Bibliometric Analysis of the Effects of Athletes' Mental Fatigue on Motivation

Yu Kaihao

Faculty of Educational Studies Universiti Putra Malaysia 43400 Upm Serdang Selangor
Email: gs66515@student.upm.edu.my

Shamsularffin Samsudin

Faculty of Educational Studies Universiti Putra Malaysia 43400 Upm Serdang Selangor
Email: shamariffin@upm.edu.my

Faizal Bin Abd Manaf

National Defence University Of Malaysia
Email: faizalmanaf@upnm.edu.my

Mohd Aswad Ramlan

Faculty of Forestry and Environment Universiti Putra Malaysia 43400 UPM Serdang Selangor
Email: m.aswad@upm.edu.my

Cong Yuxin

Faculty of Educational Studies Universiti Putra Malaysia 43400 Upm Serdang Selangor
Email: gs59370@student.upm.edu.my

Dezheng Liu

City University Malaysia
Email: liudezhenglife@gmail.com

Abstract
Mental fatigue is a psychological state caused by prolonged cognitive tasks, sustained stress, or strenuous physical activity, characterized by poor concentration, reduced decision-making ability, mood swings, and decreased motivation. In sports, athletes often face long training sessions, intensive competition schedules, and various daily stresses, which can lead to the development of mental fatigue. Mental fatigue not only affects the physical state of athletes but also has negative effects on their psychological state, weakening their motivation and enthusiasm for training and competition, thereby impacting their competitive performance and training outcomes. This paper aims to systematically review and analyze studies on the effects of mental fatigue on athletes' motivation using bibliometric analysis through CiteSpace

software. The research explores the mechanisms, degree of influence, and factors affecting how mental fatigue impacts athletes' motivation. The findings indicate that mental fatigue affects athletes' brain function and psychological state, subsequently influencing their motivation levels and performance. Additionally, the impact of mental fatigue varies due to individual differences and environmental factors, such as stress in training and competition environments, daily life pressures, and the effectiveness of social support and counseling. The research objectives include analyzing annual publications in this field, identifying key disciplines and journals, uncovering influential institutions, authors, and collaborations, understanding current research hotspots, and exploring existing issues to provide scientific references for sports training and psychological interventions.

Keywords: Mental Fatigue, Motivation, Athlete, Citespace, Bibliometric Analysis.

Introduction

The increasing demands placed on athletes, both mentally and physically, call for a deeper understanding of factors affecting their performance, such as mental fatigue. By investigating the relationship between mental fatigue and motivation, this study seeks to bridge a gap in the literature where such interactions have not been extensively explored. This is particularly relevant as motivation is a critical determinant of athletic success, and its disruption can lead to performance deterioration.

Mental fatigue is a psychological state caused by prolonged cognitive tasks, sustained stress, or strenuous physical activity, and its main features include poor concentration, reduced decision-making ability, mood swings, and decreased motivation (Cutsem et al., 2017). In the field of sports, athletes are often faced with long training sessions, intensive competition schedules, and various stresses in their daily lives, which may lead them to develop mental fatigue. Mental fatigue not only affects the physical state of athletes, but also negatively affects their psychological state (Sun et al., 2021).

Motivation is the internal drive of an individual to exert effort to achieve a certain goal. In sports, a good level of motivation is one of the key factors for athletes' success (Đurović et al., 2020). However, mental fatigue may weaken athletes' motivation and cause them to lose enthusiasm for training and competition, which in turn affects their competitive performance and training outcomes（Schiphof-Godart, Roelands, & Hettinga, 2018）. Therefore, it is important to investigate the effects of mental fatigue on athletes' motivation in order to improve athletes' competitive performance and safeguard their physical and mental health (Habay et al., 2021).

The mechanism of the effect of mental fatigue on athletes' motivation is a complex process, which is affected by a variety of factors. Firstly, mental fatigue affects athletes' brain function, leading to poor concentration, reduced decision-making ability and slower reaction time, which in turn affects their motivation and commitment to training and competition (Slimani et al., 2018). Secondly, mental fatigue affects the psychological state of athletes, leading to low mood, anxiety and increased feelings of stress, which in turn affects their motivation levels and competitive performance. In addition, mental fatigue may also affect the physiological state of athletes, leading to a decrease in their fitness levels, which in turn affects their motivation levels and performance (Smith, Marcora, & Coutts, 2015).

The extent to which mental fatigue affects an athlete's motivation is a complex issue that is influenced by a number of factors. Firstly, the degree and duration of mental fatigue directly affects the extent of its impact on athlete motivation (Schiphof-Godart, Roelands, & Hettinga, 2018). The more severe and longer the duration of mental fatigue, the greater the impact on athlete motivation. Second, individual athlete differences also affect the extent to which mental fatigue affects their motivation (Pluhar et al. 2019). Some athletes are more tolerant of mental fatigue and maintain high levels of motivation and competitive performance even when mentally fatigued. Whereas other athletes are less tolerant of mental fatigue, and their motivation levels and competitive performance decrease significantly once mental fatigue sets in (Russell et al., 2019).

The effect of mental fatigue on athletes' motivation is influenced by multiple factors. Firstly, individual factors are one of the most important factors influencing the effects of mental fatigue on athletes' motivation. Different athletes may have different levels of motivation and competitive performance when facing mental fatigue（Martin et al., 2018）
. Secondly, environmental factors can also influence the effects of mental fatigue on athletes' motivation. Stress in the training environment, tension in the competition environment, and various stresses in daily life may affect the level of mental fatigue in athletes, which in turn affects their motivation level and competitive performance (Jing-lu, 2011). In addition, social support and counselling may also influence athletes' coping with mental fatigue and its effect on motivation（Shang & Yang, 2021）.

In order to gain a deeper understanding of the effects of mental fatigue on athletes' motivation, this paper will conduct a bibliometric analysis through CiteSpace software to systematically sort out and analyse relevant studies（Marcora, Staiano, & Manning, 2009）. By searching and analysing the academic literature at home and abroad, we aim to explore the mechanism, the degree of influence, and the influencing factors of mental fatigue on athletes' motivation, so as to provide scientific basis and reference for sports training and psychological intervention (Barker et al., 2020).

Research Objectives
1. to analyse annual publications on the effects of mental fatigue on motivation in athletes and to identify the most representative disciplines and journals in the field, discovering influential national institutions, authors and their collaborations.
2. to understand current research hotspots and explore existing issues by citing relevant data from literature and journals.
3. to study the effects of psychological fatigue on athletes' motivation, including its impact on athletes' motivation to compete, motivation to train, and motivation to participate in sport, in order to explore research priorities in the field and to provide references and information for in-depth scientific research in the field of psychological fatigue.

Materials and Methods
Design
This is a descriptive bibliometric analysis and scientific mapping to identify and analysis the literature on mental fatigue and motivation. Separate analyses were also conducted to identify research trends in mental fatigue and motivation.

Sample

Since our CNKI search returned a smaller sample, we decided to use a database from web of sicence. We retrieved the target literature from Clarivate Analytics' Web of Science (WOS) core collection as it allowed us to perform precise and specific analyses of publications, authors, citations and keywords.

Data Collection

Search terms used to identify publications included: topic (mental fatigue and motivation). The search was for publications between 1992 and 2024 with a search date of 30 April 2024. Bibliometric analysis data from the Web Science Core Collection search index included sci extended, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, ccr extended, and IC. we removed duplicate publications, and in the end, we selected 640 publications.

Ethical Consideration

As no animal or human subjects were recruited for this study, ethical approval from any institution and informed consent from patients were not required.

Data Analysis

There are many ways to conduct bibliometric analyses. Such as Citespace, Video Viewer, Citespace, Organised Citation, SciMAT, Sci2, etc., all of these issues have advantages and disadvantages. Here, we use Citespace for bibliometric analyses. Co-occurring subject terms/keywords and citation analysis are the two most commonly used methods. Co-occurring subject terms/keywords analysis allows us to obtain the internal relationships and scientific structure of literature works, reflecting current research hotspots（Gureyev & Mazov, 2013）. By co-occurring cluster analysis of high-frequency words, we can objectively find the current research hotspots of mental load. Citations can reflect citations to journals, authors, papers, organizations and countries and reveal quantitative characteristics and internal laws. Direct citations and co-citations are used to find influential journals, papers, authors and organizations, and co-occurring keywords reveal hotspots and major research trends（Mustafee, Katsaliaki, & Fishwick, 2014）.

Results and Discussion

Annual Trends in Publications and Citations

We analysed 640 records published between 1992 and 2024. Of the 640 identified studies, a total of 11 categories were identified, including Article (n=554), Article Book Chapter (n=1), Article Early Access (n=12), Article Proceedings Paper (n=5), Editorial Material(n=1), Letter(n=1), Meeting Abstract(n=3), Proceedings Paper(n=23), Review(n=36), Review Book Chapter(n=1), Review Retracted Publication(n=1). As shown in Figure 1, research on the association between mental fatigue and motivation can be broadly divided into three periods. In the first period, from 1992 to 2007, the first article on the target study dates back to 1992, and in this period we can see that the volume of publications fluctuates at the <10 level. In the second period from 2008 to 2021, the number of publications is increasing rapidly, especially between 2019 and 2021 the volume of publications is increasing dramatically. This indicates that mental fatigue and motivation have gradually become hot research topics. But in the period of 2022 to 2024. The number of publications shows a decreasing trend. The number of publications is still high. This change suggests that mental fatigue as a negative

emotional state has attracted widespread attention, and more and more studies have explored the role relationship between mental fatigue and motivation.
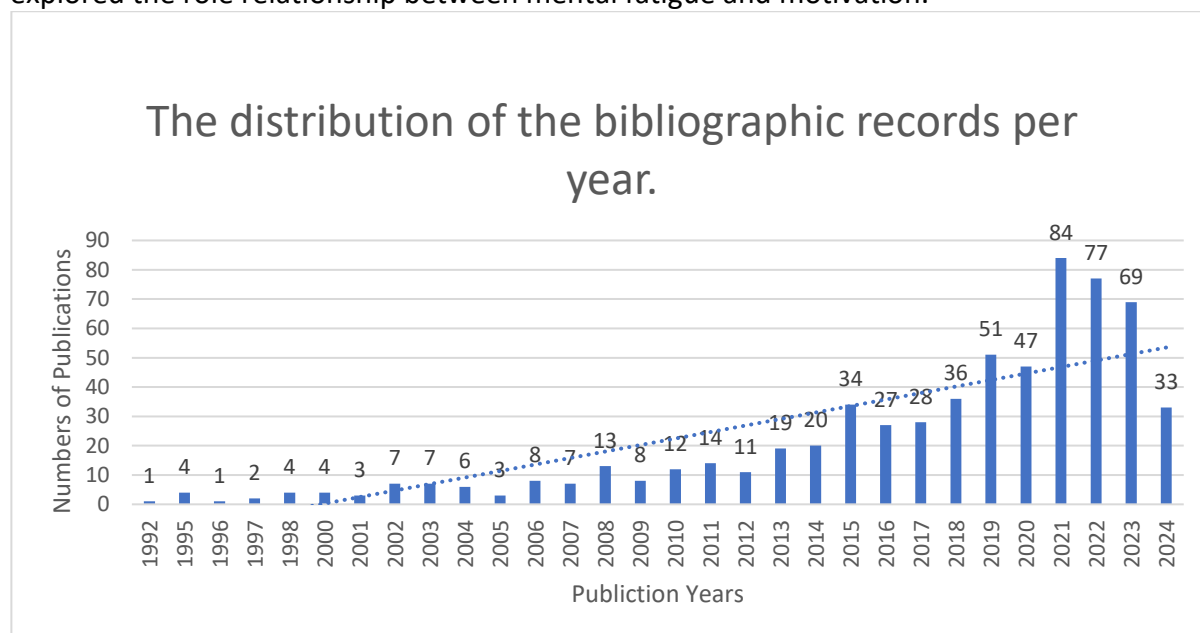

FIGURE 1 The combination chart of the number of annual publications.

Category Analysis

The top 10 frequency and centrality of subject categories related to mental fatigue and motivation indexed by the Web of Science Core Collection were illustrated by a visualizing calculation result using CiteSpace (see Figure 2). As shown in Figure 2, 122 nodes and 306 links constituted a network of such subject categories. Among them, The top ranked item by citation counts is NEUROSCIENCES, with citation counts of 88. The second one is SPORT SCIENCES, with citation counts of 80. The third is PSYCHOLOGY, with citation counts of 56. The 4th is PSYCHOLOGY, MULTIDISCIPLINARY, with citation counts of 48. The 5th is PSYCHOLOGY, EXPERIMENTAL, with citation counts of 48. The 6th is PSYCHIATRY, with citation counts of 42. The 7th is PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH, with citation counts of 41. The 8th is PSYCHOLOGY, APPLIED, with citation counts of 35. The 9th is CLINICAL NEUROLOGY, with citation counts of 34. The 10th is REHABILITATION, with citation counts of 31. Besides, we also had a dual map-based portfolio analysis of 640 articles. Also, the result showed that citing journals is associated with topics including qualitative study, mental fatigue, human brain network, organizational risk factor. The network consists of 11 clusters. The largest cluster has 25 members. The second largest cluster has 23 members. The third largest cluster has 18 members. (shown in Figure 3).
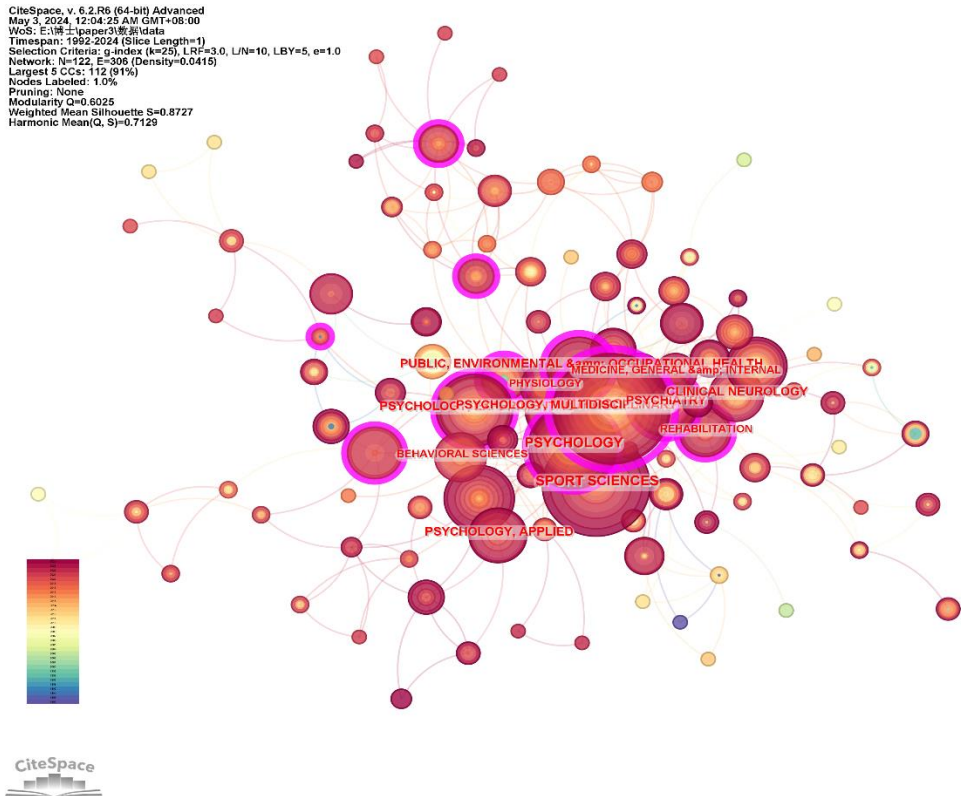
Figure 2:Disciplinary Categories in the Field of Mental Fatigue and Motivation for the Period 1992-2024 Co-occurrence Network A circle indicates a subject category. Different colours of the nodes indicate different years, and the size of the circle is weighted by the amount of literature on the category. The link between two nodes represents the interdisciplinary interaction of the literature,. Purple circles indicate centres of high intermediation.
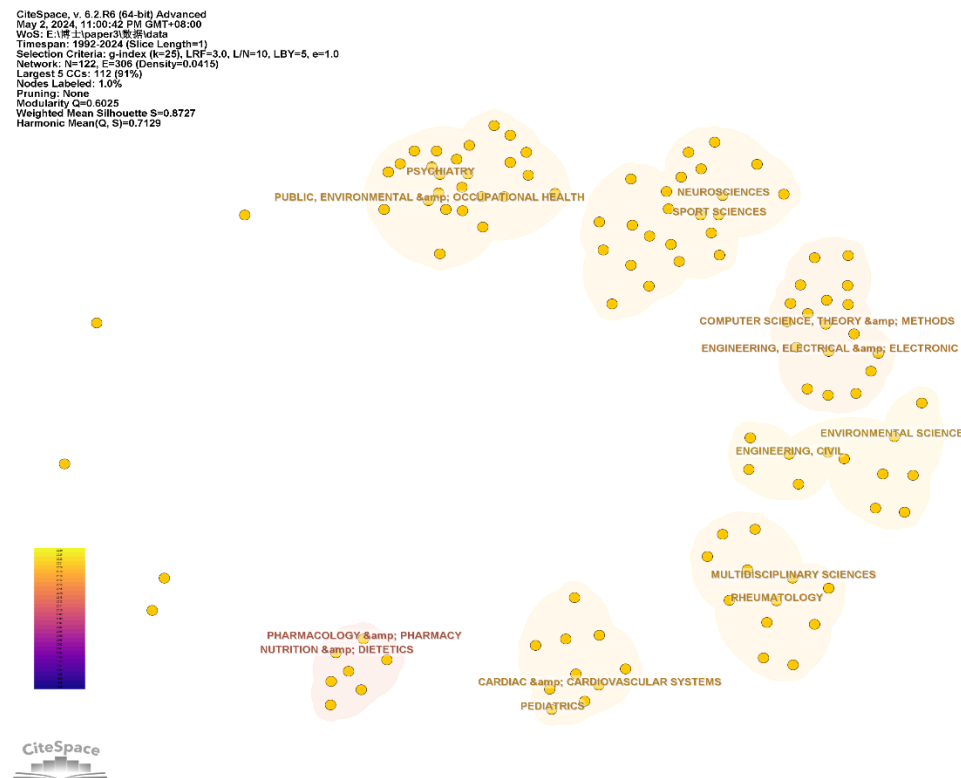
Figure 3: The clustering graph shows different clusters of topics in the literature data, with each cluster representing a set of highly relevant literature. Each node in the graph represents a category of literature, and the size of the node reflects the number of citations to the literature.'' The colours of the clustering graph indicate the different topic clusters, and the connecting lines between the nodes indicate the correlations between the literature.

Analysis of Countries

As shown in Figure 4, 75 nodes and 250 links constituted a network of such subject countries.A total of 75 countries participated in the publication on the effects of mental fatigue and motivation. The density of national and regional co-operative networks and publications is shown on maps created by CiteSpace (Figure 4 A, B). Figure 4A lists the 10 countries with the majority of publications. USA (120), NETHERLANDS (85), ENGLAND (71), GERMANY (58), AUSTRALIA (54), PEOPLES R CHINA (47), CANADA (41), FRANCE (37), JAPAN (29), and SPAIN (26) in this area. There is more collaboration in the USA, NETHERLANDS, UK, GERMANY and AUSTRALIA. It can be seen that there is a great deal of interest in 'the effects of mental fatigue and motivation' worldwide, and that research in this area has had a significant impact on the international scene. It is noteworthy that the United States of America is the country with the most publications (120) and NETHERLANDS is the country with the highest degree of centrality.

rank	counts	centrality	country
1	120	0.27	USA
2	85	0.35	NETHERLANDS
3	71	0.33	ENGLAND
4	58	0.1	GERMANY
5	54	0.06	AUSTRALIA
6	47	0.16	PEOPLES R CHINA
7	41	0.24	CANADA
8	37	0.03	FRANCE
9	29	0.04	JAPAN
10	26	0.06	SPAIN

Figure 4A：Top 10 countries/regions by number of publications
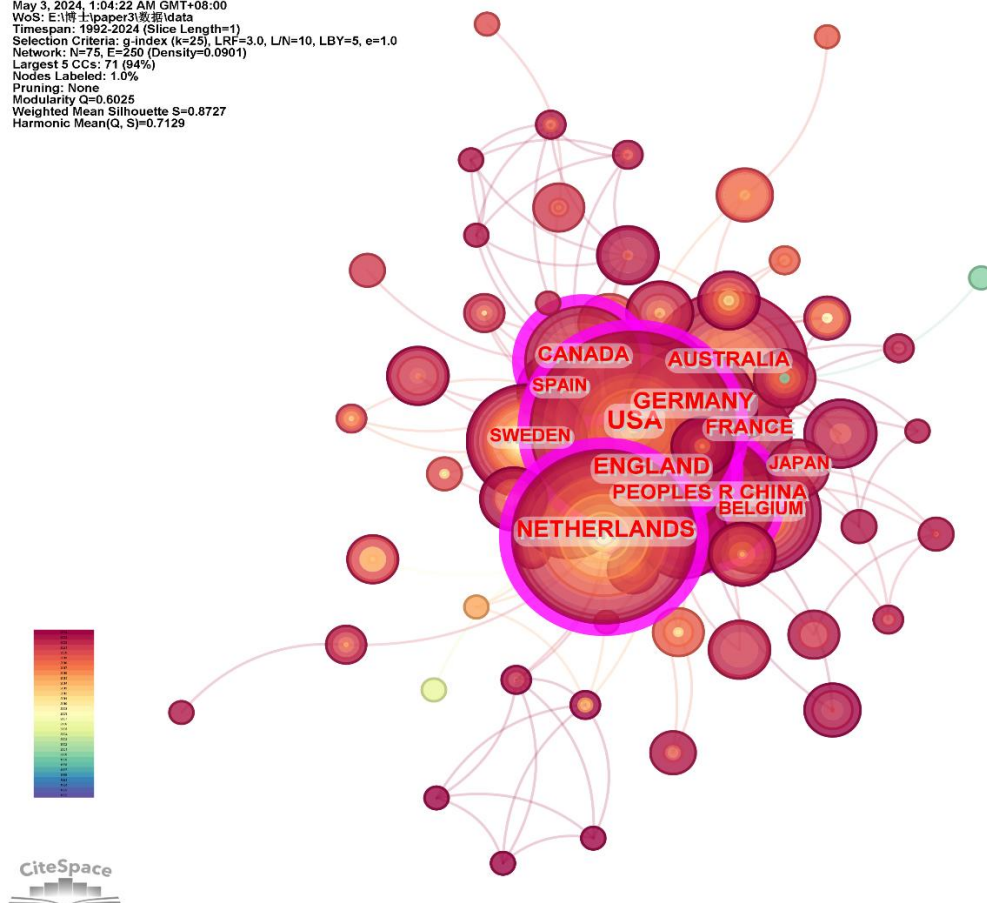
Figure 4B : The cooperation network visualizations map of countries and regions based on CiteSpace;

Analysis of Institution

A total of 421 institutions participated in the publication on the effects of mental fatigue and motivation. The visualisation map allows to find the 10 most productive institutions (Figure 5 A, B). The 10 most productive institutions are presented in Figure 5B.Radboud University Nijmegen 10 articles.University of Groningen 18 articles. Erasmus University Rotterdam 16 articles.Vrije Universiteit Amsterdam 10 articles. Vrije Universiteit Amsterdam 10. Melbourne Genomics Health Alliance 9. Erasmus University Rotterdam - Excl Erasmus MC 9. University System of Georgia 8. Leiden University - Excl LUMC 8. Leiden University 8. Institut National de la Sante et de la Recherche Medicale (Inserm) 8. As shown in Table 5A, University of Groningen has the highest number of centrality 0.06. Vrije Universiteit Amsterdam has the second highest number of centrality : 0.05.
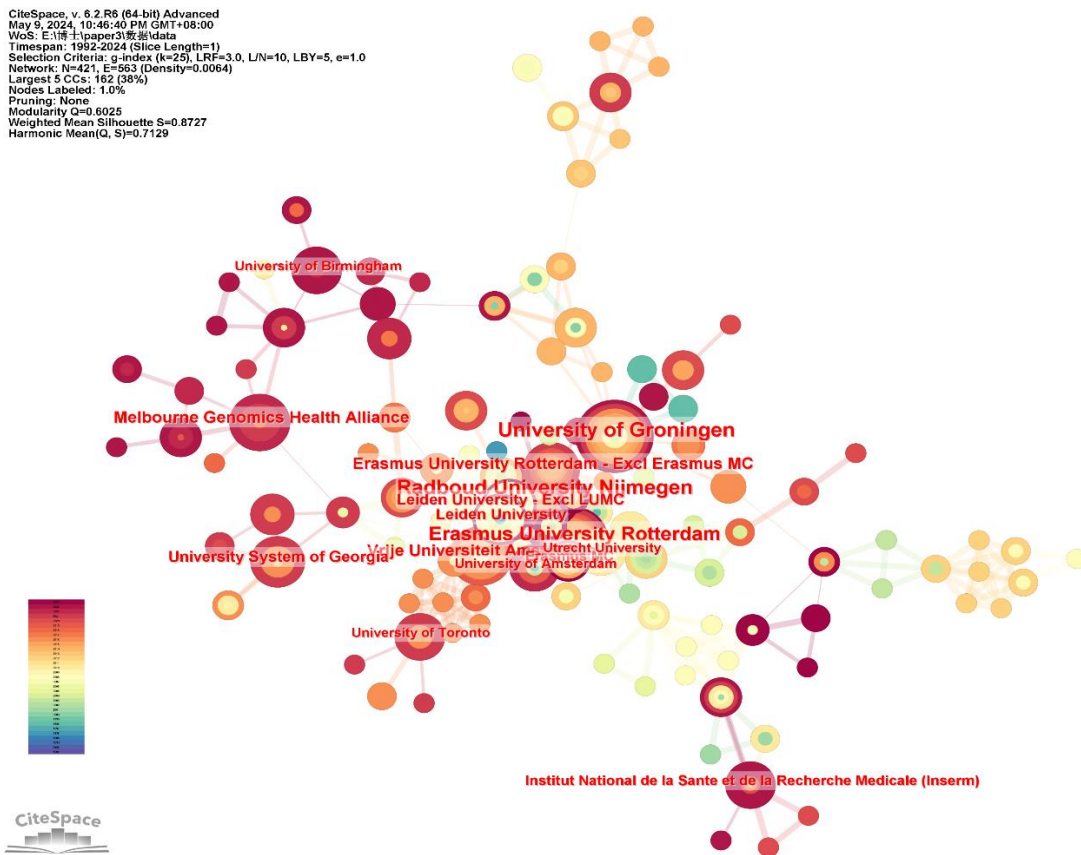
Figure 5 A The network visualizations map of institutions based on CiteSpace

rank	publication	centrality	years	institutions
1	18	0.02	2004	Radboud University Nijmegen
2	18	0.06	1998	University of Groningen
3	16	0.02	1995	Erasmus University Rotterdam
4	10	0.05	2006	Vrije Universiteit Amsterdam
5	9	0.03	2018	Melbourne Genomics Health Alliance
6	9	0	1995	Erasmus University Rotterdam - Excl Erasmus MC
7	8	0	2009	University System of Georgia
8	8	0.01	1995	Leiden University - Excl LUMC
9	8	0.01	1995	Leiden University
10	7	0.01	2010	Institut National de la Sante et de la Recherche Medicale (Inserm)

Figure 5 B: The top 10 institutions in the number of publications

Author Analysis

Since 1992, a total of 652 researchers have been involved in publishing research in this field. Visual maps can provide information about potential collaborators and help researchers to establish collaborations (Fig. 6A). As shown in Figure 6A, research in this field has yet to form a relatively tight network. Based on the number of publications that can be used to measure the depth of the author's research in the field the depth of the author's research in this field, the number of publications can be used as a basis for evaluating scientific talent. Figure 6B lists the top 10 authors in terms of the number of publications. These authors are: Coutts, Aaron J (5); Kompier, Michiel A J (4); van der linden, Dimitri (4); Marcora, Samuele M

(3); Gamberale, F (3); Baranski, JV (3); Åhsberg, E (3); Bakker, Arnold B(3); Bray, Steven R(3); Arnau, Stefan(3). And so on. It can be seen that none of the top 5 authors have published more than 10 papers. The fact that there are more than 10 publications suggests that the field is not widely researched and that it is difficult to publish.
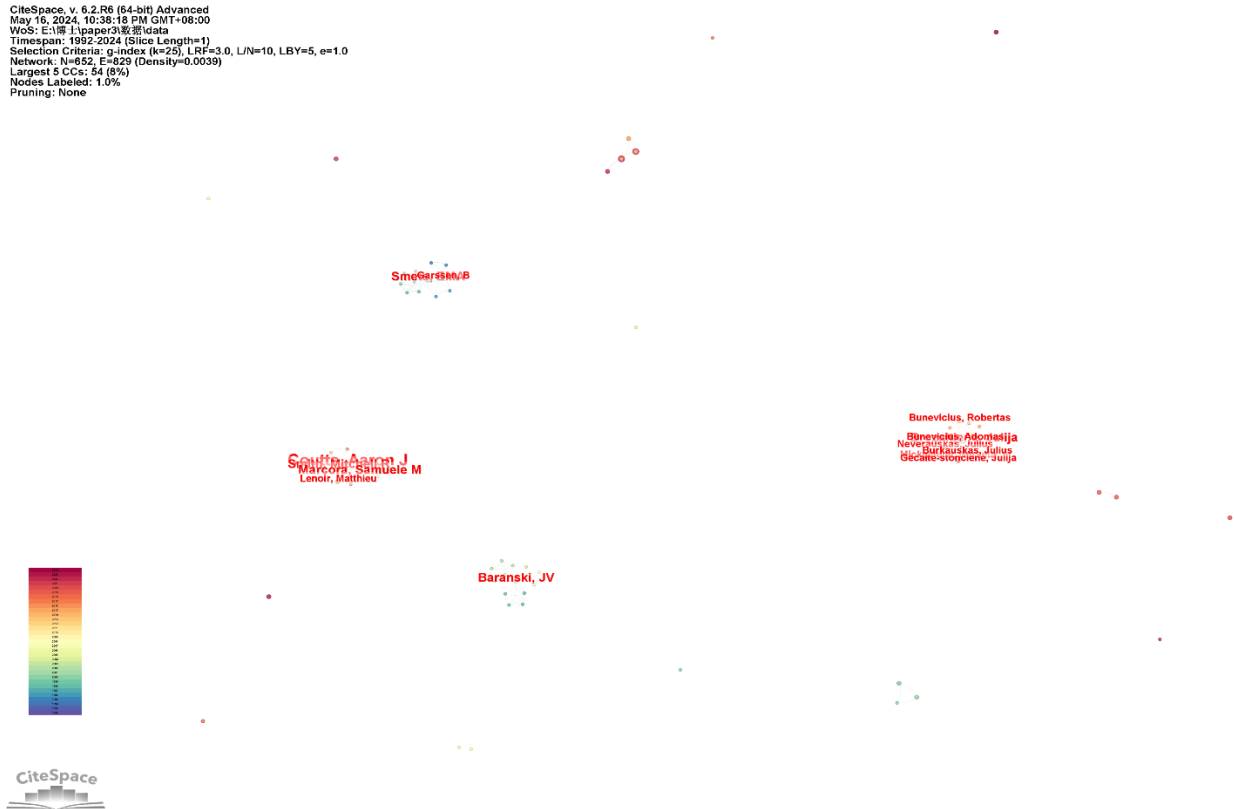

Figure 6 A The network visualizations map of authors based on CiteSpace

rank	publiction	year	author
1	5	2015	Coutts, Aaron J
2	4	2015	Kompier, Michiel A J
3	4	2015	van der linden, Dimitri
4	3	2009	Marcora, Samuele M
5	3	1997	Gamberale, F
6	3	1998	Baranski, JV
7	3	2000	Åhsberg, E
8	3	2015	Bakker, Arnold B
9	3	2017	Bray, Steven R
10	3	2016	Arnau, Stefan

Figure 6 B ：The top 10 authors in the number of publications

Strength and Limitation

There are some limitations to this study, which should be taken into account when interpreting the results. Firstly, we searched the literature, we collected data only from the web of science.to retrieve the literature. Future studies should search more databases to identify more papers. Second, our analysis only included articles. Therefore, we missed relevant articles from other literature types. Third, bibliometrics is is a quantitative analysis of scholarly publications. Articles with a high number of citations do not necessarily equate to high quality or highly relevant articles to the target field. Researchers should use multiple methods of assessment to gain a deeper understanding of this field of study. Fifth, only Citespace bibliometric methods. The use of multiple research methods can lead to more credible findings. Therefore, the use of additional methods and indicators should be considered in the future.

Conclusion

The purpose of this paper is to shed light on the impact of impact studies mental fatigue and motivation. In addition, it provides a foundation for upcoming research. The exploration strategy guide collated 640 documents Web of Science repositories between 1992 and 2024. Analysed according to the trend graph of published literature, this research exists in 11 main categories. The trend shows three stages. Analysed by category, this research is mainly applied to NEUROSCIENCES, SPORT SCIENCES, PSYCHOLOGY. Analysed by country and region. There are 75 institutions in the field, with an uneven distribution of research activities. The United States of America is undoubtedly the leader in this field worldwide. There are more than 50 countries, including NETHERLANDS and ENGLAND, and it can be seen that there is a close cooperation between USA, NETHERLANDS, ENGLANF, GERMANY, and AUSTRALIA. Analysed by institution, Radbound University Nijmegen has the highest frequency of citations, indicating the quality and influence of this journal. Analysed by author, the author Coutts, Aaron J. has the highest number of citations in the field. In summary, research on the effects of mental fatigue on motivation is still in a rapid developmental stage the United States is still leading the way.

This research paper is a boon for researchers willing to study committed to the field of mental fatigue. Network visualisation helps to identify research gaps known as hotspots. Future research can be conducted in these areas, which allows researchers to minimise the time spent on identifying the exact topic and area of research.

Aaron J. has the highest number of citations in the field. In summary, research on the effects of mental fatigue on motivation is still in a rapid developmental stage the United States is still leading the way.

This research paper is a boon for researchers willing to study committed to the field of mental fatigue. Network visualisation helps to identify research gaps known as hotspots. Future research can be conducted in these areas, which allows researchers to minimise the time spent on identifying the exact topic and area of research.

This study makes a significant contribution by offering a comprehensive bibliometric analysis of the existing research on mental fatigue and its impact on athletes' motivation. By identifying key trends, influential authors, and institutions, this research provides a valuable foundation for future studies. Moreover, it sheds light on the multifaceted effects of mental fatigue, which can influence athletes' psychological and physiological states, thereby offering practical insights for trainers and sports psychologists to enhance athlete support systems.

References
Cutsem, J., Marcora, S., Pauw, K., Bailey, S., Meeusen, R., & Roelands, B. (2017). The Effects of Mental Fatigue on Physical Performance: A Systematic Review. *Sports Medicine*, 47, 1569-1588. https://doi.org/10.1007/s40279-016-0672-0.

Sun, H., Soh, K., Roslan, S., Wazir, M., & Soh, K. (2021). Does mental fatigue affect skilled performance in athletes? A systematic review. *PLoS ONE*, 16. https://doi.org/10.1371/journal.pone.0258307.

Đurović, D., Veljkovic, A., & Petrović, T. (2020). PSYCHOLOGICAL ASPECTS OF MOTIVATION IN SPORT ACHIEVEMENT. *Facta universitatis. Series physical education and sport*, 465-474. https://doi.org/10.22190/FUPES190515044D.

Habay, J., Cutsem, J., Verschueren, J., Bock, S., Proost, M., Wachter, J., Tassignon, B., Meeusen, R., & Roelands, B. (2021). Mental Fatigue and Sport-Specific Psychomotor Performance: A Systematic Review. *Sports Medicine*, 51, 1527 - 1548. https://doi.org/10.1007/s40279-021-01429-6.

Slimani, M., Znazen, H., Bragazzi, N., Zguira, M., & Tod, D. (2018). The Effect of Mental Fatigue on Cognitive and Aerobic Performance in Adolescent Active Endurance Athletes: Insights from a Randomized Counterbalanced, Cross-Over Trial. *Journal of Clinical Medicine*, 7. https://doi.org/10.3390/jcm7120510.

Smith, M., Marcora, S., & Coutts, A. (2015). Mental Fatigue Impairs Intermittent Running Performance.. *Journal is not defined within the JOURNAL database.*. https://doi.org/10.1249/MSS.0000000000000592.

Schiphof-Godart, L., Roelands, B., & Hettinga, F. (2018). Drive in Sports: How Mental Fatigue Affects Endurance Performance. *Frontiers in Psychology*, 9. https://doi.org/10.3389/fpsyg.2018.01383.

Russell, S., Jenkins, D., Rynne, S., Halson, S., & Kelly, V. (2019). What is mental fatigue in elite sport? Perceptions from athletes and staff. *European Journal of Sport Science*, 19, 1367 - 1376. https://doi.org/10.1080/17461391.2019.1618397.

Jing-lu, G. (2011). Inducement and Recovery of Athletes' Psychological Fatigue. *China Winter Sports*.

Barker, J., Slater, M., Pugh, G., Mellalieu, S., McCarthy, P., Jones, M., & Moran, A. (2020). The effectiveness of psychological skills training and behavioral interventions in sport using

single-case designs: A meta regression analysis of the peer-reviewed studies. *Psychology of Sport and Exercise*, 51, 101746. https://doi.org/10.1016/j.psychsport.2020.101746.

Schiphof-Godart, L., Roelands, B., & Hettinga, F. (2018). Drive in sports: How mental fatigue affects endurance performance. *Frontiers in Psychology, 9*. https://doi.org/10.3389/fpsyg.2018.01383

Pluhar, E., McCracken, C., Griffith, K., Christino, M., Sugimoto, D., & Meehan, W. (2019). Team Sport Athletes May Be Less Likely To Suffer Anxiety or Depression than Individual Sport Athletes.. *Journal of sports science & medicine*, 18 3, 490-496 .

Martin, K., Meeusen, R., Thompson, K., Keegan, R., & Rattray, B. (2018). Mental Fatigue Impairs Endurance Performance: A Physiological Explanation. *Sports Medicine*, 48, 2041-2051. https://doi.org/10.1007/s40279-018-0946-9.

Marcora, S., Staiano, W., & Manning, V. (2009). Mental fatigue impairs physical performance in humans.. *Journal of applied physiology*, 106 3, 857-64 . https://doi.org/10.1152/japplphysiol.91324.2008.

Shang, Y., & Yang, S. (2021). The Effect of Social Support on Athlete Burnout in Weightlifters: The Mediation Effect of Mental Toughness and Sports Motivation. *Frontiers in Psychology*, 12. https://doi.org/10.3389/fpsyg.2021.649677.

Gureyev, V., & Mazov, N. (2013). Detection of information requirements of researchers using bibliometric analyses to identify target journals. *Information Technology and Libraries*, 32, 66-77. https://doi.org/10.6017/ITAL.V32I4.3421.

Mustafee, N., Katsaliaki, K., & Fishwick, P. (2014). Exploring the modelling and simulation knowledge base through journal co-citation analysis. *Scientometrics*, 98, 2145-2159. https://doi.org/10.1007/s11192-013-1136-z.