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REVIEW

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Bibliometric analysis of research on sarcopenic obesity: a review of scientific literature

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Summary

Considering the current prevalence in obesity and sarcopenia globally, this study aimed to summarize the development of sarcopenic obesity research to establish the topic's past, present, and future research direction using a bibliometric analysis. A comprehensive search for publications on sarcopenia and obesity was conducted in the Web of Science (WoS) database until the 31st of December 2023. We performed a detailed descriptive analysis, considering metrics like sources, authors, and documents, along with analyzing conceptual and social structures to map sarcopenic obesity research. Between 1993 and 2023, there were 4978 publications on sarcopenic obesity, representing 22.6% of the whole sarcopenia research (22070). Most published articles were originals (74.6%), and one of the highest increments in the fields was seen after 2010. The most significant contribution in this research area falls under the categories of *Nutrition & Dietetics*, *Gerontology*, and *Geriatrics & Gerontology*. Among regions, scientific production was located in 93 different countries. The United States, China, and South Korea had the highest contributions. The most relevant keywords were sarcopenia, obesity, and body composition. Research on sarcopenic obesity primarily focuses on epidemiology and identifying risk factors and outcome predictors. Yet, there is a shortage of research addressing prevention, early detection, and treatments to enhance the health of individuals with sarcopenia.

KEYWORDS
adiposity, obesity, sarcopenia, sarcopenic obesity

1 | INTRODUCTION

It is widely known that obesity has grown to epidemic proportions, being a huge problem in both high- and low-middle-income countries. In fact, over 650 million adults were obese in 2016,[1] which is expected to rise to one billion by 2030, according to the World Obesity Atlas 2022.[2] Obesity leads to other major chronic conditions, such as cardiovascular diseases[3,4] and cancer,[5,6] the leading cause of death worldwide. Unfortunately, the metabolic changes experienced by obese people—associated in part with lack of physical activity, sedentary behaviors, and adipose tissue derangements—have also deteriorated their muscle mass and function, increasing their prevalence of sarcopenia.

Sarcopenia—a complex syndrome characterized by a progressive loss of muscle strength along with a higher risk of disability and

reduction in quality of life[7–9]—is one of the 150 musculoskeletal conditions that contribute to disability across the globe.[10] When the concept was first reported in 1989,[11] the condition was only related to aging and malnourished people. However, the concept has evolved in the past 30 years, and it is currently recognized that sarcopenia begins early in life and may also be present in people with obesity.[9,12]

Sarcopenic obesity is the clinical term used to define the coexistence of obesity and sarcopenia. Sarcopenic obesity has a synergistic effect on a cascade of metabolic and functional factors unfavorable to health, being a strong and independent risk factor for multiple morbidities and all-cause mortality.[12]

Considering the current trends in obesity and sarcopenia globally, this study aimed to summarize the development of sarcopenic obesity research to establish the topic's past, present, and future research direction. Using a bibliometric analysis, we examined the growth and citation of publications, active authors, countries, and institutions, international collaboration, and the frequency of terms.

2 | MATERIAL AND METHODS

2.1 | Search strategy and data extraction

A comprehensive search for publications on sarcopenia and obesity was conducted in the Web of Science (WoS) database on the 1st of May 2024. To ensure the reliability and accuracy of our findings, we specifically utilized the WoS Core Collection, known for its rigorous selection and evaluation process of academic information. The WoS database provided extensive content coverage and detailed citation analysis information, making it an ideal resource for this study. The search strategy involved using a carefully designed equation incorporating relevant terms such as "Sarcopenic obesity," or "Sarcopenia" and "Adiposity" or "Obesity," and excluding animal studies [((TS = (((sarcopenia) AND (adiposity OR obesity)) OR ("sarcopenic obesity")))) NOT ALL = (Animals or Mice or Mice Inbred C57bl or Disease Models Animal or Rats)]. These terms were searched within the topic field, encompassing titles, abstracts, author keywords, and keyword-plus terms. We also conducted a search for the generic term "Sarcopenia" limited to human studies [((TS = (sarcopenia))) NOT ALL = (Animals or Mice or Mice Inbred C57bl or Disease Models Animal or Rats)] to compare the information retrieved from the two searches. All references indexed and published until the 31st of December 2023 were included to provide a comprehensive analysis. The WoS extraction tool was employed to extract the raw data from the WoS database, generating data in BibTeX format available to download. The following information was extracted from each document: title, journal, article type, author names, affiliations, keywords, publication date, research area, and abstract. These data formed the foundation for the bibliometric analysis and provided valuable insights into the landscape of sarcopenic obesity research.

2.2 | Data analyses

The bibliometric analysis of the raw data obtained from the WoS database was conducted using R software version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria). Specifically, the analysis was performed using the Bibliometrix R package (https://www.bibliometrix.org/home/index.php), which encompasses a comprehensive range of bibliometric methods based on the annual scientific publication. These methods enable the measurement of time trends, identification of highly cited papers, detection of prolific authors, journals, institutions, and countries, as well as the calculation and ranking of scientific production and collaboration. Descriptive bibliometric analysis of the main data was based on the metrics of sources, authors, and documents. We also performed the analysis of two structures of knowledge (conceptual and social structures) to complete the science mapping of sarcopenic obesity research. The conceptual structure was measured by co-word analysis, while the social structure was by a collaboration network analysis. To evaluate the social structure of our study's findings, we first conducted an analysis of the geographical distribution of research production in the field of sarcopenic obesity. This analysis allowed us to differentiate between publications originating from a single country (SCP) and those involving collaboration between authors from multiple countries (MCP). By assessing the prevalence of SCP and MCP within the research output, we gained insights into the patterns of international collaboration within the field. We also examined international institutions contributing to research in sarcopenic obesity and conducted network mapping of international collaborations among countries producing research in this field. Additionally, to enhance the bibliometric results by measuring the influence and quality of scientific production, the impact factors (IF) of the journals obtained were extracted from the latest Journal Citation Reports (JCR, 2022) by Clarivate Analytics. Finally, the following three indexes were estimated: (i) The **h-index** measures the impact of scholarly work by analyzing the quantity of published papers and the frequency of citations to the author's work. The index assesses the ratio of cited papers (H) to uncited ones, considering the frequency of citations for each. (ii) The **g-index** is derived from the citation distribution of a researcher's publications. It is determined by arranging a set of articles in descending order of citation counts, where the g-index represents the largest number such that the sum of citations for the top g articles is at least g^2. (iii) The **m-index** is calculated by dividing the h-index by the number of years an author has been active, defined as the years since the date of first publication.

3 | RESULTS

3.1 | Publication analysis based on numbers

The search strategy results produced 4978 publications on sarcopenic obesity between 1993 and 2023. It represented 22.6% of the whole of the retrieved documents regarding the overall sarcopenia research

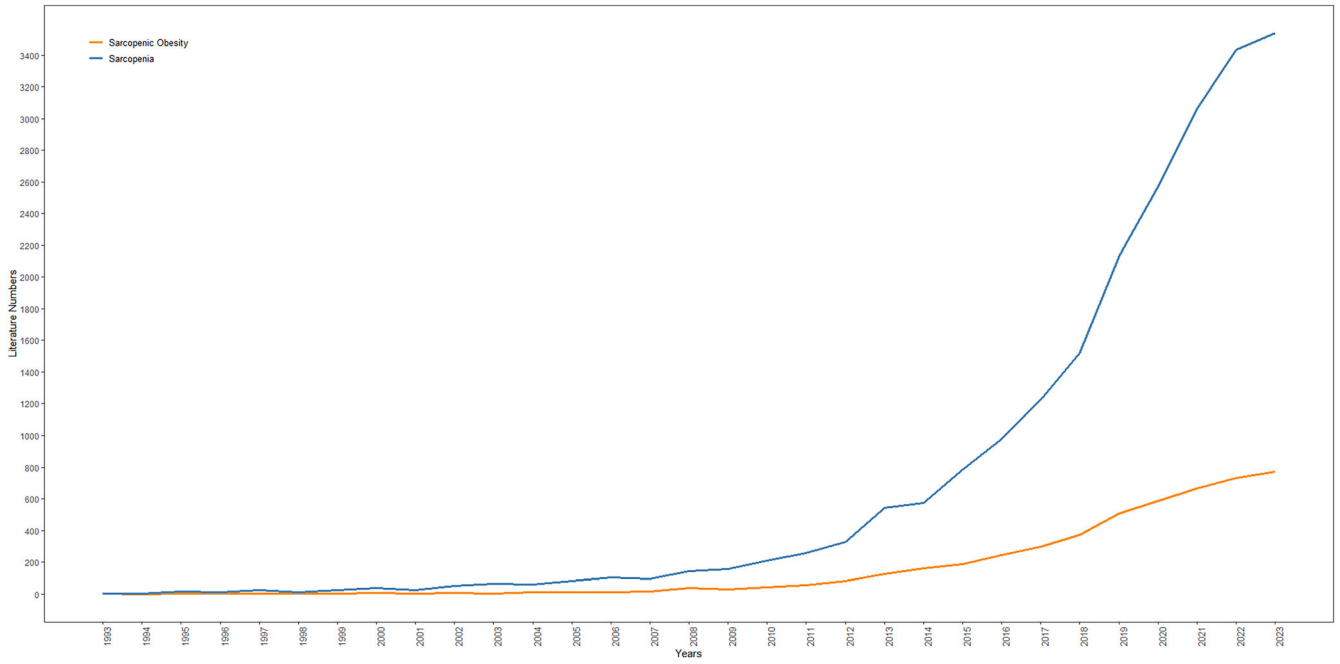

FIGURE 1 Annual scientific production of sarcopenic obesity and sarcopenia from 1993 to 2023.

TABLE 1 Top 20 most prolific journals publishing papers on sarcopenic obesity from 1993 to 2023.

Rank	Sources	No. of articles (%)	Categories (rank)	IF (JCR)
1st	*Clinical Nutrition*	144 (2.9)	Nutrition & Dietetics (14/88)	6.3
2nd	*Nutrients*	131 (2.6)	Nutrition & Dietetics (17/88)	5.9
3rd	*Journal of Cachexia Sarcopenia and Muscle*	121 (2.4)	Medicine, General & Internal; Geriatrics & Gerontology (20/169; 2/54)	8.9
4th	*PloS One*	98 (2.0)	Multidisciplinary Science (26/73)	3.7
5th	*Scientific Reports*	76 (1.5)	Multidisciplinary Science (22/73)	4.6
6th	*Journal of Clinical Medicine*	73 (1.5)	Medicine, General & Internal (58/169)	3.9
7th	*Journal of Nutrition Health & Aging*	65 (1.3)	Nutrition & Dietetics; Geriatrics & Gerontology (18/88; 14/54)	5.8
8th	*Frontiers in Nutrition*	59 (1.2)	Nutrition & Dietetics (22/88)	5.0
9th	*Nutrition*	56 (1.1)	Nutrition & Dietetics (37/88)	4.4
10th	*BMC Geriatrics*	55 (1.1)	Gerontology; Geriatrics & Gerontology (9/37; 23/54)	4.1
11th	*Experimental Gerontology*	51 (1.0)	Geriatrics & Gerontology (27/54)	3.9
12th	*Geriatrics & Gerontology International*	50 (1.0)	Gerontology; Geriatrics & Gerontology (14/37; 33/54)	3.3
13th	*Journals of Gerontology Series A: Biological Sciences and Medical Sciences*	46 (0.9)	Gerontology; Geriatrics & Gerontology (7/37; 18/54)	5.1
13th	*Osteoporosis International*	46 (0.9)	Endocrinology & Metabolism (62/145)	4.0
15th	*Journal of the American Medical Directors Association*	45 (0.9)	Geriatrics & Gerontology (5/54)	7.6
16th	*Aging Clinical and Experimental Research*	43 (0.8)	Geriatrics & Gerontology (24/54)	4.0
17th	*Frontiers in Endocrinology*	42 (0.8)	Endocrinology & Metabolism (36/145)	5.2
18th	*Medicine*	40 (0.8)	Medicine, General & Internal (119/169)	1.6
19th	*International Journal of Environmental Research and Public Health*	38 (0.8)	—	
20th	*Cancers*	34 (0.7)	Oncology (72/241)	5.2

($n = 22{,}070$). Figure 1 shows the annual evolution of the scientific production on overall sarcopenia research and sarcopenic obesity research. From their conception in 1993, the annual growth was 26.6% for the overall sarcopenia research area and 24.8% for the field of sarcopenic obesity. Although their evolution occurs parallel to each other, generating a similar number of publications during the first time period (1993–2002), the production rate was greater in overall sarcopenia research than in sarcopenic obesity from then on, but, especially, from 2012 onwards. However, the annual publication has grown exponentially in both areas in the last decade, achieving their maximum peak in 2023, with 3538 documents in overall sarcopenia and 772 documents in sarcopenic obesity research.

The 4978 documents retrieved from the sarcopenic obesity publication were based on 1156 sources, of which 573 (49.6%) published at least one document. Between two and four documents were produced by 355 (30.7%) sources, while 139 (12.0%) sources published between five and 10 documents. The remaining 89 (7.7%) sources generated >10 documents. According to the type of document, the most relevant source of the scientific production of sarcopenic obesity was derived from research articles ($n = 3712$, 74.6%). The remaining documents were reviews, which accounted for 15.6% ($n = 780$), meeting abstracts and proceeding papers ($n = 283$, 5.7%), editorial material ($n = 98$, 2.0%), and letters ($n = 86$, 1.7%). Corrections represented less than 1% of the documents ($n = 19$, 0.4%).

3.2 | Publication analysis based on journals

Table 1 presents the general characteristics of the 20 most productive journals that published articles on sarcopenic obesity research between 1993 and 2023. These journals published 1313 references, which accounted for 26.4% of all retrieved publications. The most significant contribution in this research area was facilitated by highly rated journals that primarily fall under the categories of *Nutrition & Dietetics*, *Gerontology*, and *Geriatrics & Gerontology* in WoS. The most prolific journals (>90 articles) were *Clinical Nutrition* (IF: 6.3), *Nutrients* (IF: 5.9), *Journal of Cachexia Sarcopenia and Muscle* (IF: 8.9), and *PloS One* (IF: 3.7) journals, which published approximately 9.9% ($n = 494$) of the total production.

3.3 | Publication analysis based on authors

Between 1993 and 2023, the sarcopenic obesity publication accumulated 4978 references involving 20238 authors, with an average of 6.5 authors per document and 0.3 documents per author. Most authors ($n = 20086$) published multi-authored documents while representing less than 1% ($n = 152$) of the authors who wrote single-authored documents. Considering author appearances match the number of documents an author published, there were 32,350 author appearances in this period. According to the transience index, 15540 authors had a single document, accounting for 76.8% of the total number of authors. Between two and four documents were produced by 3876 (19.1%) authors, 610 authors wrote between five and nine documents (3.0%), while only 1.0% of them ($n = 212$) published 10 or more documents. The most productive authors in the sarcopenic obesity research area (>40 publications) were Kim, J.H. ($n = 48$); Prado, C.M.M. ($n = 47$); and Batsis, J.A. ($n = 41$). Collaboration analysis showed an average co-authorship of 6.5 co-authors per document and a collaboration index of 4.16, resulting from dividing the total number of authors of multi-authored documents ($n = 20086$) by the total number of multi-authored documents ($n = 4826$).

3.4 | Publication analysis based on countries/regions and institutions

Country scientific production was measured using the number of author appearances by country affiliation. The results showed that the scientific production of sarcopenic obesity was geographically located in 93 different countries around the world. Among these countries, the United States was the country with the largest number of authors appearing in the retrieved publications ($n = 4487$, 90.1%), followed by China ($n = 3453$, 69.4%) and South Korea ($n = 2792$, 56.1%). The analysis of country collaboration was performed using the corresponding author's country affiliation. The total number of corresponding author's countries was 70, of which 13 only published one article (18.6%), 21 produced between two and 10 articles (30.0%), and 36 published >10 articles, which accounted for more than half of the total scientific production (51.4%). Table 2 shows the main features of the top 20 most prolific corresponding authors' countries in publishing research on sarcopenic obesity. The United States, China, South Korea, and Japan were the most productive countries, accumulating almost half of the total production ($n = 2417$, 48.6%). The intra-country collaboration analysis showed that these countries also had the highest number of articles published by authors from their own countries (United States = 603; China = 542, South Korea = 538; and Japan = 429). The United States ($n = 168$), Italy ($n = 96$), and the United Kingdom (n = 75) were contributors with a high number of multiple-country publication (MCP). However, in relative terms, Switzerland (MCP ratio = 0.47, total documents = 38), Sweden (MCP ratio = 0.46, total documents = 35), and Canada (MCP ratio = 0.40, total documents = 152) were the countries collaborating more actively.

Figure 2 illustrates the network mapping of international collaboration among the countries. Among the countries that engage in the most collaborations with other nations, the United States and the United Kingdom both have partnerships with 69 countries. Italy and France also have a significant number of collaborations, with 60 countries each. The United States was the country leading the largest number of international collaborations ($n = 825$). The following biggest collaborators were Italy ($n = 598$), the United Kingdom ($n = 585$), and Germany ($n = 510$). A general description of the top 20 most prolific research institutions in publishing research on sarcopenic obesity is presented in Table 3. These institutions produced 3095 documents (62.2%) out of 4978 retrieved publications. While

TABLE 2 Top 20 prolific countries of corresponding authors in publishing papers on sarcopenic obesity (1993–2023).

Countries	No. of documents	%[a]	SCP	MCP	MCP ratio[b]
USA	771	16.14	603	168	0.22
China	602	12.60	542	60	0.10
South Korea	587	12.29	538	49	0.08
Japan	457	9.57	429	28	0.06
Italy	288	6.03	192	96	0.33
Brazil	225	4.71	164	61	0.27
UK	207	4.33	132	75	0.36
Germany	189	3.96	135	54	0.29
Canada	152	3.18	92	60	0.40
Spain	145	3.04	105	40	0.28
France	140	2.93	115	25	0.18
Australia	127	2.66	91	36	0.28
Netherlands	105	2.20	65	40	0.38
Turkey	83	1.74	78	5	0.06
Mexico	56	1.17	46	10	0.18
Poland	48	1.00	44	4	0.08
India	42	0.88	32	10	0.24
Greece	39	0.82	24	15	0.39
Switzerland	38	0.80	20	18	0.47
Sweden	35	0.73	19	16	0.46

Abbreviations: MCP, multiple-country publications; SCP, single-country publications.
[a]Percentage calculated out of the retrieved 4777 documents.
[b]We calculated the multiple-country publication ratio as MCP divided by the total of published documents per country.

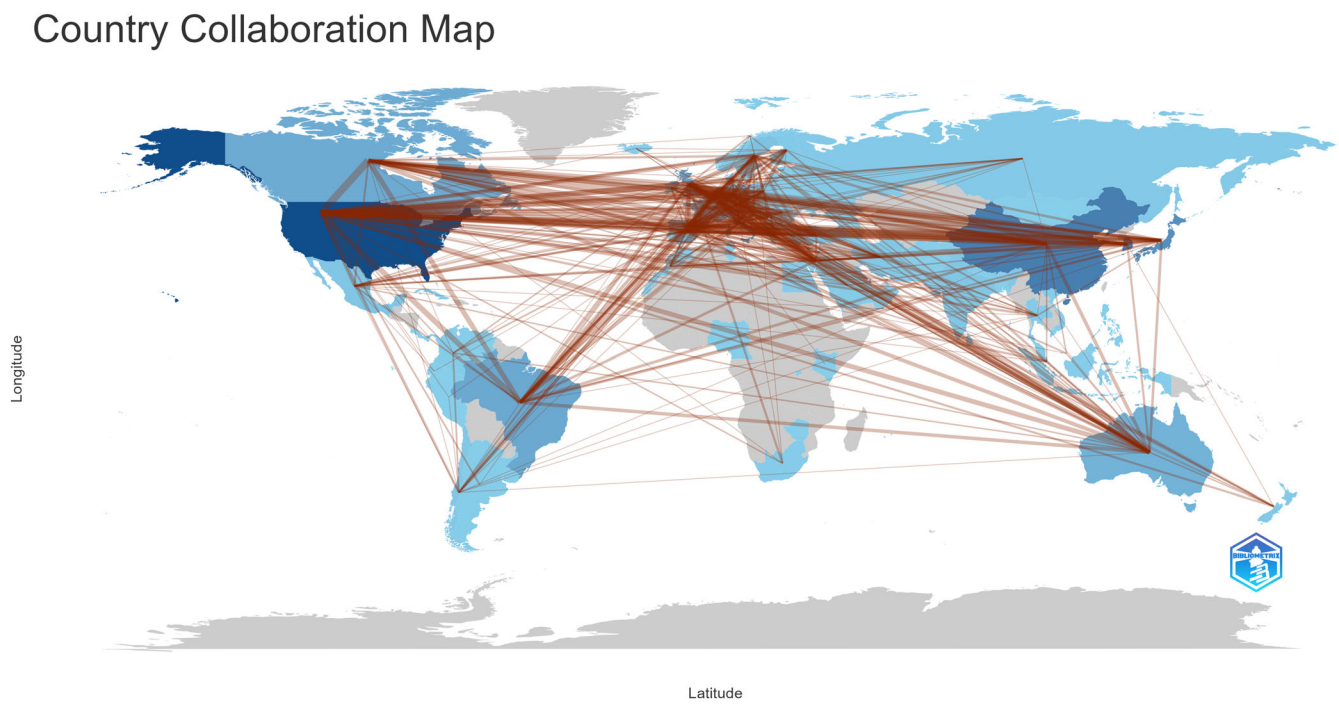

FIGURE 2 Geographical distribution map of countries' scientific production in publishing papers on sarcopenic obesity and country collaboration network map (brown lines) from 1993 to 2023.

TABLE 3 Top 20 most prolific research institutes in publishing papers on sarcopenic obesity from 1993 to 2023, sorted by the total number of articles.

Research institute	Country	No. of articles	%[a]
Yonsei University	South Korea	370	7.4
The University of Alberta	Canada	302	6.1
Seoul National University	South Korea	290	5.8
Ulsan University	South Korea	223	4.5
Sungkyunkwan University	South Korea	204	4.1
Sichuan University	China	174	3.5
Korea University	South Korea	169	3.4
The University of Sydney	Australia	127	2.6
Taipei Medical University	Taiwan	124	2.5
The University of Melbourne	Australia	117	2.4
Maastricht University	Netherlands	115	2.3
The University of São Paulo	Brazil	112	2.2
The University of California, San Francisco	USA	104	2.1
Wenzhou Medical University	China	104	2.1
Fujian Medical University	China	102	2.0
Monash University	Australia	102	2.0
Catholic University of Korea	South Korea	98	2.0
Harvard Medical School	USA	90	1.8
Kyoto University	Japan	84	1.7
The University of Florida	USA	84	1.7

[a]Percentage calculated out of the retrieved 4978 documents.

there were a few organizations from English-speaking countries such as Australia and the United States, as well as Brazil and the Netherlands, most institutions were from Asian nations, particularly South Korea, comprising 43.7% ($n = 1354$) of the total published references.

3.5 | Publication analysis based on citations

The 4978 documents included in the present bibliometric analysis had 159767 citations, with an average of 32.1 citations per document and an average of 4.1 citations per document and year. There were 712 (14.3%) documents with no citations, 1950 (39.2%) were cited between one and 10 times, 1599 (32.1%) received between 11 and 50 citations, 419 (8.4%) had between 51 and 100 citations, and 298 (6.0%) were cited over 100 times. The first article, titled "Sarcopenia and age-related changes in body composition and functional capacity" and published in 1993, has received 374 citations during this period, with a mean of 11.7 citations per year. Of the 4978 retrieved documents, all authors ($n = 20238$) were cited 169431 times, with a mean of 8.4 per author. There were 11551 (57.1%) authors with no citations, 6146 (30.4%) that received between one and 10 citations, 1967 (9.6%) that were cited from 11 to 50 times, 334 (1.7%) obtained between 51 and 100 citations, and 240 (1.2) had over 100 citations. The countries with the largest number of total citations were the United States ($n = 43,902$), South Korea ($n = 15,464$), Canada ($n = 13,437$), Spain ($n = 10997$), and Italy ($n = 10,667$), with an average article citation of 56.9%, 26.3%, 88.4%, 75.8%, and 37.0%, respectively.

Overall, the top 20 most cited authors received >1000 citations from the other authors included in the documents comprising the sarcopenic obesity research area from 1993 to 2023 (Table 4). Rolland, Y., Boirie, Y., and Cederholm, T., were the authors more cited within this study area. However, considering total citations that an article published in this area can obtain from articles indexed in WoS, the authors with the largest number of citations were Cederholm, T. ($n = 11,147$), Boirie, Y. ($n = 10,445$), and Zamboni, M. ($n = 10,152$). The highest scientific productivity were Boirie, Y. ($n = 31$, h-index = 18), Baracos, V.E. ($n = 27$, h-index = 20), and Zamboni, M. ($n = 20$, h-index = 15). In addition, based on the duration of their academic careers, the m-index showed that these authors (Baracos, V.E. = 1.2; Boirie, Y. = 1.2) experienced significant advancements in their scientific output.

The top 20 most cited articles on sarcopenic obesity are itemized in Table 5. The articles were published in 18 scientific journals, among which two were indexed *in Clinical Nutrition* (Cederholm, 2017; Deutz, 14) and two in the *Journal of the American Geriatrics Society* (Visser, 2002; Delmonico, 2007). The article by Cruz-Jentoft, published in *Age and Ageing* (2010), was by far the most cited paper, which received 8052 citations, with a mean of 536.8 citations per year. Among the other most cited papers, 40% had over 1000 citations (average citations/year = 185.7), 50% obtained >600 citations (average citations/year = 51.91), and the remaining 10% received <4600 citations (average citations/year = 33) Within the authors who contributed to the

TABLE 4 The top 20 most cited authors publishing on sarcopenic obesity from 1933 to 2023, sorted by the number of citations in the documents included in the collection.

Author	Country	h-index	g-index	m-index	LC	TC	NP	YFP
Rolland Y	France	14	15	0.7	1806	9762	15	2003
Boirie Y	France	18	31	1.2	1803	10,445	31	2010
Cederholm T	Sweden	13	15	0.9	1796	11,147	15	2010
Baracos VE	Canada	20	27	1.2	1795	7675	27	2008
Sawyer MB	Canada	12	14	0.7	1616	4878	14	2008
Zamboni M	Italy	15	20	0.7	1594	10,152	20	2004
Martin L	Canada	5	6	0.3	1572	4274	6	2008
Bauwer JM	Germany	6	7	0.4	1562	9337	7	2010
Cruz-Jentoft AJ	Spain	7	9	0.5	1547	8715	9	2010
Mccargar LG	Canada	4	4	0.2	1522	5466	4	2008
Schneier SM	France	3	3	0.2	1446	9312	3	2010
Landi F	Italy	8	11	0.5	1426	8737	11	2010
Topinkova E	Czech Republic	3	4	0.2	1397	8133	4	2010
Vandewoude M	Netherlands	2	2	0.1	1378	8066	2	2010
Baeyens JP	Belgium	1	1	0.1	1377	8052	1	2010
Martin FC	UK	1	1	0.1	1377	8052	1	2010
Michel JP	Switzerland	1	1	0.1	1377	8052	1	2010
Baumgartner RN	USA	7	8	0.3	1337	5530	8	1998
Prado CMM	Canada	9	9	0.5	1159	4998	9	2008
Lieffers JR	Canada	1	1	0.1	877	2160	1	2008

Abbreviations: LC, local citations measure how many times an author included in this collection have been cited by the documents also included in the collection; NP, number of publications; TC, total citations that an article, included in your collection, has received from documents indexed on a bibliographic Web of Science database; YFP, year of first indexed publication.

top 20 most cited articles, we identified several highly cited authors (Table 4): Cruz-Jentoft, A.J. (three papers), Baumgartner, R.N. (four papers), Prado, C.M.M. (two papers), Cederholm, T. (three papers), Baracos, V.E. (three papers), Boirie, Y., Martin, L., Sawyer, M.B., Sawyer, M.B., and Zamboni, M. (two papers), and Rolland, Y., Bauwer, J.M., Baeyens, J.P., Martin, F.C., and Michel J.P. (one paper).

3.6 | Publication analysis based on terms frequency

Figure 3 displays the network analysis of the 50 most frequently used author keywords and keyword-plus terms of the WoS database. Regarding author keywords, a total number of 5226 different keywords were identified, collectively appearing 21694 times. These terms appeared from a minimum of one occurrence to a maximum of 2072 occurrences. The most relevant author keywords were sarcopenia ($n = 2072$), obesity ($n = 1002$), body composition ($n = 660$), sarcopenic obesity ($n = 440$), aging ($n = 257$), muscle mass ($n = 210$), skeletal muscle ($n = 191$), muscle ($n = 190$), frailty ($n = 185$), and elderly ($n = 172$). Based on the 50 most frequently used author keywords, the analysis of the author keyword co-occurrences, considering both their frequency and connections, showed a network structure with two different clusters of interconnected keywords (Figure 3A). As for keyword-plus terms, a total number of unique 4705 terms were found, with the highest frequency observed being 41,074 occurrences. The term's appearances ranged from one to 1713 times. The most frequent keyword-plus terms were obesity ($n = 1713$), sarcopenia ($n = 1217$), body composition ($n = 926$), sarcopenic obesity ($n = 767$), prevalence ($n = 747$), skeletal muscle ($n = 738$), risk ($n = 638$), mortality ($n = 632$), insulin resistance ($n = 572$), and association ($n = 556$). The network analysis of keyword co-occurrences identified four distinct clusters for keywords plus (Figure 3B) that represent the knowledge structure of the research on sarcopenic obesity during 1993–2023.

4 | DISCUSSION

This bibliometric study summarized the evolution and trends in sarcopenic obesity from 1993 until 2023. Since its first recognition as an age-related decline in lean body mass in 1989, sarcopenia progressively evolved, with less than 200 publications annually. However, the publication of the first European Consensus on the definition of sarcopenia in 2010—from the European Working Group on Sarcopenia in Older People (EWGSOP)[13]—generated a before and after in this

TABLE 5 Top 20 most cited research papers of sarcopenic obesity from 1993 to 2023, sorted by a total number of citations in the WoS.

Rank	Author, year, journal, doi	Title	TC	TC_Y
1st	Cruz-Jentoft, 2010, Age Ageing, https://doi.org/10.1093/ageing/afq034	Sarcopenia: European consensus on definition and diagnosis: report of the European Working Group on Sarcopenia in Older People	8052	536.8
2nd	Baumgartner, 1998, Am J Epidemiol, https://doi.org/10.1093/oxfordjournals.aje.a009520	Epidemiology of sarcopenia among the elderly in New Mexico	2753	102.0
3rd	Prado, 2008, Lancet Oncol, https://doi.org/10.1016/S1470-2045(08)70153-0	Prevalence and clinical implications of sarcopenic obesity in patients with solid tumours of the respiratory and gastrointestinal tracts: a population-based study	2160	127.1
4th	Martin, 2013, J Clin Oncol, https://doi.org/10.1200/JCO.2012.45.2722	Cancer cachexia in the age of obesity: skeletal muscle depletion is a powerful prognostic factor, independent of body mass index	1764	147.0
5th	Ferruci, 2018, Nat Rev Cardiol, https://doi.org/10.1038/s41569-018-0064-2	Inflammageing: chronic inflammation in ageing, cardiovascular disease, and frailty	1541	220.1
6th	Mourtzakis, 2008, Appl Physiol Nutr Metab, https://doi.org/10.1139/H08-075	A practical and precise approach to quantification of body composition in cancer patients using computed tomography images acquired during routine care	1483	87.2
7th	Booth, 2012, Compr Physiol, https://doi.org/10.1002/cphy.c110025	Lack of exercise is a major cause of chronic diseases	1430	110.0
8th	Cederholm, 2017, Clin Nutr, https://doi.org/10.1016/j.clnu.2016.09.004	ESPEN guidelines on definitions and terminology of clinical nutrition	1245	155.6
9th	Janssen, 2000, J Appl Physiol, https://doi.org/10.1152/jappl.2000.89.2.465	Estimation of skeletal muscle mass by bioelectrical impedance analysis	956	38.2
10th	Deutz, 2014, Clin Nutr, https://doi.org/10.1016/j.clnu.2014.04.007	Protein intake and exercise for optimal muscle function with aging: recommendations from the ESPEN Expert Group	933	84.8
11th	Chung, 2009, Ageing Res Rev, https://doi.org/10.1016/j.arr.2008.07.002	Molecular inflammation: Underpinnings of aging and age-related diseases	883	55.2
12th	Stenholm, 2008, Curr Opin Clin Nutr Metab Care, https://doi.org/10.1097/MCO.0b013e328312c37d	Sarcopenic obesity: definition, cause and consequences	760	44.7
13th	Litwic, 2013, Br Med Bull, https://doi.org/10.1093/bmb/lds038	Epidemiology and burden of osteoarthritis	736	61.3
14th	Baumgartner, 2000, Ann N Y Acad Sci, https://doi.org/10.1111/j.1749-6632.2000.tb06498.x	Body composition in healthy aging	696	27.8
15th	Kalyani, 2014, Lancet Diabetes Endocrinol, https://doi.org/10.1016/S2213-8587(14)70034-8	Age-related and disease-related muscle loss: the effect of diabetes, obesity, and other diseases	661	60.1
16th	Baumgartner, 2004, Obes Res, https://doi.org/10.1038/oby.2004.250	Sarcopenic obesity predicts instrumental activities of daily living disability in the elderly	633	30.1
17th	Batsis, 2018, Nat Rev Endocrinol, https://doi.org/10.1038/s41574-018-0062-9	Sarcopenic obesity in older adults: aetiology, epidemiology and treatment strategies	630	90.0
18th	Visser, 2002, J Am Geriatr Soc, https://doi.org/10.1046/j.1532-5415.2002.50217	Leg muscle mass and composition in relation to lower extremity performance in men and women aged 70 to 79: the health, aging and body composition study	618	26.9
19th	Zamboni, 2008, Nutr Metab Cardiovasc Dis, https://doi.org/10.1016/j.numecd.2007.10.002	Sarcopenic obesity: a new category of obesity in the elderly	586	34.5
20th	Delmonico, 2007, J Am Geriatr Soc, https://doi.org/10.1111/j.1532-5415.2007.01140.x	Alternative definitions of sarcopenia, lower extremity performance, and functional impairment with aging in older men and women	561	31.2

Abbreviations: TC, total citations; TC_Y, total citations per year.

research area. The same consensus had a special section for sarcopenic obesity, where the expert agreed that both changes in muscle composition and fat infiltration into the muscle decreased the quality and performance of the muscle.[13] After the EWGSOP Consensus, other working groups established their operational classification and cutoff points in regions like Asia and North America between 2011 and 2014.[14–17] The latter also explained the second increment in the number of publications in both sarcopenia and sarcopenic obesity

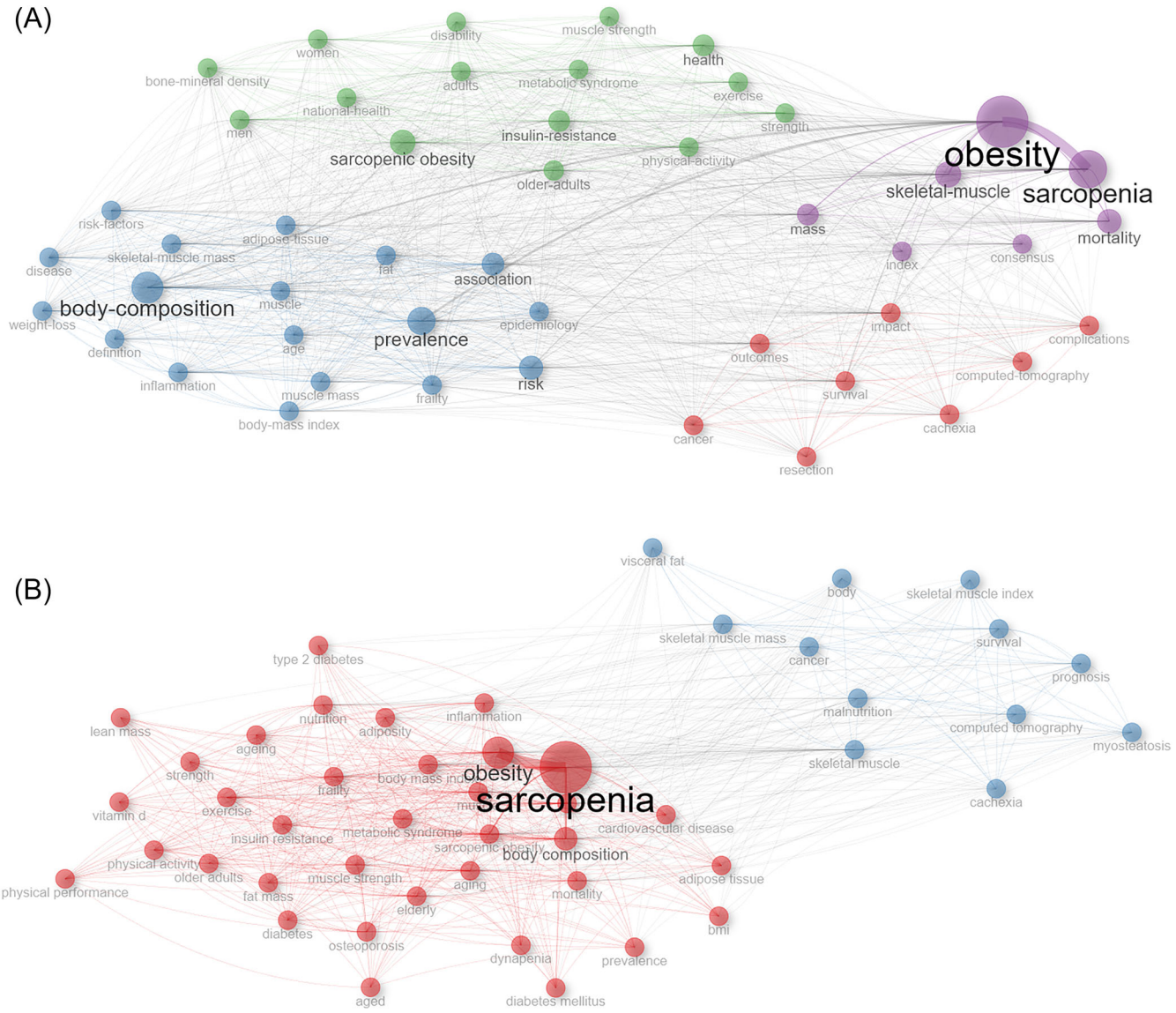

FIGURE 3 Network map of the 50 most frequently used author's keywords (A) and keyword-plus (B) co-occurrences in documents of sarcopenic obesity from 1993 to 2023.

between 2012 and 2014. Another factor that may explain this increase is the aging of countries like the United States, China, and South Korea. South Korea is among the countries with the highest prevalence of sarcopenia and, considering it is expected that people older than 65 years will reach 40% of the total population by 2040,[18] it is not surprising that the country has increased its interest in this geriatric syndrome.

With the arrival of all consensus, the research in sarcopenia and sarcopenic obesity took off. Immediately, new research identified that sarcopenia was associated with worse adverse health outcomes and higher mortality risk,[19–21] besides increasing the risk of falls and hospitalizations. Sarcopenic obesity was also identified as a leading cause of worse prognosis and increased risk of all-cause mortality in people with both conditions.[20–23] Interestingly, the current trends in obesity[2] and sarcopenia[22] may be generating a silent syndemic, decreasing the quality of life of our population.

Notwithstanding the incremented interest in sarcopenic obesity investigation, most research publications came from Asia, the United States, and Europe, and the intercountry collaboration was also higher in these geographical areas. The foregoing may be associated with higher data availability and resources to conduct research in these countries/regions and to publish in open-access journals like *Nutrients*, the *Journal of Cachexia Sarcopenia and Muscle*, and *PloS One*. Moreover, this also highlighted the limited information in other areas, such as Africa, where studies were limited to South Africa only. As in many low- and middle-income countries and regions, Africa is facing growing problems regarding obesity, which is rising among the whole population.[23] Africa is home to over 1.4 billion people, accounting for approximately 16% of the global population. Considering the

inadequate availability of adequate nutrition and healthcare among many Africans, further investigations into the burden of both sarcopenia and sarcopenic obesity are needed in the region to better understand the global burden of this disease across the globe and not only in the aforementioned areas. The latter emphasizes the relevance of international collaborations, including those in other countries and regions. One example of this type of initiative was the recent Conceptual Definition of Sarcopenia Consensus published by the Global Leadership Initiative in Sarcopenia, in which 107 participants from 29 countries were involved in developing this global consensus.[24]

The keyword co-occurrence network offers a clear snapshot of the current state of sarcopenic obesity. As it was expected, the main focus of research was obesity, sarcopenia, and their word connections, such as sarcopenic obesity and body composition. The three most frequent terms identified were (i) those associated with body composition, (ii) those associated with prevalence and risk of the exposure, and (iii) those linked with adverse health outcomes. Considering the evidence mentioned above, it can be suggested that there are three primary research directions concerning sarcopenic obesity. The first line of research aims to identify various methods for assessing sarcopenic obesity. The second line focuses on investigating the epidemiology of sarcopenic obesity, including its prevalence, incidence, and associated risk factors. Lastly, the third line of research emphasizes identifying the impact of sarcopenic obesity, such as its link to mortality and its predictive value for adverse events.

Although infrequent, it is possible to reverse sarcopenia and sarcopenic obesity in certain individuals through appropriate dietary and exercise interventions, while for others, progression can be slowed down or halted. In this context, early assessments and interventions during middle age among the general population become crucial to prevent or reverse sarcopenia or sarcopenic obesity, reducing the burden of unfavorable health outcomes. Nonetheless, numerous challenges persist. The absence of a standardized and unique classification and definition remains a significant obstacle to sarcopenic obesity research. This lack of a unified classification hampers the proper comparison of findings across different studies. In 2018, the European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO) issued a call for further investigation and action in this area,[25] and, in 2022, the group published the first Consensus Statement in the area, highlighting that sarcopenic obesity should be defined as "the coexistence of excess adiposity and low muscle mass/function" and that this definition should be implemented into clinical practice.[12] After its publication, the annual scientific production in sarcopenic obesity increased but not as much as it increased in sarcopenia alone.

Despite conducting a comprehensive search utilizing the WoS database, it is important to acknowledge the limitations inherent to this bibliometric analysis. Primarily, the utilization of the WoS database was chosen for retrieving and gathering bibliographic data, which were subsequently imported into the analysis using the Bibliometrix R package. While the WoS database is widely favored by researchers and academics for evaluating the significance and impact of scientific publications, it is not without its disadvantages.[26,27] For example, although WoS offers extensive content coverage and detailed citation information, Scopus provides a more comprehensive representation of global research output. Moreover, the restriction to WoS database may have systematically excluded studies conducted in other regions and published in their local journals that may not be part of WoS collection, generating a potential selection bias. Secondly, it was not possible to distinguish between systematic reviews or meta-analyses and literature/narrative reviews. Therefore, in this bibliometric, all were classified as reviews. Finally, we excluded research published in 2023 from our analysis because of the unavailability of complete information for the entire year, which might introduce selection bias into this bibliometric study.

5 | CONCLUSION

Our study identified a significant increase in research interest in sarcopenia and sarcopenic obesity over the past decade. While both concepts experienced a notable surge after 2010, sarcopenia evolved more than sarcopenic obesity. South Korea and Canada emerged as the leading contributors to sarcopenia-related publications, although most of this research originates from journals in the United States. Currently, research on sarcopenic obesity primarily focuses on epidemiology and identifying risk factors and outcome predictors. However, there is a dearth of research addressing prevention, early detection, and treatments to enhance the health of individuals with sarcopenia. We strongly advocate that future research should prioritize these areas. In this regard, our study seeks to aid in identifying areas of research focus and areas that require further exploration by offering thorough analyses and well-organized information on this subject matter.

AUTHOR CONTRIBUTIONS

Fanny Petermann-Rocha, Desirée Valera-Gran, and Eva-María Navarrete-Muñoz contributed to the conception and design of the study and advised on all statistical aspects. Desirée Valera-Gran and Eva-María Navarrete-Muñoz ran the analyses and interpreted the data. Fanny Petermann-Rocha performed the literature search with the support of Felipe Diaz-Toro. All authors critically reviewed this and previous drafts. All authors approved the final draft for submission, with final responsibility for publication. Desirée Valera-Gran is the guarantor.

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The authors of this manuscript certify that they comply with ethics in publishing and ethical guidelines for journal publication of obesity reviews reflected in their guide for authors.

CONFLICT OF INTEREST STATEMENT

All authors have no conflicts of interest or financial relationships relevant to this article to disclose.

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