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Review

Does sport make people healthier?—A Web of Science-based bibliometric and visualization analysis

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Abstract: Whether sports make us healthier is one of the current hot topics in society at large. This study examines the connection between physical and mental health and sports using Thomson Reuters' Web of Science™ Core Collection, using bibliometric methods and CiteSpace visualization technology. This study concludes that sports play a beneficial function in improving our physical and mental well-being, which can effectively relieve stress, improve mood, and enhance the quality of existence, but the key lies in finding the right intensity and amount of exercise to avoid psychological problems caused by overtraining or over-exercise, such as exercise addiction and other similar psychological disorders. At the same time, physical activity helps to enhance our physical fitness by promoting cellular health, including positive effects on the immune system, increased metabolic rate, and increased muscle strength and endurance. In conclusion, sport is a "double-edged sword" for physical and emotional well-being, and it is necessary to precisely regulate the impact of physical activity on both mental and physical health through the use of rational exercise methods, for which this study provides practical suggestions for the promotion of people's physical fitness and the refinement of sport research.

Keywords: physical exercise; bibliometric methods; visualization technology; human health; double-edged sword

1. Introduction

People's lives are moving more quickly as a result of modern society's rapid development, and they are also becoming more conscious of their health. Currently, physical activity, acknowledged as an efficient method for enhancing health and promoting relaxation, is also gaining more and more attention. However, modern lifestyles have brought about many health problems, such as mental health disorders, diabetes, obesity, and cardiovascular disease. The social healthcare system is heavily burdened by these issues, which also have an impact on people's quality of life. In this context, the role of physical activity as a low-cost and highly effective way of health promotion cannot be ignored. How does physical activity affect an individual's physical health and psychological state? The risk of cardiovascular disease is reduced by consistent physical activity, as evidenced by numerous studies, enhances metabolic function, fortifies the immune system, and assists in maintaining a healthy body weight [1].

Aerobic exercise has been shown to enhance circulation and augment cardiorespiratory endurance., while strength training helps to increase muscle mass and raise basal metabolic rate [2]. In terms of mental health, physical activity has shown similarly positive results. According to studies, exercise enhances mood and

quality of life while lowering symptoms of anxiety and depression. [3]. Exercise is thought to produce positive psychological effects by modulating the levels of neurotransmitters, such as endorphin release [4]. Additionally, cognitive functioning has been associated with physical activity, helping to prevent or delay cognitive decline [5]. However, the effects of physical activity are also influenced by individual differences, type of activity, frequency, duration and intensity. For example, some studies have suggested that high-intensity interval training (HIIT) may be more effective in improving cardiorespiratory fitness and reducing body fat compared to continuous aerobic exercise [6]. Moreover, the benefits of physical activity for mental health may vary based on cultural and socioeconomic contexts. suggesting that we need to consider these factors when promoting physical activity [7]. Health outcomes and physical activity engagement are also significantly influenced by socioeconomic factors. According to research, those from lower socioeconomic backgrounds may have more obstacles to engaging in physical activity, such as a lack of funds, time, or expertise [8]. In addition, differences in cultural backgrounds can affect the way physical activity is chosen and practiced, which in turn affects its health outcomes [9].

Of course, not all physical activity is good for the body, and we must pay attention to the mix of intensity and quantity because it is evident that physical activity has a variety of intricate consequences on health. First of all, excessive physical activity may indeed have adverse effects on health. For example, excessive exercise may lead to damage to multiple organs and systems in the body, including immunosuppression, rhabdomyolysis, and even sudden death [10]. In addition, prolonged extreme endurance training, such as marathons, ultramarathons, and long-distance triathlons, may lead to cardiovascular damage [11]. According to this research, while moderate exercise is good for your health, excessive physical activity may pose health risks. On the other hand, the absence of physical activity has been recognized as a substantial health risk. Reduced physical activity markedly elevates an individual's chance of acquiring type 2 diabetes. Obesity and cardiovascular disease [12]. Additionally, the absence of physical activity is considered one of the most significant health risks in modern society [13]. However, some research indicates that physical exercise may adversely affect adolescents' health behaviors. For example, one study found that school- and community-based sports programs may have a significant impact on adolescents' healthy habits [14]. In addition, the more frequently middle school students participated in physical activities, the greater the odds of increasing multiple health-hazardous behaviors [15]. Although moderate physical activity has many benefits for our health, excessive physical activity and lack of physical activity can negatively affect our health.

There is room for improvement in the aforementioned study on how sports affect both physical and mental health, encompassing the subsequent domains:

Epidemiologic research methods were frequently not used in early studies to analyze the impact of physical activity on health [16]. This has led to an incomplete understanding of the relationship between physical activity and health, particularly in terms of under-measurement of risk exposure, injury incidence, and benefits. Despite the fact that sports are known to improve health, there is inconsistent data on how various forms and intensities of physical activity affect well-being. For example, the effects of the distinctions between contact and non-contact sports, and between

popular and elite sports, in terms of the 'cost' to health, need to be studied in greater depth [17]. Notwithstanding the prospective health advantages conferred by physical activity, there is still a lack of research on the possible long-term consequences of participation in physical activity, such as the increased risk of osteoarthritis following sports injuries [18]. Insufficient research on specific populations: There is a limited number of studies examining the correlation between physical exercise and health in particular populations, such as adolescents and graduate students [19,20]. These studies contribute to a better understanding of how physical activity affects the health of different age groups. Even though there is ample proof that regular exercise can help prevent or treat a variety of chronic health issues, there is significant variation among recommendations for appropriate minimum weekly physical activity levels, which makes it more difficult for the public and healthcare providers to accept this message [21]. In addition, there are some misconceptions concerning the correlation between physical activity and well-being, such as the theory that competitive sport is harmful and exaggerating the role of sport on health [22]. These misconceptions may mislead people's perception of and participation in physical activity. In summary, research has established that physical activity enhances human health [23–25], but there is still a need to further strengthen the application of empirical research methods, expand the field of research, and address the shortcomings in the existing research results [26].

This study examines the relationship between sports and health, specifically investigating the impact of physical activity on both physical and mental well-being, as per the literature analysis above, and analyzes how physical activity can be used as a positive way of life to enhance the quality of life of individuals as well as to prevent and alleviate a variety of health problems. And this study is to comprehensively analyze the research results on the relationship between physical activity and health at home and abroad and make a comparative analysis of them. Additionally, it thoroughly examines how physical activity affects both mental and physical health, not only focusing on the direct physiological effects of physical activity, but also exploring in depth the mechanisms of its effects on mental health. In addition, by comparing the results of studies from different age groups and background populations, this paper provides a more comprehensive perspective.

2. Literature review

2.1. The correlation between athletics and psychological well-being

Physical activity has numerous positive effects on mental health. Research indicates that physical activity effectively treats clinical depression and somewhat alleviates anxiety and depressed symptoms [27]. In addition, physical activity enhances self-image, improves mood states, enhances the ability to cope with stress, and improves sleep quality. These effects are not limited to patients with clinical or subclinical depression and anxiety disorders but also apply to the general population. There is a reciprocal association between mental health and physical activity. On the one hand, exercise enhances mental well-being., and on the other hand, a good state of mental health promotes physical activity participation [28]. For instance, playing sports helps adolescents' mental health, and adolescents who are in good mental health

are more likely to play sports [29]. In addition, the benefits of physical activity on mental health have been shown to increase self-esteem, improve social skills, and improve cognitive functioning [30]. These benefits not only help to improve an individual's mental health, but also their social adjustment and quality of life [31].

Furthermore, numerous studies have demonstrated that physical activity significantly affects the course of treatment for clinical depression and anxiety disorders. First, exercise can effectively lessen anxiety and depressive symptoms. For instance, one study discovered that aerobic exercisers had lower post-intervention depression levels than a stretching control group, and that the serotonin level drop was comparable to the effects of selective serotonin reuptake inhibitors [32]. This implies that by raising serotonin levels, exercise may benefit the treatment of anxiety and depression. Additionally, exercise can enhance mental health by lowering anxiety and depressive symptoms, improving sleep disorders, and promoting good mental character [33]. These effects may be related to the positive physiological and psychological changes brought about by physical activity, such as increased confidence, increased vigor, improved thinking styles, and restoration of self-control over life [34].

However, physical activity's therapeutic effects on depression and anxiety may vary according to individual differences. For example, one study found that a sustained state of low physical activity increased the risk of high levels of anxiety and depression [35], while another study pointed out that the therapeutic effect of physical therapy for different degrees of psychological disorders varied, with better intervention for moderate or severe symptoms than for mild symptoms [36]. This implies that the length and level of physical activity may significantly affect the results of treatment.

Physical activity positively affects the treatment of depression and anxiety disorders through a variety of mechanisms, including by increasing serotonin levels and improving mental health and physiological status. However, in order to achieve optimal therapeutic effects, individual differences need to be taken into account, including duration, intensity, and type of exercise, as well as possible individual psychological and physiological characteristics. When people engage in physical activity, they often choose different physical activities according to their individual interests and health needs. Nonetheless, the illogical distribution of social resources and prejudice in the promotion of physical activity and sports may prevent individuals from accessing the most appropriate exercise for their needs [37]. This is a problem that we must recognize exists. At the same time, we need to pay attention to the fact that some studies have pointed out that sports activities may bring some negative psychological effects, such as sports addiction caused by overtraining. Specific manifestations of exercise addiction due to overtraining include increased exercise volume, withdrawal symptoms, euphoria, and relapse [38]. Exercise addicts may experience frustration and depression, decreased sleep quality, and anxiety as a result of not being able to exercise. In addition, exercise addicts may prioritize exercise over family, work, and relationships [38]. Exercise addiction may also lead to negative physical and psychological effects, such as widespread negative effects on the neuroendocrine, immune, cardiovascular, and musculoskeletal systems [39]. Therefore, when we do physical exercise, we not only need to face up to the benefits brought to us by sports but also need to grasp the negative effects of physical activities

on the body through effective methods and choose the way that suits us according to the time and place. With the development of the concept of health, people's understanding of health has changed from a single biological health to a multidimensional view of health that includes physiological, psychological, and social [40]. Therefore, the contribution of sport to health also needs to be considered from this multidimensional perspective. Not only should the focus be on mental health, but the multidimensional relationship between sport and health needs to be grasped at the same time. In conclusion, when dealing with sports, the relationship between sports and health should be examined with a dialectical perspective, and at the same time, nowadays, the problem of irrational distribution of social resources is also a problem that we must pay attention to.

2.2. Relationship between sport and physical health

The dialectical connection between health and sport: There is a complex dialectical relationship between sport and health. On the one hand, sports and physical education are seen as crucial tools for advancing health., which can improve the physiological, psychological, and social adaptability of human beings [25,41]. Conversely, excessive physical activity or irrational training methods may lead to injuries and even affect the long-term physical health of athletes. Physical activity significantly influences physical health. The risk of illnesses such as coronary heart disease, hypertension, type 2 diabetes mellitus, osteoporosis, colon cancer, anxiety, and depression is considerably decreased by regular physical activity [42]. Regularly active people have roughly half the risk of coronary heart disease, in particular, compared to sedentary people. Furthermore, physical activity has been linked to longevity and overall mortality, and studies by Harvard alumni have shown that those who are regularly physically active have a significantly lower mortality rate than those who are inactive [43].

Furthermore, exercise enhances coronary artery endothelial function. Exercise training enhances endothelium-dependent vasodilator activity in coronary arteries, according to studies., which is particularly important in patients with coronary artery disease [44]. Improved endothelial function helps to maintain normal vascular function and reduces vascular resistance, lowering the chance of developing heart disease. By altering cholesterol levels, physical activity lowers the risk of coronary heart disease. Exercise reduces low-density lipoprotein (LDL) and increases high-density lipoprotein (HDL), thereby improving the lipid profile. LDL is a significant cardiovascular disease risk factor., whereas HDL helps to remove cholesterol from blood vessel walls and reduce the risk of atherosclerosis. In addition, physical activity can help control weight and improve insulin sensitivity. Obesity is a notable risk factor for coronary heart disease, and exercise can promote energy expenditure and help to reduce body weight [45]. Exercise also lowers the risk of diabetes mellitus, a significant risk factor for cardiovascular disease, and increases insulin sensitivity. Physical activity also improves the inflammatory state. Research indicates that exercise is associated with a reduced risk of cardiovascular disease via decreasing inflammatory markers such as white blood cell count and C-reactive protein [46]. By

reducing the inflammatory response, exercise helps to reduce the risk of cardiovascular disease.

Physical activity also improves quality of life and reduces psychological stress, factors that are also strongly associated with cardiovascular health. A good psychological state and quality of life help maintain the health of the cardiovascular system. In terms of cardiovascular health, the health benefits of physical activity are widely recognized, particularly for the cardiovascular system. Research indicates that physical activity markedly decreases the risk of cardiovascular disease and related mortality [47]. In addition, different types of training sport activities (e.g., long-distance running, sprinting, handball) have different effects on athletes' perceived effort, time-limit estimation, and heart rate in extreme endurance sports [48]. In terms of musculoskeletal health, although physical activity contributes to cardiovascular fitness, it may also have some negative effects, such as musculoskeletal injuries, especially in childhood and adolescence. These injuries may affect quality of life later in life, restricting the capacity for pain-free movement and physical fitness activities [18]. In terms of body composition, various forms of exercise exert distinct influences on adipose tissue and lean body mass. For example, resistance training increases lean mass in normally adipose participants, whereas aerobic exercise primarily affects fat mass [49]. In addition, specific types of exercise (e.g., martial arts, fitness qigong) have a significant effect on body shape indicators such as waist-to-hip ratio and scapular skinfold thickness in older adults [50]. Nevertheless, while sports positively influence physical health, improper activity patterns adversely affect it. Musculoskeletal injuries during physical activity are an important consideration. Evidence suggests that children and adolescents may suffer musculoskeletal injuries while participating in physical activity, and that these injuries may limit their mobility and ability to experience pain-free mobility later in life [18]. In addition, even in the absence of injury, children and teenagers who participate in sports and fitness activities excessively may be more susceptible to osteoarthritis in the future [18].

Participants in elite sports may potentially experience detrimental effects on their health and well-being. Participating in competitive sports may make pre-existing health issues worse, increasing the risk of injury and even death, according to the evidence. Furthermore, typical training and competitive methods in some sports cultures may be detrimental in and of themselves. [51]. The adverse effects of high-intensity sport on human health should not be ignored. Studies have found that high-intensity sports may lead to problems such as immunosuppression and joint damage. Even though skeletal muscle metabolism and the prevention and treatment of chronic diseases benefit from high-intensity intermittent exercise, it's crucial to comprehend the benefits and drawbacks of this type of exercise for human health, as well as its effects on human functions and safety, in order to participate in high-intensity exercise in a positive way and prevent negative effects on the body [52]. Long-term extreme endurance training, such as marathon, ultra-marathon, and long-distance triathlon, may lead to cardiovascular damage. Such extreme, prolonged, or intense training is not a healthy form of exercise [11].

In today's society, physical activity has become an integral part of people's daily lives. It not only helps to improve physical fitness but also enhances mental toughness, which has a positive impact on health. However, excessive or inappropriate physical

activity can have adverse effects such as musculoskeletal injuries, mental health problems, and potential risks to certain populations, especially elite athletes. Understanding the complex relationship between sport and health has therefore become particularly important. At the same time, over-participation in high-intensity or extreme endurance training may adversely affect cardiovascular health. Studies have shown that prolonged high-intensity endurance training, such as marathons and ultra-marathons, may lead to pathological structural remodeling of the heart and large arteries. In addition, high-intensity endurance workouts such as marathons can trigger right ventricular damage and may accelerate cardiac aging. These studies suggest that even exercises aimed at enhancing physical endurance and cardiorespiratory fitness should follow certain scientific guidelines and the principle of moderation. The second benefit of physical activity is that it helps people become more mentally and physically fit. High-intensity interval training is believed to enhance mental resilience and assist in the prevention and management of chronic diseases, in addition to facilitating skeletal muscle metabolism. However, this does not mean that all forms of physical activity are beneficial. There is a need to provide a rational program of physical activity that is tailored to individual differences and the social context to avoid the risks associated with excessive or inappropriate exercise. The impact of cultural and socio-economic factors on physical activity should not be overlooked as well. With the advancement of the economy and the enhancement of societal living standards, there is an increasing demand for sports consumption. At the same time, health has become a cultural purpose and a standard of evaluation, as well as being closely related to economic development. Therefore, the promotion of physical education and sports should take full account of the socio-economic conditions and the guiding role of sports culture to ensure the popularity and sustainability of sports activities.

In conclusion, there are many facets and complexities to the relationship between sport and health. We must understand how sports and health are dialectically related. The relationship between competitive sports and health, socioeconomic factors' impact on athletic activities, and the guiding role of sports culture on the people, etc. Only through an in-depth understanding of the study of the relationship between sports and health from a multidimensional perspective, combining physiological and psychological factors, as well as the influence of cultural and economic factors, can we better guarantee the positive benefits of sports activities while circumventing potential problems. It is only through an in-depth understanding of the relationship between sport and health, incorporating physiological and psychological factors, as well as cultural and economic factors, that we can better safeguard the positive benefits of physical activity while avoiding potential risks and providing the public with appropriate physical activity and a healthy lifestyle. This requires us to pay attention to the health benefits of sport, but also to be alert to the possible negative impacts and to take appropriate preventive and intervention measures in order to realize the optimal benefits of physical activity.

3. Materials and methods

3.1. Research design for the impact of sport on health

In order to better understand the research situation of sport on human health, the article selects Thomson Reuters' Web of Science™ core collection, applies bibliometric methods, and adopts CiteSpace visualization technology to analyze the research lineage of sport on physical and mental health, research topics, research hotspots, research institutions, and authors, and so on, by combing the status of the research in order to better detect the future research. Citespace visualization technology is a flexible technique for identifying and illustrating new trends and ephemeral patterns in scientific literature. The technology was developed by a Chinese scholar, Chaomei Chen, in 2004, and with its powerful and advanced features, the software has gained wide application and attention at home and abroad [53]. The main contribution of CiteSpace is its ability to algorithmically and temporally identify the nature of the intellectual base, explicitly explain the value of co-cited clusters, and significantly reduce network complexity through visually salient and algorithmically detected key points [54]. The main functions of CiteSpace include the analysis of research frontiers and research hotspots based on knowledge graphs, scientometrics, and citation analysis. Analysis of author collaboration networks, author co-citation networks, and keyword co-occurrence networks, etc. [53]. Through these functions, CiteSpace can help researchers to clearly show the knowledge structure and distribution law and assist knowledge discovery [55]. All things considered, CiteSpace is an effective information visualization tool that, by recognizing and illustrating novel trends and transient patterns in scientific literature, aids researchers in comprehending the knowledge structure and development trend of their subject., thus providing an important basis and reference for future research [54,55]. The Web of Science™ core collection encompasses (Science Citation Index Expanded™ (SCI-EXPANDED), Social Science Citation Index (SSCI), the Arts & Humanities Citation Index™ (A&HCI), Conference Proceedings Citation Index-Science™ (CPCI-S)). More than 110,000 worldwide conference journals and over 10,000 globally renowned, high-impact journals are included in the database., covering a wide range of disciplines such as science, technology, humanities, and other fields, and it is highly authoritative [56]. The article is based on TS = ("sports" OR "physical activity" OR "exercise") AND TS = ("human health") as the subject; the search was set for the period 1965–2024; the type of literature was essays and review papers; the language of literature was English; and a total of 1683 documents were retrieved, with the earliest document appearing in 1996.

3.2. Research years

One key metric for assessing the success of research in a field is the shift in the number of publication times. The research stage and its dynamic progress might be reflected in the distribution of publications, which is of great significance for predicting the future trend (as shown in **Figures 1** and **2**) [57]. effects of sport on human health from 1996, authors Brines et al. [58] for the first time linking sport and human health, combined with the lifecycle theory, research on how sport affects human health began to take shape and expanded quickly; from 2002 until the growth peaked in 2022, this stage is a rapid growth stage, although some years in the middle of a slight drop back, but overall in the growth stage. From 2002 until 2022, when

growth reaches its peak, this stage is a rapid growth stage, and although some years in the middle fall back a little, the overall growth is in a state of growth; from 2022 to 2024, the research gradually begins to slow down from rapid growth, and except for a slight decrease in 2024, the whole remains relatively stable, and the application of the principle of the life-cycle cosine function curve shows that the research has entered the maturity stage.

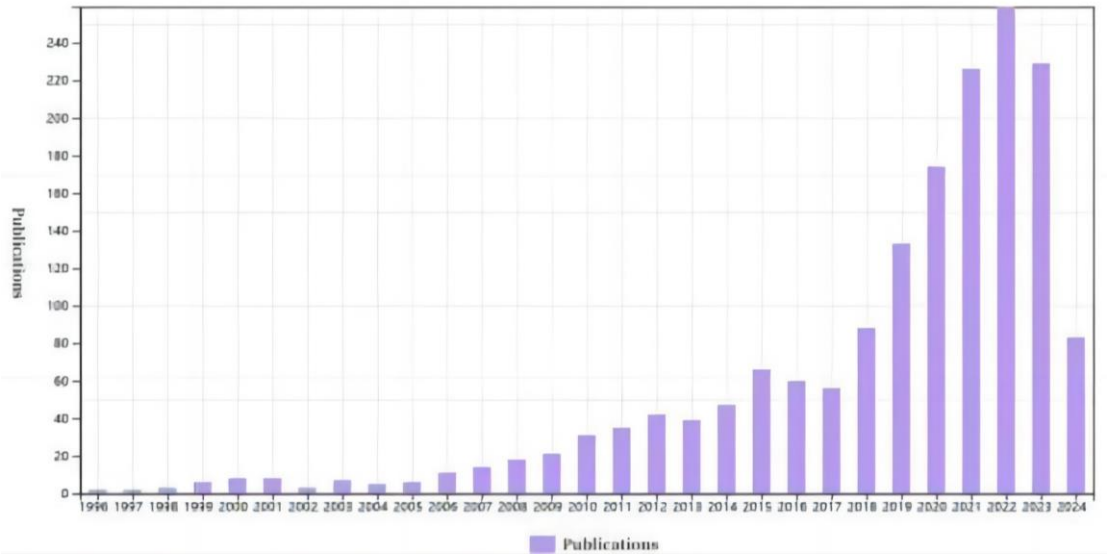

Figure 1. Temporal overview of literature publications.

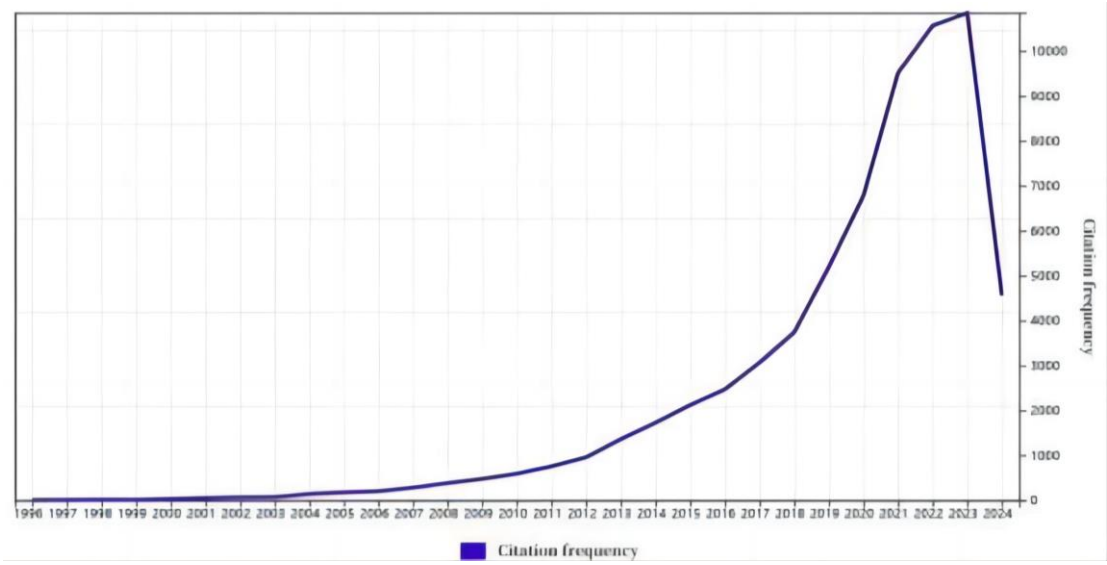

Figure 2. Temporal overview of citation frequency.

3.3. Field of research

During the period 1996–2024, research related to the impact of sport on human health is mainly concentrated in 40 disciplinary research directions, and the issuance of papers is more concentrated in 10 research areas (as shown in **Figure 3**), of which, Ecology of Environmental Sciences, Ecology of Public Environmental Sciences, Environmental Sciences, Public Environmental Occupational Health and Other Topics in Science and Technology (Science, Technology, Other Topics) accounted for the

largest proportion of 25.9%, 15.9%, 8.9%, respectively, belonging to the important areas of research on the impact of sports on human health, these three disciplinary areas have exceeded the number of articles issued. The number of papers issued in the three subject areas has exceeded the total number of 854, which fully shows that there is a crossover in the disciplines to which the existing papers belong, and the published papers not only belong to a certain discipline, but also belong to another discipline or several disciplines at the same time, for example, the highest-ranked related papers in the environmental sciences also belong to the disciplinary areas of public environment and occupational health, and at present there are many disciplines other than the environmental sciences, the public environment, and the sciences , indicating that mobile new media research involves more disciplinary fields, and inter-disciplinary cross research is an important feature of research in this field.

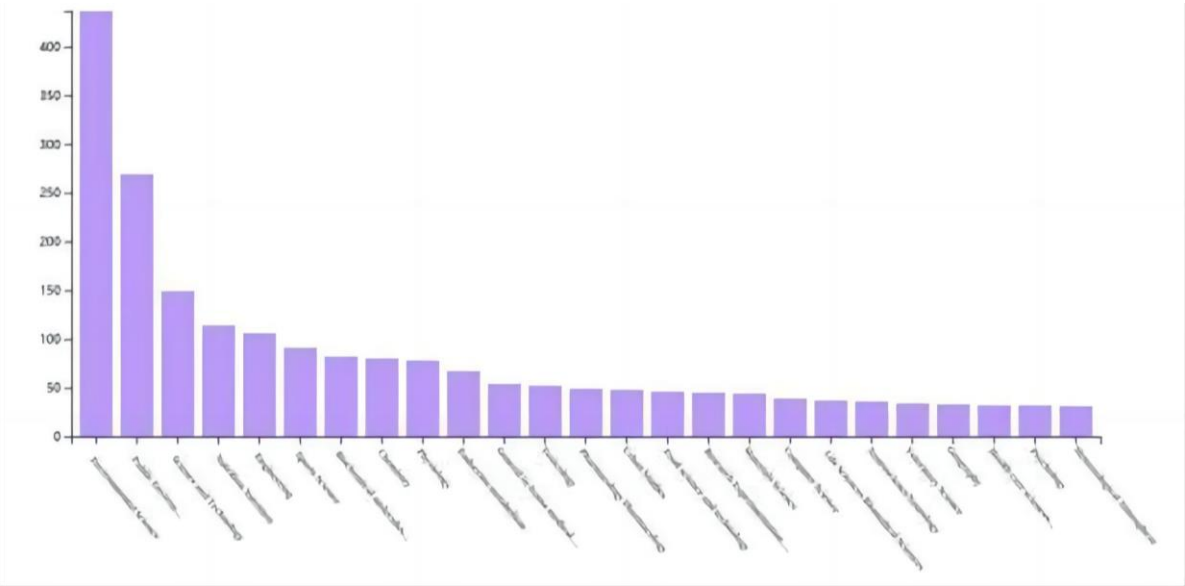

Figure 3. Main research subject areas.

3.4. Research samples

Citation is a reflection of literature being recognized and accepted, and citation frequency is an important criterion for judging the value of literature, as well as evaluating journals, disciplines, regions, authors, and units for which there is no alternative evaluation method for the time being [59]. Highly cited literature represents the research themes and hotspots of the field in a certain period of time and has strong academic value, which is called “high-frequency citations” [60]. Through the citation frequency statistics of the mobile new media research literature, we derive the top five highly cited papers among them.

The most cited is Bandura [61]; the author explores health promotion and disease prevention from the standpoint of social cognitive theory. According to the idea, human motivation, behavior, and well-being are governed by self-efficacy beliefs in conjunction with goals, outcome expectations, and perceived environmental obstacles and supports. One frequent method that psychosocial influences impact health functioning is through belief in the effectiveness of one’s exercise of control. Every essential process of personal transformation is shaped by this core idea, including

individuals' contemplation of altering their health-related behaviors, the extent of their willpower and resolve to achieve success, their resilience in recovering from setbacks and relapses, and their ability to maintain the behavioral modifications they have implemented.

Wolch et al. [62] examine the Anglo-American literature regarding urban green spaces, particularly parks, and contrast the greening initiatives in American and Chinese cities. The majority of research indicates that white and wealthier areas tend to gain disproportionately from the distribution of these places. Access to green space is therefore becoming more widely seen as an environmental justice concern. Urban dwellers' general health, mental well-being, and physical exercise can all be enhanced by green space.

Hewlings et al. [63] elucidate the effects of turmeric on exercise by discussing its role in helping to manage oxidative and inflammatory disorders, metabolic syndrome, arthritis, anxiety, and hyperlipidemia. Additionally, it might help control inflammation and muscular pain brought on by exercise, which would assist sedentary persons in recovering and performing better.

Sharifi et al. [64] critically review the biophysical-chemical characteristics of several nanomaterials, with an emphasis on the toxicological data and techniques for determining the toxicity of nanoparticles that are now accessible.

Di Renzo et al. [65], in the article, for the inaugural instance, present information regarding lifestyle, exercise habits, eating habits, and compliance with the Mediterranean dietary pattern of the Italian population during the COVID-19 lockdown.

As the top five most cited articles (**Table 1**), the whole is based on lifestyle to analyze the impact of exercise on human health, meeting the research on the impact of sport on human health through the continuous improvement and expansion of perspectives, and gradually analyzing the human body's need for exercise in terms of the environment and diet on this basis.

Table 1. Top five highly cited papers.

	Paper titles	Author	Date of Publish	Citation frequency
1	Health promotion by social cognitive means	Bandura A	2004	4196
2	Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'	Wolch JR (Wolch, Jennifer R.); Byrne J (Byrne, Jason); Newell JP (Newell, Joshua P.)	2014	2287
3	Curcumin: A review of its effects on human health	Hewlings SJ (Hewlings, Q. Susan J.); R. Kalman DS. (Kalman, T. Douglas S.) Sharifi S (Sharifi, Shahriar);	2017	1300
4	Toxicity of nanomaterials	Behzadi, S (Behzadi, Shahed); Laurent S (Laurent, Sophie); Forrest ML (Forrest, M. Laird); Stroeve P (Stroeve, Pieter)	2012	1043
5	Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey	Di Renzo L (Di Renzo, Laura); Gualtieri P (Gualtieri, Paola)	2020	956

3.5. Research frontier

Research frontiers represent emerging topics or hot trends in the field, which can be reflected through literature co-citation clustering and networks. As displayed in

Figure 4 and **Table 2**, through visualization technology, the literature related to mobile new media is formed into different thematic clusters, and the terminology (frontier terminology) and related literature (frontier literature) are extracted from the clusters to reflect the research frontier. The article chooses TOP50 as the node threshold, obtains the number of co-cited network nodes as 363, the number of links as 563, and the network density as 0.0086. 16 research topics are obtained through network clustering; the Modularity value is 0.832, the Silhouette value is 0.935 [66], and the clustering effect is decent.

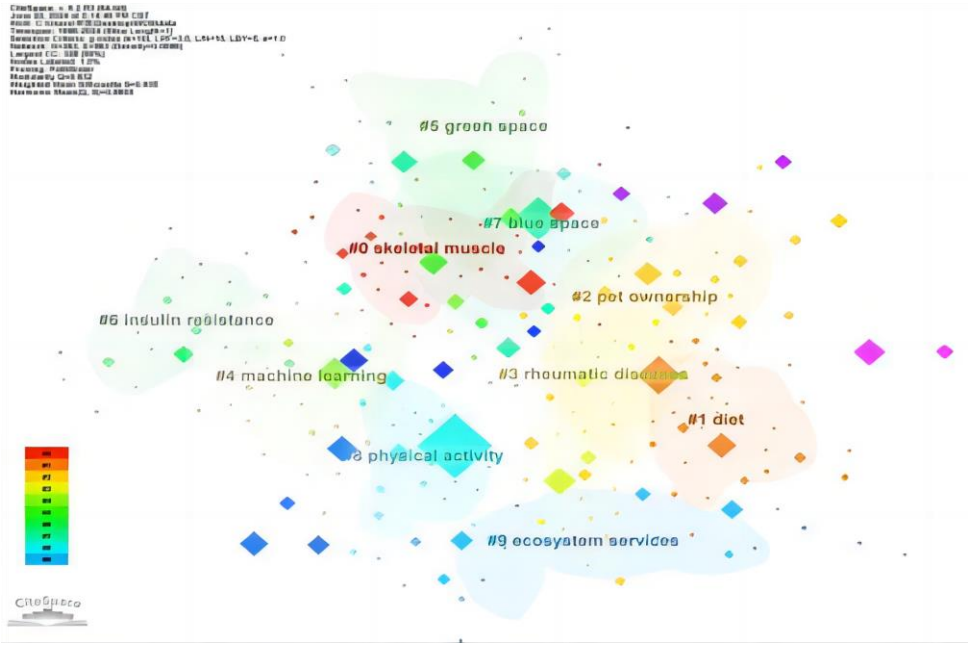

Figure 4. Literature co-citation clustering network.

Table 2. Cluster 0–10 specific information.

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)	Label (MI)
0	32	0.91	2012	skeletal muscle; hydrogen peroxide	skeletal muscle (30.12, 1.0×10^{-4}); exercise (21.24, 1.0×10^{-4}); blood pressure (10.76, 0.005)	metabolomics (0.37); uric acid (0.37); histone pos
1	30	0.927	2008	physical activity; gut microbiome; red blood cells; risk assessment	diet (17.51, 1.0×10^{-4}); ozone (9.98, 0.005); therapy (9.98, 0.005)	energy (0.41); avoidance (0.41); great north run
2	28	0.91	2018	physical activity; health promotion; risk	pet ownership (20.97, 1.0×10^{-4}); dog ownership (12.56, 0.001)	dog-walking (0.45); entheseal changes (0.45); blsa
3	27	0.919	2011	physical activity; autonomic nervous activity; social capital; risk	rheumatic diseases (10.54, 0.005); geriatrics (10.54, 0.005)	rider (0.35); preventive health (0.35); human acti
4	27	0.972	2008	physical activity; machine learning; neighborhood	machine learning (14.53, 0.001); social media (12.05, 0.001)	variable selection (0.31); feeding (0.31); environ
5	23	0.948	2005	green space; human health; urban ecosystem; systematic review insulin	green space (18.66, 1.0×10^{-4}); association (13.26, 0.001); population health (10.54, 0.005) insulin	human studies (0.35); urban ecological restoration
6	23	0.884	2009	resistance; protein metabolism; habitual physical	resistance (22.76, 1.0×10^{-4}); energy expenditure (14.03, 0.001) blue space (14.37, 0.001);	intramyocellular lipid (0.13); myokine (0.13); per landscape

Table 2. (*Continued*).

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)	Label (MI)
7	22	0.988	2013	activity; mental health; landscape physical	qualitative data (13.94, 0.001) physical activity (48.38, 1.0×10^{-4});	metrics (0.51); dog bite (0.51); environ complex
8	21	0.964	2011	activity; urban sustainability; psychologic	cardiovascular disease (13.74, 0.001)	place-based problems (0.69); ardl (0.69);
9	18	0.939	2018	ecosystem services; human health; quantitative	ecosystem services (22.48, 1.0×10^{-4}); built environment (17.29, 1.0×10^{-4})	urban agriculture (0.22); environmental knowledge
10	18	0.898	2015	public health; physical activity; air pollution	public health (39.87, 1.0×10^{-4}); mental health (25.55, 1.0×10^{-4}); heat exposure (10.43, 0.005)	land management (0.36); land-use (0.36); Indonesia

Cluster #0 Skeletal muscle, the largest of the entire network clusters, contains 32 documents with a silhouette value of 0.91 and an average year of 2012., which is very close to the maximum value of 1, indicating that the results formed by this cluster are highly reliable. This cluster focuses on the study of skeletal muscle and also contains the terms exercise, blood pressure, amino acids, and nitrate.

Cluster #1 diet, which is in second place, has 30 documents with an average time of 2008 and a silhouette value of 0.927, which makes the analysis very reliable. This cluster contains the terms ozone (9.98, 0.005), therapy (9.98, 0.005), carbon dioxide (9.98, 0.005), and exercise (9.47, 0.005) in addition to studying diet.

Cluster #2 pet ownership, ranked third with 28 documents with an average time of 2018 and a Silhouette value of 0.91, yielded reliable results. This cluster was obtained by LLR for the clustering feature terms pet ownership (20.97, 1.0×10^{-4}), dog ownership (12.56, 0.001), human-animal interaction (12.19, 0.001), depression (10.68, 0.005), residential greenness (8.23, 0.005), which mainly reflects the value of human-animal interaction and physical fitness.

In addition, the article selects the first-ranked citation sizing literature from each cluster and obtains a total of 11 pieces of literature with no less than 0.25 activity, as shown in **Table 3**, to represent the research frontiers in this field.

Table 3. The 11 papers in the clusters with no less than 0.25 activity level.

Cluster	Coverage	Research frontier literature (Author, Date, Title)
0	22	Labib SM, Lindley S, Huck JJ. Spatial dimensions of the influence of urban green-blue spaces on human health: A systematic review [J]. Environmental Research, 2020, 180: 108869.
1	21	Frumkin H, Bratman G N, Breslow SJ, et al. Nature contact and human health: A research agenda [J]. Environmental Health Perspectives, 2017, 125(7): 075001.
2	20	Marselle M R, Irvine K N, Lorenzo-Arribas A, et al. Moving beyond green: Exploring the relationship of environment type and indicators of perceived environmental quality on emotional well-being following group walks [J]. International Journal of Environmental Research and Public Health, 2015, 12(1): 106–130.
3	12	Cella V, Bimonte V M, Sabato C, et al. Nutrition and physical activity-induced changes in gut microbiota: Possible implications for human health and athletic performance [J]. Foods, 2021, 10(12): 3075.
4	8	Voelker S, Kistemann T. Reprint of: "I'm always entirely happy when I'm here!" Urban blue enhancing human health and well-being in Cologne and Düsseldorf, Germany [J]. Social Science & Medicine, 2013, 91: 141–152.
5	16	Subramaniam R P, Richardson R B, Morgan K T, et al. Computational fluid dynamics simulations of inspiratory airflow in the human nose and Nasopharynx [J]. Inhalation Toxicology, 1998, 10(2): 91–120.
6	7	Higgins J W, Temple V, Murray H, et al. Walking sole mates: Dogs motivating, enabling and supporting guardians' physical activity [J]. Anthrozoös, 2013, 26(2): 237–252.

Table 3. (*Continued*).

Cluster	Coverage	Research frontier literature (Author, Date, Title)
7	13	Yuan J P, Peng J, Yin K, et al. Potential health-promoting effects of astaxanthin: A high-value carotenoid mostly from microalgae [J]. Molecular Nutrition & Food Research, 2011, 55(1): 150–165.
8	11	Dunn JR, Dyck I. Social determinants of health in Canada's immigrant population: Results from the National Population Health Survey [J]. Social Science & Medicine, 2000, 51(11): 1573–1593.
9	9	Di Raimondo D, Tuttolomondo A, Musiari G, et al. Are the myokines the mediators of physical activity-induced health benefits? [J]. Current Pharmaceutical Design, 2016, 22(24): 3622–3647.
10	11	Moffet J. Environmental priority setting based on comparative risk and public input [J]. Canadian Public Administration, 1996, 39(3): 362–385.
11	5	Kaplan S, Kaplan R. Health, supportive environments, and the reasonable person model [J]. American Journal of Public Health, 2003, 93(9): 1484–1489.

Labib et al. [67] as the most active citing literature in cluster #0, accounting for 22% of the cited literature in this cluster and representing the research frontier of cluster #0. The essay primarily addresses the correlation between human health and the urban environment. In the results, the authors provide practical recommendations to build the urban environment and improve human health. The article cites 204 references.

Frumkin et al. [68] serves as the most active citation-giving literature in cluster #1, accounting for 21% of the cited literature in this cluster and representing the research frontier of cluster #1. The authors offer a study agenda on nature contact and health, emphasizing important research areas and important concerns that, if addressed, will serve as the foundation for evidence-based public health initiatives. The publication includes 357 references. The authors contend that there may be several health advantages for people who interact with nature. Despite the abundance of evidence, many things remain unknown. It is possible to produce significant, high-impact public health insights through a thorough research effort that is directed by an emphasis on major open questions.

Marselle et al. [69] as the most active citation-giving literature in cluster #2, occupying 20% of the cited literature in this cluster and representing the research frontier of cluster #2. The findings, which include 106 citations, highlight the significance of more study on the impact of environmental type and quality on well-being as well as the necessity of accounting for the benefits of physical activity in studies on the green movement.

Cella et al. [70] as the most active citing literature in cluster #3, accounting for 12% of the cited literature in this cluster and representing the research frontier of cluster #3. The scientists came to the conclusion that the gut microbiota is a complex, diverse microbial population that is influenced by both endogenous and external influences after citing 193 papers. Exogenous factors that may impact the endocrine system and function as endocrine organs themselves include diet and exercise; they appear to be possible determinants of microbial diversity at both the taxonomic and functional levels. A lack of specific knowledge persists concerning the altered microbial populations and the mechanisms involved. Furthermore, the relationship between the metabolic utility potential of the gut microbiota and microbial transformation remains unclear. In order to determine whether microbiome alteration might be a useful strategy for enhancing human health and athlete performance, as

well as whether these benefits can be extended to the promotion of general population health, more study is required through long-term, carefully planned studies. The authors of this paper evaluate and compile the state of the art regarding the relationships and interactions among hormonal changes, physical performance, and the composition and function of the microbiome.

Voelker and Kistemann [71] as the most active citation in Cluster #4, accounting for 8% of the cited literature in the cluster and representing the research frontier of Cluster #4. The authors offer a thorough analysis of studies on the positive effects of urban blue on well-being and health outcomes. Applying the idea of the extended therapeutic landscape, users of a downtown promenade were observed and questioned. It was determined that essential components of well-being include the physical surroundings, social connections, emotional bonds, and the opportunity to engage in various outdoor activities.

Subramaniam et al. [72] as the most active citation applicator in cluster #5, accounting for 16% of the cited literature in this cluster and representing the research frontiers of cluster #5. It primarily looks at earlier attempts to mathematically mimic nasal airflow characteristics in humans and lab animals, both here and elsewhere. An anatomically precise three-dimensional model of the adult nasopharynx and nasal cavity was created. In order to simulate rest and light motion under steady-state inspiratory conditions (steady-state inspiratory flow rates: 15 L/min and 26 L/min, respectively), the fluid dynamics software package FIDAP was used to solve the Navier-Stokes and airflow continuity equations for airflow using the finite element method. This resulted in simulated airflow streamlining in the major nasal passages, which were complicated in the vestibule and nasopharynx. Two downward countercurrent spiral vortices were created by the nasopharynx expanding, and swirling airflow and circulation flow were anticipated in the nasal vestibule. The medial nasal tract was the main area where significant lateral flow was seen. Distribution of flow between the two simulated inspiratory rates, certain nasal regions stayed nearly constant. The area around the posterior nasal valve had the fastest blood flow. The ventral and medial areas of the major nasal airway had the highest air velocities. The pressure drop and computed nasal velocity field generally match experimental findings reported in the literature. The model is developed for assessing alterations in airflow and nasal resistance resulting from prevalent surgical and medical conditions, as well as to lessen ambiguity in human health risk evaluations for drugs inhaled.

4. Research topics on the effects of exercise on physical and mental health

4.1. Context

Examining the time zone view of the keywords related to the effects of sport on mental and physical health reveals that the topic of study has been shifting nearly annually. Considering how frequently the theme words occur, as shown in **Table 4**, the topic words of the previous years were counted and summarized.

Table 4. Frequency of occurrence of subject terms.

Keywords	Year	Strength	Begin	End
particulate matter	2020	8.21	2020	2022
pet ownership	2011	6.67	2011	2020
green space	2010	6.59	2013	2018
skeletal muscle	2011	5.94	2012	2016
inflammation	2022	5.77	2022	2024
human skeletal muscle	2009	5.21	2009	2017
cancer	1999	4.86	2014	2019
biodiversity	2015	4.86	2015	2019
dog ownership	2010	4.78	2010	2020
quality	2013	4.73	2022	2024
population	2022	4.61	2022	2024
urban	2019	4.54	2019	2021
urban green space	2021	4.53	2021	2022
companion animals	2018	4.48	2018	2019
climate change	2012	4.38	2019	2021
gene expression	2010	4.38	2010	2016
community	2003	4.27	2003	2014
therapeutic landscapes	2013	4.23	2013	2015
validation	2022	4.22	2022	2024
pollution	2022	4.22	2022	2024
coronary heart disease	1998	4.07	1998	2016
natural environments	2020	4.07	2020	2021
environment	2016	4.06	2016	2017
insulin sensitivity	2020	4	2020	2021
physical exercise	2016	3.84	2020	2022
health benefits	2021	3.78	2021	2022
pm2.5	2021	3.78	2021	2022
green spaces	2019	3.73	2019	2022
united states	2018	3.68	2022	2024
natural environment	2013	3.63	2013	2015
residential greenness	2020	3.61	2020	2021
mental health	2015	3.51	2017	2018
public health	2008	3.44	2015	2018
expression	2013	3.42	2022	2024
oxidative stress	2010	3.42	2018	2019
gut microbiota	2017	3.41	2021	2024

4.2. Topic evolution

To more thoroughly examine the development and evolution of the relationship between sport and health through the relevant literature between 1996 and 2024, and combining the key theme terms formed in each year, the research themes and their

evolution are mainly focused on three aspects: Encompassing the initial phase of examining the effects of sport on physical and emotional well-being, the middle stage of study on the relationship between sport and health, and the current level of achievement on the relationship between sport and health.

Combined with the knowledge map of the impact of sport on health formed by the visualization technology (shown in **Figure 5**), it can be clearly seen that the mobile new media has belonged to the stage of theme formation since 1997. The largest circle, according to the mediated centrality, represents the early development of the theme field with exercise at its core. This suggests that the theme co-occurs more frequently in the early stages and that the related theme content is more concerning. The circle's color indicates that the theme is still a hotspot for research today. The circle's hue indicates that the topic is still a popular area for research today. The connecting lines between the colors and themes indicate that the circles are reasonably near to one another, especially from the early formation to the middle stage. The connecting lines are the closest, indicating that the middle stage themes are based on the early themes and come from them. The analysis in **Table 5** shows that some themes will be closed in less than 2024, while some themes are still hot in research, such as (inflammation), (quality), (population), (United States), (expression), and (gut microbiota).

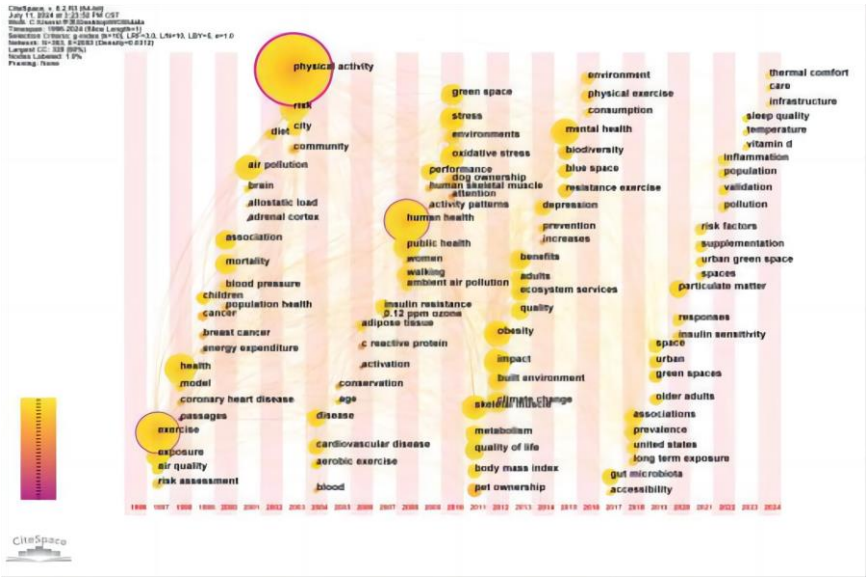

Figure 5. Knowledge map of the effects of sport on physical and mental health.

Table 5. Values of key research hotspots bursts.

Sequence	bursts	Research hotspots
1	8.22	particulate matter
2	7.14	green space
3	6.93	pet ownership
4	6.22	skeletal muscle
5	5.77	inflammation
6	5.27	human skeletal muscle
7	5.05	biodiversity
8	4.99	dog ownership

4.3. Research hotspots on the effects of sport on physical and mental health

4.3.1. Research hotspots

Keywords are the core of the research topic, while the relationship status between keywords can reflect the degree of attention to keywords and in this way, reflect the research hotspots in the field. Knowledge network mapping is drawn by visualization technology, and the research hotness is reflected by nodes; node size is the reflection of frequency, the node connecting line is the reflection of relationship degree, and node color is the reflection of attention degree.

4.3.2. Research on key hotspots

In order to better understand the hotspots of mobile new media research topics, combined with visualization technology, it is reflected by the burst value, which reflects the hotspots in the research frontiers through the red color of the origin. As shown in **Figure 6**, 2020 particulate matter, as the research subject of the article, is the darkest color of the node in the whole knowledge graph, and the connecting line with it is relatively thicker than the others, which indicates that it has the greatest influence.

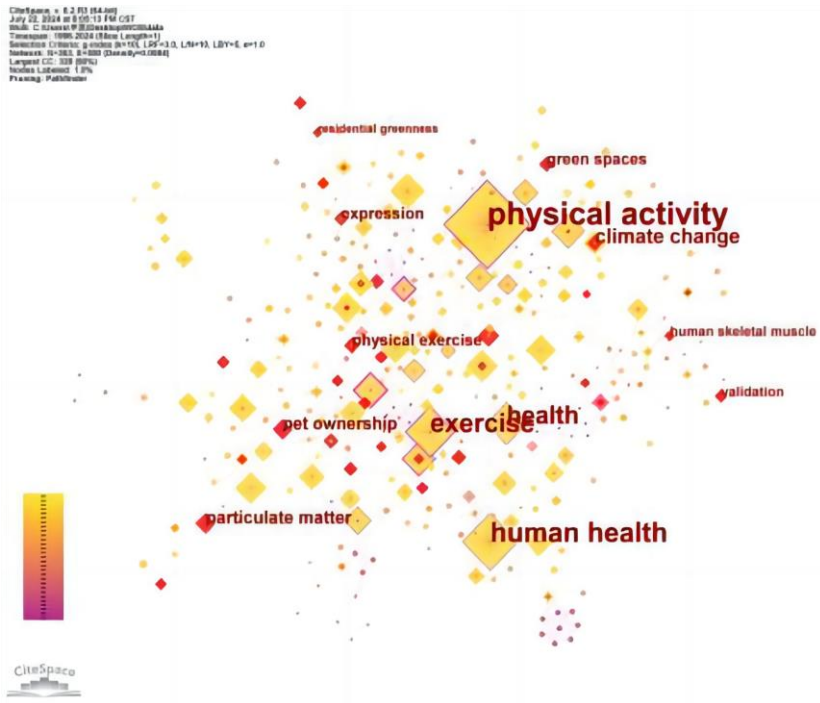

Figure 6. Key research hotspots.

Combined with the relevant indicators, eight keywords were comprehensively selected as the research hotspots in this field, which are basically consistent with the evolution of the research themes, as shown in **Figure 6**, such as green space, dog ownership, and human skeletal muscle in the early period, focusing on the process of researching the impact of the environment on physical and mental well-being; pet ownership, skeletal muscle, and biodiversity are more focused on the physical aspects of the impact of exercise on physical and mental health; and particulate matter and

inflammation in the current period are more focused on the narrative of health at the micro level.

5. Discussion

The research attributes about the influence of sports on health can be examined from various perspectives., including the time span of research, the diversity of research objects, the evolution of research methods and the application of research results. Starting from 1996, the impact of sport on physical and mental health has gradually developed into an emerging research field after 28 years of development, with an average of nearly 100 articles published each year, and has developed from the early growth stage to the mature stage, forming its own unique research characteristics.

In terms of time span, early studies focused on the potential benefits of physical activity on human health, such as the 1966 study that emphasized the fact that the effects of sports and recreational activities on health are not yet fully understood and that more epidemiological research techniques are needed to explore these effects [16]. In recent years, research has focused more on the specific mechanisms and effects of physical activity; for example, a 2011 study detailed the promotion of physical activity on physical and mental health and its mechanisms [73].

The diversity of research objects is also an important feature of sport health impact research. Whereas earlier studies may have focused more on specific populations or specific types of sports, modern studies have covered populations ranging from children to the elderly and from culturally diverse populations to a variety of occupations. A 2009 study demonstrated that physical activity positively influenced physical health., mental health, social health, and overall health of graduate students [24].

Third, the evolution of research methods is also a notable feature. While early studies may have relied on observational studies or small-scale experimental designs, modern studies have adopted more sophisticated and refined methods, such as the use of ultrasound to test bone density to study the relationship between sport and bone health [74]. This advancement in methodology has led to more accurate and reliable research results.

The application of findings is also an important aspect of sport health impact research. As research progresses, more and more evidence supports the use of physical activity as an effective means of preventing and treating a wide range of diseases. For example, the 2021 study showed a positive association between regular physical activity and high levels of physical strength, good mental health status, and standard body weight [75].

Not only that, the research themes are more focused. Although the effects of physical activity on physical and mental health have evolved over the past decade or so and numerous research themes have been developed, they still evolve and develop around the physical activity theme that was developed in the early days. Moreover, it can be clearly recognized from the connection between the themes that, although it has experienced several important theme transitions in the process of research development, it still develops in the original field and does not enter into new fields,

which belongs to the theme breakthrough of the research foundation. In addition, the time of the cited literature shows that the early research foundation still has a strong influence on the current research. All these factors fully indicate that the research theme is more concentrated and has not yet formed a diversified development.

In addition, research specialties are more diverse. Through relevant searches and analysis of the Thomson Reuters Web of Science™ Core Collection, the research on the impact of sport on physical and mental health involves 37 disciplines, which is broader in scope and far beyond the academic background of a single discipline. In addition, the research literature shows that much of the research literature shows the phenomenon of disciplinary intersection, belonging to multiple disciplinary fields, which is more consistent with the impact of sport on physical and mental.

Finally, the research hotspots are also more diversified. By summarizing and analyzing the hotspots at each stage of the impact of sport on physical and mental health from 1996 to 2024, it is found that the hotspots of research in the early period are mainly reflected in the macro field; for example, exercise is obviously the perspective of the macro field. With the continuous maturity of technology, the research perspective slowly progresses to the micro level, for example, human health in 2008, with the continuous deepening of the content, the impact of sports on physical and mental health from the growth of the development to maturity, and with the development of the Internet gradually penetrating into all areas of society, the original perspective has been unable to meet the needs of the community, and the hotspot of the current research focuses on mental health and cellular health. Health. The research hotspots fully show the diversified development of sports research on physical and mental health.

In conclusion, research on the impact of sport on health is a constantly developing and deepening process, involving a wide range of research fields and methods, with the aim of providing scientific guidance and advice to the public in order to promote overall health and well-being.

6. Conclusion

6.1. Key findings on the impact of sport on health

Sport’s effects on mental and physical health have been extensively studied, covering a wide range of effects from physiological to psychological. Based on the literature retrieved in this paper, we can summarize the positive and negative effects of physical activity on physical health and mental health, and discuss the innovations and limitations of this study.

Positive effects: Sports can significantly improve the physical health of individuals, including improving lung capacity, heart function, and promoting bone and muscle growth.

Especially for adolescents and college students, sports can not only reduce psychological pressure, prevent and treat psychological diseases, but also improve self-confidence and self-knowledge, emotions and interpersonal relationships. At the same time, sport has a significant positive impact on mental health, including improving students’ self-perception, helping them regulate their emotions correctly, improving their interpersonal relationships, and cultivating their goodwill quality. In

addition, physical education and sports can gradually eliminate the negative factors in people's psychology by improving their mental health and cultivating their tough will quality.

Negative effects: Despite the many benefits of sports to physical health, there are also certain risks, such as sports injuries, fatigue caused by overtraining, and sports addiction. In addition, sports may also bring about some negative effects, including the possible development of low self-esteem, fear of competition, rudeness, and irritability. In addition, extreme physical activity may have a negative impact on the mental health of athletes.

In summary, physical activity has significant positive effects on an individual's physical and mental health, including mood regulation, reducing depression and anxiety, promoting personal development, and improving quality of life. Notwithstanding the positive effects of physical activity, there are some potential adverse effects, such as overtraining that may lead to sports injuries or other health problems. Therefore, in order to maximize the benefits of exercise while reducing potential risks, participants should follow a scientific approach to exercise that focuses on moderation and safety. By taking into account individual circumstances and social environments, we can achieve the optimal benefits of physical activity.

6.2. Innovations and limitations of this study

This study's novelty lies in its thorough examination and comparative analysis of domestic and international research findings on the connection between physical exercise and health. It also comprehensively analyzes the effects of physical activity on physical and mental health, not only focusing on the direct physiological effects of physical activity but also exploring in depth the mechanisms of its effects on mental health, such as the role of mental toughness [76]. In addition, by comparing the results of studies from different age groups and background populations, this paper provides a more comprehensive perspective.

This paper's weakness is that, despite extensive research on the effects of physical activity on mental health, the specific mechanisms regarding the effects of different types, intensity, frequency and duration of physical activity on mental health still need to be further explored [77]. In addition, there is a high risk of bias in treatment trials in existing studies, which limits the general applicability of the results [78]. At the same time, the lack of data from long-term follow-up studies prevents us from fully understanding the long-term effects of physical activity and sport on individual health impacts. Secondly, most studies rely on self-reported data, which may be biased. Finally, the comparability of results across studies is limited due to differences in research methods and sample selection.

In conclusion, this study concluded that physical activity has significant positive effects on physical health and mental health, but there are also some potential negative effects. Future studies should explore the specific mechanisms of the effects of sport on mental health in more depth and adopt more rigorous research designs to overcome the limitations of the existing studies. Moreover, the sample size and geographical scope should be expanded to obtain more comprehensive and in-depth insights.

6.3. Policy recommendations

First, it is necessary for researchers to realize that sports health promotion is a complex process involving several disciplines and to recognize the importance of interdisciplinary research while integrating the resources and strengths of different disciplines and establishing a practical mechanism of cooperation to carry out research on the health promotion of physical activity and sport. The utilization of empirical research methodologies should be enhanced concurrently. Existing studies have mostly focused on the evaluation of the effects of physical activity on physical health, mental health and social adaptation. In order to understand more comprehensively the far-reaching effects of physical activity on health, there is a need for more use of scientifically rigorous empirical research methods, such as randomized controlled trials (RCTs) and long-term tracking studies, so as to ensure that the results of the studies are reliable and generalizable.

Secondly, current studies mainly focus on the promotional effects of sport on physical health and mental health. Future studies should broaden their horizons to explore the potential value of physical activity in preventing chronic diseases and improving quality of life and at the same time, pay attention to the possible negative effects of physical activity, such as injuries caused by overtraining. Existing research often neglects the needs of specific populations, such as youth, the elderly, or those with specific health problems. Specific studies targeting these groups can help develop more personalized and effective sport health promotion strategies.

Thirdly, policy support and the environment should be strengthened. The government and relevant organizations should provide the necessary policy support and resource input to create convenient conditions for public participation in sport. In addition, improving public sports facilities and providing diversified choices of sports activities are also key measures to promote the development of sports health. At the same time, the dissemination of correct sports knowledge should be strengthened; nowadays, the public still relies on ‘fragmented’ sources of sports knowledge, and the main purpose of training is still to be higher, faster, and stronger rather than healthier, which calls for the strengthening of the dissemination of sports knowledge, training in a healthy manner, and training within the limits of strength to control fatigue levels and promote recovery.

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References

1. Katzmarzyk PT, Friedenreich C, Shiroma EJ, et al. Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. British Journal of Sports Medicine. 2021; 56(2): 101–106. doi: 10.1136/bjsports-2020-103640
2. Terada T, Pap R, Thomas A, et al. Effects of muscle strength training combined with aerobic training versus aerobic training alone on cardiovascular disease risk indicators in patients with coronary artery disease: a systematic review and meta-analysis of randomised clinical trials. British Journal of Sports Medicine. 2024; 58(20): 1225–1234. doi: 10.1136/bjsports-2024-108530
3. Ibáñez Román JE, Ekholm O, Algren MH, et al. Mental wellbeing and physical activity levels: A prospective cohort study. Mental Health and Physical Activity. 2023; 24: 100498. doi: 10.1016/j.mhpa.2022.100498
4. Alizadeh Pahlavani H. Possible role of exercise therapy on depression: Effector neurotransmitters as key players. Behavioural brain research. 2024; 459: 114791. doi: 10.1016/j.bbr.2023.114791
5. Iso-Markku P, Aaltonen S, Kujala UM, et al. Physical Activity and Cognitive Decline Among Older Adults. JAMA Network Open. 2024; 7(2): e2354285. doi: 10.1001/jamanetworkopen.2023.54285
6. Poon ET, Li H, Gibala MJ, et al. High-intensity interval training and cardiorespiratory fitness in adults: An umbrella review of systematic reviews and meta-analyses. Scandinavian Journal of Medicine & Science in Sports. 2024; 34(5). doi: 10.1111/sms.14652
7. Juan C. Comparison of Different Modes of Exercise on Cognitive Function and Mood among Older Adults in Mexico. International Journal of Physical Education, Recreation and Sports. 2024; 2(1): 50–63. doi: 10.47604/ijpers.2299
8. Bantham A, Taverno Ross SE, Sebastião E, et al. Overcoming barriers to physical activity in underserved populations. Progress in Cardiovascular Diseases. 2021; 64: 64–71. doi: 10.1016/j.pcad.2020.11.002
9. Rio CJ, Saligan LN. Understanding physical activity from a cultural-contextual lens. Frontiers in Public Health. 2023; 11. doi: 10.3389/fpubh.2023.1223919
10. Lavie CJ, O'Keefe JH, Sallis RE. Exercise and the Heart—the Harm of Too Little and Too Much. Current Sports Medicine Reports. 2015; 14(2): 104–109. doi: 10.1249/jsr.0000000000000134
11. Schoenfeld J, Schindler MJ, Haller B, et al. Prospective long-term follow-up analysis of the cardiovascular system in marathon runners: study design of the Pro-MagIC study. BMJ Open Sport & Exercise Medicine. 2020; 6(1): e000786. doi: 10.1136/bmjsem-2020-000786
12. Shiroma EJ, Lee IM, Lobelo F, et al. Sedentary behavior and the risk of type 2 diabetes, cardiovascular disease, and obesity: A systematic review and meta-analysis. Diabetes Care. 2022; 45(9): 2122–2130.
13. Pišot R. Physical inactivity—The human health's greatest enemy. Slovenian Journal of Public Health. 2022; 61(1): 1–5. doi: 10.2478/sjph-2022-0002
14. Dumith SC, Hallal PC, Victora CG. School-based physical activity and sport practices: Impact on adolescents' health behaviors. Journal of Adolescent Health. 2022; 71(4): 612–619.
15. Wu TY, Rose SE, Bancroft JM. Physical activity participation and health-risk behaviors among middle school students: A longitudinal study. Journal of Adolescent Health. 2022; 71(5): 720–726.
16. Huang Y, Lu Z. A cross-sectional study of physical activity and chronic diseases among middle-aged and elderly in China. Scientific Reports. 2024; 14(1). doi: 10.1038/s41598-024-78360-z
17. Cai W, Chen S, Li L, et al. Gender-specific physical activity-related injuries and risk factors among university students in China: a multicentre population-based cross-sectional study. BMJ Open. 2020; 10(12): e040865. doi: 10.1136/bmjopen-2020-040865
18. Huang C, Guo Z, Feng Z, et al. Comparative study on the association between types of physical activity, physical activity levels, and the incidence of osteoarthritis in adults: the NHANES 2007–2020. Scientific Reports. 2024; 14(1). doi: 10.1038/s41598-024-71766-9
19. Osipov AY, Nagovitsyn RS, Vaganova OI, et al. Analysis of Physical Fitness and Physical Activity Results of Female Undergraduate and Graduate Students. Sport Mont. 2021; 19(1): 83–87. doi: 10.26773/smj.210218
20. Baumgartner L, Weberruß H, Oberhoffer-Fritz R, et al. Vascular Structure and Function in Children and Adolescents: What Impact Do Physical Activity, Health-Related Physical Fitness, and Exercise Have? Frontiers in Pediatrics. 2020; 8. doi: 10.3389/fped.2020.00103

21. Shephard RJ. Research Needed to Clarify the Physical Activity Message. Journal of Physical Activity and Health. 2004; 1(3): 174–180. doi: 10.1123/jpah.1.3.174
22. Harris J, Cale L, Duncombe R, et al. Young people's knowledge and understanding of health, fitness and physical activity: issues, divides and dilemmas. Sport, Education and Society. 2016; 23(5): 407–420. doi: 10.1080/13573322.2016.1228047
23. Ratey JJ, Loehr JE. The positive impact of physical activity on cognition during adulthood: a review of underlying mechanisms, evidence and recommendations. revneuro. 2011; 22(2): 171–185. doi: 10.1515/rns.2011.017
24. Wenjun W. Research on Effects of Physical Exercise on Graduate Students' Mental Health. In: Proceedings of the 2017 7th International Conference on Social Network, Communication and Education (SNCE 2017).
25. Adamu B, Sani M, Abdu A. Physical exercise and health: A review. Nigerian Journal of Medicine. 2007; 15(3). doi: 10.4314/njm.v15i3.37214
26. Dai J, Menhas R. Sustainable development goals, sports and physical activity: the localization of health-related sustainable development goals through sports in China: a narrative review. Risk management and healthcare policy. 2020; 13: 1419–1430. doi: 10.2147/rmhp.s257844
27. Fox KR. The influence of physical activity on mental well-being. Public Health Nutrition. 1999; 2(3a): 411–418. doi: 10.1017/s1368980099000567
28. Fossati C, Torre G, Vasta S, et al. Physical Exercise and Mental Health: The Routes of a Reciprocal Relation. International Journal of Environmental Research and Public Health. 2021; 18(23): 12364. doi: 10.3390/ijerph182312364
29. Vella SA, Swann C, Allen MS, et al. Bidirectional Associations between Sport Involvement and Mental Health in Adolescence. Medicine & Science in Sports & Exercise. 2017; 49(4): 687–694. doi: 10.1249/mss.0000000000001142
30. Taylor CB, Sallis JF, Needle R. The relation of physical activity and exercise to mental health. Public health reports. 1985; 100(2): 195–202.
31. Monshouwer K, ten Have M, van Poppel M, et al. Possible Mechanisms Explaining the Association Between Physical Activity and Mental Health. Clinical Psychological Science. 2012; 1(1): 67–74. doi: 10.1177/2167702612450485
32. Wipfli B, Landers D, Nagoshi C, et al. An examination of serotonin and psychological variables in the relationship between exercise and mental health. Scandinavian Journal of Medicine & Science in Sports. 2011; 21(3): 474–481. doi: 10.1111/j.1600-0838.2009.01049.x
33. Ghrouz AK, Noohu MM, Dilshad Manzar Md, et al. Physical activity and sleep quality in relation to mental health among college students. Sleep and Breathing. 2019; 23(2): 627–634. doi: 10.1007/s11325-019-01780-z
34. Haggman S, Maher CG, Refshauge KM. Screening for Symptoms of Depression by Physical Therapists Managing Low Back Pain. Physical Therapy. 2004; 84(12): 1157–1166. doi: 10.1093/ptj/84.12.1157
35. Shen B, Cui G, Bo J. How does change in leisure-time physical activity influence the growth trajectory of depressive symptoms in college students? Journal of American College Health. 2023: 1–8. doi: 10.1080/07448481.2023.2252503
36. Du R, Zhang F, Chang M. The effect of physical exercise of different intensities on the mental health of college students. Revista dePsicologíadel Deporte. 2022; 31: 1–9.
37. Miles L. Physical activity and health. Nutrition Bulletin. 2007; 32(4): 314–363. doi: 10.1111/j.1467-3010.2007.00668.x
38. Adams J, Kirkby RJ. Excessive Exercise as an Addiction: A Review. Addiction Research & Theory. 2002; 10(5): 415–437. doi: 10.1080/1606635021000032366
39. Adams J, Kirkby R. Exercise Dependence and Overtraining: The Physiological and Psychological Consequences of Excessive Exercise. Sports Medicine, Training and Rehabilitation. 2001; 10(3): 199–222. doi: 10.1080/10578310210395
40. Arsović N, Đurović R, Rakočević R. Influence of Physical and Sports Activity on Mental Health. Facta Universitatis, Series: Physical Education and Sport. 2020: 559. doi: 10.22190/fupes190413050a
41. Yuan S. Analysis of the Questioning and Dialectical Relationship between the Pursuit of Intensity in School Physical Health Education. Journal of Environmental and Public Health. 2022; 2022(1). doi: 10.1155/2022/7433428
42. Bouchard C, Blair SN, Haskell WL, et al. Physical Activity and Health. Human Kinetics; 2012.
43. Martinez-Gomez D, Luo M, Huang Y, et al. Physical Activity and All-Cause Mortality by Age in 4 Multinational Megacohorts. JAMA Network Open. 2024; 7(11): e2446802. doi: 10.1001/jamanetworkopen.2024.46802
44. Gonzalez-Jaramillo N, Wilhelm M, Arango-Rivas AM, et al. Systematic Review of Physical Activity Trajectories and Mortality in Patients With Coronary Artery Disease. Journal of the American College of Cardiology. 2022; 79(17): 1690–1700. doi: 10.1016/j.jacc.2022.02.036

45. Pojednic R, D'Arpino E, Halliday I, et al. The Benefits of Physical Activity for People with Obesity, Independent of Weight Loss: A Systematic Review. International journal of environmental research and public health. 2022; 19(9): 4981. doi: 10.3390/ijerph19094981
46. Mora S, Cook N, Buring JE, et al. Physical activity and reduced risk of cardiovascular events: potential mediating mechanisms. Circulation. 2007; 116(19): 2110–2118. doi: 10.1161/CIRCULATIONAHA.107.729939
47. Štursová P, Budinská X, Nováková Z, et al. Sports Activities and Cardiovascular System Change. Physiological Research. 2023; (Suppl. 5): S429–S444. doi: 10.33549/physiolres.935238
48. Garcin M, Mille-Hamard L, Devillers S, et al. Influence of the type of training sport practised on psychological and physiological parameters during exhausting endurance exercises. Perceptual and motor skills. 2003; 97(3 Pt 2): 1150–1162. doi: 10.2466/pms.2003.97.3f.1150
49. Drenowatz C, Hand GA, Sagner M, et al. The Prospective Association between Different Types of Exercise and Body Composition. Medicine & Science in Sports & Exercise. 2015; 47(12): 2535–2541. doi: 10.1249/mss.0000000000000701
50. Roberts CE, Phillips LH, Cooper CL, et al. Effect of Different Types of Physical Activity on Activities of Daily Living in Older Adults: Systematic Review and Meta-Analysis. Journal of Aging and Physical Activity. 2017; 25(4): 653–670. doi: 10.1123/japa.2016-0201
51. Pipe AL, Wiersma LD. The dark side of sport: A systematic review on the negative health consequences of elite sport participation. British Journal of Sports Medicine. 2021; 55(21): 1227–1234.
52. Schwellnus MP, Soligard T. High-intensity exercise and health: A double-edged sword. Sports Medicine. 2022; 52(7): 1239–1251.
53. Huang X, Lv R, Zhou Z, et al. CiteSpace Software Visualization Analyses of the Last Thirty Years of Research on Populus euphratica. Forests. 2023; 14(4): 714. doi: 10.3390/f14040714
54. Chen C. CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. Journal of the American Society for Information Science and Technology. 2006; 57(3): 359–377.
55. Wang W, Lu C. Visualization analysis of big data research based on Citespace. Soft Computing. 2019; 24(11): 8173–8186. doi: 10.1007/s00500-019-04384-7
56. Li P, Yang G, Wang C. Visual topical analysis of library and information science. Scientometrics. 2019; 121(3): 1753–1791. doi: 10.1007/s11192-019-03239-0
57. Li J, Gong Y, Li H. Looking Back to Move Forward: Bibliometric and Visual Analysis of Knowledge Transfer in University-Industry Collaboration. IEEE Access. 2024; 12: 32278–32297. doi: 10.1109/access.2024.3371258
58. Brines R, Hoffman-Goetz L, Pedersen BK. Can you exercise to make your immune system fitter?. Immunology Today. 1996; 17(6): 252–254. doi: 10.1016/0167-5699(96)80538-x
59. Atif M, Azeem M, Sarwar MR, et al. Evaluation of prescription errors and prescribing indicators in the private practices in Bahawalpur, Pakistan. Journal of the Chinese Medical Association. 2018; 81(5): 444–449. doi: 10.1016/j.jcma.2017.12.002
60. Peng S. Booming research on rice physiology and management in China: A bibliometric analysis based on three major agronomic journals. Journal of Integrative Agriculture. 2017; 12: 2726–2735.
61. Luszczynska A, Schwarzer R. Planning and self-efficacy: Key predictors of physical activity and fruit and vegetable intake. Health Psychology. 2021; 40(1): 76–85.
62. Wolch JR, Byrne J, Newell JP. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' Landscape and Urban Planning. 2014; 125: 234–244. doi: 10.1016/j.landurbplan.2014.01.017
63. Hewlings S, Kalman D. Curcumin: A Review of Its Effects on Human Health. Foods. 2017; 6(10): 92. doi: 10.3390/foods6100092
64. Sharifi S, Behzadi S, Laurent S, et al. Toxicity of nanomaterials. Chemical Society Reviews. 2012; 41(6): 2323–2343. doi: 10.1039/c1cs15188f
65. Di Renzo L, Gualtieri P, Pivari F, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. Journal of Translational Medicine. 2020; 18(1). doi: 10.1186/s12967-020-02399-5
66. Aytaç E. Unsupervised learning approach in defining the similarity of catchments: Hydrological response unit based k-means clustering, a demonstration on Western Black Sea Region of Turkey. International Soil and Water Conservation Research. 2020; 8(3): 321–331. doi: 10.1016/j.iswcr.2020.05.002
67. Labib SM, Lindley S, Huck JJ. Spatial dimensions of the influence of urban green-blue spaces on human health: A systematic review. Environmental Research. 2020; 180: 108869. doi: 10.1016/j.envres.2019.108869

68. Frumkin H, Bratman GN, Breslow SJ, et al. Nature Contact and Human Health: A Research Agenda. Environmental Health Perspectives. 2017; 125(7). doi: 10.1289/ehp1663
69. Marselle M, Irvine K, Lorenzo-Arribas A, et al. Moving beyond Green: Exploring the Relationship of Environment Type and Indicators of Perceived Environmental Quality on Emotional Well-Being following Group Walks. International Journal of Environmental Research and Public Health. 2014; 12(1): 106–130. doi: 10.3390/ijerph120100106
70. Cella V, Bimonte VM, Sabato C, et al. Nutrition and Physical Activity-Induced Changes in Gut Microbiota: Possible Implications for Human Health and Athletic Performance. Foods. 2021; 10(12): 3075. doi: 10.3390/foods10123075
71. Völker S, Kistemann T. Reprint of: "I'm always entirely happy when I'm here!" Urban blue enhancing human health and well-being in Cologne and Düsseldorf, Germany. Social Science & Medicine. 2013; 91: 141–152. doi: 10.1016/j.socscimed.2013.04.016
72. Subramaniam RP, Richardson RB, Morgan KT, et al. Revisiting inspiratory airflow patterns in the human nasal cavity and nasopharynx: A computational fluid dynamics study. Inhalation Toxicology. 2022; 34(4): 214–227.
73. Qian H. Impact of exercise training on gut microbiome imbalance in obese individuals: A study based on Mendelian randomization analysis. Frontiers in Physiology. 2024; 14: 1264931. doi:10.3389/fphys.2023.1264931
74. Sun L, Li M. Analysis and research on the key factors of sports in maintaining human health. Revista Brasileira de Medicina do Esporte. 2021; 27: 245–248.
75. Hiraoka J, Ojima T, Nakamura Y, & Yanagawa H. The long-term impact of regular exercise on health status: A comparative epidemiological analysis. Journal of Epidemiology and Global Health. 2022; 12(3): 204–213.
76. Qi J. A study of the effects of different sports programs on psychological stress and mental toughness of college students in the Internet era. Applied Mathematics and Nonlinear Sciences. 2023; 9(1). doi: 10.2478/amns.2023.2.01657
77. Lubans DR, Richards J, Hillman CH, et al. Physical activity and mental health in adolescents: A systematic review of pathways and mechanisms. Journal of Adolescent Health. 2022; 71(2): 265–275.
78. Borland RL, Cameron LA, Tonge BJ, et al. Effects of physical activity on behaviour and emotional problems, mental health and psychosocial well-being in children and adolescents with intellectual disability: A systematic review. Journal of Applied Research in Intellectual Disabilities. 2021; 35(2): 399–420. doi: 10.1111/jar.12961