Analysis of Hotspot and Evolution of Exercise and Obesity in the Perspective of Combination of Sports and Medicine

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Abstract. The relationship between exercise, obesity, and related issues has currently become a hot topic in international research. This article uses 1745 articles on "Exercise and Obesity" included in the Web of Science Core Collection as the data source, and conducts bibliometric analysis on the obtained data using CiteSpace V. The research results indicate that the field of exercise and obesity research is currently in the stage of internalization and absorption, and there is a need to increase support and investment in innovative research to ensure the sustainable development of this field; At the same time, academic teams and research institutions should strengthen interaction and cooperation, promote knowledge sharing, innovative research methods, and interdisciplinary integration. From the trend of research, the public's attention to this topic is gradually shifting from scattered to concentrated. The future focus will be on the effectiveness of exercise interventions, individual differences, and interdisciplinary cooperation, to provide scientifically precise strategies for the prevention and treatment of obesity.

Keywords. Physical exercise; Obesity; Cardiovascular disease; Evolution.

1. Introduction

The latest WHO data indicates that 2.1 billion individuals globally are overweight or obese, marking a tripling since 1975. By 2016, the figure had risen to over 1.9 billion adults aged 18 and above, with 650 million qualifying as obese [1]. Obesity impacts not only physical appearance but also poses significant health risks. It is associated with an increased likelihood of hypertension [2], diabetes [3], atherosclerosis [4], and other chronic conditions, ranking as the fifth leading cause of mortality worldwide [5, 6]. As societal progress and health consciousness advance, addressing obesity has become a critical public health issue. Exercise stands out as a non-pharmacological weight management strategy, mitigating the negative impacts of dietary restrictions and medications on the well-being of those with obesity [7, 8]. This study utilizes the CiteSpace V tool to analyze literature on exercise and obesity from the Web of ScienceTM Core Collection, aiming to elucidate the current research landscape, identify key areas of interest, and track emerging trends. It also aims to clarify the trajectory of research into exercise interventions for obesity and its associated comorbidities, offering insights for scholars in the field [9, 10].

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2.   Data Sources and Research Methods

2.1. Data Sources

This study utilized the Web of Science database platform's Core collection as the primary source for data retrieval. Initially, the search term TS= "exercise" was entered in the topic field, recorded as #1, followed by the term "obesity" in the topic field, recorded as #2. The search was combined using the "AND" operator, with the time range set from 2014 to 2024 (search date: July 25, 2024), yielding 20,185 records. The search was then refined by selecting "sport science" as the criterion, resulting in 1,797 records. The literature format was specified as "English Article," and a final total of 1,745 articles was identified for use as the data source (see Figure 1).
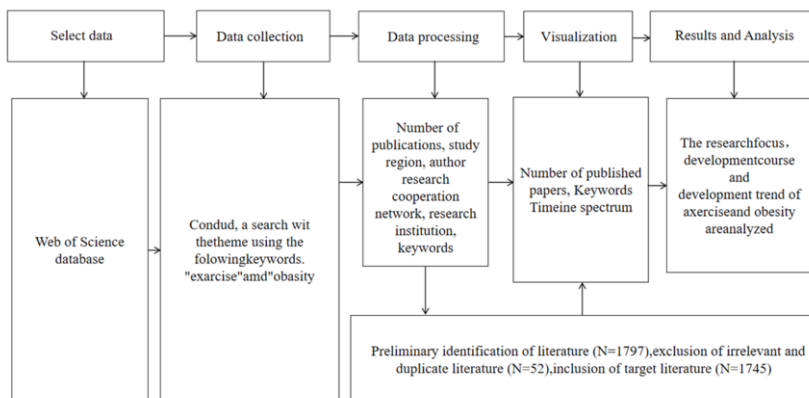

Figure 1. Data screening process

2.2. Research Methods

The scientific knowledge mapping software CiteSpace 6.2 R6 (64-bit) advanced was employed for the visualization and systematic analysis of research literature related to exercise and obesity. Price's Law, with the formula $M \approx 0.749\sqrt{N_{max}}$, was employed to determine the core keywords, authors, and regions within the field of exercise and obesity research. This approach aids in focusing on significant elements. In this context, N_{max} represents the highest frequency of node occurrences within the statistical period. The threshold value M is used to identify core nodes when their frequency reaches the M value. All statistical outcomes in this study were not subjected to rounding.

3.   Results

3.1. Statistical Analysis of Literature Volume

Mining the annual changes in literature provides a direct reflection of the general trend in the field of exercise and obesity research [11] (shown as Figure 2). As depicted in Figure 2, the annual publication volume related to exercise and obesity research

exhibited a fluctuating upward trend from 2014 to 2024. This trend is primarily due to the dramatic increase in the obese population caused by sedentary lifestyles and unhealthy dietary habits. The resulting chronic diseases from obesity pose a severe threat to public health, with an average annual publication volume of 165 articles.
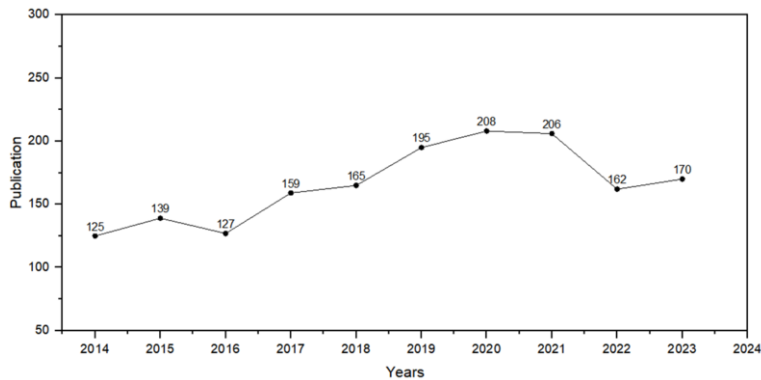

Figure 2. Annual number of publications

3.2. Co-Author Analysis

In the co-author analysis, "Author" was set as the node, resulting in a corresponding author co-occurrence map [12]. This study included a total of 450 authors with 758 connections, and the network density was 0.0075 (see Figure 3).

Figure 3. Co-Author Analysis

The number of publications by authors was represented by the size of the nodes in the network graph, with node colors ranging from dark to light representing the publication time from distant to recent. A significant increase in recent publications is indicated as a burst node, marked in red in the figure. The degree of collaboration between authors is represented by the connections and the thickness of the lines between nodes [13].

Core authors who have published key papers in exercise and obesity research to some extent represent the latest and most important research directions in the field. In the database, Ortega, Francisco B, is the author with the highest number of publications, with a total of 22 related studies, mainly focusing on the impact of exercise on children with obesity. The author with the second-highest number of publications is Esteban-Cornejo, Irene, who is part of the same research team as the leading author, with 12 publications. According to Price's Law for identifying core authors, those with at least four publications were considered core authors. A total of 50 core authors were identified, who collectively published 280 related studies, accounting for 16.04% of all research. Additionally, the co-authorship network map in the field of exercise and obesity has formed a relatively stable academic research collaboration network structure.

3.3. Co-Institutions Analysis

A co-occurrence analysis of the institutions publishing research articles resulted in 367 nodes and 846 connections, with a network density of 0.0126 [14] (Figure 4). According to Price's Law, the threshold value (Threshold) was set at 5, with $M \approx 4.854$. The top 10 institutions by publication volume are as follows: University of Granada (42 articles), University of North Carolina (42 articles), Universidade de Sao Paulo (34 articles), Louisiana State University System (32 articles), Pennington Biomedical Research Center (30 articles), California State University System (29 articles), University of California System (29 articles), State University System of Florida (28 articles), CIBER-Centro de Investigación Biomédica en Red (25 articles), and University of Ottawa (24 articles).

Figure 4. Co-Institutions analysis

3.4. Co-Country Analysis

According to the visualization map from Citespace, the literature on exercise and obesity research spans 88 countries or regions. Based on Price's Law, we set the node threshold at 20 (Figure 5). The United States accounts for approximately *34.55%* of the total literature output in the field of exercise and obesity research, holding an absolute

dominant position. Following the United States are Brazil (189 articles, *10.83%)*, Canada (176 articles, *10.08%*), Spain (158 articles, *9.05%*), the United Kingdom (140 articles, 8.02%), China (125 articles, *7.16%*), and Australia (122 articles, *6.99%*). Japanese historian and physicist Mitsuharu Togawa, referring to "Chronicles of Science and Technology" and "Webster's Biographical Dictionary," conducted a statistical analysis of global scientific activities, defining the center of scientific activity as "a country's significant scientific achievements accounting for more than 25% of the world's significant scientific achievements" [10]. It is evident that the United States is the global scientific hub for exercise and obesity research, reflecting the emphasis the U.S. places on this field of study and its substantial research output in exercise and obesity, facilitated by a comprehensive scientific research system.
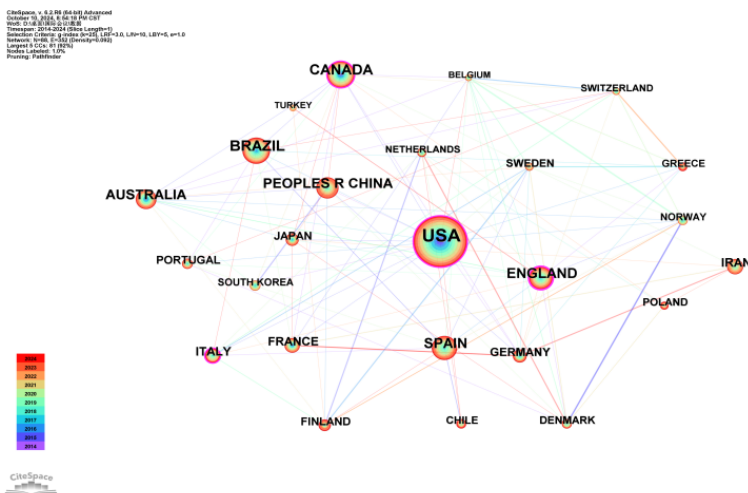

Figure 5. Co-Country Analysis

3.5. Keyword Analysis

3.5.1. Co-occurrence Analysis of Keywords

Keywords serve as a concise summary of a paper's theme, and analyzing them helps researchers understand the core and focal points of a field [15, 16](Table 1). Through the co-occurrence analysis of keywords, a network of 468 nodes and *2,175* links was obtained, with a network density of *0.0199*. In addition to foundational terms like "exercise" and "obesity," keywords such as "weight loss," "insulin resistance," "health," and "children" appear frequently, indicating they are research hotspots in the field of exercise and obesity. The results show that the field primarily focuses on "exercise" and "obesity" as the main themes, extending to a broad range of research content and levels. This includes medical field studies on "insulin resistance," "metabolic syndrome," "adipose tissue," and "cardiovascular diseases," as well as sports field studies on "skeletal muscle," "fitness," "resistance," and "aerobic exercise," with a primary focus on "children" and "adolescents."

Table 1. The frequency of keywords in the research field of exercise and obesity is TOP30

Rank	Count	Centrality	Keywords	Rank	Count	Centrality	Keywords
1	597	0.00	physical activity	16	128	0.03	aerobic exercise
2	539	0.00	obesity	17	127	0.02	cardiorespiratory fitness
3	532	0.00	exercise	18	119	0.01	association
4	255	0.01	overweight	19	117	0.02	fitness
5	221	0.03	weight loss	20	107	0.02	adipose tissue
6	220	0.01	body composition	21	107	0.02	resistance
7	215	0.02	insulin resistance	22	98	0.03	risk factors
8	184	0.03	health	23	98	0.02	cardiovascular disease
9	169	0.01	children	24	96	0.03	insulin sensitivity
10	160	0.01	skeletal muscle	25	88	0.02	intensity
11	143	0.01	risk	26	81	0.04	performance
12	140	0.01	metabolic syndrome	27	78	0.03	women
13	135	0.02	adolescents	28	77	0.02	sedentary behavior
14	131	0.01	body mass index	29	76	0.02	strength
15	130	0.01	adults	30	76	0.02	energy expenditure

3.5.2. Cluster of Keywords

Clustering of keywords is a concentrated distillation of research themes, and analyzing them helps to uncover hotspots within the field more deeply [17] (Figure 6).
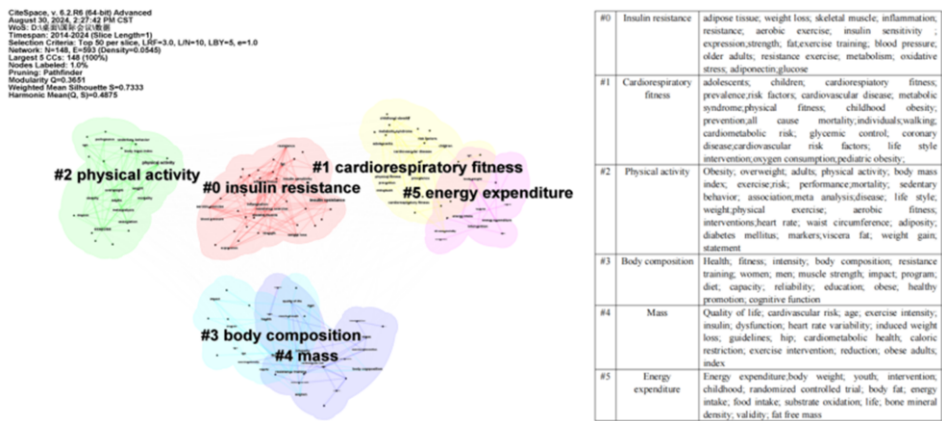

Figure 6. Cluster of Keywords

The map generated by the keyword clustering analysis produced a network of 148 nodes and 593 links, with a Modularity Q of 0.3651, suggesting a clear definition of the keyword clusters in exercise and obesity research. The Mean Silhouette score of 0.7333 indicates a high homogeneity within the network, thus confirming the reliability of the keyword clustering results.

Furthermore, the keyword clusters can be summarized into the following categories: #0 insulin resistance, encompassing terms like adipose tissue, weight loss, skeletal

muscle, and inflammation; #1 Cardiorespiratory fitness, including adolescents, children, prevalence, and risk factors; #2 Physical activity, comprising obesity, overweight, adults, and body mass index; #3 Body composition, mainly focusing on health, fitness, intensity, and body composition; #4 Mass, containing quality of life, cardiovascular risk, age, and exercise intensity; #5 energy expenditure, body weight, youth, and intervention.

3.5.3. Keyword Timeline Analysis

Analyzing the keyword timeline map, which produced 148 nodes and 593 connections with a network density of 0.0545 (Figure 7), revealed a downward trend in the number of keyword nodes from 2014 to 2024.
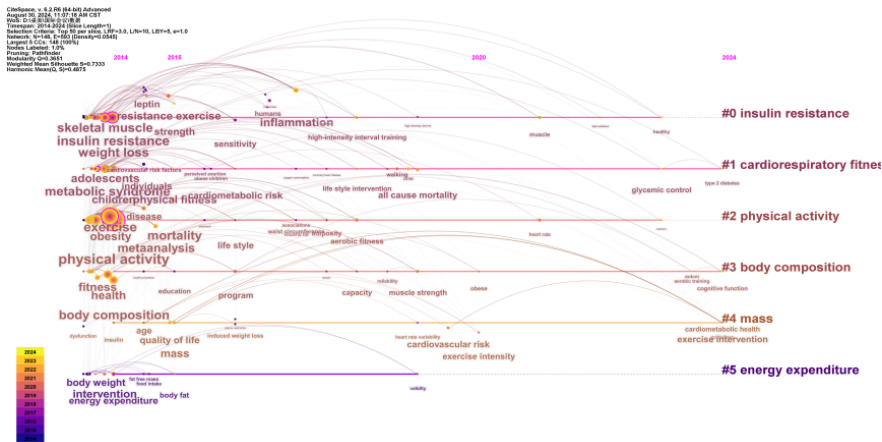

Figure 7. Keyword Timeline Analysis

The evolution of keywords has gradually shifted from multiple dispersed research nodes to a concentrated research focus. The field's research is undergoing a process of integration, where once dispersed research questions are converging into a central issue. The boundaries between terms are becoming blurred, reflecting a trend towards a more unified and comprehensive research perspective as researchers explore the complex relationship between obesity and exercise. This trend indicates a centralization of research focus, possibly foreshadowing future studies that will delve more deeply into the comprehensive impact of exercise interventions on obesity and related health issues.

4. Discussion

4.1. State of Research

The analysis of publication trends indicates that the volume of research literature in the field of exercise and obesity experienced nonlinear growth from 2014 to 2024. Specifically, there was a significant increase in annual publications between 2016 and 2021. However, a decline in publication volume has been observed in the last two years, which may reflect that the field is currently in a phase of internalization and absorption. To foster further development in this area, it is necessary to enhance support and investment in innovative research to stimulate new research vitality and breakthroughs.

The co-authorship network analysis suggests that several stable core research teams

have been established in the field of exercise and obesity research. While collaboration within teams is close-knit, there is a dispersion in collaboration between teams, indicating a need to increase inter-team communication and collaboration to broaden research perspectives, leverage strengths, and deepen research. Analyzing the publication volume of institutions such as the University of Granada, University of North Carolina, and Universidade de Sao Paulo can effectively reveal research trends, key issues, and innovative directions in the field of exercise and obesity, providing valuable references and guidance for academic research and practical applications in this area.

Keyword analysis indicates that research in the field of exercise and obesity primarily focuses on two core concepts: "exercise" and "obesity." Based on these concepts, a wide range of research content and multi-level research dimensions have been developed. As research progresses, there is an observable trend of research topics converging from multiple dispersed areas to a centralized focus. This trend suggests that future research will lean towards in-depth exploration and refined analysis, aiming for more significant progress at both theoretical and practical levels. Specifically, research in this field places greater emphasis on systematic studies of the effectiveness of exercise interventions in obesity prevention and treatment, as well as individual differences, to provide more scientific and precise strategies. Additionally, interdisciplinary collaboration will be an important direction for future research, integrating knowledge and techniques from different fields to achieve new breakthroughs in the pathophysiology of obesity, the biological effects of exercise interventions, and the comprehensive management of obesity-related diseases.

4.2. Current and Potential Research Hotspots

Research in the field of exercise and obesity is dedicated to preventing or improving the harm of obesity and its related complications through exercise prescriptions. Early studies mainly focused on the weight loss and fat reduction effects of different types and intensities of exercise. Recent research has expanded to include exercise interventions for obesity-related complications such as early-stage diabetes, arteriosclerosis, and hypertension in obese populations.

The mechanisms of obesity exercise intervention involve associations between exercise and energy substances, neuroendocrine responses, lipid metabolism, cardiopulmonary function, and vitamins. Currently, exercise prescriptions combined with dietary management and drug control to improve the health of obese populations have been widely studied, but there is a lack of scientific innovation and significant discoveries. Future research trends can become more detailed, introducing stricter conditions based on existing foundations to refine experimental parameters and enhance the specificity of research designs.

5. Conclusion

This study collected 1,745 documents on exercise and obesity from the Web of Science Core Collection database and used the CiteSpace V visualization analysis tool to conduct an in-depth analysis of the research status and hotspots from 2014 to 2024, as well as their evolutionary trends. The results indicate that:

1)The field of exercise and obesity research is currently in a phase of internalization and absorption, requiring increased support and investment in innovative research to

ensure the sustainable development of this field;

2) There should be enhanced interaction and collaboration between academic teams and research institutions to promote knowledge sharing, innovation in research methods, and interdisciplinary integration;

3) Research topics are gradually shifting from being dispersed to concentrated, with future emphasis on the effectiveness of exercise interventions, individual differences, and interdisciplinary collaboration to provide scientifically precise strategies for the prevention and treatment of obesity.

Acknowledgment

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