



# Exploring the Fusion of Metaverse and Sports: Current Trends and Future Directions

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**Abstract.** Metaverse is a virtual realization of the physical environment made possible with lifelogging tools like physiological sensors that help in performing life-like virtual interactions amongst users/customers present as avatars in the cyber-physical world. The metaverse is a rapidly growing technology that has the potential to revolutionize the world of sports. In this research work, we used the Scopus database to extract documents published in the domain of sports and metaverse. The descriptive analysis and collaboration analysis of existing literature, and topic modeling Latent Dirichlet Allocation of abstracts highlight the use of augmented reality, virtual reality, blockchain, artificial intelligence, wearables, and the Internet of Things in building domain-specific applications. The findings reveal that these technologies can enhance the learning and training experience for athletes, providing them with immersive and interactive environments to hone their skills. The physical and psychological well-being of athletes can be ensured with the rational use of metaverse. However, the use of these technologies also raises concerns about privacy and the protection of data. The research in the domain of information technology and information systems from marketing is also unexplored. As the metaverse continues to evolve, it is important for the sports industry to address these concerns and ensure that the use of these technologies is done in a responsible and ethical manner.

**Keywords:** sports · metaverse · augmented reality · virtual reality · healthcare · e-sports · digital technologies

## 1 Introduction

The term “metaverse” refers to a 3D virtual environment that emulates facets of the real world and enables users to interact and communicate in the digital space. It is a collection of 3D virtual environments designed for boosting social and business-related interactions. Metaverse is a highly focused area in industrial innovations due to the rapid growth of blockchain, artificial intelligence, and extended reality (augmented reality (AR) and virtual reality (VR)) in the areas of education, health management, tourism management, order tracking, supply chain management, and more (Dwivedi et al. 2022; Dwivedi et al. 2023; Kar and Varsha 2023).

The Covid-19 pandemic transformed the low acceptance of technology and forced people to increase immersive time, that is, perform personal and professional tasks through virtual modes such as meetings or monetary transactions (Mehra et al. 2023; Mogaji et al. 2023). Increased acceptance of virtual technologies encouraged brands to rapidly move toward Metaverse - the 3D immersive virtual spaces where blockchain-enabled non-fungible tokens (NFTs) can provide a new hybrid experience to users (Arya et al. 2023).

The social media revolutionized sports consumption and participation, by allowing fans and spectators to present views and opinions in real-time. Sports organizations, sports marketers, teams, sports managers, athletes, brand managers, and many more entities utilized social media to target global audiences which was earlier not possible through conventional sports consumption platforms such as television (Mehra et al. 2022). Metaverse holds the potential to reshape sports altogether. Right from the domain of physical and psychological health management of athletes, sports education, physical education, participation, and consumption of sports can be rejigged making sports a lot more cohesive for fans and athletes (Demir et al. 2022). For health and fitness management among athletes, metaverse has opened new doors. Performance enhancement and mental health management of e-sports athletes are the two primary areas where metaverse applications need to be properly thought and implemented (Cai et al. 2022).

With numerous positives, the researchers have presented concerns over the use of Metaverse as well. In the domain of marketing, AR/VR can provide never-seen-before enriching experiences to customers (Dwivedi et al. 2023a). One thing that researchers are deeply concerned about is the privacy of the personal data that contains the micro-information related to the participants such as personal information, digital signatures, and interaction patterns. Security of supply chain data (Richey Jr et al. 2023), implementation of Digital Twins, and logistics are some of the issues that need to be addressed at the managerial levels (Dwivedi et al. 2023b). Environmental sustainability is another major cause of concern as metaverse platforms require an immense amount of energy to be kept operational (Kshetri and Dwivedi 2023).

The primary goal of the semi-systematic review of the literature is to explore the utility, applications, and adoption of metaverse or AR/VR across different fields of sports. The findings in this study primarily reveal the use of AR and VR across the domains of sports education, physical education, e-sports, sports psychology, behavior analysis, and more. The findings in this research are novel as we did not come across any study that has examined the use of metaverse or AR/VR technologies in sports at a broader scale. Latter discussion encourages us to find the answer to the following research question:

**(RQ: What are the prominent themes of research in the domain of sports and metaverse?).**

## 2 Methodology

For performing the semi-systematic review of existing literature, we used the Scopus database, as it is one of the largest databases of scholarly articles and research. The research that contains a combination of keywords as per the following query was searched. AND/OR boolean operators help to remain specific with the topic of research and avoid unwanted articles.

*(("metaverse" OR "augmented reality" OR "virtual reality") AND ("sport" OR "sports" OR "esport" OR "e-sport" OR "esports" OR "e-sports" OR "physical education" OR "sports education" OR "sports medicine" OR "fitness" OR "athlete" OR "sport management" OR "sport marketing" OR "sport sponsorship" OR "sport communication" OR "sportsperson"))).*

The above query resulted in a total of 317 research papers. We further restricted our research to papers of articles category only, which yielded 178 papers. The abstracts of these 178 papers were manually investigated, and 39 irrelevant papers were removed. Hence, we were left with 139 papers, on which the entire research was performed. The descriptive overview of these 139 papers is shown in Fig. 1.



**Fig. 1.** Descriptive overview

## 3 Results and Analysis

In this section, we share the results and findings. This Section is further divided into different sub-sections, each depicting its results and insights.

### 3.1 Annual Scientific Production

Figure 2 shows the annual number of papers published in the domain of metaverse and sports. The results depict that, over the years this research area is gaining attention, with an exponential growth in the count of articles in the years 2022 and 2023 (Till July).

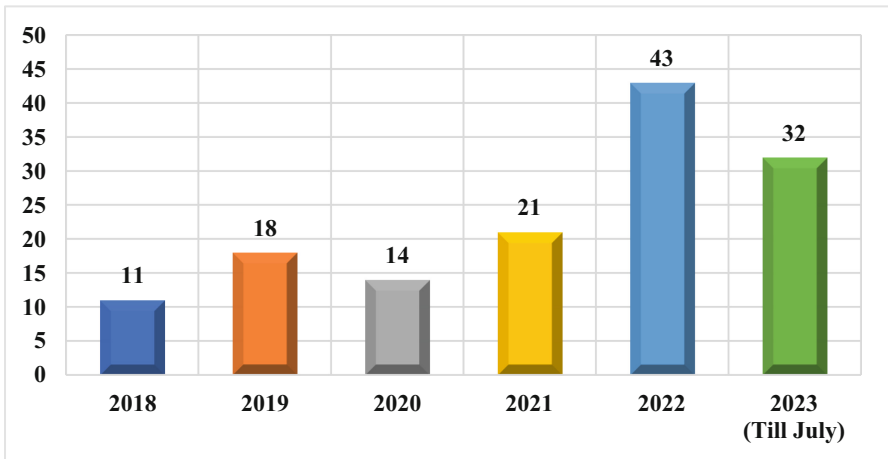


Fig. 2. Annual Scientific Production

### 3.2 Impactful Countries

Table 1 lists the top 10 countries that have contributed the most to this domain. China tops the list with 42 documents, more than triple as compared to the Korea and USA. Countries from across the globe have made notable contributions.

### 3.3 Impactful Document

Citation count helps to identify the value of an article in terms of its relevance to the readers. Table 2, lists the documents sorted in order of number of citations in descending order. These articles focus on (a) **sports psychology and behavior analysis** (Düking et al. 2018; Bird 2019; Kim and Ko 2019; Uhm et al. 2020), (b) **physical fitness** (de Melo et al. 2018), (c) **sports pedagogy** (Chang et al. 2019; Ding et al. 2020; Soltani and Morice 2020), (d) **performance analysis** (Faure et al. 2019), and (e) **digital technologies** (Neumann et al. 2017).

### 3.4 Prominent Topics

To identify the wider spectrum of topics being stressed by the researchers in the domain of metaverse and sports, we performed the topic modeling based on Latent Dirichlet Allocation of the abstracts (Singh et al. 2020). The results obtained have been tabulated in Table 3. In order to identify an ideal number of topics coherence score was calculated for topics (2–20). The results show that 11 topics were ideal for research. Hence, 139 articles were segregated among the identified 11 topics.

- (a) **Sports Psychology:** The articles clustered in this domain focus on the studies that analyze the psychology of university students and athletes and human posture analysis while participating in virtual environments (Li 2023; Wang and Xu 2023).

**Table 1.** Most impactful countries

Country	Number of Articles	Single Country Publication	Multiple Country Publication	Frequency	MCP_Ratio
China	42	33	9	0.302	0.214
Korea	13	9	4	0.094	0.308
USA	13	9	4	0.094	0.308
Germany	11	9	2	0.079	0.182
India	4	4	0	0.029	0.000
Spain	4	4	0	0.029	0.000
Australia	3	2	1	0.022	0.333
Italy	3	2	1	0.022	0.333
Malaysia	3	3	0	0.022	0.000

**Table 2.** Most cited documents

Article	Total Citations	TCpy	Normalized TC
Kim and Ko (2019)	177	35.40	8.80
Neumann et al. (2017)	135	22.50	4.76
Soltani and Morice (2020)	71	17.75	2.50
Ding et al. (2020)	58	14.50	2.05
Düking et al. (2018)	53	8.83	1.87
de Melo et al. (2018)	38	6.33	1.34
Faure et al. (2019)	37	9.25	1.30
Uhm et al. (2020)	36	9.00	1.27
Chang et al. (2019)	34	8.50	1.20
Bird (2019)	33	8.25	1.16

- (b) **Decision Making:** This cluster contains the articles that primarily present the analysis of the decision-making of individuals towards utilizing AR and VR in learning and paras sports (Dias et al. 2021; Dirin et al. 2023).
- (c) **Virtual Reality:** VR is the epicenter of the articles in the third cluster which showcases various studies conducted using 360° applications in the domains of health and off-field decisions during live events (Kittel 2019; Vincent and Frewen 2023).
- (d) **E-Sports:** E-Sports pose a challenge to maintaining good mental health. The studies in this cluster provide solutions in improving the overall experience while participating in E-Sports and maintaining physical and mental health (Wang et al. 2021; Cai et al. 2022).

**Table 3.** Results of Topic Modeling

Cluster No.	Cluster Name	Keywords	Article Count
1	Sports Psychology	students, fitness, martial arts, psychological, paper, recognition, algorithms, based, engagement, university	4
2	Decision Making	generated, proportion, athletes, old, physical, presenters, preparing, bodied, youth, collaborative	3
3	Virtual Reality	virtual, reality, sports, development, sense, teaching, game, technology, study	21
4	E-Sports	football, video, based, performance, esport, tracking, image, gaming, trajectory, match	2
5	Sports Pedagogy	virtual, reality, sports, technology, education, physical, research, system, training, teaching	36
6	Healthcare	pain, received, training, weeks, group, team, trial, hospital, postoperative, rehabilitation	4
7	Behavior Analysis	sports, study, intention, analysis, industry, sport, leisure, recognition, model, service differentiation	14
8	Training and Fitness	training, reality, physical, group, study, virtual, fitness, results, performance, augmented	42
9	Sports Injury	jump, differences, laboratory, ar, generate, landing, volleyball, drop, measure, movement	5
10	Technology Adoption	study, technology, sports, adoption, information, consumption, related, vr, purpose, users	5
11	Performance Enhancement	athletes, performance, learning, athlete, systems, practice, adults, older, dynamics	3

- (e) **Sports Pedagogy:** Relatively high number of articles clustered in this domain showcases the value and importance that has been given to education and learning systems by the researchers. The articles clustered in this domain indicate incorporating VR in curriculum and physical education can help in providing better assistance to students as well as teachers. The teaching and learning can be made a lot more enjoyable and effective (Zhang et al. 2021; Wang et al. 2022).
- (f) **Healthcare:** The articles clustered in the domain of healthcare primarily identify the use of VR and metaverse in gaining endurance performance and minimizing performance anxiety (Huang et al. 2022). The study by Zhang et al. (2022) concludes that immersive experiences of VR promotes active participation in exercise.
- (g) **Behavior Analysis:** The study by Kim and Ko (2019) has identified that VR spectatorship amplifies flow experience via vividness, interactivity, and telepresence. Capasa et al. (2022) provided a model of behavioral intention based on the unified theory of acceptance and use of technology (UTAUT) and technology acceptance model (TAM) to assess the curiosity and self-construal of spectators for using VR technology in spectating mega sports events.
- (h) **Training and Fitness:** The eighth cluster contains the abstracts for the articles that encourage the use of VR and AR for the purposes of training and fitness. One of the articles in this cluster by Mokmin and Rassy (2022) presents a study that indicates the positive impact of AR technology in the subject of physical education among the students with difficulty in learning. Another article by Ahsan et al. (2022) shows that significant improvement in postural stability was seen among participants in the VR training program.
- (i) **Sports Injury:** The article by Adams et al. (2019) focuses on taking the laboratory setting for biomechanical analysis such as measuring knee load to the field that could help curb such injuries. Another article in this cluster by Riehm et al. (2022) proposed a soccer-specific VR header assessment system to assess the athletes for unhealthy, homogeneous movement patterns, and rigid neuromuscular control strategies that were earlier neglected in traditional laboratory assessments.
- (j) **Technology Adoption:** In the tenth cluster, the studies highlighting the possibility to adopt AR and VR by consumers or spectators have been discussed. Goebert et al. (2022) in their study concluded that media providers need to introduce AR components, where media giants such as ESPN do not consider AR as a trend. A study by Seong and Hong (2022) based on Extended Planned Behavior Theory shows significant rise in participation in virtual sports because of the COVID-19 pandemic.
- (k) **Performance Enhancement:** Stone et al. (2018) used an Ecological dynamics framework to understand the use of VR in performance enhancement of athletes. Gao and Zhang (2023) found that pre-competition mindfulness meditation enhances athletes' attentional control, focus during competition and improves athletic performance.

## 4 Discussions

Metaverse has gained huge attention in a little time among consumers, spectators media giants, researchers, healthcare professionals, and many more. The findings of this study suggest that primarily the research in the field of metaverse and sports is centered around

using AR and VR technologies with IoT, Cloud Computing, Blockchain, and Artificial Intelligence. The most prominent research domains that were identified through topic modeling are Sports Psychology, Decision Making, VR, E-Sports, Sports Pedagogy, Healthcare, Behavior Analysis, Training and Fitness, Sports Injury, Technology Adoption, and Performance Enhancement. As the metaverse is a newer concept in action, it needs to mature with ongoing research and garnered huge benefits in such a short span of time.

Despite the vast number of benefits, there is a paucity of information about its implementation and adoption at the public/global level. During the inception and early stages of social media, data privacy was a major issue. With the metaverse being susceptible to network attacks, cybersecurity becomes essential to protect data generated and gathered while using the metaverse (Dwivedi et al. 2022). Physical education, sports education, and sports training in the virtual environment of the metaverse should be explored with effective implementation and execution (Demir et al. 2022).

As the health and education of children (the future athletes), is of utmost importance, we propose the use of metaverse with psychopedagogy, nursing, child care, and pediatrics as the domains for future research directions. Similarly, Metaverse along with sports marketing, is an unexplored research domain, which can provide new avenues to the researchers in the domains such as fan engagement, sports advertising, social media marketing, and sports sponsorship.

## 5 Conclusions

Through the analysis of the Scopus dataset, we have tried to find the sub-fields that have received attention from the researchers in the domain of metaverse and sports. The research in the domain of metaverse and sports is still in its infancy and has got a greater scope. We retrieved only 139 documents for which we performed the topic modeling. The results reveal that studies primarily focus on the impact of metaverse on education, health, fitness, and cognition. The researchers have proposed solutions for improving the quality of teaching and online education through intuitive learning, remote monitoring, improved concentration, and learning efficiency, and performance enhancement through digital means. AR, VR, Blockchain, IoT, wearable devices, and NFTs have been proposed as backbones for the metaverse. Sports marketers, sports managers, and sports advertisers need to think about exploiting metaverse for providing solutions, expand audience/customers, and enhance the monetization of organizations.

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