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A bibliometric analysis of the effects of aerobic exercise on overweight (1978–2025)

Un análisis bibliométrico de los efectos del ejercicio aeróbico sobre el sobrepeso
(1978–2025)

Wei Chen  1,2

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Abstract: Overweight is a global public health concern associated with multiple chronic conditions. Aerobic exercise, widely recognized for improving weight control, cardiorespiratory fitness, and metabolic function, has become central to intervention strategies. However, the global research landscape addressing aerobic exercise specifically for overweight populations remains insufficiently mapped. This study aimed to analyze scientific development, main research topics, and collaboration patterns using bibliometric methods based on publications indexed in the Web of Science Core Collection (SCIE and SSCI) from 1978 to 2025 (search date: March 23, 2025). A total of 3,983 documents were retrieved and analyzed using the Bibliometrix package (R), with results visualized through publication trends, co-authorship and co-citation networks, and keyword clustering. The field has expanded rapidly since 2000, showing an average annual growth rate of 7.35%. The United States ranks first in publication volume and citation impact, followed by the United Kingdom and Canada. China demonstrates substantial research output but lower citation performance, highlighting the need for stronger international collaboration. High-impact publishing venues are primarily from exercise science and obesity-related research areas. Keyword and network analyses reveal a shift from general intervention studies toward more specific mechanisms, populations, and multidimensional outcomes, including insulin resistance, body composition, and cardiorespiratory fitness. A strong international collaboration structure, especially within North America and Europe, is also evident. Overall, research on aerobic exercise for overweight individuals has evolved into a multidisciplinary and globally collaborative field. Future efforts should emphasize research quality, deeper collaboration, and tailored intervention strategies to support global health.

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Keywords: aerobic exercises, physical activity, public health, body weight.

Resumen: El sobrepeso es un problema de salud pública a nivel mundial, asociado con múltiples enfermedades crónicas. El ejercicio aeróbico, ampliamente reconocido por mejorar el control del peso, la aptitud cardiorrespiratoria y la función metabólica, se ha convertido en una estrategia central de intervención. Sin embargo, el panorama científico global sobre ejercicio aeróbico específicamente en poblaciones con sobrepeso sigue insuficientemente mapeado. El objetivo de la investigación fue analizar el desarrollo científico, los principales temas de investigación y los patrones de colaboración mediante métodos bibliométricos en publicaciones indexadas en la Colección Principal de Web of Science (SCIE y SSCI) entre 1978 y 2025 (fecha de búsqueda: 23 de marzo de 2025). Se recuperaron 3983 documentos y se analizaron utilizando el paquete *Bibliometrix* (R), visualizando las tendencias de publicación, redes de coautoría y cocitación, así como la agrupación de palabras clave. El campo ha crecido aceleradamente desde el año 2000, con una tasa media anual del 7.35%. Estados Unidos lidera en volumen e impacto de citación, seguido por Reino Unido y Canadá. China presenta una alta producción científica pero menor rendimiento de citas, destacando la necesidad de fortalecer la colaboración internacional. Las revistas de mayor impacto pertenecen principalmente a las áreas de ciencias del ejercicio y obesidad. El análisis de palabras clave muestra una transición desde intervenciones generales hacia mecanismos específicos, poblaciones concretas y resultados multidimensionales, como la resistencia a la insulina, la composición corporal y la aptitud cardiorrespiratoria. Se concluye que la investigación sobre ejercicio aeróbico en personas con sobrepeso ha evolucionado hacia un campo multidisciplinario y de colaboración global. Los esfuerzos futuros deben priorizar la calidad científica, la cooperación internacional y estrategias de intervención adaptadas que favorezcan la salud global.

Palabras clave: ejercicios aeróbicos, actividad física, salud pública, peso corporal.

1. Introduction

Overweight and obesity have become major global public health concerns, with their prevalence continuing to rise and being closely associated with a range of chronic conditions, including cardiovascular disease, type 2 diabetes, metabolic syndrome, and cognitive decline (Heiss & Goldberg, [2016](#); Gregg & Shaw, [2017](#); Ng et al., [2025](#)). It is projected that by 2030, the global population affected by overweight and obesity will exceed



2 billion, posing a serious threat to human health and the sustainability of healthcare systems worldwide (Ralston et al., [2021](#); Szymonik, [2023](#)). Empirical evidence suggests that regular physical activity plays a crucial role in preventing excessive weight gain and obesity-related diseases (Jakicic et al., [2019](#)), and should be considered a key component of public health interventions. Among various intervention strategies, aerobic training has been widely adopted for weight management and health improvement in overweight and obese populations due to its beneficial effects on enhancing cardiorespiratory fitness, increasing insulin sensitivity, improving body composition, and modulating systemic inflammation (Al-Mhanna et al., [2024](#); Fan & Wang, [2025](#)).

In recent years, research on aerobic exercise interventions for overweight populations has rapidly expanded. However, current studies predominantly focus on discrete aspects such as metabolic regulation mechanisms, exercise prescription optimization, and interventions for specific populations, leading to a fragmented research landscape with limited thematic coherence and scholarly integration (Sousa et al., [2022](#)). Given the increasing global obesity crisis and the growing emphasis on physical activity for prevention (Strain et al., [2024](#)), it is crucial to gain a macro-level understanding of the global evolution and thematic priorities in this domain. Bibliometrics, as a quantitative approach, facilitates mapping disciplinary development, and identifying core literature, influential authors, and emerging research frontiers, offering insights to enhance integration and advancement in the field (Aria & Cuccurullo, [2017](#); Dunaiski et al., [2019](#); Chen & Morazuki, [2024a](#), [2024b](#)).

This study utilizes bibliometric methods to comprehensively analyze literature on aerobic exercise interventions for overweight individuals, published between 1978 and 2025. The study seeks to delineate the historical trajectory and current development in the field, to identify key contributors and collaboration patterns, to extract major research hotspots and emerging themes, and to critically evaluate the strengths and limitations of the existing knowledge base. Ultimately, the study aims to construct a systematic knowledge map of aerobic exercise-based interventions for overweight individuals and provide evidence-based references for formulating obesity prevention strategies within the realm of public health.

2. Methods

This study employed a scientometric and bibliometric design based on citation and keyword metadata, aiming to systematically characterize the knowledge structure, research hotspots, and thematic evolution of the field of aerobic exercise interventions for overweight populations. The Web of Science Core Collection (WoS CC)—comprising the Science Citation Index Expanded (SCIE) and the Social Sciences Citation Index (SSCI)—was



selected as the sole data source. This choice was justified by its broad coverage and consistent indexing in disciplines such as sports science, public health, and rehabilitation/exercise medicine, as well as its provision of standardized bibliographic fields (Author Keywords, AK; Keywords Plus, KP). Moreover, WoS CC offers high compatibility with major scientometric tools, including Bibliometrix (R 4.4.3) (Chen & Morazuki, [2024a](#), [2024b](#)), VOSviewer (v1.6.20), and CiteSpace (v6.2.6), ensuring analytical reproducibility and cross-study comparability. The potential coverage bias arising from not incorporating Scopus or PubMed databases was acknowledged and discussed in the Discussion section.

The data retrieval was conducted on March 23, 2025, using a Topic Search (TS) query in the Web of Science Core Collection (WoS), defined as follows: TS = (“aerobic exercise” OR “aerobic training” OR “aerobic physical activity” OR “aerobic fitness” OR “aerobic capacity” OR “cardiorespiratory exercise” OR “cardiorespiratory training” OR “cardiorespiratory fitness” OR “endurance training” OR “endurance exercise” OR “endurance activity”) AND TS = (“overweight” OR “excess weight” OR “pre-obese” OR “preobesity” OR “pre-obesity” OR “increased body weight” OR “elevated BMI” OR “high body mass index”). To ensure topic specificity and reproducibility, the search strategy was structured around two conceptual dimensions: (i) intervention—represented by aerobic, cardiorespiratory, and endurance constructs, and (ii) population/status—represented by overweight- and BMI-related terminology. Intervention-related terms were standardized at the phrase level, whereas population-related terms explicitly delimited the scope through BMI descriptors. The term “obesity” was intentionally excluded to prevent topic drift and maintain analytical precision.

A pilot comparison demonstrated that proximity operators (e.g., NEAR/x) and wildcard symbols yielded minimal coverage gains while introducing noise and reducing cross-software consistency. Given the prevalence of multimodal or combined interventions in this field, the NOT operator was avoided to minimize the risk of excluding relevant records. Considering overall coverage, precision, and replicability, the final query adopted a “phrase + explicit synonym enumeration” strategy. During analysis, Author Keywords (AK) were used as the primary data source and Keywords Plus (KP) as supplementary. Synonym normalization, Top-N filtering, and minimum occurrence thresholds were applied to ensure conceptual consistency and robustness of the results. It is important to note that TS (Topic)—the standard search field recommended by WoS—encompasses Title, Abstract, AK, and KP, providing broader semantic coverage than TI (Title) alone. To guarantee the scientific validity and comprehensiveness of the search protocol, two domain experts with backgrounds in exercise nutrition and resistance training independently reviewed and confirmed the search logic and keyword combinations as methodologically sound and thematically appropriate.



An initial search yielded 4,424 records. Subsequent inclusion and exclusion procedures were conducted within the Web of Science (WoS) platform. Specifically, document types were restricted to Article and Review (excluding $n = 176$), and the indexing databases were confined to the Science Citation Index Expanded (SCIE) and the Social Sciences Citation Index (SSCI) (excluding $n = 265$). In addition, records were cross-checked based on WoS document-type annotations and remarks to identify and exclude any retracted or substantially corrected publications—none were detected. Following in-platform screening, the complete bibliographic metadata were exported in Plain Text format (Full Record & Cited References) in batches and subsequently converted into analytical data frames using Bibliometrix (R 4.4.3). Duplicate entries were examined through Zotero v6.0 and manual verification, with no duplicates identified. Ultimately, 3,983 publications (1978–2025) were retained for quantitative and network-based analyses.

Overall bibliometric indicators were generated using Bibliometrix, while VOSviewer (v1.6.20) was employed to construct and visualize collaboration and co-occurrence networks through clustering algorithms. CiteSpace (v6.2.6) was used to detect burst keywords and to trace the evolution of thematic trends over time. The Annual Growth Rate (AGR) of publications was computed using the standard formula. For derived statistics not directly generated by Bibliometrix (e.g., annual cumulative keyword frequencies), brief computational procedures were described to enhance transparency and reproducibility. As this study was based exclusively on publicly available bibliographic metadata, it involved no identifiable personal information or experimental interventions and therefore did not require ethical approval.



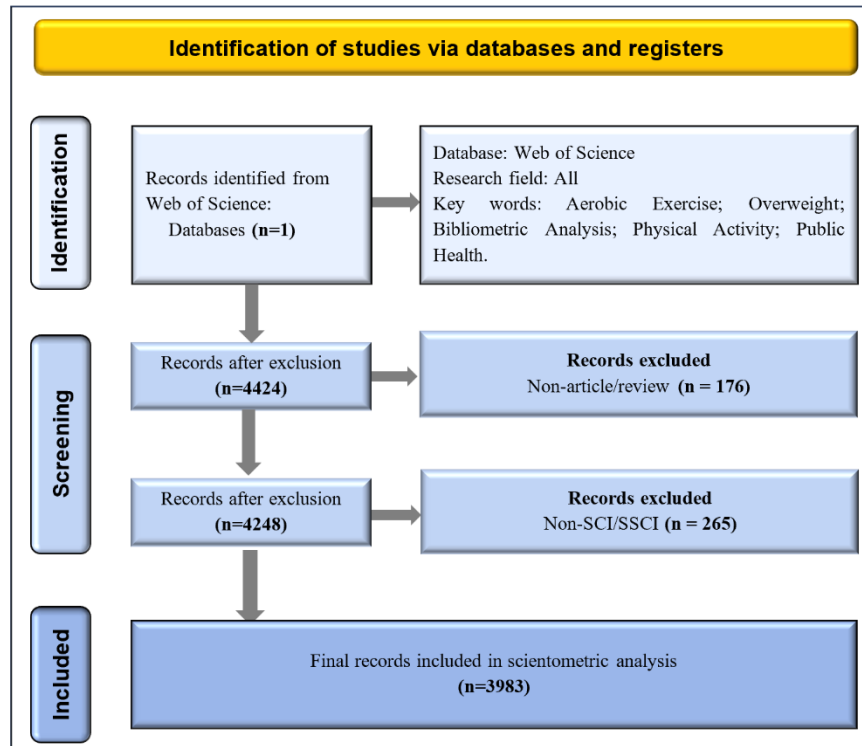


Figure 1. Flowchart of the publication's selection. Note. Publications were retrieved from the Web of Science Core Collection using topic-based search terms related to aerobic exercise and overweight. After screening and data cleaning, 3,983 English-language articles and reviews published between 1978 and March 2025 were included for bibliometric analysis.

3. Results

3.1 Main information

A total of 3,983 publications from 1978 to 2025 were included in the final analysis, showing a consistent upward trajectory with a marked acceleration after the year 2000 (see Figure 2). The field demonstrated a high degree of research collaboration, with an average of 6.35 authors per publication and an international collaboration rate of 31.56%. The mean citation count reached 44.04 citations per paper, indicating a substantial academic impact. In total, 4,388 Author Keywords and 4,675 Keywords Plus were identified, encompassing dimensions such as intervention modalities, metabolic indicators, and target populations, thereby reflecting the multidisciplinary integration and thematic complexity of this research domain (Figure 2). Note: The data for 2025 are based on publications indexed up to March and are presented as provisional values for reference (Chen & Morazuk, [2025](#)).



Figure 2. Key bibliometric indicators of aerobic exercise research on overweight (1978–2025). Note: Data for 2025 are based on publications indexed until March and are provisional.

3.2 Analysis of Research Productivity and Scholarly Influence

3.2.1 National Scientific Production and Citation Impact

At the national level, publication volume and citation impact are key indicators for the assessment of research influence and the degree of international engagement. [Table 1](#) presents the scientific output and academic impact of major countries in the field of aerobic exercise interventions for overweight. The United States ranks first with an overwhelming lead of 4,556 publications, far surpassing other countries in terms of research output. Moreover, U.S.-based publications have accumulated a total of 82,492 citations, with an average of 70.40 citations per article, indicating both a high volume and exceptional quality of research. It should be emphasized that this conclusion is partly shaped by the coverage profile of the WoS Core Collection (which indexes a comparatively high proportion of U.S.-origin journals) and by the United States' systemic advantages in this area—namely, sustained and substantial research funding (e.g., NIH support), well-developed research infrastructure and a strong tradition of interdisciplinary collaboration, as well as the research and policy demand driven by a high prevalence of obesity. Taken together, these factors help explain the United States' pronounced lead within the WoS context.

Canada and Australia rank second (1,066 articles) and third (838 articles), respectively, with impressive citation performance—averaging 56.70 and 56.60 citations per article. European countries such as the United Kingdom, Finland, the Netherlands, and Sweden also exhibit high average citation counts (ranging from 48 to 57), reflecting their sustained strength in producing high-quality research.

On the other hand, China ranks sixth in publication volume with 829 articles, gradually catching up with developed countries in quantity. However, its average citation count is only

15.10—substantially lower than that of the United States, Canada, and Australia—suggesting relatively limited academic influence and considerable scope to enhance high-impact output and international visibility. This pattern aligns with the well-documented “impact gap,” whereby rapid growth in publication volume in emerging economies outpaces gains in citation impact; moreover, international co-authorship and researcher mobility are associated with higher visibility and citations. Accordingly, strengthening collaborative ties is a recognized pathway to improving impact (González-Brambila et al., [2016](#); Khor & Yu, [2016](#); Sugimoto et al., [2017](#); Chinchilla-Rodríguez et al., [2019](#); de Lima et al., [2021](#); Strain et al., [2024](#)). A similar profile is observed for Brazil, Chile, Iran, and Japan, which are active in publication output yet exhibit comparatively lower citation impact. This is consistent with evidence from Latin American and Asian research systems showing that international collaboration significantly elevates citation performance, underscoring a catch-up trajectory (Wagner & Jonkers, [2017](#); Chinchilla-Rodríguez et al., [2019](#); Hiruy et al., [2019](#); de Lima et al., [2021](#)).

Overall, research on aerobic exercise interventions for overweight displays a global pattern centered on the United States, with leadership from developed Western nations and participation from a diverse range of countries. The strong scientific investment and international collaboration of the United States contribute to its central position—an observation that aligns with broader trends in science, where international collaboration is often associated with greater citation impact and enhanced research productivity (Chinchilla-Rodríguez et al., [2019](#)). Moving forward, it is essential to further encourage developing countries to engage in partnerships with leading international research teams. Such collaborations can facilitate resource and knowledge sharing, enhance research quality, and foster a more balanced and inclusive global development of the field.

Table 1.

Analysis of National Scientific Production and Citation Impact

Country	Scientific Production(Freq)	Total Citations	Average Article Citations
USA	4,556	82,492	70.40
Spain	1,377	7,389	25.10
Canada	1,066	12,127	56.70
Brazil	941	5,001	19.60
Australia	838	11,320	56.60
China	829	3,568	15.10
Uk	619	7,782	49.60



France	457	2,315	23.40
Finland	388	3,624	53.30
Italy	370	2,058	23.40
Chile	359	835	12.50
Germany	359	2,057	24.20
Portugal	340	1,607	21.40
Iran	299	1,123	13.50
Sweden	283	2,556	48.20
Norway	262	2,208	36.80
Denmark	257	2,544	37.40
Netherlands	252	3,417	57.00
Japan	245	1,354	21.50
Switzerland	192	1,590	39.80

Source: the authors.

As demonstrated above, the United States far surpasses other countries in both publication volume and citation metrics, which is closely related to its substantial investment in research and long-standing academic tradition (Chinchilla-Rodríguez et al., [2019](#)). Meanwhile, countries such as Canada, Australia, and several European nations exhibit notably high per capita research impact, reflecting advantages in research efficiency and output quality. This pattern is consistent with previous findings indicating that open and collaborative scientific environments are more likely to yield high-impact research outcomes (Wagner & Jonkers, [2017](#)).

Emerging economies such as China have experienced rapid growth in publication volume in this field; however, improving research quality and international visibility remains a critical challenge for the next stage of development. Several studies have suggested that enhancing international research collaboration, targeted training for graduate researchers, and improving academic English writing skills can significantly increase the citation impact of research output from developing countries (Sugimoto et al., [2017](#)).

In summary, the global landscape of research on aerobic exercise interventions for overweight is characterized by a pattern of "broad participation with concentrated influence," wherein many countries contribute to the field, but scholarly impact remains heavily concentrated among a small number of leading nations. This underscores the importance of promoting more international collaborative projects aimed at strengthening the research capacity of countries with limited scientific resources, thereby advancing the field through more inclusive and cooperative efforts.

3.2.2 Analysis of Institutional Output

Research institutions serve as critical engines for scientific discovery. Figure 3 presents the top 20 institutions ranked by publication volume in the field of aerobic exercise interventions for overweight. The University of Granada (Spain) leads the list with 272 publications, significantly ahead of other institutions, underscoring its prominent role in this research domain. It is followed by the Pennsylvania Commonwealth System of Higher Education, the University of North Carolina, and Duke University in the United States, each contributing over 160 publications. These results reflect the institutional clustering advantage of U.S. universities in this field. Other prolific institutions include the University of Sydney (Australia) and the University of Ottawa (Canada), among other well-established research universities.

Most of the high-output institutions are located in countries that rank near the top by national publication volume and/or average citations in this field ([Table 1](#)), consistent with the country-level pattern and the institutional distribution shown in Figure 3. Leading institutions typically host multiple active research teams and benefit from robust research funding, enabling them to produce sustained and programmatic research output. At the institutional level, the U.S. university system demonstrates considerable collective strength, with numerous universities ranking highly and showing relatively balanced contributions. This suggests that research productivity in the U.S. is distributed across multiple institutions rather than concentrated in a single entity. In contrast, the outstanding performance of the University of Granada can be attributed to its long-standing focus on youth physical fitness and obesity research. Scholars such as Ortega F. B., one of the most prolific authors in the field, have played a pivotal role in international collaborations and have significantly shaped the institution's academic influence.

In summary, the analysis of institutional output highlights the leadership of top universities in North America and Europe in advancing research on aerobic exercise and overweight. Moving forward, there is a clear need to enhance inter-institutional collaboration, for instance, through large-scale multi-institutional research initiatives. Such cooperation may help to integrate complementary strengths, foster methodological innovation, and promote data sharing, thereby expanding both the depth and breadth of future research in the field.

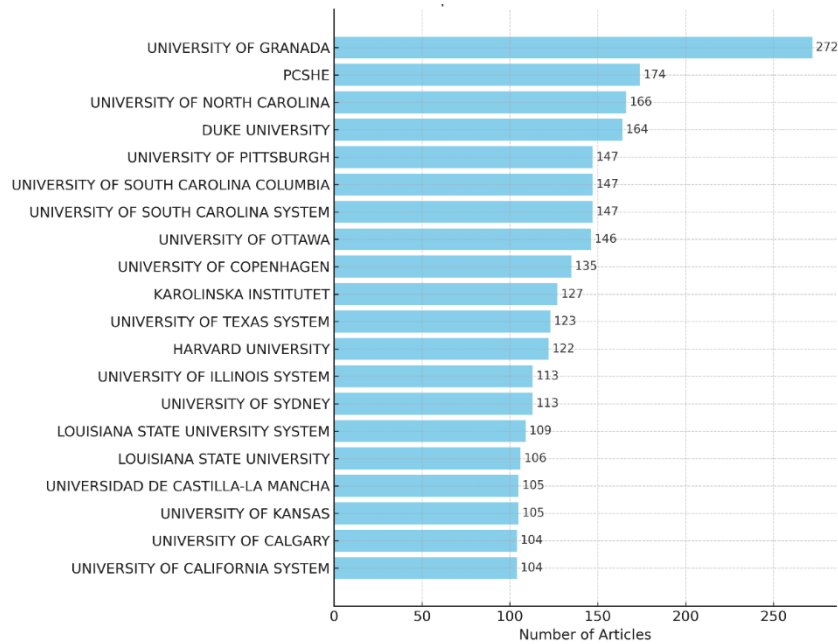


Figure 3. Top 20 Most Productive Institutions. Source: the authors.

3.2.3 Source Impact and Core Journal Evaluation

Journals serve as the primary medium for the dissemination of scientific knowledge and exert a direct influence on research visibility and academic impact. [Table 2](#) lists the top 20 core journals by publication volume in the field of aerobic exercise interventions for overweight and presents a comprehensive analysis of key bibliometric indicators, including the number of publications, h-index, g-index, m-index, and total citations.

The results indicate that *Medicine and Science in Sports and Exercise* leads the field with 106 related publications. It also holds the highest h-index (44) and g-index (78), along with a total citation count of 6,494, underscoring its authoritative status and sustained influence in sports medicine research. The *International Journal of Environmental Research and Public Health* ranks second with 96 publications; however, its h-index (19) is comparatively lower, likely due to the journal's broad multidisciplinary scope and variability in article impact. Both the *International Journal of Obesity* and *Obesity* are central journals in obesity research, having published 88 and 84 articles, respectively, with total citation counts of 5,621 and 4,648.

Notably, several emerging open access journals have gained prominence in recent years. For instance, *PLOS ONE*, *Frontiers in Physiology*, and *Nutrients*—despite being relatively young—demonstrate high m-index values (1.941, 1.818, and 1.385, respectively), reflecting rapid citation growth within a shorter time frame. All operating under gold open-access models with CC BY licenses and article processing charges (status verified on journal/publisher websites, accessed March 2025). This trend aligns with the broader shift

toward open access publishing, which facilitates faster and wider dissemination of research findings due to free accessibility, often resulting in increased citation rates (Wagner & Jonkers, [2017](#)).

Consistent with database subject classifications, most source journals in our set fall within Health Sciences—e.g., Public Health, Physiology, Nutrition & Dietetics, Pediatrics, and Psychology—underscoring the field’s multidisciplinary footprint. For example, the included publications encompass traditional sports medicine journals, comprehensive public health outlets, and nutrition and metabolism journals, indicating that the topic of aerobic exercise interventions for overweight populations has attracted attention across multiple disciplinary domains. The research thus spans a broad spectrum of content—from physiological mechanisms to population-level health outcomes—reflecting the interdisciplinary nature of this field. Such a diverse journal distribution contributes to expanding the research influence by facilitating the dissemination of exercise-intervention evidence across wider academic and practical contexts. For researchers, selecting an appropriate journal for submission is crucial: publishing in high-impact specialized journals ensures visibility and citation by core disciplinary audiences, whereas interdisciplinary journals can broaden readership and enhance the translational and practical impact of research findings.



Table 2.

Top 20 most productive journals in the field and their citation impact metrics

Source	Articles	h_index	g_index	m_index	Total Citations	Start Year
Medicine and science in sports and exercise	106	44	78	1.294	6,494	1992
International journal of environmental research and public health	96	19	29	1.267	1,214	2011
International journal of obesity	88	42	74	1.2	5,621	1991
Obesity	84	37	67	1.85	4,648	2006
Plos one	72	33	53	1.941	2,935	2009
Applied physiology nutrition and metabolism	63	23	43	1.15	1,915	2006
Frontiers in physiology	62	20	28	1.818	972	2015
Nutrients	60	18	27	1.385	864	2013
Pediatric exercise science	56	18	30	0.72	1,087	2001
Journal of sports medicine and physical fitness	52	15	24	0.536	719	1998
Scandinavian journal of medicine & science in sports	51	22	48	0.733	2,399	1996
BMC public health	49	22	37	1.048	1,423	2005
Journal of sports sciences	48	20	43	0.909	1,864	2004
European journal of applied physiology	44	18	31	0.643	1,074	1998
Journal of physical activity & health	44	17	31	1	1,034	2009
Medicine & science in sports & exercise	38	18	38	0.375	2,407	1978
Journal of applied physiology	37	23	37	0.793	2,151	1997
Preventive medicine	37	22	37	0.611	2,018	1990
Metabolism-clinical and experimental	35	28	35	0.737	2,214	1988
Nutrición hospitalaria	33	11	18	0.733	388	2011

Source: the authors.

As shown in [Table 2](#), researchers should carefully consider both the reputation of the journal and its target readership when selecting an outlet for publication. For studies focused on the physiological mechanisms of exercise, specialized journals such as *Medicine & Science in Sports & Exercise* are more appropriate, as they offer strong peer recognition and high citation potential. In contrast, research addressing public health policies or population-based interventions may benefit from dissemination in



interdisciplinary journals such as *BMC Public Health* or *International Journal of Environmental Research and Public Health (IJERPH)*, which offer broader reach and greater potential for translational impact. Regardless of journal type, high-quality research will ultimately generate academic influence. Therefore, researchers should prioritize the scientific rigor and innovation of their work, striving to produce robust and impactful findings. Timely publication and dissemination of well-conducted research are essential for supporting global efforts to prevent and manage overweight and obesity through evidence-based interventions.

3.2.4 Most Influential Authors and Their Citation Performance

To further reveal the academic ecosystem of the field, we analyzed the top 20 most productive and influential authors (see [Table 3](#)). In terms of publication volume, Ortega F. B. ranks first with 89 articles, reflecting his sustained and prolific research commitment in this area. He is affiliated with the University of Granada (Spain), which was also identified in the previous section as one of the most productive institutions in this field. He is followed by Ruiz J. R. (University of Granada) and Blair S. N. (Harvard University, USA), whose institutions likewise rank among the leading contributors, further demonstrating the alignment between individual productivity and institutional research strength. Notably, Blair S. N. not only ranks among the top in publication count but also stands out as the most influential scholar, with a total of 10,259 citations, an h-index of 43, and a g-index of 69. This indicates both his pioneering contributions to the field of physical activity and health, and the foundational role his work has played in shaping subsequent research.

Table 3.

Top 20 most productive authors and their citation metrics in the field.

Author	Articles	h_index	g_index	m_index	Total Citations	Start Year
Ortega FB	89	37	68	1.85	4,762	2006
Blair SN	69	43	69	1.536	10,259	1998
Ruiz JR	53	30	53	1.5	2,912	2006
Lavie CJ	44	32	44	1.882	4,914	2009
Church TS	42	28	42	1.167	5,144	2002
Mota J	42	15	27	0.75	857	2006
Cadenas-Sánchez C	41	22	34	2.2	1,214	2016
Donnelly JE	39	25	39	0.806	4,087	1995
Jakicic JM	38	27	38	0.871	5,320	1995
Hillman CH	35	22	35	1.158	3,872	2007

Esteban-cornejo I	33	19	33	1.188	1,089	2010
Labayen I	33	18	31	1.5	972	2014
Kraus WE	32	22	32	0.88	2,733	2001
Moreno LA	32	25	32	1.25	1,997	2006
Mctiernan A	31	22	31	0.786	2,047	1998
García-Hermoso A	29	13	25	1.083	651	2014
Miguelles JH	28	15	28	1.5	886	2016
Andersen LB	27	14	27	0.7	1,376	2006
Martínez-Vizcaíno V	27	16	27	1.231	999	2013
Earnest CP	25	19	25	0.792	2,510	2002

Note. Authors are ranked by total publications. Indicators (h-index, g-index, m-index, and total citations) were calculated using Bibliometrix. “Start Year” denotes the first year of publications indexed in the Web of Science Core Collection and may not correspond to the author’s actual first year of publication. Source: the authors.

Overall, the group of highly productive authors is dominated by scholars from Europe and North America. Latin American authors are represented in the dataset—primarily from Brazil and Chile—although none appear among the top-20 most productive authors or institutions (see [Table 1](#) and [Figure 3](#)). This includes senior researchers with early and substantial contributions—such as Blair S. N., whose work since the 1980s has significantly shaped the relationship between exercise and health—as well as rising young scholars who have emerged in recent years. For instance, Cadenas-Sanchez C. has published 41 articles since 2016 and holds an m-index of 2.2, reflecting rapid academic growth and high impact potential. Similarly, early-career researchers such as Miguelles J. H., Labayen I., and García-Hermoso A. have each achieved m-indices greater than 1.0, indicating notable productivity and visibility within a relatively short time frame. The emergence of this new generation suggests a promising trajectory for sustained development in the field.

Further insights are drawn from the publication trajectories of top authors (Figure 4). Scholars such as Ortega F. B., Ruiz J. R., and Church T. S. have remained active since 2006, with steadily increasing output, particularly after 2015—a period marked by growing global interest in youth fitness and the effectiveness of exercise interventions. This productivity surge is also attributed to their involvement in international collaborative projects; for example, Spanish researchers like Ortega and Ruiz have maintained frequent partnerships with teams in the United States and the United Kingdom, enhancing their research output and global influence.

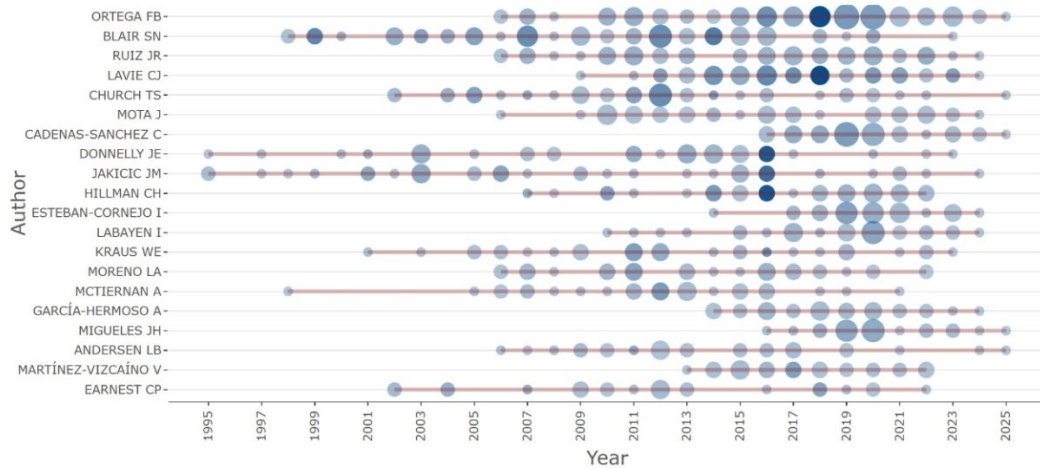


Figure 4. Authors' production over time (1995–2025). Note. This bubble chart displays the annual publication trajectories of the top 20 most productive authors in the field. The x-axis represents the publication year and the y-axis lists author names. Bubble size indicates the number of publications per year, while color depth represents total citations (TC) in that year. Authors are arranged in the same order as in [Table 3](#) to facilitate comparison between the two. The visualization highlights generational patterns in research productivity, showing early pioneers (e.g., Blair S. N., Donnelly J. E.), active mid-career scholars (e.g., Ortega F. B., Ruiz J. R.), and emerging researchers (e.g., Cadenas-Sánchez C., Migueles J. H.). Source: the authors.

By contrast, some early pioneers such as Donnelly J. E. and Jakicic J. M. were most active between 1990 and 2010. Although their recent output has declined, their cumulative citations remain high (4,087 and 5,320 respectively), indicating the continued relevance of their foundational work in the current knowledge system. Additionally, emerging researchers such as Esteban-Cornejo I. and Martínez-Vizcaíno V. have demonstrated stable publication output and high m-indices over the past five years, suggesting they are rapidly joining the ranks of core contributors in the field.

Together, [Table 3](#) and [Figure 4](#) depict a generationally layered structure among core authors, consisting of senior pioneers, established mid-career researchers, and dynamic early-career scientists. This multi-generational composition ensures continuity and innovation, fostering both the accumulation and diffusion of academic knowledge. The publication trajectories and citation patterns of these authors trace the intellectual evolution of the field: early researchers laid the groundwork through foundational studies, mid-career scholars expanded and empirically enriched the content, while the new generation is exploring interdisciplinary directions and driving emerging frontiers. Across the corpus, articles list a mean of 6.35 authors, with 31.56% involving international co-authorship;

predominant disciplinary affiliations are sport/exercise science, public health/epidemiology, physiology, and nutrition, and most contributors are based in universities or academic medical centers (see Figures 2–3). This progression aligns with general models of scientific development and reflects the vitality and momentum of the field over the past several decades. With the continued engagement of senior experts and the growing participation of young scholars, it is reasonable to expect that research on aerobic exercise interventions for overweight will continue to yield high-quality contributions and move toward greater academic maturity.

[Figure 4](#) presents a bubble chart depicting the annual publication patterns of core authors, reflecting their "academic age" within the field. The x-axis represents publication year, while the y-axis lists author names. Bubble size indicates the number of publications in a given year, and color depth corresponds to the total number of citations that year. The chart reveals temporal differences in research activity among authors: for instance, Blair S. N. made significant contributions during the late 1990s and early 2000s. Although his publication output has declined in recent years, his earlier work continues to receive substantial citations, attesting to its lasting influence.

In contrast, authors such as Ortega F. B. and Ruiz J. R. entered their most active publishing periods after 2005, with steadily increasing output peaking in recent years. Notably, some authors exhibit "dual peaks" of publication volume and citation impact within specific timeframes. For example, Ortega F. B. shows the largest and darkest-colored bubbles between 2019 and 2021, suggesting a combination of high productivity and rapid citation accumulation during that period. This may be associated with his leadership or participation in high-impact research projects, coinciding with the emergence of topical issues within the field during that time.

Senior scholars such as Donnelly J. E. and Jakicic J. M. show concentrated publication activity between 1995 and 2010, with bubble sizes gradually shrinking thereafter. This trend reflects their gradual transition away from frontline research, possibly shifting toward administrative or mentorship roles. Nevertheless, their earlier work—such as Donnelly's large-scale intervention trials on exercise and weight loss—remains highly cited and foundational to the field.

Overall, Figure 4 illustrates the generational dynamics of knowledge production: early pioneers laid the groundwork, mid-career researchers expanded the domain, and emerging scholars are exploring new directions. This succession ensures the vitality and continuity of the field. Looking forward, the integration of new technologies such as wearable devices and big data analytics into obesity intervention research is expected to attract more scholars with interdisciplinary backgrounds. Consequently, the composition of core authors will likely become increasingly diverse, bringing fresh perspectives and methodological innovations.

As noted by Chinchilla et al. (2019) in their bibliometric study, the scientific leadership of nations or teams is closely tied to the strength of their collaboration networks. The same applies at the individual level: engaging in inter-team collaborations and broadening research horizons can facilitate the generation of high-quality work and enhance scholarly visibility. This trend is clearly reflected in the trajectories of core authors and offers valuable guidance for the next generation of researchers aiming to make impactful contributions through collaboration.

3.3 Trend Analysis

3.3.1 Trend of Annual Scientific Production

Figure 5 illustrates the annual number of publications and the corresponding Annual Growth Rate (AGR) from 1978 to 2025. The developmental trajectory of this field can be broadly divided into three phases: the initial exploratory stage (1978–1999), the rapid growth stage (2000–2015), and the fluctuation-adjustment stage (2016–present).

During the initial stage, the annual number of publications was minimal, generally fewer than 10 per year, indicating that research on aerobic exercise interventions for overweight individuals was still in its infancy. With the turn of the 21st century, and in parallel with the global rise in obesity and increased interest in exercise-based interventions, research output grew significantly. From 2000 to 2010, the annual number of publications increased from several dozen to 139 in 2010. This growth further accelerated, reaching 230 publications by 2015, marking a period of substantial scholarly attention and active research development in this area.

Since 2016, the annual output has remained high—consistently above 230 publications per year—yet the growth rate has shown noticeable fluctuations. The year 2020 marked the highest number of publications to date (272), but the growth rate stagnated in 2021 (AGR ≈ 0). From 2019 to 2024, the AGR exhibited a wave-like pattern of decline, rebound, and subsequent drop. Notably, while 2022 saw a record output of 281 publications, the AGR turned negative (-0.78). A negative AGR indicates a temporary decline in publication output compared with the previous year, reflecting short-term fluctuations rather than a long-term downward trend. The figure rebounded slightly in 2023 but decreased again to 196 in 2024. It is important to note that data for 2025 only reflects records up to the end of March, with 56 publications—an underestimation due to the incomplete timeframe, and thus not indicative of the full year's trend.

Overall, nonlinear regression analysis of data from 1978 to 2024 reveals a significant positive correlation between publication volume and time ($R^2 = 0.7604$), confirming a sustained upward trajectory in research output over the long term. This aligns with the increased scientific demand driven by the global obesity epidemic and reflects the



continuous emergence of new research topics and technologies that fuel scholarly activity. Looking ahead, further growth may be catalyzed by cross-disciplinary integration and the adoption of innovative technologies such as digital health tools and AI-assisted interventions. For example, wearable devices enable high-frequency data collection on physical activity and health markers, supporting precision interventions and personalized guidance. Likewise, integrating behavioral science into exercise intervention strategies may enhance adherence and long-term efficacy.

In summary, the annual scientific production trends demonstrate that research on aerobic exercise interventions for overweight has evolved from a nascent field into a mature domain. Despite recent slowdowns in growth rate, the overall momentum remains strong. This underscores the need for continued attention and support from research management bodies and funding agencies, particularly during phases of growth deceleration, to sustain innovation and prevent decline in scholarly interest. The academic community should consolidate existing achievements, refine key scientific questions, and deepen investigations to maintain healthy and progressive development of the field.

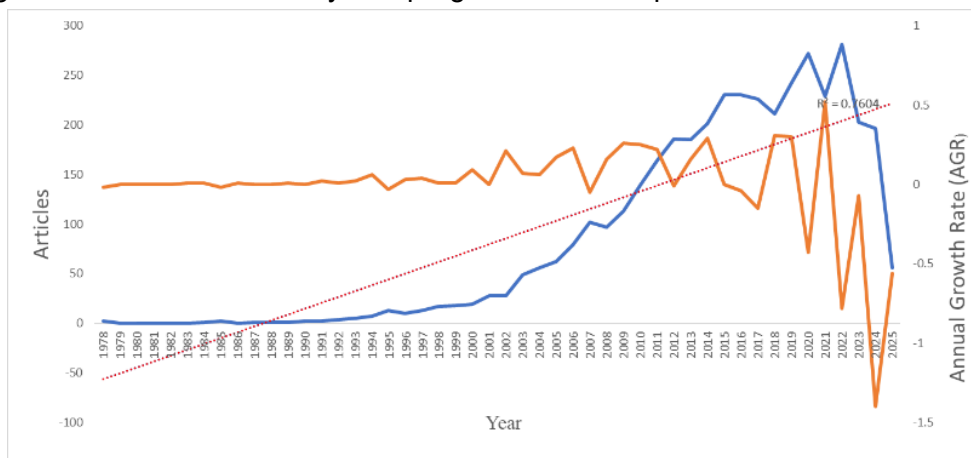


Figure 5. Annual scientific production and annual growth rate (AGR) for studies on aerobic exercise and overweight (1978–2025). Note. The blue line represents the annual number of publications, and the orange line shows the annual growth rate (AGR). A negative AGR denotes a temporary decline in publication output compared with the previous year, reflecting short-term fluctuations rather than a sustained downward trend. Source: the authors.

3.3.2 Keyword Evolution and Thematic Dynamics

To comprehensively elucidate the thematic evolution and knowledge structure in research on aerobic exercise interventions for overweight populations, both Keywords Plus and Author Keywords were analyzed. This dual-perspective approach allows for a broader capture of implicit conceptual linkages through Keywords Plus while maintaining the



precision and author intent reflected in Author Keywords, thus ensuring a more complete understanding of the field’s semantic landscape.

3.3.2.1 Trends in Keywords Plus

As illustrated in Figures 6 and 7, the annual and cumulative frequency analysis of high-frequency Keywords Plus reveals a clear trajectory of thematic evolution. Since 2000, the field has witnessed a rapid increase in both publication output and keyword diversity, reflecting its growing academic prominence. Terms such as “overweight,” “physical activity,” “cardiorespiratory fitness,” and “obesity” have consistently appeared at high frequencies, peaking between 2010 and 2021, with over 60 occurrences per year. These keywords represent the enduring thematic backbone of the field.

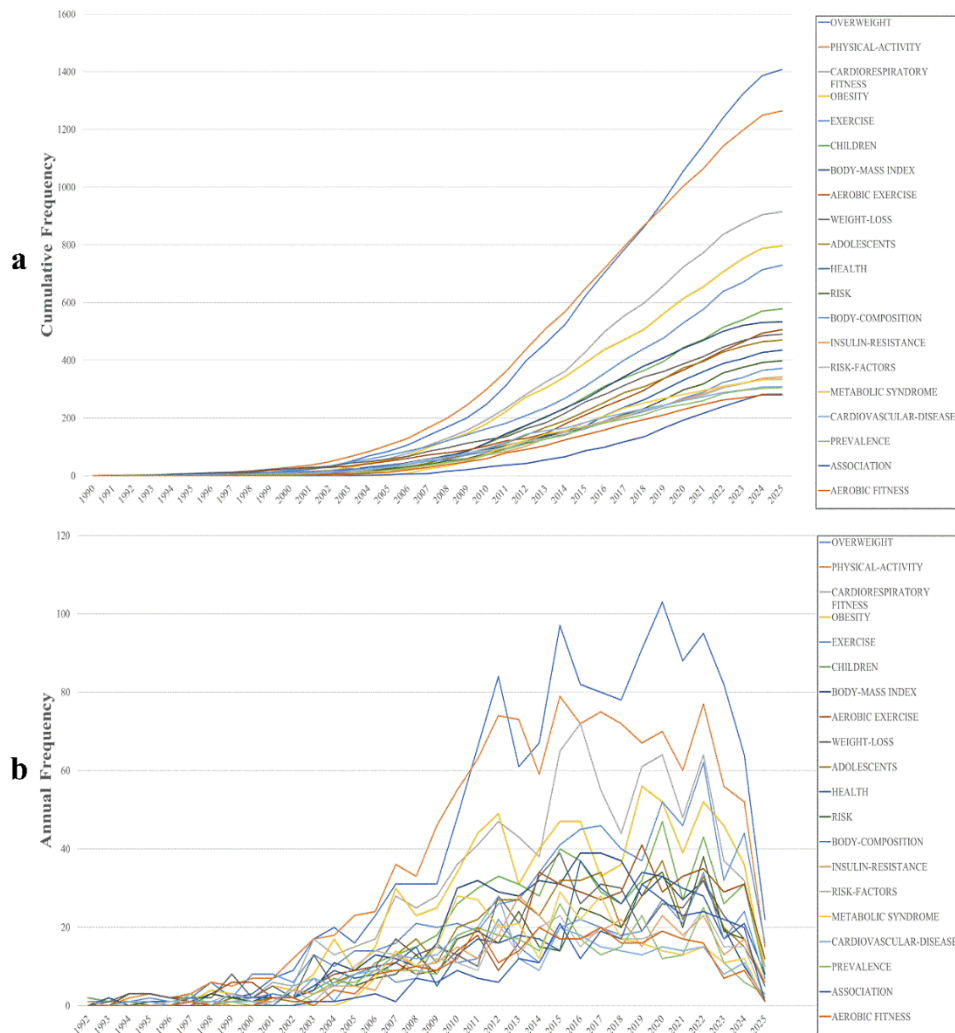


Figure 6. Keyword dynamics of 20 core Keywords Plus related to aerobic exercise and

overweight (1990–2025). Note. (a) Cumulative frequency (running totals by year). (b) Annual frequency (yearly occurrences). Colors are identical across panels to facilitate comparison. Values for 2025 are partial (records indexed through March only). Data: Web of Science Core Collection; Keywords Plus extracted with bibliometrix and series calculated/plotted in Excel. Source: the authors.

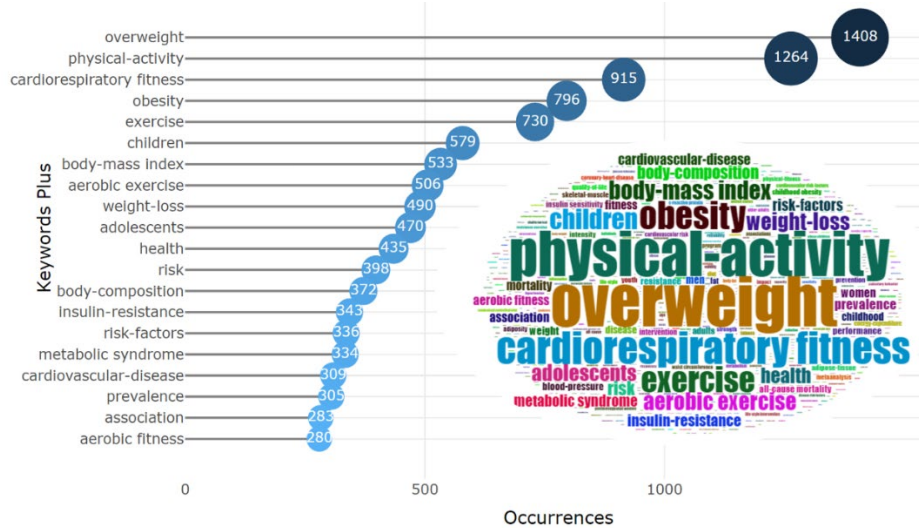


Figure 7. Top 20 Keywords Plus by Frequency and Word Cloud Representation in the Field of Aerobic Exercise and Overweight (1978–2025). Source: the authors.

In contrast, emerging terms such as “exercise,” “body mass index,” “aerobic exercise,” “children,” and “insulin resistance” have shown rapid growth since 2015, suggesting a transition from general public health research toward mechanism-oriented and population-specific investigations. More recent keywords—“risk factors,” “metabolic syndrome,” “aerobic fitness,” and “adolescents”—indicate increasing attention to multidimensional health outcomes and targeted interventions. The apparent decline in keyword frequency for 2025 is attributable to the data being limited to publications indexed through March and does not represent the full year. Notably, psychosocial/behavioral constructs (e.g., motivation, self-efficacy, social support, behavior change) do not appear among the top 20 Keywords Plus or leading annual-frequency terms, indicating that psychosocial perspectives are underrepresented in this corpus relative to physiological and clinical themes (see Figures 6–7).

From the cumulative frequency dimension, the long-term structure of research hotspots appears stable, reflecting the maturation of the field’s knowledge base. As shown in Figure 6, “overweight” (1,408), “physical activity” (1,264), and “cardiorespiratory fitness” (915) remain the three most frequent keywords, forming the semantic core of the discipline. Mechanism-related keywords—such as “insulin resistance,” “body composition,” and “metabolic syndrome”—exhibit steep upward trajectories, signaling a rising focus on



metabolic mechanisms and physiological adaptations. Collectively, the evolution of Keywords Plus illustrates a layered development process—from intervention efficacy to mechanistic exploration and population differentiation—reflecting an increasingly multidisciplinary and applied orientation.

3.3.2.2 Evolution of Author Keywords

To complement the above findings, Author Keywords were examined to capture authors' intentional expressions of research foci. Using CiteSpace's burst detection algorithm ($\gamma = 0.9$; minimum duration = 1 year), 29 keywords with significant citation bursts were identified (see Figure 8), highlighting periods of concentrated academic attention. Results indicate a three-phase evolution of thematic emphasis: Early stage (1999–2010): Keywords such as “body weight” and “energy expenditure” reflected broad behavioral interventions focusing on weight management and cardiovascular risk. Middle stage (2010–2020): Terms like “insulin resistance” and “muscular strength” emerged, signaling a shift toward metabolic pathways and muscle physiology. Recent stage (2020–present): Bursts in “high-intensity interval training (HIIT),” “type 2 diabetes mellitus,” and “network meta-analysis” underscore the transition toward precision interventions and evidence-based evaluation. Among them, “HIIT” (strength = 10.09; burst = 2018–2025) ranks highest, reflecting its rising popularity due to time efficiency and metabolic benefits. Similarly, the bursts in “insulin resistance” and “muscular strength” reinforce the growing focus on muscle–metabolism interactions, while “type 2 diabetes mellitus” indicates an expansion from weight control to comprehensive metabolic regulation.

Top 20 Keywords with the Strongest Citation Bursts

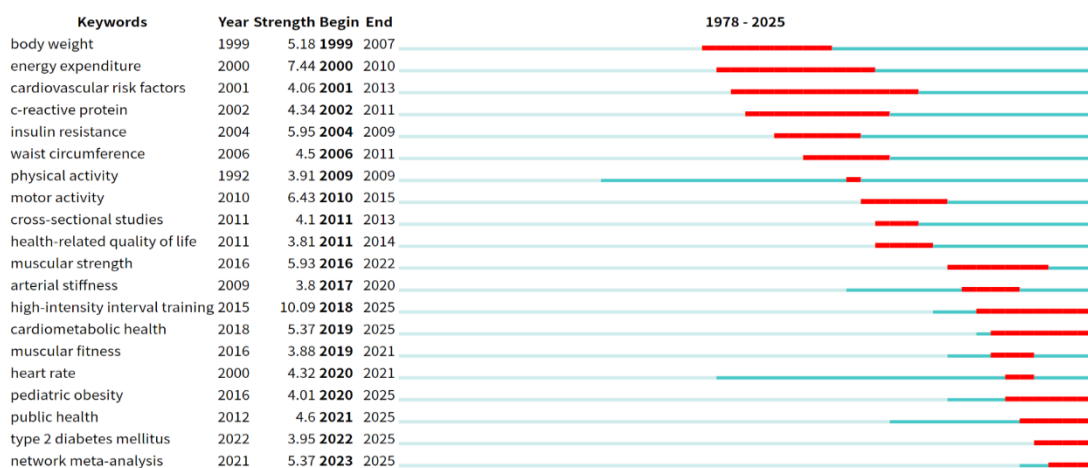


Figure 8. Top 20 author keywords with the strongest citation bursts in studies on aerobic exercise interventions for overweight (1978–2025). Note. The figure displays the 20 author

keywords with the highest burst strengths identified by CiteSpace’s burst-detection algorithm. The horizontal axis indicates the year range (1978–2025); red bars denote the burst periods for each keyword, and the blue thin lines mark the full occurrence span across the study window. A higher burst strength reflects more concentrated short-term scholarly attention. Recent emerging hotspots include high-intensity interval training (HIIT), muscular strength, type 2 diabetes mellitus (T2DM), and network meta-analysis, signaling a shift in the field from macro-level behavioral regulation toward precision interventions and evidence-based evaluation. Source: the authors.

In addition, frequency visualization of Author Keywords (see Figure 9) shows that “obesity” (978), “exercise” (629), “physical activity” (565), “cardiorespiratory fitness” (331), and “overweight” (310) dominate the field, forming the triadic core of exercise–weight management–cardiorespiratory health. Other frequently used terms—such as “body composition,” “children,” “weight loss,” “metabolic syndrome,” “insulin resistance,” and “diet”—reveal sustained interest in physiological mechanisms, youth interventions, and nutritional integration. The word cloud demonstrates a power-law distribution, where a few dominant terms define the disciplinary nucleus, while a wide array of low-frequency terms capture emerging and interdisciplinary themes.

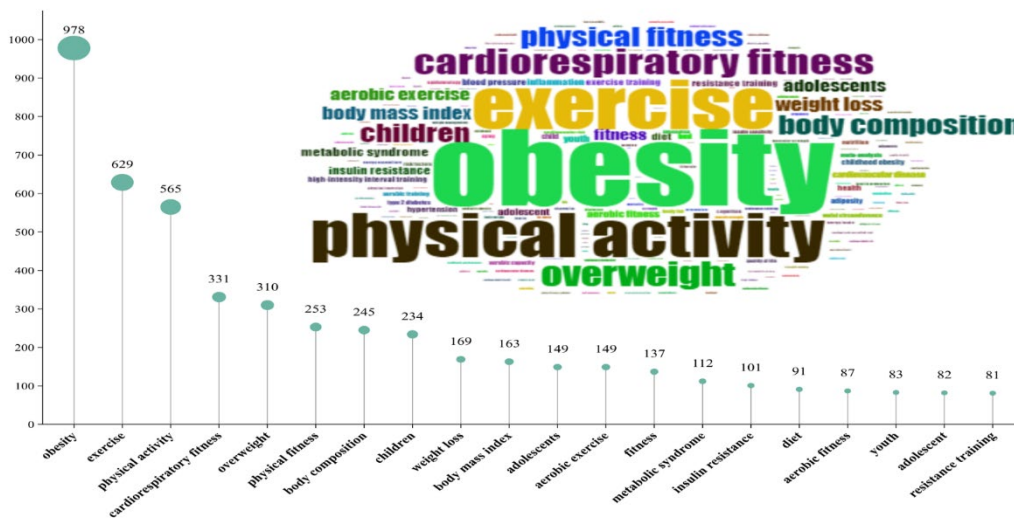


Figure 9. Bubble-chart and word-cloud visualization of high-frequency author keywords in studies on aerobic exercise interventions for overweight (1978–2025). Note. The bubble-chart (left) presents the top 20 author keywords on the X-axis ranked by occurrence frequency, with bubble size corresponding to the proportional frequency; the word cloud (right) visualizes the same keywords, in which font size is proportional to frequency. Keyword frequencies were calculated from N = 3,983 documents indexed in the Web of Science Core Collection (1978–2025), indicating that terms such as obesity, exercise, and



physical activity have remained persistently high-frequency, forming a research structure centered on exercise, weight control, and cardiorespiratory health. The power-law distribution observed in the word cloud reflects a concentrated thematic core alongside substantial topical diversity. Source: the authors.

Taken together, the integration of Keywords Plus and Author Keywords analyses demonstrates that research on aerobic exercise and overweight has progressively evolved from macro-level behavior regulation toward mechanistic integration, precision assessment, and individualized interventions, marking a transition into a mature, system-oriented, and multidisciplinary research domain.

3.3.3 *Keyword Co-occurrence Network and Cluster Analysis*

The keyword co-occurrence network analysis (Figure 10) revealed two core research directions in the domain of aerobic exercise interventions for overweight. The first cluster centers on aerobic exercise and weight management, with key terms such as "exercise", "physical activity", and "weight loss", highlighting the role of physical activity in controlling body weight and reducing fat mass. The second cluster focuses on cardiorespiratory fitness and overweight, represented by keywords such as "cardiorespiratory fitness", "overweight", "obesity", and "health", underscoring the importance of aerobic exercise in enhancing cardiorespiratory fitness, lowering cardiovascular risk, and addressing overweight and obesity-related conditions.

The analysis indicates that aerobic exercise plays a pivotal role in both weight management and cardiometabolic health improvement. Research in this area continues to grow steadily, reflecting its broad and sustained impact on health promotion and obesity prevention. These findings suggest that future research should aim to integrate multiple health indicators to enhance both the scientific rigor and practical effectiveness of exercise-based interventions. For policymakers and clinical practitioners, recognizing the multi-dimensional health benefits of physical activity is essential. Emphasizing the broader outcomes of exercise interventions can support the development of personalized programs and enable more comprehensive evaluation of their effectiveness.

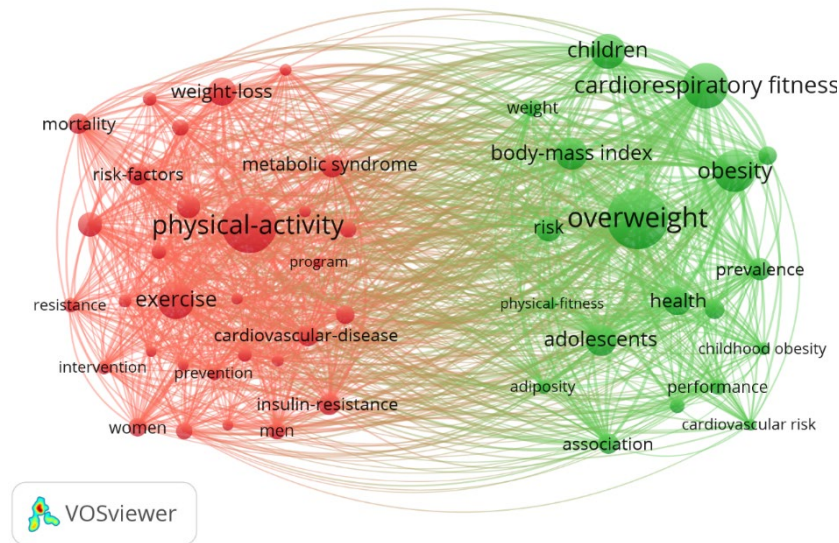


Figure 10. Keyword Co-occurrence Network and Cluster. Source: the authors.

3.4 Collaboration Network Analysis

To comprehensively illustrate the scientific collaboration landscape in the field of aerobic exercise and overweight, a three-domain collaboration network was constructed based on the relationships among authors (Author), their affiliations (AU_Affiliation), and their respective countries (AU_UN, AU_CO), as shown in Figure 11. This visualization presents the multilevel relational pathways among individuals, institutions, and nations, offering a multidimensional perspective on the spatial distribution and structural patterns of collaborative research forces.

As shown in the figure, the United States (USA) emerges as the dominant contributor in this field, with the highest number of collaborative institutions and prolific authors. Leading scholars such as Donnelly J. E., Kraus W. E., and Blair S. N. are affiliated with top-tier American universities including Duke University, Harvard University, and the University of North Carolina—highlighting the country’s central role in shaping global research on this topic.

Spain also demonstrates strong research activity within Europe, with core contributors such as Ortega F. B., Cadenas-Sanchez C., and Migueles J. H. primarily affiliated with the University of Granada, forming a prominent research cluster. In addition, institutions in Canada (e.g., University of Ottawa, University of Calgary), Australia (University of Sydney), the United Kingdom (University of Leeds), Denmark, and Sweden are closely connected to American and Spanish teams, forming a high-density network of international collaboration.

This three-field plot not only reveals author-institution affiliations but also reflects the intensity of academic linkages among institutions and countries. It provides a foundational

overview for the subsequent in-depth analyses of country-level collaboration (Section 3.4.1), institutional collaboration (Section 3.4.2), and author collaboration (Section 3.4.3).

Overall, the findings indicate that the field has developed a highly internationalized collaboration network, centered around North America and Europe, with a concentrated distribution of research resources and influence.

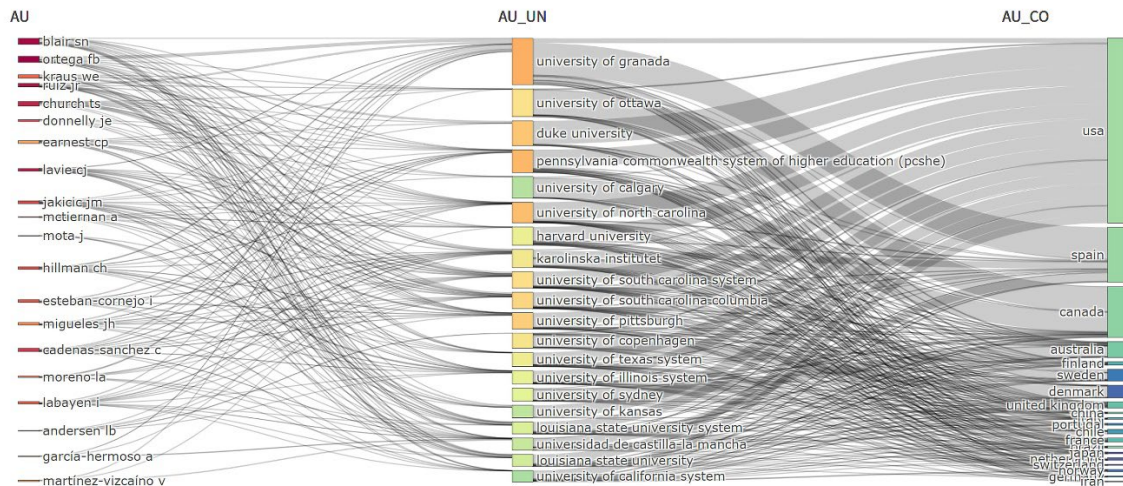


Figure 11. Three-Field Plot. Source the authors.

3.4.1 Country Collaboration Network Analysis

Figure 12 presents the collaboration network among the top 20 countries in terms of publication volume. The United States occupies the most central position in the network, having established strong collaborative ties with multiple countries including Germany, the United Kingdom, Australia, Canada, Spain, Brazil, China, and France. The U.S. not only leads in overall research output but also ranks highest in the number of multi-country publications (MCP), reflecting its dominant role in the field and its strong global collaboration capacity.

Among European countries, the United Kingdom, Germany, France, and Spain frequently collaborate both with each other and with the United States, forming a tightly connected transatlantic research cluster. Similarly, Australia and Canada, as research-intensive Commonwealth countries, show active engagement in collaborations with both American and European partners. In Asia, China has produced a substantial number of internationally co-authored publications; however, its partnerships are still primarily concentrated with institutions in Europe and North America, with relatively limited intra-regional collaboration. Countries such as Japan and South Korea have contributed to the field but remain peripheral nodes in the global collaboration network, indicating comparatively lower influence in international scientific cooperation.

Overall, the country-level collaboration network is characterized by a core-periphery

structure dominated by developed countries in Europe and North America. Emerging economies are increasingly integrated but generally remain in subordinate positions. Among the top-20 countries in our dataset, Brazil (Articles=255; MCP=102; MCP%=40.0%), China (236; 85; 36.0%), Iran (83; 25; 30.1%), and Chile (67; 40; 59.7%)—the emerging economies in this field—have become increasingly integrated into the global collaboration network; however, relative to the North American–European core (the United States, the United Kingdom, Germany, France, Australia, and Canada), they still occupy less-central/peripheral positions in Figure 10, with smaller nodes, thinner edges to the hubs, and generally smaller volumes of multi-country publications. Although Chile (59.7%) and Spain (58.2%) show high MCP shares, their absolute output and brokerage roles are more limited. In Asia, Japan (MCP%=15.9%) and South Korea (25.9%) also appear peripheral in this network. This pattern is consistent with global trends across scientific disciplines, where countries with stronger research capacity are more likely to serve as collaboration hubs and benefit more from international partnerships. In the context of this field, the United States has expanded its research scale and impact through extensive international cooperation. Prior studies have shown that internationally co-authored articles tend to receive more citations than those authored by researchers from a single country (de Lima et al., [2021](#)), further highlighting the strategic value of global collaboration.

From the perspective of the corresponding author's affiliation, an analysis of single-country publications (SCP) versus multi-country publications (MCP) reveals that developed countries such as the United States maintain dominance in both independent and collaborative outputs. Meanwhile, countries such as Spain, Brazil, China, and Canada demonstrate strong performance in both domestic research output and international collaborations, indicating a balanced development strategy that combines internal research investment with active global engagement. This dual approach is conducive to enhancing overall academic influence.

In general, the country collaboration network indicates that the field of overweight intervention research is currently led by North America and Europe. However, participation from regions such as the Asia-Pacific and Latin America is steadily increasing, and the scope of collaboration is continuously expanding. This trend aligns with broader developments in global science, where the proportion of internationally co-authored publications has been rising over recent decades, and research has increasingly become a globalized endeavor. Looking forward, as countries like China continue to strengthen their research capacity and global health challenges become more interconnected, cross-regional scientific collaboration is expected to deepen. For instance, fostering intra-Asian and South-South cooperation through multinational intervention trials can diversify study populations and facilitate the exploration of culturally tailored intervention strategies,

thereby producing more globally applicable evidence. International organizations and major funding programs - such as the European Union's Horizon initiatives - can also play a catalytic role by supporting transnational research teams in addressing overweight and obesity.

In conclusion, country-level collaboration has become an indispensable component of research on aerobic exercise interventions for overweight. Deepening international cooperation enables resource sharing, fosters interdisciplinary dialogue, and accelerates both scientific discovery and knowledge translation. Promoting more inclusive and geographically diverse research partnerships will not only contribute to solving the global obesity epidemic but also enhance the scientific capacity of participating countries.

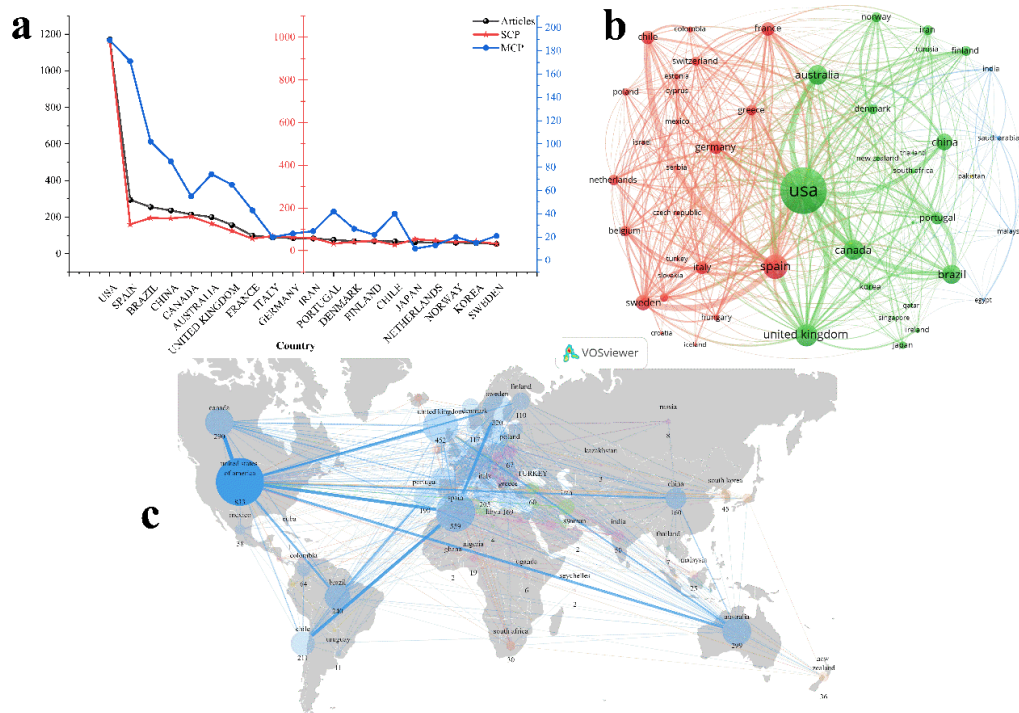


Figure 12. Country Collaboration Network. Note. (a) Output and collaboration mode by corresponding-author country: total articles and counts of SCP (single-country publications) and MCP (multi-country publications). (b) Country collaboration network (exported from Bibliometrix and redrawn in VOSviewer): node size \propto output; edge width \propto collaboration strength; colors denote clusters. (c) Geographic view of country-to-country collaboration (Scimago Graphica): circle size indicates output; links reflect cross-border collaboration strength. *2025 is partial (indexed through March). Abbreviations: SCP, single-country publications; MCP, multi-country publications. Source: the authors.

3.4.2 Institution Collaboration Network Analysis

The institutional collaboration network reveals a multi-centered, nested structure in

which core institutions play pivotal roles in linking global research resources. As shown in Figure 13, transnational clusters led by the University of Granada (Spain), the Pennsylvania Commonwealth System of Higher Education (USA), and the Karolinska Institute (Sweden) are positioned at the center of the collaboration network. These institutions exhibit high connectivity and bridging capacity, forming a European–North American nexus that serves as the core hub for international cooperation. In contrast, institutions such as the Louisiana State University System and the University of South Carolina System represent regionally concentrated clusters characterized by strong internal ties but limited external collaborations. Additionally, elite institutions such as Harvard University and the University of California system, though not forming distinct standalone clusters, contribute significantly to network cohesion by serving as cross-cluster connectors.

Overall, the network exhibits the typical characteristics of a "big science" organizational model: a small number of highly productive and central institutions act as core nodes, facilitating multi-institutional and multicenter studies through extensive partnerships. This network configuration facilitates data sharing, resource integration, and methodological coordination, features shown to enhance the effectiveness of cross-disciplinary 'team science' and to be particularly well-suited for complex, interdisciplinary problems such as aerobic-exercise interventions for overweight populations (Cummings & Kiesler, [2005](#); Council et al., 2015; Fortunato et al., [2018](#)). However, current collaboration patterns still show geographical limitations. Cross-continental partnerships are largely concentrated among a few top-tier institutions. Looking ahead, targeted policy instruments and consortium-based platforms are warranted to broaden participation by less research-intensive (small and medium) institutions. Empirical evidence shows that capacity-building programs can reduce geographic concentration and raise competitiveness of underfunded jurisdictions—for example, the U.S. EPSCoR program is positively associated with gains in research capacity and states' shares of federal academic R&D (Wu, [2010](#)). This need is further underscored by the persistent core–periphery pattern in international collaboration, where cross-continental ties concentrate in a small core of highly connected countries/institutions (Leydesdorff & Wagner, [2008](#)). Encouraging these institutions to overcome geographic constraints and participate more actively will be critical to fostering a more inclusive and systemically integrated global research ecosystem.

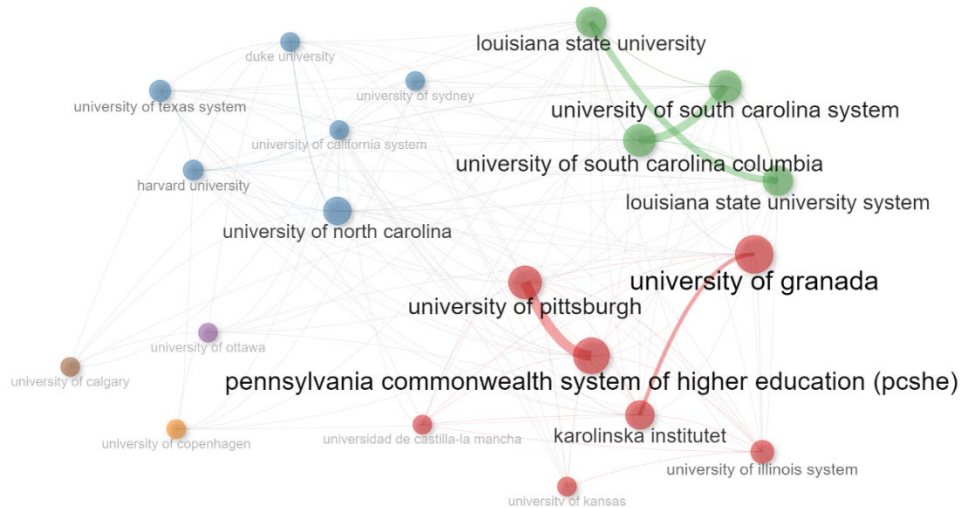


Figure 13. Top 20 Institution Collaboration Network. Source: the authors.

3.4.3 Author Collaboration Network Analysis

The author collaboration network (Figure 14) reveals the emergence of several core collaborative clusters, characterized by a structure of high-density intra-group cooperation and low-density inter-group connectivity. Notably, a highly cohesive network has been established around Ortega F. B., consisting primarily of Spanish researchers such as Ruiz J. R., Cadenas-Sanchez C., and Labayen I. This group has conducted extensive and systematic research on youth physical fitness and health outcomes, producing a substantial body of high-quality work. Their collaboration model demonstrates a healthy academic ecosystem, further reinforced by the integration of emerging scholars into the research pipeline.

Another prominent cluster is led by Blair S. N., with key collaborators including Church T. S. and Earnest C. P. This group primarily focuses on adult physical activity and chronic disease risk, playing a significant role in the development of exercise prescription and public health promotion policies. Although the two major clusters differ in both research themes and geographical focus, and exhibit limited direct collaboration, each has made important contributions to advancing its respective domain through strong internal coordination.

Interestingly, several peripheral nodes—such as Jakicic J. M. and Moreno L. A.—demonstrate tendencies toward cross-team linkages, serving as potential knowledge bridges within the network. Overall, the author collaboration structure reflects a trend of "core-team leadership, intergenerational synergy, and emerging cross-domain connections." This indicates a well-organized research environment with considerable potential for collaborative advancement.

As research questions grow increasingly complex, future progress will likely depend on large-scale, multicenter collaborative projects. Such efforts could help bridge the current

structural segmentation of the network, facilitate knowledge integration, promote methodological complementarity across teams, and ultimately foster the development of a more inclusive and systemically interconnected global research community.

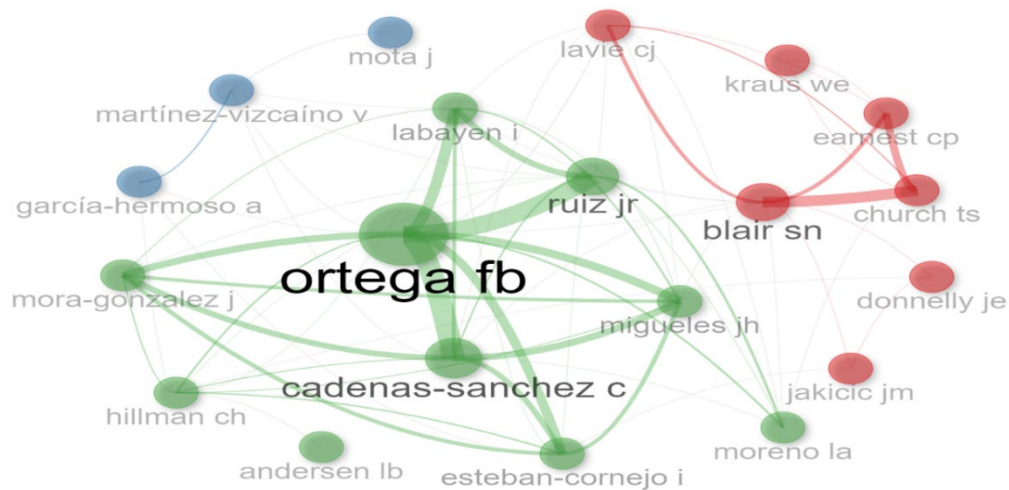


Figure 14. Author Collaboration Network. Source the authors.

3.5 Thematic Evolution Analysis

By visualizing the evolution of keyword pathways from 1980 to 2025 (Figure 15), this study illustrates the formation, progression, and thematic convergence of research topics within the field of aerobic exercise and overweight. The overall trajectory demonstrates a phased transition—from foundational theories, to practical interventions, and subsequently to population-specific analyses and multidimensional health outcome evaluations—exhibiting a clear temporal logic and trend of thematic refinement.

During the period from 1978 to 2010, research primarily focused on basic concepts such as “*physical activity*”, “*insulin resistance*”, “*energy intake*”, and “*weight loss*”. These themes laid the theoretical groundwork for understanding the mechanisms through which aerobic exercise influences overweight and metabolic health. Between 2011 and 2014, research shifted toward themes like “*overweight*”, “*skeletal muscle*”, “*children*”, and “*executive function*”, marking a growing interest in physiological responses and behavioral mechanisms across different subpopulations, particularly among children.

From 2015 to 2018, the field exhibited further thematic convergence around “*aerobic fitness*”, “*weight loss*”, and “*overweight*”, with increased co-occurrence of terms such as “*exercise*” and “*cardiometabolic outcomes*”. This period underscored the critical role of aerobic training in weight management and the improvement of health markers, forming a tightly coupled thematic structure linking *aerobic exercise*, *overweight intervention*, and *health benefits*.

Between 2019 and 2021, the field entered a phase of accelerated development, with

keywords like “aerobic exercise”, “children”, and “responses” gaining prominence. This reflects an intensified focus on intervention efficacy and individual response variability across demographic subgroups. In the most recent period (2022–2025), research themes have reconverged on “overweight”, now linked with “aerobic exercise” and increasingly with “cardiorespiratory fitness”, highlighting a shift toward comprehensive evaluations of health outcomes, particularly cardiorespiratory fitness, as a key measure of intervention success.

The variation in path thickness also underscores “overweight” as a persistent central node across all stages of thematic evolution, while “exercise”, “aerobic fitness”, and “cardiorespiratory fitness” have emerged in succession, reflecting the field’s transition from singular intervention approaches to more integrative health-oriented paradigms.

In summary, the thematic evolution clearly depicts the field’s development from broad behavioral constructs (*physical activity*) to empirical intervention research (*aerobic exercise*), and ultimately toward outcome-based evaluations (*cardiorespiratory fitness*). Future research is expected to emphasize individualized interventions, multidimensional health impact assessments, and tailored strategies for overweight youth populations, thereby advancing both scientific depth and real-world applicability.

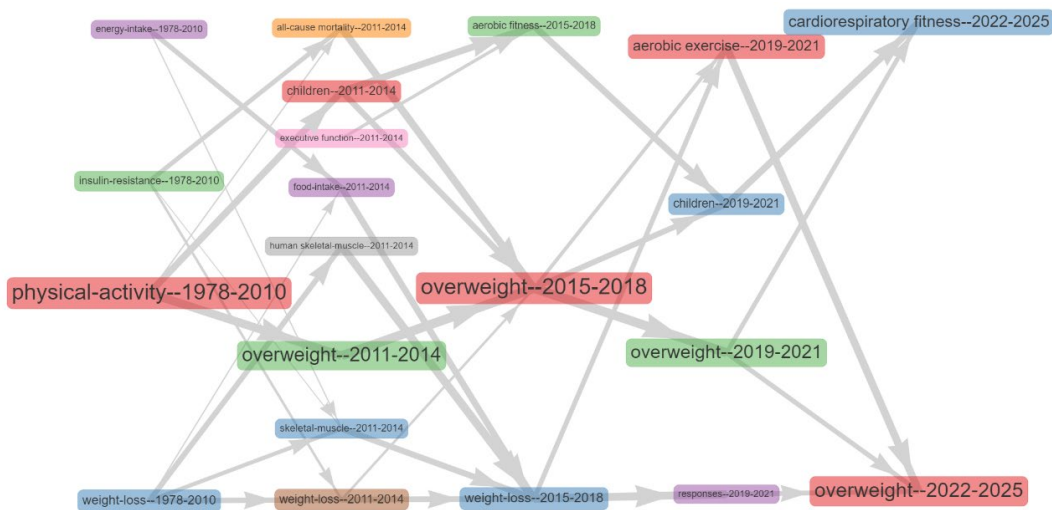


Figure 15. Thematic evolution map of research on aerobic exercise and overweight (1978-2025). Note. Generated using Bibliometrix (R 4.4.3) software, combined with Keywords Plus and the Walktrap clustering algorithm. Node size indicates keyword frequency; arrow thickness indicates thematic continuity between different time slices. Source: the authors.

4. Discussion

This study conducted a comprehensive bibliometric analysis of literature published between 1978 and 2025, outlining the developmental trajectory and research landscape in the field of aerobic exercise interventions for overweight. The results demonstrate that the

field has experienced substantial growth and expansion over the past several decades, mirroring the global rise in overweight and obesity and the associated public health burden (GBD 2015 Obesity Collaborators, [2017](#); Ng et al., [2025](#)). Overweight and obesity have been consistently linked to an increased risk of cardiovascular disease, type 2 diabetes, and other chronic conditions, contributing to millions of premature deaths each year (Akil & Ahmad, [2011](#)). In response to this escalating crisis, many countries have increased their research investments, with particular emphasis on lifestyle-based strategies—especially exercise interventions—for weight management and health promotion. Aerobic exercise has emerged as a widely recognized and effective approach, offering both safety and efficacy in the prevention and treatment of excess weight (Jakicic et al., [2019](#)). Our bibliometric findings affirm this trend: over the past two decades, research output in this field has grown at an average annual rate exceeding 7%, reflecting sustained academic interest and a growing body of evidence supporting exercise-based interventions for overweight and obesity.

This expansion also reflects a paradigm shift in the role of physical activity. Aerobic exercise is no longer viewed solely as a weight loss aid but increasingly as a cornerstone of chronic disease prevention and population health improvement—a consensus that has been widely endorsed in international guidelines and policy frameworks (DiPietro et al., [2019](#); Katzmarzyk et al., [2019](#)). For instance, the World Health Organization’s 2020 Guidelines on Physical Activity emphasize that engaging in at least 150 minutes of moderate-intensity aerobic exercise per week is critical for maintaining a healthy weight and reducing the risk of multiple diseases (Bull et al., [2020](#)). This recommendation aligns closely with our findings, which reveal a thematic evolution toward multidimensional health outcomes in recent literature. As scientific evidence accumulates, it informs guideline development, which in turn drives further research into effective exercise strategies, creating a positive feedback loop between science and policy. The flourishing of aerobic exercise intervention research is thus driven not only by academic curiosity but also by the pressing demands of public health.

4.1 Key Findings and International Comparison

This study highlights the global distribution and developmental trajectory of research in the field of aerobic exercise interventions for overweight. First, in terms of scientific output and academic influence, developed countries—particularly the United States—hold a dominant position, far surpassing other nations in both publication volume and citation impact. This finding is consistent with the global landscape of obesity-related research. (GBD 2015 Obesity Collaborators, [2017](#)), in their analysis of obesity research across 195 countries, also identified the United States as the largest contributor to obesity-related



publications, with superior research quality and impact. Our results further narrow this focus to exercise-based overweight interventions, reaffirming the leadership of the U.S. This dominance can be attributed to several factors: sustained financial support from agencies such as the National Institutes of Health (NIH), well-established research infrastructures, and a long-standing tradition of interdisciplinary collaboration. Moreover, given the high prevalence of obesity in the U.S., both the scientific community and public health agencies have demonstrated strong interest in exercise-based interventions, thereby driving substantial research output in this domain.

By contrast, emerging economies such as China have shown rapid growth in publication volume in recent years yet continue to lag behind in average citation metrics. This suggests that countries like China are still in the catch-up phase in terms of scientific influence and academic visibility and must further improve the quality and innovativeness of their research output. This phenomenon, often described as the "impact gap," refers to a pattern whereby increases in publication volume in developing countries outpace gains in citation-based impact (González-Brambila et al., [2016](#); Hiruy et al., [2019](#)). Such discrepancies may stem from differences in research experience, international collaboration networks, and language barriers. Encouragingly, we observed that over 30% of China's publications in this field involve international co-authorship. This is a positive trend, as international collaboration is known to enhance the quality and impact of scientific publications. As shown by (Chinchilla-Rodríguez et al., [2019](#)), internationally co-authored papers tend to receive more citations than single-country publications—an effect particularly pronounced in countries with relatively limited research resources. Therefore, with continued expansion of collaborative efforts with leading institutions in Europe and North America, countries like China are expected to strengthen their global influence in this research domain. Indeed, this trend is already evident in practice: in recent years, several multinational studies involving Chinese researchers have been published in top-tier journals. For example, collaborative childhood obesity intervention projects with institutions such as Harvard University have yielded impactful results published in *The Lancet* family of journals (Zhu & Yin, [n.d.](#)).

Meanwhile, countries such as Canada, Australia, and those in Northern Europe, despite smaller research volumes, exhibit high average citation rates—demonstrating the effectiveness of a "high-quality, small-country" model. A bibliometric analysis by Železnik et al. ([2023](#)) on weight loss motivation research similarly found that Australia and Canada rank among the top in terms of both output and quality. In our analysis of aerobic exercise interventions for overweight, these countries likewise show strong performance by focusing on specialized research niches. For instance, Australia has produced widely cited pioneering studies on high-intensity interval training (HIIT) for obesity, while countries such

as Finland and Denmark have excelled in promoting physical activity among children. These findings suggest that smaller nations can achieve significant global influence by leveraging unique strengths, such as national cohorts or specialized experimental platforms. This aligns with the principle that research quality is more important than quantity (Kreiman & Maunsell, [2011](#); Pal, [2021](#); Liu et al., [2024](#)), and it offers a valuable reminder that academic excellence should not be measured by volume alone. For developing countries, the strategic priority should be to improve the quality and originality of individual studies, thereby creating landmark research outputs with international impact, rather than focusing solely on publication quantity.

4.2 Evolution of Research Hotspots and Comparison with Existing Literature

Our keyword and thematic analyses reveal a clear progression in research focus within the field of aerobic exercise interventions for overweight—from macro-level concepts to more nuanced, mechanistic topics, and from single-effect outcomes to multidimensional health benefits. This pattern aligns closely with findings from prior narrative reviews and bibliometric studies conducted both in China and internationally. For instance, (Hruby & Hu, [2015](#)) reviewed the evolution of obesity epidemiology and noted that early research primarily emphasized associations between obesity and chronic diseases, whereas more recent studies have shifted toward examining intervention strategies and broader health outcomes. In the domain of exercise interventions, Jakicic et al. ([2019](#)) similarly found that over the past decade, the field has moved from evaluating weight loss alone to assessing the role of physical activity in preventing metabolic disorders and enhancing mental health. Our findings support and extend this observation. Specifically, keywords such as “BMI” and “weight loss” dominated around the year 2000, but terms like “cardiorespiratory fitness” and “metabolic syndrome” have since gained prominence. In recent years, keywords such as “cognitive function” and “inflammation” have also emerged, indicating an increasing focus on neurological and immunological dimensions of exercise benefits. These trends are consistent with global research developments. For example, Xia et al. ([2024](#)) conducted a bibliometric study on aerobic fitness in children and found that cognition and brain health have become prominent research directions. Similarly, Sousa et al. ([2022](#)) reviewed the overlapping impacts of aerobic exercise on obesity, diabetes, and Alzheimer’s disease, emphasizing that improved insulin sensitivity may serve as a shared pathway for multiple disease prevention. These examples reflect a broader paradigmatic shift in exercise science—from traditional outcome-specific frameworks to more integrated, systems-oriented approaches.

Our thematic evolution map captures this transformation well, illustrating the transition from simplified concepts such as “physical activity – overweight” to more complex



frameworks like “*aerobic exercise – cardiometabolic outcomes.*” Furthermore, our analysis shows a growing focus on children and adolescents, a trend that correlates with the rising prevalence of obesity in younger populations. National surveys in China and elsewhere have highlighted a sharp increase in youth overweight rates, necessitating targeted research and intervention efforts (Zhang et al., [2018](#); Yu et al., [2024](#)). Our data confirm this trend: the keyword “*children*” has increased significantly in frequency since 2010. This aligns with recent evidence from China, where a comprehensive review by Wang et al. ([2024](#)) reported that national health policies and school-based initiatives—such as improved physical activity provision, nutrition education, and family–school cooperation—have stimulated a rapid growth of research and intervention programs targeting childhood obesity. Internationally, major intervention trials such as the FITKids project (USA) and the IDEFICS study (Europe) have also generated a large volume of literature since 2010, which is well reflected in our keyword statistics.

Therefore, our bibliometric results provide a reliable representation of the parallel evolution of research hotspots in both domestic and international contexts. This reinforces the value of bibliometrics as a “barometer of science”—a method capable of capturing the rise and fall of scholarly interests through frequency and clustering analyses of keywords (Wang & Chai, [2018](#); Oliveira et al., [2019](#)). Such insights hold considerable value for both researchers and research administrators. Scholars can use these data to identify emerging frontiers, while funding agencies and policymakers can allocate resources strategically in line with thematic trends. For instance, the observed rise in interest surrounding “*youth exercise interventions*” suggests a pressing need for increased support in this domain. Accordingly, funding programs and grant mechanisms may be tailored to prioritize this direction, thereby fostering further development. Similar to (Železnik et al., [2023](#)) recommendation based on bibliometric analysis, which identified emerging topics such as “*digital health interventions*” and “*social media and weight loss,*” we argue that strategic attention to new hotspots can accelerate innovation and improve research translation in this rapidly evolving field.

4.3 Strengths and Limitations

This study offers several notable strengths. First, by utilizing a large-scale bibliometric dataset, we provide a comprehensive overview of the developmental trajectory and structural characteristics of the research field of aerobic exercise interventions for overweight individuals. Our approach addresses the fragmentation seen in previous qualitative or topic-specific reviews. For example, Jakicic et al. ([2019](#)) synthesize evidence on adult weight-gain prevention and physical activity but do not map cross-country/institutional collaboration or longer-term topic evolution; Sousa et al. ([2022](#)) focus

on mechanistic cross-talk (e.g., insulin resistance) across obesity-related conditions, without integrating authorship networks or source-journal structures; and Hruby & Hu (2015) provide a broad narrative on obesity epidemiology rather than the exercise-intervention subfield. In contrast, our bibliometric design integrates multiple layers—countries, institutions, authors, journals, and keywords—thereby offering a system-level view that complements these valuable yet domain-bounded syntheses.

On one hand, we compiled literature spanning nearly 47 years, enabling an in-depth examination of long-term trends and the identification of key phases of development. On the other hand, through multidimensional analyses—covering countries, institutions, authors, journals, and keywords—we systematically uncover the knowledge production patterns and collaborative structures in this domain. This panoramic perspective is highly valuable for researchers seeking to position their work within the broader academic landscape and identify future research directions. Unlike traditional reviews that rely solely on qualitative summaries, our study employs quantitative metrics to enhance objectivity. For instance, we demonstrate the importance of international collaboration using measurable data, and we delineate thematic clusters through keyword co-occurrence networks, providing robust empirical support for our interpretations. Additionally, our use of advanced bibliometric techniques—such as co-word clustering and thematic evolution analysis—enriches the analytical depth and reveals latent knowledge structures. Our methodology draws upon and extends prior bibliometric investigations in adjacent fields. Studies examining the bibliometric patterns of physical activity and diabetes (Huang et al., 2022) or obesity-related pain research (Gao et al., 2025) have yielded valuable insights using similar techniques. By referencing these approaches, we ensured a rigorous analytical framework and careful interpretation of results. Furthermore, we undertook meticulous data preprocessing—standardizing author and institutional names, consolidating synonyms, and verifying highly cited references—to improve the accuracy of the analysis. Overall, we believe this study provides meaningful guidance for understanding both the historical context and current status of this research field.

Nonetheless, several limitations warrant discussion. First, our dataset relies exclusively on the Web of Science Core Collection (WoS CC), which predominantly indexes English-language journals and provides uneven coverage of regional outlets. As a result, contributions from non-English scholarly ecosystems may be underestimated—not only in East Asia (e.g., China, Japan) but also in Latin America (e.g., Brazil, Chile, Mexico, Colombia), where substantial work on exercise and obesity is published in Spanish/Portuguese or national-language journals that are indexed mainly in regional platforms (e.g., SciELO, LILACS, RedALyC) and are not consistently covered by WoS CC. Consequently, the scientific influence and collaboration patterns of these regions may be



attenuated in our maps. For example, many Chinese-language studies on exercise interventions for obesity in leading domestic journals lie outside our corpus. While WoS remains the standard for international bibliometrics and ensures cross-study comparability, future research should triangulate WoS with Scopus and regional indices (e.g., SciELO Citation Index, LILACS, RedALyC, CNKI), and report coverage diagnostics/sensitivity analyses to present a more complete global picture.

Second, bibliometric analysis inherently emphasizes macro-level trends and structural patterns but lacks the granularity required for in-depth discussion of specific scientific mechanisms. Although our study identifies prominent themes and their evolution, it does not explore, for instance, the precise physiological pathways through which aerobic exercise improves insulin resistance. For such insights, readers should refer to systematic reviews or meta-analyses. While we highlight “insulin resistance” as a research hotspot, we cannot evaluate the consistency or effect size of related findings within this framework.

Third, bibliometric indicators are often subject to citation lag. Recently published but impactful studies may not yet be widely cited, potentially underestimating their influence. For example, publications from 2023–2024 may still be emerging in terms of citations but could represent significant advancements. This limitation is reflected in our author and journal analysis, where some emerging scholars and new journals exhibit high m-indices despite lower cumulative metrics. As such, we endeavored to balance static and dynamic indicators and discussed emerging trends to mitigate this limitation.

Finally, although we analyzed collaboration networks and emphasized the value of cooperation, bibliometric data alone cannot assess the quality of collaboration or the distribution of contributions among co-authors. The higher citation rates of internationally co-authored papers may be influenced by various factors, and causality cannot be inferred solely based on co-authorship. However, numerous studies have demonstrated that international collaboration enhances research visibility and citation impact (de Lima et al., [2021](#); Khor & Yu, [2016](#); Wang et al., [2024](#)). While we draw reasonable conclusions based on established literature, readers should interpret the benefits of collaboration with caution. In summary, the limitations of this study highlight the importance of interpreting bibliometric findings in conjunction with domain-specific expertise. We have cross-referenced authoritative reviews and statistical reports to ensure the robustness of our interpretations. Nevertheless, readers are advised to consider these caveats when applying our conclusions, to avoid overgeneralization and ensure appropriate contextualization.

5. Conclusion

This study employed bibliometric methods to systematically analyze the global



research landscape on aerobic exercise interventions for overweight individuals from 1978 to 2025. We examined publication trends, key contributing countries and institutions, emerging research hotspots, and collaboration networks. The findings indicate a sustained growth in scientific output in response to the escalating global burden of obesity, with the United States occupying a central position in an increasingly internationalized research network.

Over the past decades, research focus has evolved from a primary emphasis on weight loss to a more comprehensive understanding of the multifaceted benefits of aerobic training, including improvements in cardiorespiratory fitness, metabolic health, and cognitive function. Current research hotspots include the optimization of aerobic exercise prescriptions to enhance overall health outcomes in overweight populations, the elucidation of metabolic pathways affected by exercise interventions, and the development of tailored programs for vulnerable populations such as children and adolescents.

Aerobic training has been widely recognized as an effective strategy for both weight control and chronic disease prevention. Its benefits extend beyond weight reduction, offering significant contributions to overall health improvement (GBD 2015 Obesity Collaborators, [2017](#); Jakicic et al., [2019](#)). The accumulation and dissemination of knowledge have been greatly facilitated by collaborations among leading authors and high-impact institutions. However, there remains a notable disparity in research quality and global visibility between developed and developing countries.

Future studies should prioritize strengthening international and interdisciplinary collaboration, emphasizing personalized intervention approaches and multidimensional health assessments. Special attention should be directed toward evaluating the long-term effects and underlying mechanisms of aerobic exercise across diverse populations.

It is particularly important to expand focus on key populations such as children and adolescents, promoting lifelong healthy behaviors through school- and community-based intervention programs. In summary, this study offers a comprehensive academic map of the field, providing valuable insights for researchers in shaping future agendas and for policymakers in designing evidence-based intervention strategies.

Given the substantial health burden posed by overweight and obesity—which markedly increase the risk of cardiovascular diseases, type 2 diabetes, and other chronic conditions, leading to millions of premature deaths worldwide each year, and are projected to affect more than 2 billion individuals globally in the coming decades (GBD 2015 Obesity Collaborators, [2017](#); Ng et al., [2025](#))—the ongoing global efforts to combat overweight and obesity are expected to intensify. Consequently, the field is likely to witness a growing number of high-quality, multicenter studies aimed at addressing unresolved scientific questions and informing evidence-based practices for more effective prevention and

intervention. Ultimately, embedding the principle of "exercise is medicine" into obesity prevention and management systems will be pivotal in improving population health. The synergistic advancement of scientific research and public health practice is essential to curb the obesity epidemic and achieve the shared goal of "healthy weight through active intervention," contributing meaningfully to the global health agenda.

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Appendix.

Table S1. Output and international collaboration indicators by corresponding-author country (1978–2025)

Country	Articles	Articles %	SCP	MCP	MCP %
USA	1172	29.4	983	189	16.1
SPAIN	294	7.4	123	171	58.2
BRAZIL	255	6.4	153	102	40
CHINA	236	5.9	151	85	36
CANADA	214	5.4	159	55	25.7
AUSTRALIA	200	5	126	74	37
UNITED KINGDOM	157	3.9	92	65	41.4
FRANCE	99	2.5	56	43	43.4
ITALY	88	2.2	68	20	22.7
GERMANY	85	2.1	62	23	27.1
IRAN	83	2.1	58	25	30.1
PORTUGAL	75	1.9	33	42	56
DENMARK	68	1.7	41	27	39.7
FINLAND	68	1.7	46	22	32.4
CHILE	67	1.7	27	40	59.7
JAPAN	63	1.6	53	10	15.9
NETHERLANDS	60	1.5	47	13	21.7
NORWAY	60	1.5	40	20	33.3
KOREA	58	1.5	43	15	25.9
SWEDEN	53	1.3	32	21	39.6

Notes: Countries are assigned based on the affiliation of the corresponding author and are ordered by Articles (descending). Articles % denotes the country's share of the corpus; SCP = single-country publications; MCP = multi-country publications; MCP % = $MCP / (SCP + MCP) \times 100$. Data underpin Figure 10 and were derived from the WoS Core Collection (SCIE, SSCI); screening and de-duplication procedures are described in Methods and the Appendix. Values are rounded; minor discrepancies may occur due to rounding. * 2025 is a partial year (records indexed through March).



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