al., 2020; Dickinson, 2020; Hébert and Amédée, 2020; Kim and Choi, 2020). Severe illness and injury hinder one's ability to consistently perform their current personal lifestyle (Appel, 2020).

In addition, detachment is a negative feeling with blame and an absence of positive emotion (Macia et al., 2020). In Ross et al. (2018) study, the factor detachment gained the highest value in influencing mental operational impairment. Also, according to Mountjoy et al. (2015), there are three types of violence against sports players, namely, self-directed, interpersonal and organizational violence. The first concern, scanty literature, refers to self-harm (self-abuse), eating habit disorders and suicidal cases (Lang, 2020). The second phenomenon has occurred in different forms, such as emotional abuse, bullying, over-training, physical aggression, sexual abuse and extreme forcing to punishment (Ohlert et al., 2020). The third option is related to perpetrators, such as coaches and sports club officials (Mountjoy et al., 2015). This type of violence happens when the coaches and institutional boards treat abusive behavior and emotional abuse upon athletes (Jacobs et al., 2016). Furthermore, worries related to an early retirement due to injury or violence is also an added pressure for the gymnasts (Rich et al., 2022).

On the other hand, the human brain's Cognitive-Motor Integration (CMI) performance is impaired up to two years' post-concussion (Dalecki et al., 2016). CMI requires the brain to perform components of cognition and motor activities, and it is a crucial skill in one's daily life and in most sports (Dalecki et al., 2019). Moreover, repeated hits to the head in football games cause subclinical effects on brain function such as longer and more severe problems in concentration, memorization, headache and sometimes, physical weakness like keeping one side (Tsushima et al., 2018).

At the end, the literature review on PTSD of this study, including in the sections of literature review and conclusion sections, are developed through 13 popular databases such as Sage, Taylor and Francis, Elsevier, emerald insight, Springer, Wiley, etc. Taylor and Francis is the highest database with 26% among peers, followed by Elsevier (15%), others or online media (10%), Springer (8%), etc. Figures 5 and 6 shows the database used for this review. A total of 62 articles are reviewed. European Journal of Psychotraumatology is standing at the top place, followed by Brain Injury, British Journal of Sports Medicines, etc. Others refer to online media. Figure 3 demonstrates the list of selected journals and no. of articles chosen from them.

3.4. DDD (depersonalization-derealization disorder)

Twisties sometimes have a psychodynamic origin, PTSD, which leads to detachment from the sense of self (Renaud, 2015), a dissociation accompanied by depersonalization and derealization (Casiglia and Tikhonoff, 2021). Symptoms of DDD are for sure independent risk factors for the persistence or incidence of elevated symptoms of depression/anxiety (Schlax et al., 2020; Toupet et al., 2019). Depersonalization/Derealization symptoms seem to be related to anxiety and depression, which are prominent in women, and there will be substantial physical discomfort symptoms, such as migraine (Toupet et al., 2019). As for athletes, derealization makes the patient, athletes, in this case, feel unreal about the surrounding environment and lack the depth of feeling, especially the part of familiarity with the direction of the exercise, space, motions, and locations.

The sources of Depersonalization-derealization disorder (DDD) are poorly understood but may lead to immense distress (Millman et al., 2021). The dissociative subtype of posttraumatic stress disorder (D-PTSD) is estimated to occur in approximately 14% of those with posttraumatic stress disorder (PTSD) (De Haan et al., 2020). De Haan et al. (2020) also suggested that emotional and physical abuse are associated with D-PTSD for childhood treatment.

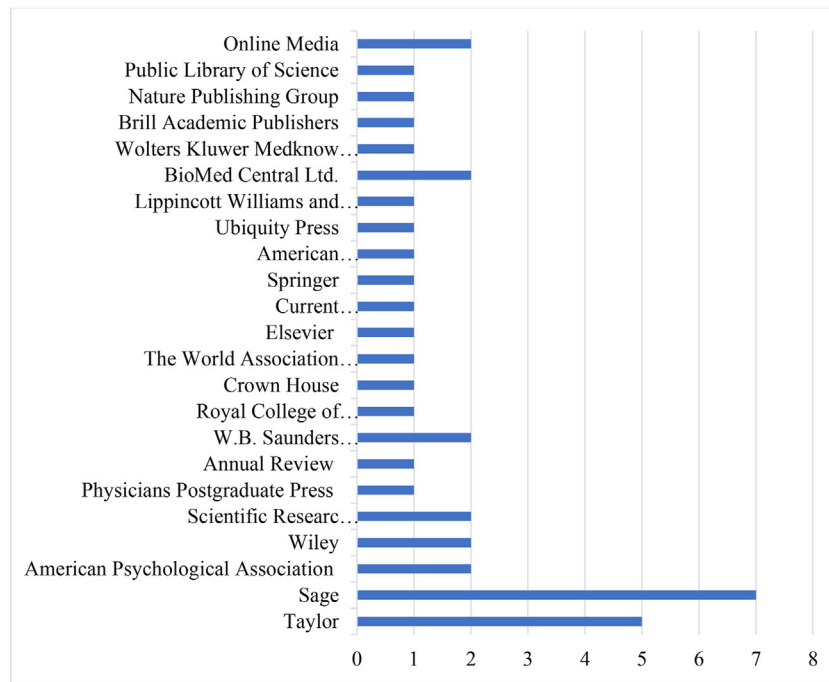


Figure 4. Databases of the selected articles of above-mentioned literature for twisties

Background depersonalization and derealization will interrupt perceptual integration and alter the quality of subjective experiences in terms of feelings of reality and thus make an individual detach from the self or the surroundings (Buetiger et al., 2020).

3.5. Proposition Development and conceptual framework of this study

Heydrich et al. (2019) indicated that patients with ictal depersonalization-like symptoms report altered self-identification with

their bodies. Mild DDD is a common phenomenon (Michal and Beutel, 2009; Cox and Swinson, 2002), which has around 1–2% of prevalence 1–2% rate in the general population in the Western hemisphere (Michal and Beutel, 2009). The cerebellum has control over human beings' spatial balance and subjective consciousness (Casiglia et al., 2012), which is related to individuals' cognition in terms of destroying and changing an individual's perceptual integration and the quality of subjective experiences in the way of derealization (Buetiger et al., 2020). Therefore, this study suggested that individuals' thinking, negative feeling and emotions

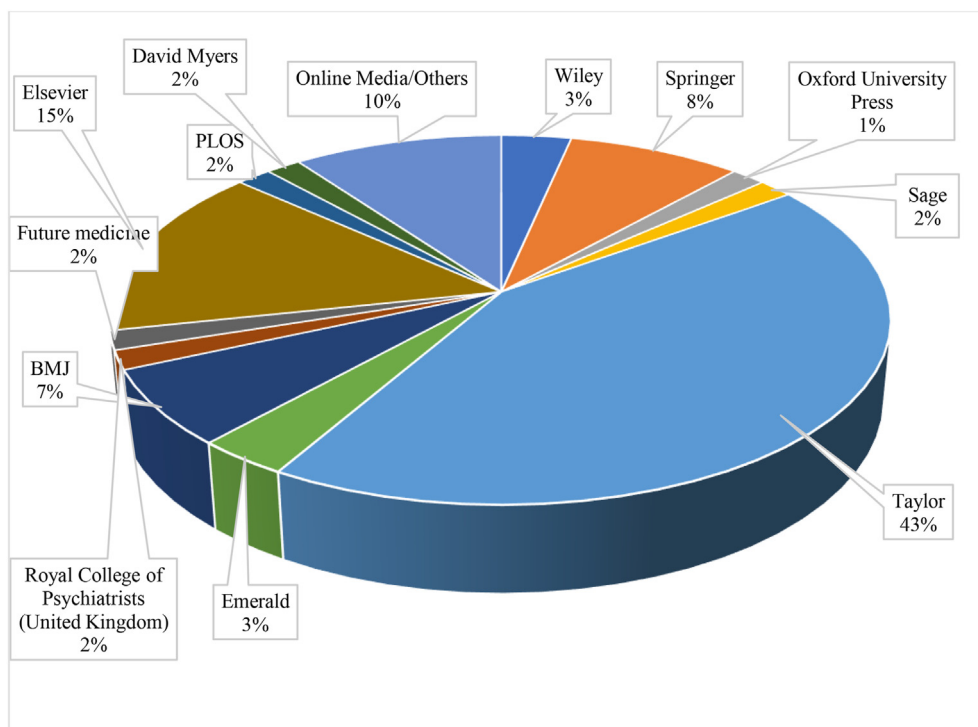


Figure 5. Databases used for review of PTSD.

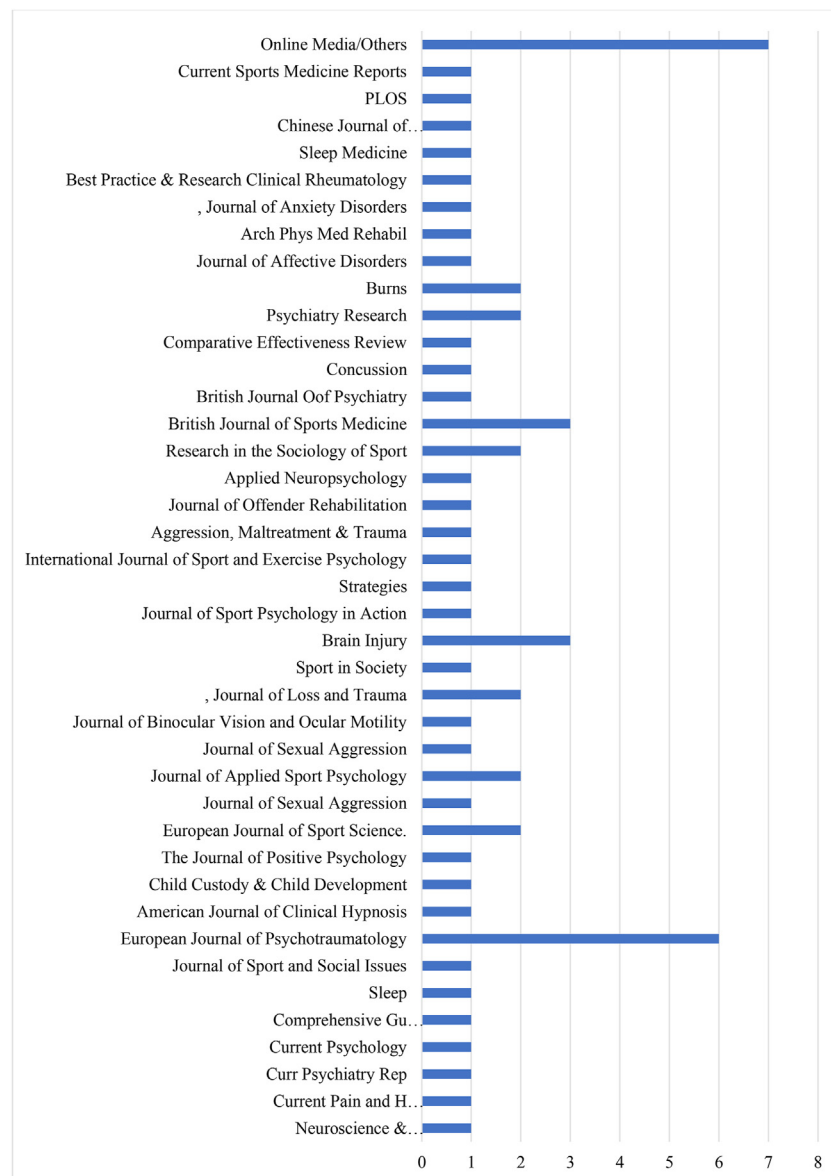


Figure 6. Databases of the selected articles of above-mentioned literature for PTSD.

(suppression and no way to escape from the stressor), which lead to individuals' PTSD, cause individuals' Depersonalization-derealization disorder (DDD), and lead to athletes' twisties feelings.

Based on inferences on antecedents causing twisties, this study has proposed six propositions (Figure 7) via indicated stressors (Figure 8), and a conceptual framework for testing for future studies (Figure 9) as follows:

4. Discussion: possible solutions for athletes' twisties symptoms

Because the literature on the twisties issue of athletes is quite scarce. So, the authors' literature review in the outcome/output variable will go back to check on the possible skills in solving the problem of twisties of athletes. Therefore, with the perspective of finding solutions in solving the twisties symptom of athletes, the conclusion is divided into two parts; one discusses one possible way of solving the twisties issue, which was the promotion of the mental toughness capability of athletes. And the second part of the conclusion focuses on the other methods in helping emotional regulation of athletes from the perspectives of attention training strategy of coaches, athletes' HRV tests, adjustment of

organizational stressors, WED methods, and development of dual career paths of athletes, regulation of awareness of athletes about the impact from gender, seniority, and environment, and finally the climate control during training. Following is the structure of the solutions being presented in following sections (Figure 10).

4.1. Promotion of Athletes' mental toughness to Resist Stressors

Competition is the activity of deriving to gain achievement by defeating supremacy over other competitors (Listra, 2015). When athletes attempt to win in a competition, they all try to make their job perfectly, but perfectionism is a risk factor for causing burnout because it is associated with a stress-related process (Madigan et al., 2016). Gustafsson et al. (2015) indicated junior athletes who have high perfectionism concerns might be at greater risk for burnout caused by the fact that their parents focus on failure and victory without attempting their best. On the other hand, junior athletes who are forced by parents to be perfect have more positive beliefs rather than those who are not encouraged by parents (Madigan et al., 2015). This is evidence that another mediator can affect perfectionism's positive attitude toward

No.	Content of Propositions
Proposition 1	Because of nine reasons suggested, athletes seem no way to escape from stressors as the general public
Proposition 2	Because of no way to escape from the stressor, athletes tend to have psychological suppression phenomenon
Proposition 3	Psychological suppression phenomenon of athletes tends to lead to PTSD in athletes
Proposition 4	Long term harsh physical training tends to lead to PTSD in athletes
Proposition 5	Because of PTSD, athletes may get the symptom of Depersonalization-derealization disorder (DDD).
Proposition 6	Depersonalization and derealization cause athletes to have twists when stressors are overloaded.

Figure 7. The six propositions.
 Note: basketball image is by Alexander Lesnitsky from Pixabay; Image of the player by David Stephanus from Pixabay

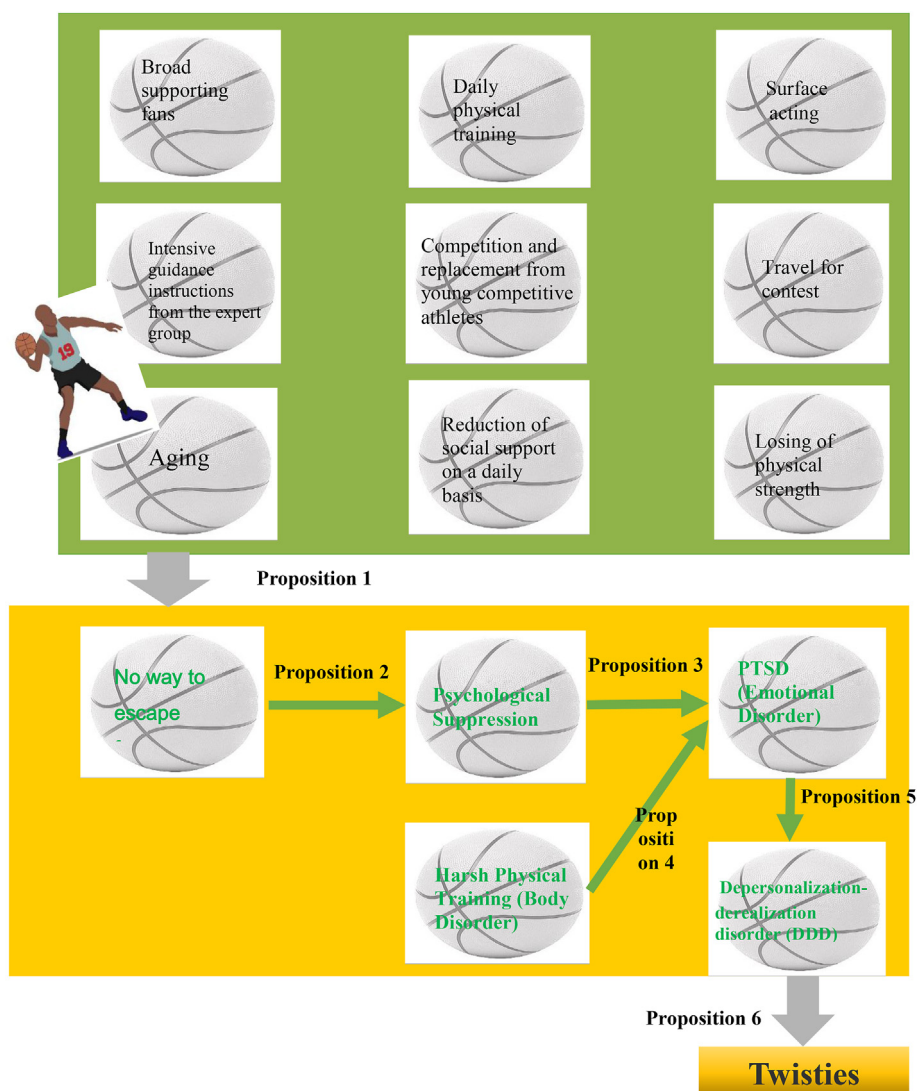


Figure 8. Nine grid basketball-pattern stressor of athletes (the stressful work environment).

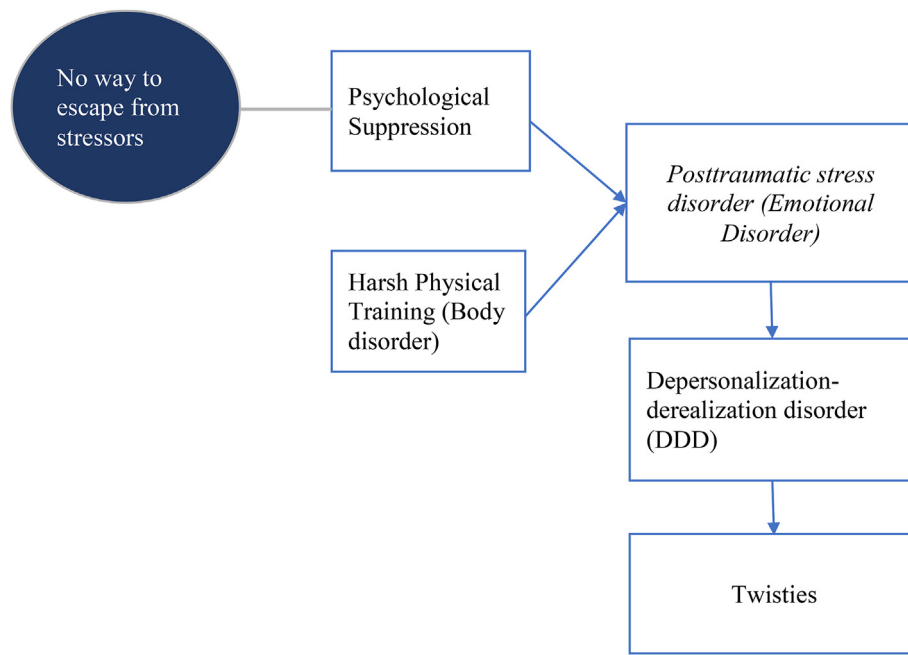


Figure 9. Conceptual framework on antecedents that cause twisties for future studies.

Part I	
4.1 Promotion of Athletes' Mental Toughness to Resist Stressors	
Part II	
4.2. Other methods in helping emotional regulation of athletes	
4.2.1	Interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR
4.2.2	Monitoring on Athlete's HRV test results to ensure the Athlete's ability to resist pressure
4.2.3	Avoid organizational stressors
4.2.4	WED: Written Emotional Disclosure method
4.2.5	Improve various support systems for athletes: dual career paths
4.2.6	Athletes' Stressful Awareness about the impact of gender, seniority, and environment

Figure 10. The structured solutions proposed.

perfectionism. A positive attitude (positive appealing) is associated with mental resilience (Keyes, 2002, as cited in Muir and Munroe-Chandler, 2020). Resilience settles at the heart of emotional governance, the know-how of stress, and mental health. Athletes must consider strengthening toughness to help promote adaptive and effective emotional tactics and mitigate the stress (Crawford et al., 2021). Since the athletic and entrepreneurial careers are considered high workloads, perpetual pressure and riskiness of failure, they should nature resilience and inspiration to cope with those conditions because its ability enables an individual to adapt to, adjust, or monitor traumatic circumstances (Steinbrink et al., 2019). Goal-orientated mindset helps athletes when they go towards achievements in stressful conditions. In this matter, team-goal-orientation is more effective than individual-goal-orientation.

While sports leaders' goal orientation setting is influenced by pressure workloads, perceived stress positively impacts winning goal orientation (Harms et al., 2016).

Furthermore, control of emotions and emotional experiences during competition boosts the capacity of the athletes. Those who have high emotion control can manage and adapt emotions in difficult conditions (Ward and Clair-Thompson, 2018). Meanwhile, "love" in sport also upgrades mental power in the match, e.g., career satisfaction, career enjoyment and joy caused by social support (Ward and Clair-Thompson, 2018). Athletes try to love "Pain", called "Love Pain", as a way not to bother their winning desire, despite the hardship that goes on to annoy (Jones, 2018). The ability to tolerate pain and fatigue and maintain a constant effort efficiency while emerging disengagement from body

senses is essential in this context (Meggs et al., 2018). This is inspired by their genuine interest in the sport and also, and encouragement in mental toughness is generated by family support and good relationship with coaches (Zhou et al., 2018; Cooper et al., 2018). Mental resilience is associated with self-awareness (Drinkwater et al., 2018; Kuettel and Larsen, 2019; Russell et al., 2019; Bean et al., 2019; Sullivan et al., 2021). Awareness, a key constituent of mindfulness, is increased by an individual's bare attention focusing on a definite thing (Gouttebarga et al., 2018). The constant self-awareness holding thoughts of mind power can make or break the athletes' efforts (Rensburg and Ogujiuba, 2020).

Mental toughness is the possession of psychological skills that empower a person to better resolve many demands throughout life while enduring more purposeful, intent, confident, and managerial under pressure (Crawford et al., 2021). It enables the person to constantly gain the goal of success that possesses the commitment to be the critical outcome of mental resilience (Gucciardi et al., 2008, as cited in Whitton et al., 2020). It is a state-like psychological property with purposeful, adjustable and productive natures for performing and retaining goal-oriented objectives (NCAA Division I Collegiate Coach p-8 as cited in Weinberg et al., 2020). It resides at the core of handling pressure caused by competitive competition. If the pressure is not effectively approached, the pressure can erode an individual's expected goals (Rensburg and Ogujiuba, 2020). Perfectionism, resilience and goal orientation are the critical elements of mental toughness to overcome pain while the competition pressure is high (Whitton et al., 2020). In addition, anger, love, inspiration, and awareness increase within-person mental resilience (Cooper et al., 2018). These factors can be supported to improve and maintain mental resilience by coach, parental involvement, governmental involvement and sports psychologist perspective (Anthony et al., 2017; Hussey et al., 2019; Jones, 2018; Jewett et al., 2018; Ramos et al., 2021; Schulenkorfa and Siefken, 2018; Weinberg et al., 2020; Whitton et al., 2020).

To conclude, firstly, athletes' mental resilience comprised of emotional experiences and mental powers can be encouraged or boosted by multiple stakeholders such as coaches, parents, government and sports psychologists towards sustainable achievements (Gorzynski et al., 2020; Henriksen et al., 2020; Hilliard et al., 2020; Murray et al., 2020; Tran, 2015). Meanwhile, the coach's role in building the mental toughness of athletes is tremendously critical; four themes are identified: the relationship between coach and athlete, coaching theory, training circumstance and strategies, and negative experience and influence (Weinberg et al., 2016). Sports environment involving insulting behaviors, toxic cultures and weak mental health knowledge in which sports trainers ignore athletes' mental conditions can severely hamper athletes' performance (Henriksen et al., 2020). Furthermore, Jones (2018) reveals that parents' support makes the athletes happy and motivated. Family support plays a paramount role in functional-pleasant emotional reactions (Cooper et al., 2018). Besides, young athletes show they're willing to find assistance for personal cases from coaches, family and friends (Hilliard et al., 2020; Murray et al., 2020). However, lacking support and discouragement from them severely interrupt the mental resilience of athletes (Cover et al., 2018; Hussey et al., 2019; Ward and

Clair-Thompson, 2018). At the macro level, sport and health development, government and policymakers are considered major bodies for designing productive frameworks (Schulenkorfa and Siefken, 2018). Government grants funding for national sports development and enacts sports policies to be adhered to by all stakeholders (McGuine et al., 2021; Schulenkorfa and Siefken, 2018). However, cutting budgets or inadequate funding also interrupt the motivation of sports personnel, especially coaches and athletes (Wainwright, 2021). Despite a variety of researches in line with coaching, parental and governmental involvement in existing literature, the role of sport psychologist in mental toughness seems to have ignored (Weinberg et al., 2016). Their review reveals that coaches should be determined to educate themselves and their knowledge should be delivered to athletes and staffs to reflect on what they got from different experiences and knowledge.

Secondly, sports psychiatrists should portray the main role in designing and evaluating mental health education (Gorzynski et al., 2020). A diverse group of experts (stakeholders including sport psychologists) can mitigate stigma to address personnel, cultural and environmental aspects which impact on athletes' mental well-being (Henriksen et al., 2020) despite requiring good collaboration in a wide range of different cultural or professional perspectives (Gorzynski et al., 2020).

Thirdly, existing literature identifies the antecedents of the mental toughness of athletes and the ways how to encourage mental resilience through stakeholder involvement. It is perceived that the factors, namely perfectionism, resilience, goal orientation, anger, love, inspiration and self-awareness, are impacted by the stakeholders such as coach, parental involvement, governmental involvement and sports psychologist perspective. However, there are positive and negative impacts on them. Therefore, the authors proposed Figure 11, which points out the influences of stakeholder involvement on antecedents of the mental toughness of athletes.

The above-mentioned review on mental toughness is from 2015 to 2021 (Figures 12a, b, c and d), and their research subjects are selected in their regions. Studies from the USA and UK are most demanding, such as 37% and 23%, followed by Canada (12%), Australia (11%) and 17% (Sweden, Denmark, Italy, Netherlands, South Africa and Estonia). Types of research include 48% quantitative, 46% qualitative and 6% review papers. 31% of total studies is collected in 2018, followed by 26% in 2020, 14% in 2019, and 3% in 2016. Articles are selected from six databases such as Taylor & Francis (57%), Emerald Insight (14%), Elsevier (11%), Sage (6%), John Wiley & Sons (3%), Springer (3%) and National Athletic Trainers' Association (USA) (6%).

4.2. Other methods in helping emotional regulation of athletes

It seems that the twisties of athletes have a lot to do with the cause of PTSD, so the principle of treatment should still focus on PTSD.

PTSD patient rate is growing around the globe annually. Table 1 shows the rate of PTSD population with countries. 1 in 3 veterans around the world faces PTSD (Worrier WOD, 2022). It effects approximately 3.5 % of the American population every year (Lynch, 2021). 1 in 11 people



Figure 11. The influences of stakeholder involvement on antecedents of the mental toughness of athletes.

suffer it throughout their lifetime and female is twice than male to experience it (Torres, 2020) because less or no income in households might impact this perspective (Kumar et al., 2007 as cited in Pillai et al., 2016). In Australia, about 13.3% of people suffer from it in the life period (Nasir et al., 2021). In Japan, 0.4%–0.7% of the population experience it (Kageyama and Solomon, 2018). In China, it is ranged from 6.4% to 7.8% in general population (Zhou et al., 2021). In Canada, the prevalence rate in general population is estimated as 9.2% (Ameringen et al., 2008). In the UK, the rate is between 4 to 5% (Reuters, 2018). In Germany, it is from 1% to 3%. Despite not having an accurate estimate, 1 in 8 elite athletes might have it in the U.S. (Lynch, 2021). In some athlete population, it might be occurred between 13% and 25% (Aron et al., 2019).

Menke and Germany (2018) and Atkinson (2019) stated that the negative consequences of traumatic events could lead to suicidal ideation and behaviors associated with psycho-emotional pains. Thus, mental health professionals or sports psychologists play important roles in sports clubs so that the athletes can benefit from their assistance to take precautions or prevent mental disorders such as PTSD (Menke and Germany, 2018).

When approaching to cure the PTSD symptoms either athlete or non-athlete, the psychologist or clinician will have to use their experience and choose the appropriate existing treatments (Conidi, 2020). In the clinical phase, a psychiatrist usually switches to different medications based on the patient's response, tolerability and other conditions of slow or fast metabolism of the intended medication (Schrader and Ross, 2021). Pharmacological treatment using Selective Serotonin Reuptake Inhibitors-SSRIs and psychological interventions (debriefing, group therapy, cognitive behavior therapy and school/community-based interventions) are the most common treatments for PTSD. SSRIs is a well-known therapy for PTSD (Grasser and Javanbakht, 2019; Parise et al., 2001). Paroxetine and sertraline, which can be used in SSRIs, are the only two drugs approved by FDA for PTSD treatment (Nøhr et al., 2021). In addition to pharmacological therapy, psychological treatments also play a crucial role in PTSD and can be divided into psychotherapeutic and psychoeducational (CPG, 2017). The former involves trauma-focused cognitive-behavioral therapy (TF-CBT), exposure therapy, cognitive processing therapy (CPT) and eye moment desensitization and reprocessing (EMDR) therapy (Bisson et al., 2007; Forman-Hoffman

Table 1. Rate of PTSD patient population with countries.

Country	Percent of PTSD Population
US	3.5%
Canada	9.2%
UK	4–5%
Australia	13.3%
Japan	0.4–0.7%
China	6.4–7.8%

et al., 2018; American Psychological Association, 2017). The latter refers to the treatment from the educational perspective. The clinician needs to disclose information to patients with realistic hopes, such as returning to exercise, re-injury probability or knowledge about avoiding re-injury, considering their needs for exercise and rehabilitation (Whittaker and Roos, 2019). Regarding knowledge worthiness, Aron et al. (2019) indicated that sports club officials could not access information about trauma-related mental chaos of athletes if athletes do not routinely examine mental disorders while it is a common problem among them. Figure 13 summarizes the cause and effect between trauma events and PTSD in accordance with the literature review mentioned-above.

4.2.1. Interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR

Caputo (2019) explains that the range of wrong attention (maybe too wide or too narrow caused by oversteering via focusing on the object consistently) being affected by psychological factors may lead to incorrect interpretation of the environmental information and thus cause the human brain thus causing hallucinations. The error illusion content discussed by Caputo (2019) includes: (1) Changes in the shape of facial features; (2) Lifeless faces, similar to the experience of the soul leaving the body; (3) False hallucinations: the interpretation of idealized faces and personalities rather than the real face of the other party-involving dissociative phenomena. (4) Illusion related to depersonalization; (5) Identity dissociation.

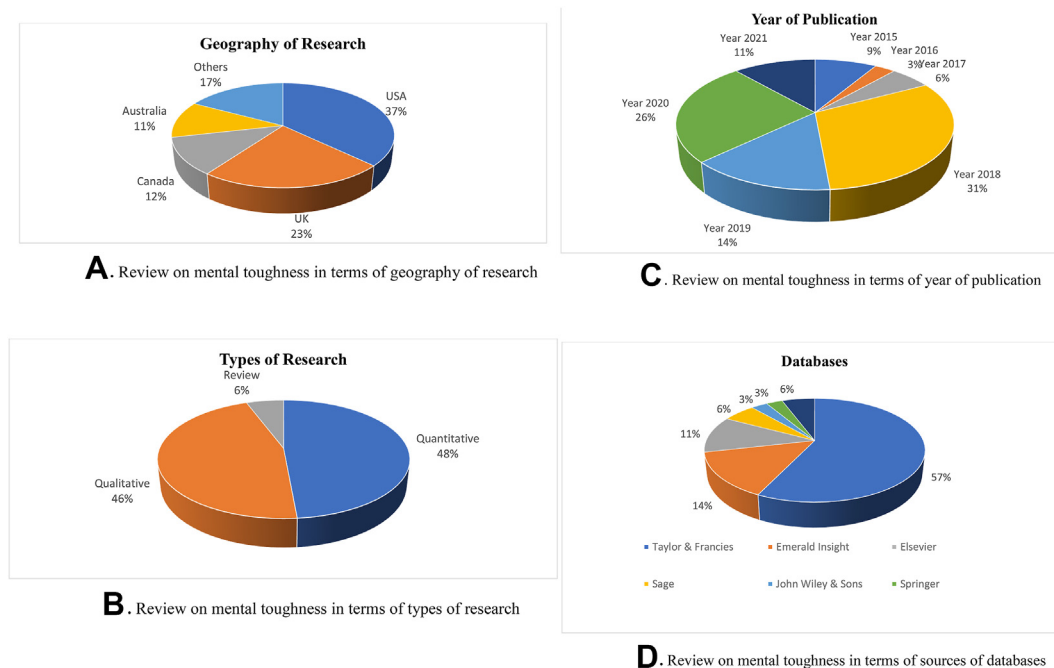


Figure 12. a. Review on mental toughness in terms of geography of research. b. Review on mental toughness in terms of types of research. c. Review on mental toughness in terms of year of publication. d. Review on mental toughness in terms of sources of databases.

Colic et al. (2020) suggested interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR.

4.2.2. Monitoring on Athlete's HRV test results to ensure the Athlete's ability to resist pressure

HRV (heart rate variability) is a measurement utilizing the interval between heartbeats to produce very small changes. The HRV measurement result is that heart rate variability is not arrhythmia, but the human body relies on coping with external stressors such as various changes inside and outside the body - emotions, physical uncomfortableness, spicy food, and the like are all possible sources causing the variables of the heart rate. The interval between heartbeats thus produces very slight changes, which are heart rate variability and can be used indirectly for understanding the variability state of the autonomic nervous system. Autonomic nervous system disorders are not conducive to stress management and emotional regulation. HRV can test them out. And the above section's review indicated that athletes' DDD might come from autonomic disorders. Usually, patients diagnosed with autonomic nervous system disorders tend to have symptoms of inexplicable discomfort in various parts of the body and various psychological problems such as anxiety, depression, inattention, and memory loss. For example, Dziembowska et al. (2016) used the autonomic nerve symptom viewpoint to measure the effect of heart rate variability biofeedback training to explain how to conduct emotional regulation for athletes. Dziembowska et al. (2016) showed that athletes with better self-control ability to receive biological feedback training and good autonomic nervous system flexibility tend to have more flexibility in stress management. In short, if the HRV test results of the athletes show that the autonomic nervous function of the athletes has problems, the coaching team can check the athletes' perceived stress source and levels and thus formulate regulation strategies, such as daily routine activities and sleep quality, intake food materials, even though mindfulness activities and mediation, in order to intervene and relieve the stress of athletes and improve athletes resistance level, be concentrate, not be affected by external interference, and appropriately resist pressure to compete (Gruzelier et al., 2014).

4.2.3. Avoid organizational stressors

Wu et al. (2021) tested the relationships among organizational stressors, competitive trait anxiety, and burnout symptoms in athletes and came out with the results indicating that organizational stressors can

indirectly cause athletes to have high levels of competitive trait anxiety, which may lead to job burnout. However, the indirect impact of organizational stressors on athletes' burnout through competitive trait anxiety is weaker for athletes with higher levels of psychological flexibility. That is to say: (1) The source of stress given by the organization or say the team does cause exhaust and burnout symptoms, which indirectly leads to anxiety of athletes. (2) The different levels of competitive trait anxiety of athletes show the different levels of stress resistance of athletes, and (3) The anti-stress intervention of athletes is important: normal anti-stress training can avoid various sources of stress for athletes. It is necessary to train athletes' stress resistance and psychological regulation capability to quickly adapt to various stressors from organizations, coaches, peer competition, and so on. In short, an athlete's burnout experience examination is often directed to organizations (team coach, guidance, and other relevant professionals) that should develop effective emotion regulation strategies to prevent or reduce athletes' burnout levels of negative emotions and promote athletes' stress resistance, and cause fatigue of athletes.

Also, the climate during training can be paid attention with. Ruiz et al. (2019) used a special research method to test three variables: motivational climate, motivation regulations, emotional states, before and after training changes within a few months, and then emphasized created and controlled motivational climate by the coach in order to help athletes in coping stress.

4.2.4. WED: Written Emotional Disclosure method

Beginning in 2019, the negative impact of COVID-19 on the mental health of athletes has also been discussed. The negative impact on mental health usually leads to depression and anxiety symptoms; COVID-19 is a stressor. Davis et al. (2019) indicated that interrupting the contests' schedule can cause emotional distress for athletes. There are also some regulations about quarantine, reduction of income, delays in the schedule, and the unsealing time of unblocking the city because of the loss of teammates. The face-to-face social and emotional support from the coach can make athletes feel mentally troubled. Davis et al. (2019) introduced WED (Written Emotional Disclosure) as a means of emotional processing for athletes during the COVID-19 pandemic. WED has been supporting the emotional processing of athletes during injury recovery and had some good effects. Davis et al. (2019) also provided evidence to support the effectiveness of WED as a valid emotional regulation method in treating the negative psychological issues brought by covid-19.

4.2.5. Improve various support systems for athletes: dual career paths

The dual career path is a career path system and incentive mechanism designed to provide professional and technical personnel in the organization with equal status, remuneration and more career development opportunities. The dual career path mechanism aims to let people who take the professional path have equal development opportunities and levels with others during the development of their careers. Davis et al. (2019) collected data on athletes and then interviewed coaches to explore the positive impact of the dual career path on the experience of skiers and athletes, including psychological, social and economic benefits. Research has found that coaches use training diaries and ongoing communication to teach athletes to train self-awareness and regulation strategies - through continuous communication and a rise in athletes' perceptual awareness - athletes can improve their stress resistance capabilities and optimize the quality of athletes training performance - less stress with higher performance at the end.

4.2.6. Athletes' Stressful Awareness about the impact of gender, seniority, and environment

Italy is one of the countries most affected by the COVID-19 crisis, di Fronso et al. (2020) examined Italian athletes who performed during the COVID-19 crisis and had dysfunctional psychosocial states before and after covid, as well as the level changes upon the variables of gender and performance. di Fronso's et al. (2020) research results indicated that female athletes seem to be more sensitive to external pressure than men;

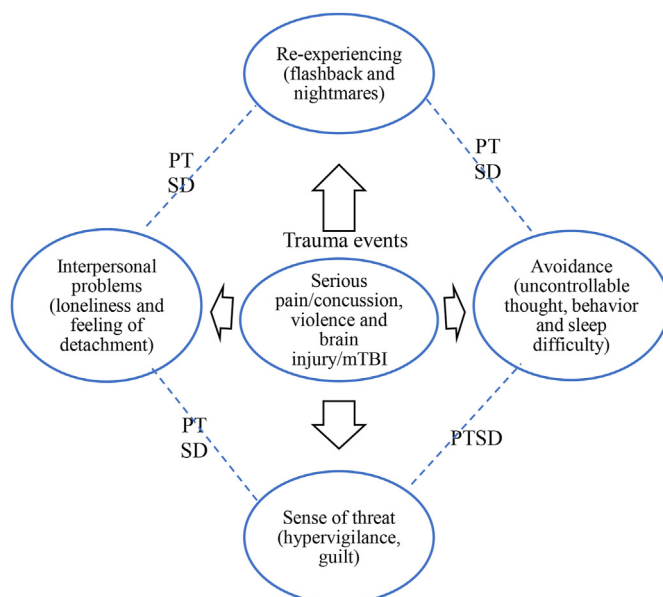


Figure 13. Cause and effects between Trauma events and PTSD

novice athletes are more sensitive to external pressure than senior athletes.

5. Conclusion

Although there are many treatment methods for DDD, the stressor sources of athletes' DDD and ordinary people are quite different. Therefore, traditional DDD treatments may not apply to athletes. This is why the authors of this study have done a special analysis of athletes' stressor sources in this study. According to literature review results, we understand that twisties could be a type of Depersonalization-derealization disorder resulting from a posttraumatic stress disorder (PTSD) (Edwards and Angus, 1972; Krause-Utz et al., 2017). In Holmes et al. (2005) study, many patients with PTSD experience dissociative symptoms. What treatment should be applied for this symptom? There are a variety of treatments for this phenomenon. Sommer et al. (2013) discussed somatic interventions and psychotherapy (e.g., talk therapy and hypnosis-based treatment) for DDD treatment. In addition, Hypnosis is a therapy by makes sure one's mind is relaxed, and in-depth concentration is developed (Bliss, 1983). Somatic intervention is a technique for dissociation treatment by allowing the one to sense and hinder normal patterns like anxiety, stress and fear, discharging the bodily pressure and related memories, and moving forward in a tranquilizer and centered way (Donatone, 2013). In talk therapy, there are three stages; creating a therapeutic relationship with the patient for comfortability and feeling of safety, processing traumatic memories (main part) using global trauma measures, and constructing an integrated sense of self (Bailey and Brand, 2017). Hollander (2009) introduced Eye Closure, Eye Movements (ECEM), which is adapted from the Eye Movement Desensitization and Reprocessing (EMDR) protocol for utilization in the treatment of depersonalization disorder.

Objective depersonalization is the feeling of detachment from one's body and is associated with feelings of loss of control over one's own body; derealization refers to the altered perception of one's surroundings becoming unreal (Heydrich et al., 2019). In the past, twisties have been few mentioned till the 2020 Olympics. Twisties disorder is detachment from the sense of self (Renaud, 2015) in dissociation accompanied by depersonalization and derealization of athletes. Past studies have suggested that hypnosis can be one of the methods to treat the depersonalization and derealization caused by trauma in the short term (Kluft, 1992; Nash et al., 1984; Giordano et al., 2012). But does hypnosis also apply to athletes' depersonalization and derealization caused by physical and psychological trauma? If twisties are completely caused by psychodynamics, hypnosis may not end and will take long turns. Therefore, this study suggested that it is still necessary to understand the mechanism of athletes' twisties and give formal psychotherapy such as depriving pathogenic value (Gold and Quiñones, 2020; Spiegel and Cardena, 1990).

5.1. Theoretical Implication

The mental disorder "twisties" have not been mentioned in the medical literature (Casiglia and Tikhonoff, 2021), and so does the scant discussion on the depersonalization-derealization symptom (DDS), which is under-researched (Michal et al., 2016). Therefore, through the theoretical dialogue on the symptom of twisties, this study helps promote the development of the research of "twisties." Using the IPO model via triangulation testing purpose, this study categorized the literature to explore input variables causing athletes' twisties and identified process variables in psychological mechanisms bridging suppression, and finally discussed the existing possible ways in helping athletes to solve problems caused by twisties. Except for the previously summarized sources of stressors and possible conceptual framework causing twisties; this study also suggested six propositions for future studies tests, as well as concluded possible programs assisting athletes in twisties as (1) prevention of oversteering via consistent focusing on the object cause wrong attention; (2) focus on Athlete's HRV test results to ensure the enhancement of Athlete's ability to resist the pressure; (3) avoid

organizational stressors: the necessity of intervention for athletes' psychological stress resistance training; (4) WED - Written Emotional Disclosure method; (5) improve various support systems for athletes: dual career paths; (6) awareness about the impact of gender, seniority, and environment; (7) controlled climate during training, and finally the promotion of the athletes' mental toughness level in preventing stress in advance.

5.2. Limitations and suggestions for future studies

In the past literature, there was no way to find the literature that could solve the problem of twisties to help the authors infer why twisties may occur. Although authors of this study had tried to use a more organized literature review structure (i.e., IPO Model, Triangulation Test, and PRISMA Items Checklists) to try to connect the past research results with inferences on the possible antecedents and mechanisms causing athletes twists symptoms, the authors hope that future scholars can assist in developing more experiments in related fields to assist in multiple verifications of the research results deduced in this paper.

The authors aimed to grab scholars' attention in investigating the mental health issues of athletes – taking twisties as an example. There are too few relevant documents; the authors have tried their best to use the IPO model, combing with Triangulation and the PRIMA Items Checklist at the later-on stage, to categorize past research results to let readers have clearer concepts for analysis and understanding; so that readers can more easily obtain the research results of past research effectively and efficiently. The authors believe that relevant dialogue should be augmented in the future, including practical qualitative and quantitative research in interviews, experiments, and questionnaires to athletes. Thus, a more practical and accurate way of solving athletes' psychological stress could be found in future studies.

Throughout the literature, some research gaps are discovered. Research related to athlete PTSD is still lacking (Conidi, 2020). The consequences of victims and bullying among peers or from coaches or institutional boards in sports remain understudied (Lang, 2021). A few studies have investigated the correlation between PTSD headache and cognition (Kwan et al., 2021). Although trauma-related guilt is an important factor, it is still an undeveloped or underexplored construct in understanding PTSD and chronic pain (Hébert et al., 2020). In addition, scholars have received little attention to the institutional context related to behavior in nurturing athletes (Jacobs et al., 2016). Also, Daniel (2014) ever suggested that athletes should use the system I brain system instead of system II so that the cognitive thinking will least intervene in automatic/heuristic thinking function. This is a good phenomenon for exploration and testing in the future.

In short, after the literature review section, the author established a series of propositions to summarize the influential factors triggering twisties. Then, in the conclusion section, the authors used mainly the promotion of the mental toughness method and several other minor methods to illustrate and provide strategies for solving the psychological twisties symptoms of athletes. The first contribution of this study is that, whether it is propositions or strategies to solve twisties, there is too little literature that can support the relevant research. Thus, it is hard to form a systematic review (finding similar kinds of literature in the past to process a consistent comparison). Therefore, the author hopes that future research scholars can propose a further experimental method, meta-analysis method, or quantitative method to repetitively verify the validity of the propositions and solution strategies proposed in this article.

Declarations

Author contribution statement

Guishen Yu: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools and data; Wrote the paper.

Kuei-Feng Chang: Performed the experiments; Contributed reagents, materials, analysis tools and data; Wrote the paper.

I-Tung Shih: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools and data; Wrote the paper.

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Data availability statement

No data was used for the research described in the article.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Appendix A. Concepts of the Preferred Reporting Items for Scoping Reviews of PRISMA-scr Checklist being Applied

No of Items in PRISMA Checklist	PRISMA Item's Concepts Being Applied for Each Section of This Study	Reports on Applications of this study (Yu-01)	Examples (sentences adopted from the content of this study)
1	Title	The title of this study has identified the scope of research.	An Exploration of the Antecedents and Mechanisms Causing Athletes' Stress and Twisties Symptom
2	Structured Abstract	The abstract is revised to be structured abstract.	The structures are: Research Background, Aim, Research Method, Results, and Conclusion.
3	Introduce the rationale for developing this study and paper	In the section of introduction, the authors introduce the rationale for developing this study: How the authors determined that research objectives that address the research question.	In short, stress from twisties, anxiety (Schlax et al., 2020), and worries about coming back from the twisties are double stress on athletes. We can see that since the NCAA's promotion of psychological care for athletes from 2015 to 2016, the psychological problem of athletes is no longer a problem that should be hidden, but a mental health issue that can be publicly inspected, that we all should pay attention to. Therefore, the research of sports psychology has gradually risen.
4	To state the research objective in the section of introduction	To state the research objective in the section of introduction	This also formed the motivation of this research for finding good stress coping methods for athletes. By using a traditional qualitative literature review method combining with the Input-Process-Output Model way of reviewing antecedents of twisties via appealing to the PRISMA Items' checklist, this study aims to explore and categorize influential factors in causing twisties of athletes to help construct models among relevant stress management skills of athletes in conquering stress. This study contributes to summarize stressors causing twisties of athletes, proposes six propositions for the test of future studies, and a conceptual framework on antecedents that cause twisties.
5	Clear description of the legible research methods	A clear description of the legible research methods in the section of introduction and then a detailed description the research methods' concepts in following section 2: 2. Literature review strategy 2.1. Prospective Categorization of literature via IPO model 2.2. Triangulation Test	By using a traditional qualitative literature review method combining with the Input-Process-Output Model way of reviewing antecedents of twisties via appealing to the PRISMA Items' checklist, this study aims to explore and categorize influential factors in causing twisties of athletes to help construct models among relevant stress management skills of athletes in conquering stress.
6	Legitimacy of research methods	To increase the level of legitimacy of the research method, IPO model, triangulation test, and also PRISMA Items Checklist are added in this study.	OK
7	Sources of Information Collected	Except the 3 expertise books, one doctoral thesis, 39 references are mainly from 38 journals: Ann. Clin. Transl. Neurol, Int. J. Event Festiv. Manag., Int. J. Sport Exerc. Psychol., BMC medicine, International Journal of Mental Health Promotion, Am. J. Clin. Hypn., Ann Intern Med, Appl. Psychophysiol. Biofeedback, Biofeedback, Consciousness Cogn., Curr. Psychol., Curr. Psychiatry Rep., Depersonalization. Br. J. Psychiatry, Depress Anxiety, Front. Neurol., Frontiers in psychology, Int. J. Clin. Exp. Hypn, Int. J. Psychophysiol, Int. J. Stress Manag., International Journal of Stress Management, J Clin Psychiatry, J. Affect. Disord, J. Leisure Sports Manag., J. Trauma Dissociation, J. Traumatol, J. Anxiety Disord, J. Clin. Psychol, Journal of Open Innovation: Technology,	OK

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(continued)

No of Items in PRISMA Checklist	PRISMA Item's Concepts Being Applied for Each Section of This Study	Reports on Applications of this study (Yu-01)	Examples (sentences adopted from the content of this study)
		Market, and Complexity, Multisensory Res, Nature, Physical therapy, PLoS, PLoS Medicine, Psychiatric Med., Psychology, Psychosom. Med. Psychother, and Systematic reviews.	
8	Methods of collecting information sources	As the literature on twisties is few, the authors used the IPO model to collect relevant literature for the convenience of identifying the possible mechanism that causes athlete's twisties symptom. Using the IPO models, the authors can (1) search and remove irrelevant articles; (2) identify and screen literature based on the studies' scope, and then finalize the list of studies to be included.	OK
9	In the source of evidence for research methods, the method and logic of data selection	The authors determined the keywords and decide how the data will be excluded and included for the reference list. And finally, 3 books, 32 journal papers for general IPO-structured literature review, and 8 journal papers are adopted as references of this study, (they are all English-written publications), were selected.	Keywords for selection of the information source include 18 terms: anxiety, athletes, athletes' mental toughness, depersonalization, depersonalization-derealization disorder, derealization, dissociative disorders, emotional labor, organizational stressors, PTSD, self-efficacy, sports performance, stress, stress management, stress release, suppression, system 1, twisties.
10	Data charting process for Research Methods	Certain significant variables have graphical & % presentation on the literature review results, as in the past, those variables were less discussed and organized in the literature review on the phenomenon of athletes twisties symptom. For example, section 3.2. Twisties, 3.3. Post-traumatic stress disorder of Athletes (PTSD), 4.1. Promotion of Athletes' Mental Toughness to Resist Stressors, and 4.2. Other methods in helping emotional regulation of athletes were all presented in graphical & percentage ways in order to better integrate the data and offer readers a better and comprehensive description of the segmented information sources collected.	Certain significant variables have graphical & % presentation on the literature review results, as in the past, those variables were less discussed and organized in the literature review on the phenomenon of athletes twisties symptom. For example, section 3.2. Twisties, 3.3. Post-traumatic stress disorder of Athletes (PTSD), 4.1. Promotion of Athletes' Mental Toughness to Resist Stressors, and 4.2. Other methods in helping emotional regulation of athletes were all presented in graphical & percentage ways in order to better integrate the data and offer readers a better and comprehensive description of the segmented information sources collected.
11	Description of the data and samples collected in the research methodology	This study has used PRISMA Items Checklist to comprehensively describe the data and samples collected in the research methodology.	
12	Critical assessment of individual sources of evidence for research methods	As the direct source of evidence to infer twisties symptom for athletes seem not sufficient, traditional literature inference methods seem not sufficient. Therefore, this study used the IPO model to collect relevant literature for the convenience of identifying the possible mechanism that causes athlete's twisties symptom. Using the IPO models, the authors can (1) search and remove irrelevant articles; (2) identify and screen literature based on the studies' scope, and then finalize the list of studies to be included.	OK
13	Synthesis of research results in the section of research method	The purpose of this research is to summarize the founded antecedent variables and mechanisms that influence and cause athletes' twisties symptom. Therefore, section 3, Analysis, via literature review for inferences, is to summarize the antecedent variables and mechanism causing athletes' twisties symptom, which was integrated to become six contributive theoretical propositions, and a conceptual framework on antecedents that cause twisties for future studies at the end of the section. The section 4, Discussion, aims to discuss the possible solutions for solving athletes' twisties symptoms according to the evidences gathered in section 3, and come up with Figure 10, which present the structure of the solutions being presented, including 4.1 Promotion of Athletes' Mental Toughness to Resist Stressors, 4.2. Other methods in helping the emotional regulation of athletes.	
14	Selection of sources of evidence collected in research findings	Using traditional literature inference methods, this study gathers the literature and categorized the segmented and distinguished data sources according to the literature's characteristics in terms of causality, contextual and other concepts, so that sources of individual evidence that present strong logic in connection to literature are transformed into 6 propositions as the research findings in the first state, which help form a more accurate, comprehensive and even more complicated interpretation of research findings.	

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No of Items in PRISMA Checklist	PRISMA Item's Concepts Being Applied for Each Section of This Study	Reports on Applications of this study (Yu-01)	Examples (sentences adopted from the content of this study)
15	Characteristics of the sources of evidence gathered in the findings of the study	Analysis on the references characteristics of this study includes: 3 books, 1 doctor thesis, 31 journal papers for general IPO-structured literature review, and 8 journal papers are adopted as references of this study. They are all English-written publications. Keywords for selection of the information source include 18 terms: anxiety, athletes, athletes' mental toughness, depersonalization, depersonalization-derealization disorder, derealization, dissociative disorders, emotional labor, organizational stressors, PTSD, self-efficacy, sports performance, stress, stress management, stress release, suppression, system 1, twisties.	Except the 3 expertise books, one doctoral thesis, 39 references are mainly from 38 journals: Ann. Clin. Transl. Neurol, Int. J. Event Festiv. Manag., Int. J. Sport Exerc. Psychol., BMC medicine, International Journal of Mental Health Promotion, Am. J. Clin. Hyp., Ann Intern Med, Appl. Psychophysiol. Biofeedback, Biofeedback, Consciousness Cogn., Curr. Psychol., Curr. Psychiatry Rep., Depersonalization. Br. J. Psychiatry, Depress Anxiety, Front. Neurol., Frontiers in psychology, Int. J. Clin. Exp. Hypn, Int. J. Psychophysiol, Int. J. Stress Manag., International Journal of Stress Management, J Clin Psychiatry, J. Affect. Disord, J. Leisure Sports Manag., J. Trauma Dissociation, J. Traumatol, J. Anxiety Disord, J. Clin. Psychol, Journal of Open Innovation: Technology, Market, and Complexity, Multisensory Res, Nature, Physical therapy, PLoS, PLoS Medicine, Psychiatric Med., Psychology, Psychosom. Med. Psychother, and Systematic reviews.
16	A critical assessment of the characteristics of the research findings with respect to the sources of evidence gathered.	Except for 8 journal papers referred for PRISMA items, 31 journal papers were referred specifically for the development of the propositions and suggestions of the solutions are the end of the study. However, from the link of the topics/literature showing up in different sections, we can see that one theoretical variable has been extensively discussed among different sections, or say, connections between literature reviews for development were clearly constructed.	For example, Cox et al. (2002) discussion on the topic of depersonalization has been shown in the section of 3.1. Suppression and sources of stress of athletes/3.5. Proposition Development and conceptual framework of this study. Michal et al. (2009) discussion on the topic of depersonalization-derealization disorder has been shown in the section of 1. Introduction/3.1. Suppression and sources of stress of athletes/3.2. Twisties/3.5. Proposition Development and conceptual framework of this study/5.1. Theoretical Implication. Casiglia et al. (2012) discussion on the topic of depersonalization-derealization disorder has been shown in the section of 3.4. DDD (Depersonalization-derealization disorder)/5.1. Theoretical Implication, and the like.
17	Sources of individual evidence for research findings	Using traditional literature inference methods, this study gathers the literature and categorized the segmented and distinguished data sources according to the literature's characteristics in terms of causality, contextual and other concepts, so that sources of individual evidence that present strong logic in connection to literature are transformed into 6 propositions as the research findings in the first state, which help form a more accurate, comprehensive and even more complicated interpretation of research findings.	
18	Comprehensive Interpretation of Research Results	To have a better comprehensive Interpretation of the Research results, the authors used listed propositions, a conceptual framework, and organized tables containing suggestions of the solutions to let readers easily illustrate and visualize the evidence being collected, organized, and presented.	For example, the authors, based on the research scope of this study, in section 3, Analysis, transfer the research results (stage 1) into six contributive theoretical propositions and a conceptual framework on antecedents that cause twisties for future studies at the end of the section. And in Section 4, Discussion, the authors discuss the possible solutions, including 4.1 Promotion of Athletes' Mental Toughness to Resist Stressors, 4.2. Other methods in helping the emotional regulation of athletes are as follows.
19	In the discussion paragraph, summarize and discuss the evidence gathered in this study	The purpose of this research is to summarize the founded antecedent variables and mechanisms that influence and cause athletes' twisties symptom. Therefore, section 3, Analysis, via literature review for inferences, is to summarize the antecedent variables and mechanism causing athletes' twisties symptom, which was integrated to become six contributive theoretical propositions, and a conceptual framework on antecedents that cause twisties for future studies at the end of the section. The section 4, Discussion, aims to discuss the possible solutions for solving athletes' twisties symptoms according to the evidences gathered in section 3, and come up with Figure 10, which present the structure of the solutions being presented, including 4.1 Promotion of Athletes' Mental Toughness to Resist Stressors, 4.2. Other methods in helping the emotional regulation of athletes.	For example, 4.2.1 Interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR 4.2.2 Monitoring on Athlete's HRV test results to ensure the Athlete's ability to resist pressure 4.2.3. Avoid organizational stressors 4.2.4. WED: Written Emotional Disclosure method 4.2.5. Improve various support systems for athletes: dual career paths 4.2.6. Athletes' Stressful Awareness about the impact of gender, seniority, and environment
20	Explain the limitations of the study	Explain the limitations of the study was well made to indicate that this study's limitation at 5.2. Limitations and suggestions for future studies.	For example, At 5.2. Limitations and suggestions for future studies, this study indicated that: The authors believe that relevant dialogue should be augmented in the future,

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No of Items in PRISMA Checklist	PRISMA Item's Concepts Being Applied for Each Section of This Study	Reports on Applications of this study (Yu-01)	Examples (sentences adopted from the content of this study)
			including practical qualitative and quantitative research in interviews, experiments, and questionnaires to athletes. Thus, a more practical and accurate way of solving athletes' psychological stress could be found in future studies. Throughout the literature, some research gaps are discovered. Research related to athlete PTSD is still lacking (Conidi, 2020). The consequences of victims and bullying among peers or from coaches or institutional boards in sports remain understudied (Lang, 2021). A few studies have investigated the correlation between PTSD headache and cognition (Kwan et al., 2021). Although trauma-related guilt is an important factor, it is still an undeveloped or underexplored construct in understanding PTSD and chronic pain (Hébert et al., 2020). In addition, scholars have received little attention to the institutional context related to behavior in nurturing athletes (Jacobs et al., 2016). Also, Daniel (2014) ever suggested that athletes should use the system I brain system instead of system II so that the cognitive thinking will least intervene in automatic/heuristic thinking function. This is a good phenomenon for exploration and testing in the future.
21	Conclusion of this study	Conclusion of this study has been organized to include a short discussion on the comprehensive explanation about the general and practical contribution of this study at the beginning of the 5. Conclusion section, following with 5.1. Theoretical Implication and 5.2. Limitations and suggestions for future studies.	OK

Referred Source: Adopted and Updated according to: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA ScR): Checklist and Explanation. *Ann Intern Med.* 2018; 169:467–473. <https://doi.org/10.7326/M18-0850>.

Appendix B. Analysis of the References Characteristics of this Study

No.	References	Type of Publication	Language	Publication Year	Name of the Journal	Keywords	Sections cited this reference
1	Edwards, J. G. and Angus, J. W. (1972). Depersonalization. <i>Br. J. Psychiatry</i> , 120: 242–244. https://doi.org/10.1192/bjp.120.555.242	Journal	English	1972	<i>Depersonalization. Br. J. Psychiatry</i>	Depersonalization	5. Conclusion
2	Spiegel, D. and Cardena, E. (1990). New uses of hypnosis in the treatment of posttraumatic stress disorder. <i>J. Clin. Psychiatry</i> .	Journal	English	1990	<i>J Clin Psychiatry</i>	PTSD/stress	5. Conclusion
3	Kluft, R. P. (1992). The use of hypnosis with dissociative disorders. <i>Psychiatric Med.</i> 10: 31–46.	Journal	English	1992	<i>Psychiatric Med.</i>	dissociative disorders	5. Conclusion
4	Cox, B. J. and Swinson, R. P. (2002). Instrument to assess depersonalization-derealization in panic disorder. <i>Depress Anxiety</i> 15, 4: 172–175. https://doi.org/10.1002/da.10051	Journal	English	2002	<i>Depress Anxiety</i>	depersonalization	3.1. Suppression and sources of stress of athletes/3.5. Proposition Development and conceptual framework of this study
5	Lagos, L., Vaschillo, E., Vaschillo, B., Lehrer, P., Bates, M., & Pandina, R., (2008). Heart rate variability biofeedback as a strategy for dealing with competitive anxiety: A case study. <i>Biofeedback</i> , 36(3), 109.	Journal	English	2008	<i>Biofeedback</i>	anxiety	1. Introduction
6	Michal, M., Beutel, M. E. (2009). Depersonalisation/Derealisation-Krankheitsbild, Diagnostik und Therapie [Depersonalisation/derealization - clinical picture, diagnostics and therapy].	Journal	English	2009	<i>Psychosom. Med. Psychother</i>	Depersonalization-derealization disorder	1. Introduction/3.1. Suppression and sources of stress of athletes/3.2. Twisties/3.5. Proposition Development and conceptual framework of this study/5.1. Theoretical Implication

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No.	References	Type of Publication	Language	Publication Year	Name of the Journal	Keywords	Sections cited this reference
	<i>Z. Psychosom. Med. Psychother.</i> 55:113–40. German. https://doi.org/10.13109/zptm.2009.55.2.113						
7	Shih, H.-C. (2009). The Study on the Job Characteristics of Emotional Labor and Responding Strategies of Employee: Explained by an IPO Model. [doctoral thesis]. [Yuntech, (Taiwan)]: National Yunlin University of Science and Technology	Journal	English	2009	<i>doctoral thesis</i>	Emotional Labor/organizational stressors	2.1. Prospective Categorization of literature via IPO model/3.1. Suppression and sources of stress of athletes
8	Casiglia, E., Tikhonoff, V., Giordano, N., Regaldo, G., Facco, E., Marchetti, P., Schiff, S. et al. (2012). Relaxation versus fractionation as hypnotic deepening: Do they differ in physiological changes? <i>Int. J. Clin. Exp. Hypn.</i> 60, 3: 338–355. https://doi.org/10.1080/00207144.2012.675297	Journal	English	2012	<i>Int. J. Clin. Exp. Hypn</i>	Depersonalization-derealization disorder	3.4. DDD (Depersonalization-derealization disorder)/5.1. Theoretical Implication
9	Gruzelier, J. H., Thompson, T., Redding, E., Brandt, R., and Steffert, T. (2014). Application of alpha/theta neurofeedback and heart rate variability training to young contemporary dancers: State anxiety and creativity. <i>Int. J. Psychophysiol.</i> 93: 105–11. https://doi.org/10.1016/j.ijpsycho.2013.05.004	Journal	English	2014	<i>Int. J. Psychophysiol</i>	Stress release/anxiety/athletes	4.2.2. Monitoring on Athlete's HRV test results to ensure the Athlete's ability to resist pressure
10	Flinchbaugh, C., Luth, M. T., and Li, P. (2015). A challenge or a hindrance? Understanding the effects of stressors and thriving on life satisfaction. <i>Int. J. Stress Manag.</i> 22: 323–345. https://doi.org/10.1037/a0039136	Journal	English	2015	<i>Int. J. Stress Manag.</i>	Stress management	3.1. Suppression and sources of stress of athletes
11	Renaud, K. J. (2015). Vestibular function and depersonalization/derealization symptoms. <i>Multisensory Res.</i> 28: 637–651. https://doi.org/10.1163/22134808-00002480	Journal	English	2015	<i>Multisensory Res</i>	Depersonalization-derealization disorder	3.2. Twisties/3.4. DDD (Depersonalization-derealization disorder)/5. Conclusion
12	Yang, R., Yi, F., Tsai, C., 2015. The impact of mental skills training on sports performance. <i>J. Leisure Sports Manag.</i> 1, 8–19.	Journal	English	2015	<i>J. Leisure Sports Manag.</i>	Athletes' Mental Toughness/sports performance.	1. Introduction
13	Dziembowska, I., Izdebski, P., Rasmus, A., Brudny, J., Grzelczak, M., and Cysewski, P. (2016). Effects of heart rate variability biofeedback on EEG alpha asymmetry and anxiety symptoms in male athletes: A pilot study. <i>Appl. Psychophysiol. Biofeedback</i> , 41, 2: 141–150. doi: 10.1007/s10484-015-9319-4	Journal	English	2016	<i>Appl. Psychophysiol. Biofeedback</i>	Stress release/anxiety/athletes	4.2.2. Monitoring on Athlete's HRV test results to ensure the Athlete's ability to resist pressure
14	Gerich, J. (2017). The relevance of challenge and hindrance appraisals of working conditions for employees' health. <i>Int. J. Stress Manag.</i> 24: 270–292. https://doi.org/10.1037/s107000038	Journal	English	2017	<i>International Journal of Stress Management</i>	Stress management/Suppression/athletes	3.1. Suppression and sources of stress of athletes
15	Peper, E., & Aita, J., (2017) Winning the Gold in Weightlifting Using Biofeedback, Imagery, and Cognitive Change. <i>Biofeedback</i> , 45(4), 77–82.	Journal	English	2017	<i>Biofeedback</i>		1. Introduction
16	Krause-Utz, A., Frost, R., Winte, D., Bernet, M., and Elzinga, B. M. (2017). Dissociation and Alterations in Brain Function and Structure: Implications for Borderline Personality Disorder. <i>Curr. Psychiatry Rep.</i> 19: 6–27. https://doi.org/10.1007/s11920-017-0757-y	Journal	English	2017	<i>Curr. Psychiatry Rep.</i>	dissociative disorders	5. Conclusion

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No.	References	Type of Publication	Language	Publication Year	Name of the Journal	Keywords	Sections cited this reference
17	Dewe, H., Watson, D. G., Kessler, K., and Braithwaite, J. J. (2018). The depersonalized brain: New evidence supporting a distinction between depersonalization and derealization from discrete patterns of autonomic suppression observed in a non-clinical sample. <i>Consciousness Cogn.</i> 63:29–46. https://doi.org/10.1016/j.concog.2018.06.008	Journal	English	2018	<i>Consciousness Cogn.</i>	Suppression/derealization	3.1. Suppression and sources of stress of athletes
18	Zhou, R., Kaplanidou, K., Papadimitriou, D., Theodorakis, N. D., Alexandris, K., 2018. Understanding the inspiration among active participants in sport events. <i>Int. J. Event Festiv. Manag.</i> 9, 332–348.	Journal	English	2018	<i>Int. J. Event Festiv. Manag.</i>	Athletes' Mental Toughness/stress	4.1. Promotion of Athletes' Mental Toughness to Resist Stressors
19	Caputo, G. B. (2019). Strange-face illusions during eye-to-eye gazing in dyads: specific effects on derealization, depersonalization and dissociative identity. <i>J. Trauma Dissociation</i> , 20, 4: 420–444. https://doi.org/10.1080/15299732.2019.1597807	Journal	English	2019	<i>J. Trauma Dissociation</i>	derealization, depersonalization	4.2.1 Interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR
20	Davis, P., Halvarsson, A., Lundström, W., and Lundqvist, C. (2019). Alpine Ski Coaches' and Athletes' Perceptions of Factors Influencing Adaptation to Stress in the Classroom and on the Slopes. <i>Front. Psychol.</i> 10, 1–12. https://doi.org/10.3389/fpsyg.2019.01641	Journal	English	2019	<i>Frontiers in psychology</i>	Stress release/athletes	4.2.4. WED: Written Emotional Disclosure method/4.2.5. Improve various support systems for athletes: dual career paths
21	Heydrich, L., Marillier, G., Evans, N., Seeck, M., and Blanke, O. (2019). Depersonalization and Derealization-Like Phenomena of Epileptic Origin. <i>Ann. Clin. Transl. Neurol.</i> 6: 1739–1747. https://doi.org/10.1002/acn3.50870	Journal	English	2019	<i>Ann. Clin. Transl. Neurol.</i>	Depersonalization-derealization disorder	3.2. Twisties/3.5. Proposition Development and conceptual framework of this study/5. Conclusion
22	Ruiz, M.C., Robazza, C., Tolvanen, A., Haapanen, S., Duda, J.L., 2019. Coach-Created Motivational Climate and Athletes' Adaptation to Psychological Stress: Temporal Motivation-Emotion Interplay. <i>Front. Psychol.</i> 10, 617. https://doi.org/10.3389/fpsyg.2019.00617	Journal	English	2019	<i>Frontiers in psychology</i>	Stress release/anxiety/athletes	4.2.3. Avoid organizational stressors
23	Toupet, M., Van Neche, C., Hautefort, C., Heuschen, S., Duquesne, U., Cassoulet, A., and Grayeli, A. B. (2019). Influence of Visual and Vestibular Hypersensitivity on Derealization and Depersonalization in Chronic Dizziness. <i>Front. Neurol.</i> 10. https://doi.org/10.3389/fneur.2019.00069	Journal	English	2019	<i>Front. Neurol.</i>	Depersonalization-derealization disorder	3.4. DDD (Depersonalization-derealization disorder)
24	Colic, J., Bassett, T. R., Latysheva, A., Imboden, C., Bader, K., Hatzinger, M., Mikoteit, T., Lieb, R., Gloster, A.T., and Hoyer, J. (2020). Depersonalization and derealization in embarrassing social interactions: an experience sampling study in social phobia, major depression and controls. <i>J. Anxiety Disord.</i> 70, (102189). https://doi.org/10.1016/j.janxdis.2020.102189	Journal	English	2020	<i>J. Anxiety Disord</i>	Depersonalization-derealization disorder	1. Introduction/4.2.1 Interventions that correct for cognitive misinterpretations and appropriate relaxation and mindfulness practice in correcting a range of attention might reduce DP/DR
25	di Fronso, S., Costa, S., Montesano, C., Di Gruttola, F., Ciofi, E. G., Morgilli, L., Robazza, C., and Bertollo, M. (2020). The effects of COVID-19 pandemic on perceived stress and	Journal	English	2020	<i>Int. J. Sport Exerc. Psychol.</i>	Stress release/athletes	4.2.6. Athletes' Stressful Awareness about the impact of gender, seniority, and environment

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No.	References	Type of Publication	Language	Publication Year	Name of the Journal	Keywords	Sections cited this reference
	psychosocial states in Italian athletes. <i>Int. J. Sport Exerc. Psychol.</i> 1–13. https://doi.org/10.1080/1612197X.2020.1802612						
26	Gold, S. N. and Quiñones, M. (2020). Applicability of hypnosis to the treatment of Complex PTSD and dissociation. <i>Am. J. Clin. Hyp.</i> 63: 78–94.	Journal	English	2020	<i>Am. J. Clin. Hyp.</i>	PTSD	3.2. Twisties/5. Conclusion
27	Schlax, J., Wiltink, J., Beutel, M. E., Münzel, T., Pfeiffer, N., Wild, P., Blettner, M., Kerahrodi, J. G., and Michal, M. (2020). Symptoms of depersonalization/derealization are independent risk factors for the development or persistence of psychological distress in the general population: Results from the Gutenberg health study. <i>J. Affect. Disord.</i> 273: 41–47. https://doi.org/10.1016/j.jad.2020.04.018	Journal	English	2020	<i>J. Affect. Disord</i>	Depersonalization-derealization disorder	1. Introduction/3.4. DDD (Depersonalization-derealization disorder)
28	Casiglia, E. and Tikhonoff, V. (2021). “Twisties” and Olympic Games: A Role for Hypnosis in Top-Level Athletes Who Have Lost the Sense of the Self in Aerial Space? <i>Psychology</i> , 12, 1379–1383. https://doi.org/10.4236/psych.2021.129086 .	Journal	English	2021	<i>Psychology</i>	Twisties	3.2. Twisties
29	Fan, S. C., Shih, H. C., Tseng, H. C., Chang, K. F., Li, W. C., and Shia, A. S. (2021). Self-Efficacy Triggers Psychological Appraisal Mechanism for Mindset Shift. <i>Int. J. Ment. Health Promot.</i> 23: 57–73.	Journal	English	2021	<i>International Journal of Mental Health Promotion</i>	Self-efficacy	3.1. Suppression and sources of stress of athletes
30	Millman, L. M., Hunter, E. C., Orgs, G., David, A. S., and Terhune, D. B. (2021). Symptom variability in depersonalization-derealization disorder: A latent profile analysis. <i>J. Clin. Psychol.</i> https://doi.org/10.1002/jclp.23241	Journal	English	2021	<i>J. Clin. Psychol</i>	Depersonalization-derealization disorder	1. Introduction/3.4. DDD (Depersonalization-derealization disorder)
31	Wu, D., Luo, Y., Ma, S., Zhang, W., and Huang, C.-J. (2021). Organizational stressors predict competitive trait anxiety and burnout in young athletes: Testing psychological resilience as a moderator. <i>Curr. Psychol.: A Journal for Diverse Perspectives on Diverse Psychological Issues.</i> https://doi.org/10.1007/s12144-021-01633-7	Journal	English	2021	<i>Curr. Psychol.</i>	Emotional Labor/organizational stressors	4.2.3. Avoid organizational stressors
32	Zhou, Y., Shang, Z., Zhang, F., Wu, L., 2021. PTSD: Past, present and future implications for China. <i>Chin. J. Traumatol.</i> 24, 187–208.	Journal	English	2021	<i>J. Traumatol</i>	PTSD	4.1. Promotion of Athletes' Mental Toughness to Resist Stressors
1	Bandura, A. (1992a). “Exercise of personal agency through the self-efficacy mechanism,” in the Self-efficacy: Thought control of action, ed. R. Schwarzer, (Washington, D.C.: Hemisphere), 3–38.	Book	English	1992		Self-efficacy	3.1
2	Bandura, A. (1997a). Self-efficacy: The exercise of control. New York: Freeman.	Book	English	1997		Self-efficacy	3.1
3	Selwyn, L. (2014). Goleman, Daniel. Focus: The Hidden Driver of Excellence. <i>Library Journal</i> , 139(3), 61–62.	Book	English	2014		System I	2. Literature review strategy - PRISMA
1	Liberati, A., Altman, D., Tetzlaff, J., Mulrow, C., Gøtzsche, P., Ioannidis, J., et al. (2009). The PRISMA statement	Journal	English	2009	<i>PLoS Medicine</i>		2. Literature review strategy - PRISMA

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No.	References	Type of Publication	Language	Publication Year	Name of the Journal	Keywords	Sections cited this reference
	for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: Explanation and elaboration. <i>PLoS Medicine</i> , 6(7), e1000100.						
2	Liberati, A., Tetzlaff, J., & Altman, D. G. Group P 2009 Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. <i>PLoS Available: http://journals.plos.org/plosmedicine/article</i> .	Journal	English	2009	<i>PLoS</i>		2. Literature review strategy - PRISMA
3	Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2009). Reprint—preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. <i>Physical therapy</i> , 89(9), 873–880.	Journal	English	2009	<i>Physical therapy</i>		2. Literature review strategy - PRISMA
4	Gurevitch, J., Koricheva, J., Nakagawa, S., & Stewart, G. (2018). Meta-analysis and the science of research synthesis. <i>Nature</i> , 555 (7695), 175–182.	Journal	English	2018	<i>Nature</i>		2. Literature review strategy - PRISMA
5	Moher, D. (2018). Reporting guidelines: doing better for readers. <i>BMC medicine</i> , 16(1), 1–3.	Journal	English	2018	<i>BMC medicine</i> ,		2. Literature review strategy - PRISMA
6	Tricco, AC, Lillie, E, Zarin, W, O'Brien, KK, Colquhoun, H, Levac, D, Moher, D, Peters, MD, Horsley, T, Weeks, L, Hempel, S et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. <i>Ann Intern Med</i> . 2018;169(7):467–473. https://doi.org/10.7326/M18-0850 .	Journal	English	2018	<i>Ann Intern Med</i>		2. Literature review strategy - PRISMA
7	Gough, D., Thomas, J., & Oliver, S. (2019). Clarifying differences between reviews within evidence ecosystems. <i>Systematic reviews</i> , 8(1), 1–15.	Journal	English	2019	<i>Systematic reviews</i>		2. Literature review strategy - PRISMA
8	Regona, M., Yigitcanlar, T., Xia, B., & Li, R. Y. M. (2022). Opportunities and adoption challenges of AI in the construction industry: a PRISMA review. <i>Journal of Open Innovation: Technology, Market, and Complexity</i> , 8(1), 45.	Journal	English	2022	<i>Journal of Open Innovation: Technology, Market, and Complexity</i>		2. Literature review strategy - PRISMA

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