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Article

Associations Between Sarcopenia/Muscular Atrophy and Cardiovascular Diseases: Science Mapping and Research Analysis

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Abstract

Aims/Background: Sarcopenia, a progressive muscle-wasting disorder, is increasingly being recognized for its association with cardiovascular disease (CVD). Despite the growing recognition of this association, the number of studies exploring their interaction remains limited. This study aims to clarify the intellectual landscape, research productivity, and emerging trends at the intersection of sarcopenia and CVD. **Methods**: A total of 348 original studies published between 1970 and 2024 were analyzed using Bibliometrix and VOSviewer. Growth trends, key contributors, collaboration networks, co-word network analyses, and thematic evolution were examined. Emerging topics were identified using keyword co-occurrence, clustering, and Bradford's law analysis. **Results**: Research on sarcopenia and CVD has expanded significantly, with 86.2% of publications emerging in the last decade at an annual growth rate of 8.45%. Japan (74 documents) leads the research output, followed by China (58) and the USA (53). Journal of Vascular Surgery contributed the most to this study. Landi was the most prolific scholar during this period. We identified six thematic clusters. Post-pandemic studies have shifted toward rehabilitation, functional assessments, and long-term outcomes. Cohort studies are a trending topic, highlighting the association between sarcopenia and increased risk of heart failure, stroke, myocardial infarction, and ischemic heart disease. Mendelian randomization studies have provided insights into the genetic link between muscle deterioration and CVD. Endovascular procedures are also an emerging theme, with sarcopenia being linked to higher post-surgical complications and mortality. **Conclusion**: Sarcopenia-CVD research is growing but remains less explored compared to other CVD fields. The key gaps include the need for standardized diagnostic criteria, longitudinal studies across diverse populations, and mechanistic investigation. Future research should integrate artificial intelligence (AI)-driven predictive models, refine Mendelian randomization methodologies, and expand the studies on the impact of sarcopenia on endovascular interventions to improve patient outcomes.

Keywords: sarcopenia; cardiovascular disease; bibliometric analysis; Mendelian randomization; endovascular procedures

1. Introduction

Sarcopenia is a musculoskeletal disorder characterized by a gradual decline in muscle mass and strength, particularly in older adults [1]. Sarcopenia involves diminished levels of three characteristics: muscular strength, muscle quantity or quality, and physical performance [2]. This musculoskeletal deterioration may hinder everyday activities and indicate a prognostic value for worse postoperative outcomes as well as elevated complication rates, mortality, and morbidity in major surgical operations [3]. Sarcopenia is significantly associated with a higher occurrence of falls and an elevated risk of fractures [4]. Moreover, diminished muscle mass or function, which are both indicators of sarcopenia, constitute risk factors for the loss of independence in individuals aged >90 years [5].

The causes of sarcopenia are mostly linked to the complex and poorly understood processes of aging. Factors contributing to its development include diminished size and quantity of type II muscle fibers, sedentary behavior, obesity, insulin resistance, lowered serum concentrations of androgens and growth factors, insufficient protein intake, and attenuated muscle protein synthesis (MPS) in response to protein consumption or resistance training [1,5,6,7]. Sarcopenia is linked to, and may partially result from, various chronic diseases that adversely impact the musculoskeletal system and physical activity. These conditions include chronic obstructive pulmonary disease (COPD) [8], chronic heart failure (CHF) [9], chronic kidney disease (CKD) [10], diabetes mellitus (DM) [11], human immunodeficiency virus (HIV) [12], and cancer [6,13,14]. Theoretically, these disease processes may influence sarcopenia primarily through direct effects on muscle function, or secondarily through the reduction of physical activity or caloric intake [15].

Cardiovascular diseases (CVDs) remain the greatest threat to global health, claiming nearly 18 million lives annually [16]. The impact of CVD continues to worsen as populations age and lifestyles become more inactive alongside rising rates of diabetes and obesity. The focus of recent research has been on early detection and on under-

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standing the influence of inflammation and how CVD intersects with other age-related conditions, such as muscle loss (sarcopenia), frailty, and metabolic syndrome [17,18]. However, while there is plenty of research on CVD, the link between muscle-wasting disorders and heart health has not been thoroughly examined in large studies, especially in those using bibliometric methods [19]. Better understanding of this connection could lead to stronger prevention and rehabilitation approaches, particularly for older adults.

Sarcopenia is associated with faster progression of CVDs and higher risks of mortality, falls, and reduced quality of life, particularly among older adults [13]. Although the pathophysiological processes are complicated, the main cause of sarcopenia is an imbalance between anabolic and catabolic muscle homeostasis, with or without neuronal loss [20]. The development of sarcopenia is linked to inherent molecular pathways of aging, chronic diseases, starvation, and immobility [21]. Screening and testing for sarcopenia among individuals with chronic illnesses may be especially crucial [11]. Early identification of sarcopenia is crucial as it offers a chance for treatments to stop or slow down the development of muscle disease, thereby affecting cardiovascular outcomes [20,22].

The complex pathophysiological mechanisms underlying the bidirectional relationship between sarcopenia and cardiovascular diseases (CVDs) have not been sufficiently explored. While previous studies have examined the impact of sarcopenia on health, there is a critical gap in understanding how cardiovascular conditions contribute to muscle deterioration and vice versa. Although a bibliometric study published by Tan et al. [19] investigated this relationship in elderly populations, more recent research is needed to study the post-pandemic shifts, emerging methodologies, and updated trends. This study addressed this gap by systematically mapping the current body of literature and analyzing research patterns to clarify the evolving interplay between sarcopenia and CVD.

2. Methods

2.1 The Scopus Database

Numerous databases have emerged on the World Wide Web due to the growth of the electronic era. These databases provide citation analysis and search capabilities specific to a given topic. In this study, the scientific abstract and citation database (Scopus; https://www.scopus.com) was selected owing to its extensive journal coverage, superior citation analysis, and practical search facilities. While Web of Science has broader historical coverage, Scopus provides approximately 20% more citations, making it a more comprehensive tool for bibliometric analysis [23,24].

2.2 Search Strategy and Sample Size Determination

The MeSH (https://meshb-prev.nlm.nih.gov/) database [25] and literature reviews [20,26,27,28,29,30,31,32,33] were used to extract potential keywords for bibliographic data mining from Scopus. These keywords (**Supplementary File 1**) were combined using Boolean operators. The exact search query was executed using the Scopus advanced search function on 28 December 2024, and included the following logic: TITLE ("sarcopenia" OR "muscular atrophy") AND TITLE-ABS-KEY ("Cardiac surgery" OR "Heart failure" OR "Aortic aneurysm" OR "Myocardial infarction" OR other CVD-related terms listed in **Supplementary File 1**). Although the search was restricted to the TITLE field for sarcopenia-related terms to increase specificity and reduce noise from unrelated literature, broader inclusion via the TITLE-ABS-KEY field was applied for CVD-related terms. This targeted approach allowed for higher relevance while maintaining reasonable sensitivity. The initial search yielded 451 documents of all types, without time or language restrictions. The document types included articles (79.56%), reviews (10.89%), letters (4.00%), editorials (2.22%), conference papers (1.33%), notes (0.89%), errata (0.67%), and short surveys (0.44%). The search was refined by limiting the results to original English-language articles using the Scopus filters: AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")), resulting in a final dataset of 348 original research articles. Two independent reviewers conducted literature screening. Disagreements were resolved through discussion, and if a consensus was not reached, a third senior researcher was consulted. A bibliometric study requires at least 200 documents for reliable conclusions, as smaller samples lack the statistical power to distinguish trends. A sample size of 200 or more ensures robust differentiation and enhances the validity of the institutional assessments [34]. The methods used in this study are illustrated in Fig. 1.

2.3 Inclusion and Exclusion Criteria

This bibliometric analysis included original research articles published in English and indexed in the Scopus database. Articles were selected based on predefined search terms related to sarcopenia and cardiovascular diseases (CVDs). To be included, studies had to: (1) be peer-reviewed original research, and (2) explicitly address the intersection of sarcopenia or muscular atrophy with any form of CVD.

Exclusion criteria served as an additional filtering layer to refine the initial search results. Excluded items included non-English publications, review articles, editorials, letters, conference proceedings, notes, errata, and short surveys. Furthermore, articles were excluded if they did not present original empirical data or lacked a clear and direct focus on both sarcopenia and CVDs. This approach ensured the analysis remained centered on high-quality, relevant primary research.

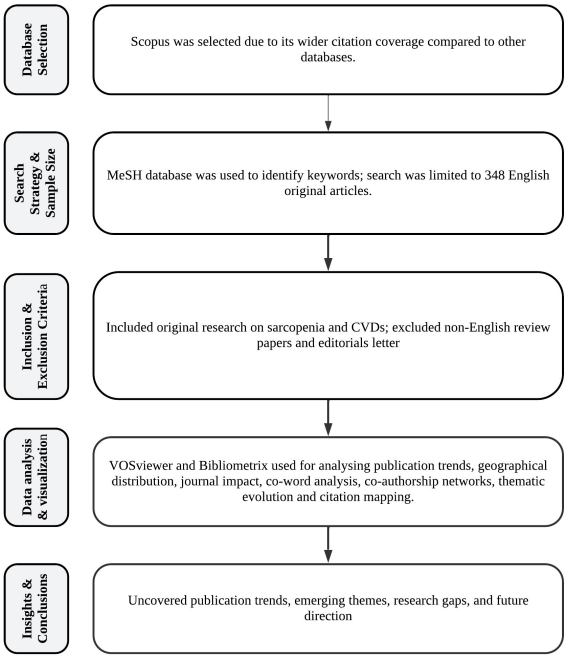


Fig. 1. Flowchart illustrating the methodological framework of the bibliometric study on sarcopenia and CVDs. The process includes database selection (Scopus), keyword extraction from MeSH and literature, search strategy formulation, document screening based on inclusion/exclusion criteria, and data analysis using Bibliometrix and VOSviewer for mapping publication trends, co-authorship networks, thematic evolution, and citation analysis. The figure was created using PowerPoint (Microsoft Corporation, Redmond, WA, USA). CVDs, cardiovascular diseases.

2.4 Tools for Mapping and Visualization

VOSviewer (version 1.6.20; developed by the Centre for Science and Technology Studies, Leiden University, Leiden, the Netherlands) and the Bibliometrix (R-package version 4.2.1; Department of Economics and Statistics, University of Naples Federico II, Naples, Italy) were used to analyze and visualize the data [35,36].

2.5 Analysis and Visualization

This study employed a comprehensive bibliometric analysis encompassing multiple dimensions, including publication trends, geographical distribution, journal impact, co-word analysis, co-authorship networks, thematic evolution, and citation mapping [35,36,37,38]. Publication trends and growth analysis assessed the annual research output, citation impact, and research acceleration. Geographical distribution was mapped using the Total Link Strength (TLS) tool in VOSviewer to analyze international collaborations. Bradford's law was used to identify core journals that publish the highest number of articles in vascular surgery, geriatrics, nutrition, endocrinology, and cardiology. Co-word and keyword analyses were used to examine frequently occurring terms, bibliometric word clouds, and bigram/trigram mapping to detect thematic structures. Co-authorship network analysis visualizes research collaborations and identifies influential authors using the h-index, g-index, m-index, total citations (TC), and number of publications (NP). Thematic evolution analysis has tracked research shifts from aging and muscle atrophy to cardiovascular interventions, Mendelian randomization (MR), and imaging-based assessments. The impact of coronavirus disease 2019 (COVID-19) was analyzed through pre-pandemic (1970–2020) and post-pandemic (2021–2024) trends, revealing an increased emphasis on rehabilitation, frailty, postoperative complications, and functional assessments. To preserve the logical structure of the manuscript, content related to thematic evolution and the impact of COVID-19 is discussed exclusively in the Results section, rather than in the Methods section. Citation analysis and influence mapping identified high-impact studies, co-citation networks, and bibliographic coupling to highlight the foundational literature. This methodological approach provided a multidimensional analysis of sarcopenia and CVD research and uncovered publication trends, emerging themes, research gaps, and future directions. Figures were generated using VOSviewer (version 1.6.20; Center for Science and Technology Studies, Leiden University, Leiden, the Netherlands) and Bibliometrix (R-package version 4.2.1; Department of Economics and Statistics, University of Naples Federico II, Naples, Italy).

3. Results

The growth of research on sarcopenia and CVD has accelerated significantly over the past decade, with 86.2% of the publications published since 2014 (Fig. 2). Since its inception in 1970, the field has accumulated 348 documents, with a notable surge after 2020. The annual growth rate of 8.45% reflects increasing scientific interest, while the documents' average age of 5.96 years indicates that recent publications dominate the literature. The high impact of the field is evident from the average of 25.54 citations per document, highlighting its growing relevance in clinical and research settings.

The continental distribution of research production on sarcopenia and CVD is dominated by Asia, North America, and Europe, with Japan (74 documents), China (58 documents), and the USA (53 documents) leading the output. Italy (29) and Germany (23) also contribute significantly. The top five countries in terms of the number of citations were the USA (3059), Italy (2617), Japan (2468), Germany (1520), and Spain (1479) (Fig. 3). Collaboration strength, measured by TLS, ranked Germany (43), the USA (40), and Italy (38) as the most collaborative countries (Fig. 3B). Of the 49 participating countries, only 19 met the threshold of four publications, highlighting the regional disparities in research engagement. International co-authorship remained relatively low (13.62%), indicating limited global collabo-

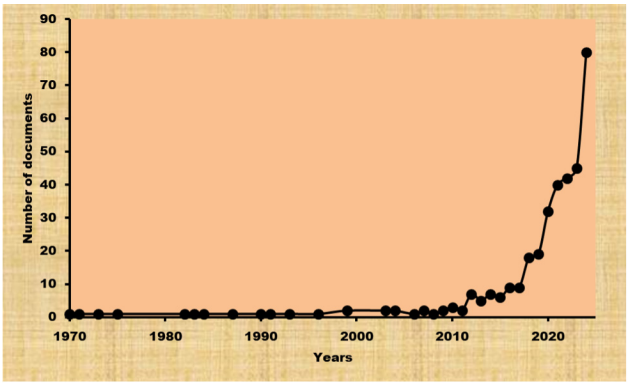


Fig. 2. Growth of research on sarcopenia and cardiovascular diseases. This figure illustrates the exponential increase in the number of publications related to sarcopenia and cardiovascular diseases from 1970 to 2024, with 86.2% of studies published in the last decade. This reflects growing scientific interest and research expansion in this field.

ration despite increasing research output. Fig. 3, generated using VOSviewer, maps the key contributors and their collaborative links, illustrating the geographical concentration of research efforts. The collaboration network revealed five clusters: the green cluster included the USA, South Korea, Taiwan, and China; the blue cluster included Canada and Switzerland; the red cluster featured Italy, Spain, Sweden, Austria, and the Netherlands; the yellow cluster comprised Germany and Brazil; and the purple cluster included Japan and Singapore.

3.1 Leading Sources: Bradford's Law

Bradford's law identified 27 core journals (Zone 1) out of 211 sources covering research on sarcopenia and CVD (Fig. 4). These core journals published 114 articles, accounting for approximately 32.8% of the total research output. The Journal of Vascular Surgery had the highest number of contributions (eight articles), followed by Clinical Nutrition ESPEN (six articles), European Geriatric Medicine (six articles), and the Journal of Nutrition, Health and Aging (six articles). Other key journals, such as Experimental Gerontology, Journal of Clinical Medicine, and BMC Geriatrics, contributed four to five articles each. The top ten sources collectively published 56 articles (49% of Zone 1), reflecting the concentration of the field in vascular surgery, geriatrics, oncology, and nutrition. A decline in article frequency beyond rank 10 indicates a high dispersion of research across the remaining sources, emphasizing the need for targeted dissemination in high-impact journals.

The analysis of the most frequent terms in document titles was conducted using bigram terms mapped through the word cloud feature in Bibliometrix (Fig. 5). The most recurring terms include "muscular atrophy" (66 occurrences), "spinal muscular" (53), "patients undergoing" (26), "cohort study" (19), and "heart failure" (19). Other frequently used terms such as "aortic aneurysm" (13), "long-term survival" (12), "aneurysm repair" (11), and "cross-sectional study" (10) highlight the focus on cardiovascular conditions, surgical interventions, and patient outcomes. The acknowledged themes include sarcopenia and muscular disorders (muscular atrophy, sarcopenia screening, muscle mass), CVDs and surgery (heart failure, aortic aneurysm, cardiac surgery), oncology and comorbid conditions (cancer patients, diabetes, cognitive impairment), clinical research and study designs (cohort studies, randomization, systematic review), postoperative outcomes and prognostic factors (postoperative complications, long-term survival, risk factors), and respiratory and neurological conditions (respiratory distress, acute stroke). These themes highlight the multidisciplinary nature of the research on sarcopenia and CVDs.

The most influential authors who have reported research on sarcopenia and CVD (Table 1) were identified based on their h-index, g-index, m-index, TC, and NP. The h-index measures an author's productivity and citation impact (h papers cited at least h times). The g-index prioritizes highly cited works (g papers with at least g^2 citations). The m-index adjusts the h-index by career length (h-index divided by years since first publication), indicating research consistency. Landi, F. ranks highest with h-index, g-index, m-index, TC, and NP of 10, 10, 0.714, 1426, and 10, respectively. Other leading contributors included Bernabei, R. (h-index 7, 1296 citations), Onder, G. (h-index 6, 1220 citations), and Tosato, M. (h-index 5, 973 citations). The presence of authors with high citation counts but fewer publications highlights the significant research impact in this field.

Co-word network analysis based on author keywords identified six clusters, each representing a different thematic area related to sarcopenia and CVD (Fig. 6). Cluster 1 (red) is the most prominent, with "sarcopenia" as the central node; it had the highest betweenness (942.17), indicating its critical role in the network. This cluster included keywords such as frailty, mortality, aging, CVD, cardiac surgery, stroke, rehabilitation, nutrition, and postoperative complications, highlighting the connection between sarcopenia and various cardiovascular conditions and their impact on clinical outcomes. Cluster 2 (blue) focused on prognosis, heart failure, cachexia, muscle wasting, and physical performance, emphasizing the role of muscle deterioration in worsening cardiovascular conditions and patient recovery. Cluster 3 (green) included spinal muscular atrophy (SMA) and spinal muscular atrophy with respiratory distress (SMARD), representing rare neuromuscular disorders linked to muscle degeneration. Cluster 4 (purple) consisted of muscle mass, muscle strength, and gait speed, which are key indicators of sarcopenia and functional decline in patients with CVD. Cluster 5 (orange) included screening and calf circumference, highlighting the diagnostic approaches for sarcopenia in patients with CVD. Finally,

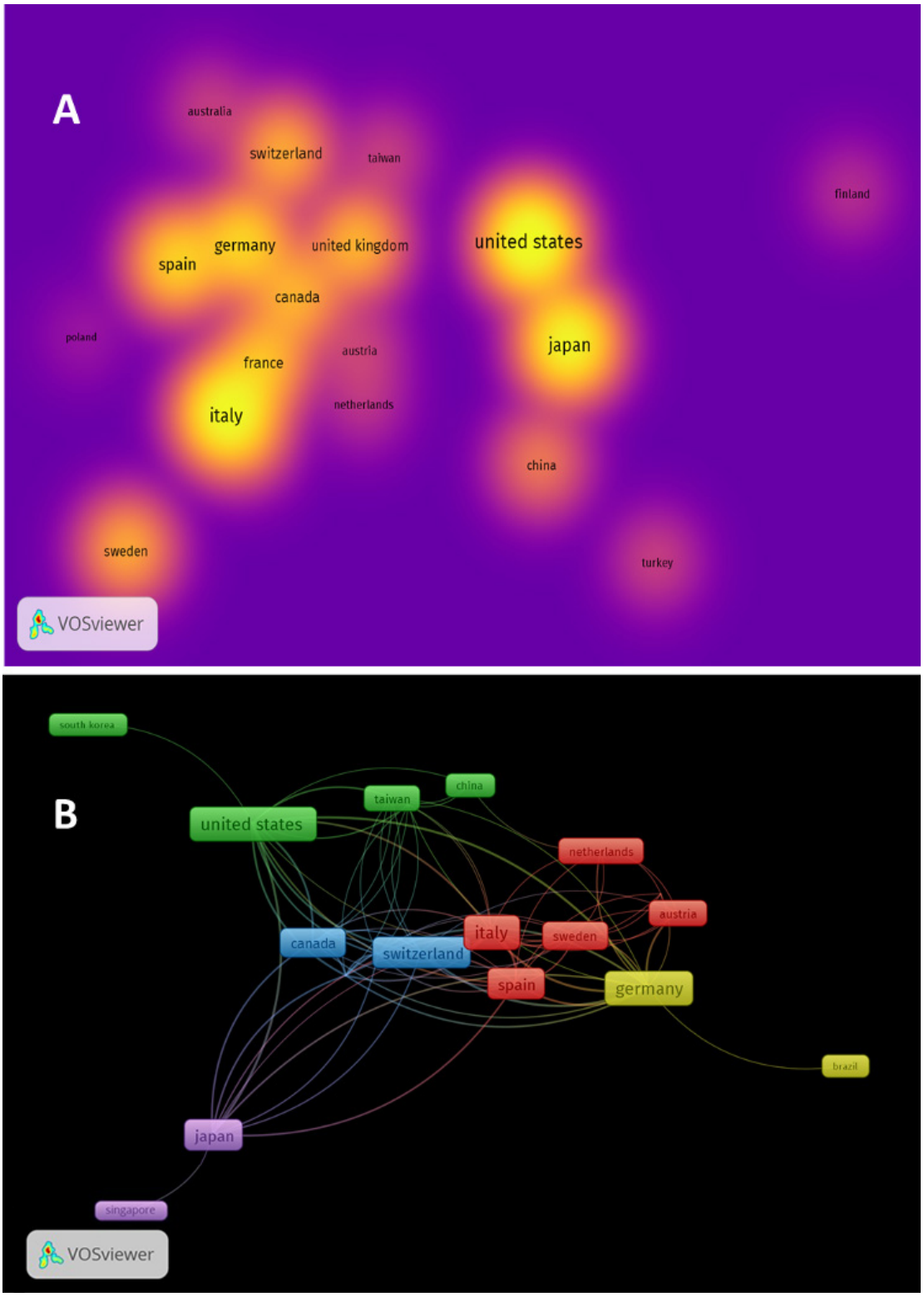


Fig. 3. Global collaboration and citation impact in sarcopenia and cardiovascular disease research. Generated using VOSviewer, (A) shows the total number of citations (represented by halo intensity), whereas (B) illustrates international collaboration strength, measured by Total Link Strength (TLS). Among the 49 countries, 19 met the inclusion threshold of at least four publications, and were grouped into five clusters: green (USA, South Korea, Taiwan, and China), blue (Canada and Switzerland), red (Italy, Spain, Sweden, Austria, and the Netherlands), yellow (Germany and Brazil), and purple (Japan and Singapore). This figure underscores both the global citation impact and disparities in collaborative research across regions. Owing to the nature of the visualization, some country names may appear to be overlapping or unclear.

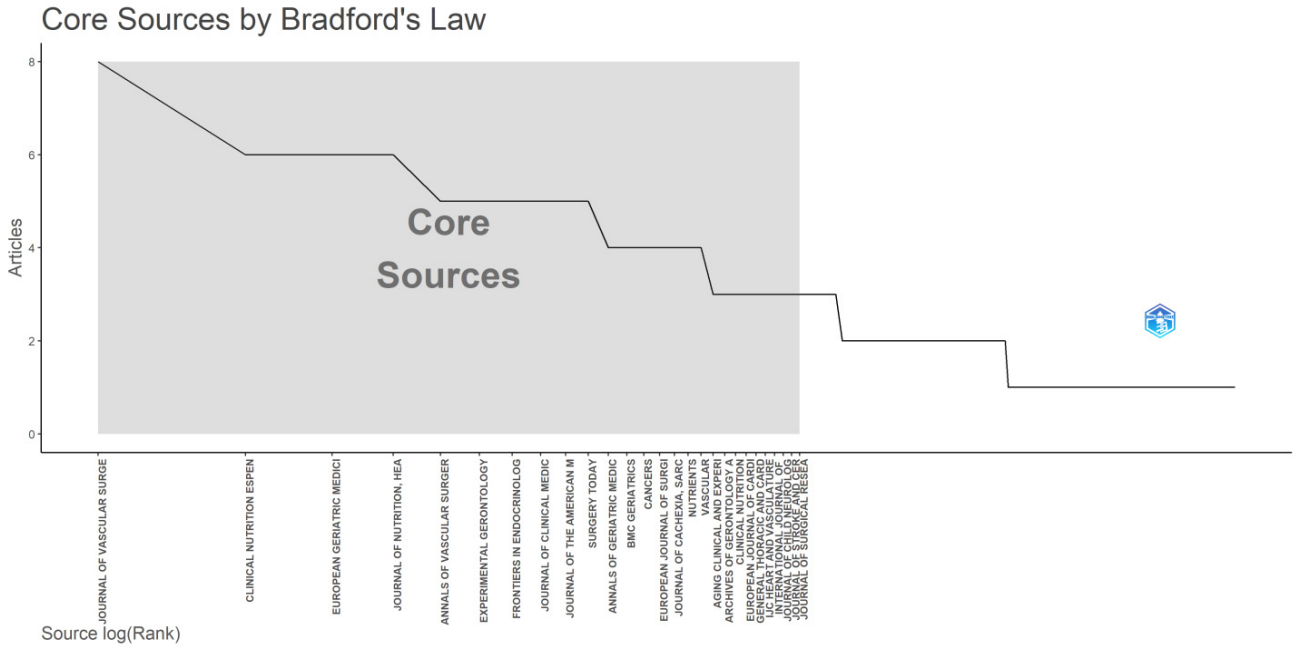


Fig. 4. Core journals by Bradford's law. This figure, generated using Bibliometrix, illustrates the identification of 27 core journals (Zone 1) from 211 sources related to sarcopenia and cardiovascular disease (CVD) research, contributing 32.8% of the total number of publications.



Fig. 5. Most frequent terms in sarcopenia and cardiovascular disease research titles. This word cloud, generated using Bibliometrix, visualizes the most frequent bigram terms in document titles.

Cluster 6 (brown) contained androgen receptors, suggesting that hormones influence muscle atrophy. Network visualization further illustrated the centrality of sarcopenia and its interconnections with multiple cardiovascular conditions, emphasizing the need for comprehensive research on its role in CVD outcomes.

3.2 Paradigm Shifts

The paradigm shifts in sarcopenia and cardiovascular disease (CVD) research reflect evolving thematic priorities over time, as illustrated in Fig. 7A. From 2021 to 2023, growing attention was given to topics such as muscle mass and MR, reflecting the increasing interest in genetic and functional assessments of muscle health. By 2024, newer themes, such as computed tomography, prog-

Table 1. Most influential scholars.

Author	h-index	g-index	m-index	Total citations	Number of publications
Landi, F.	10	10	0.714	1426	10
Bernabei, R.	7	7	0.500	1296	7
Onder, G.	6	6	0.429	1220	6
Cherubini, A.	5	5	0.500	174	5
Tosato, M.	5	5	0.357	973	5
Fukuda, H.	4	4	0.667	118	4
Halil, M.	4	4	0.333	80	4
Kim, K.W.	4	4	0.800	54	4
Liperoti, R.	4	4	0.286	1146	4
Martone, A.M.	4	4	0.400	118	4

Note: This table lists the most influential authors in sarcopenia and cardiovascular disease research based on bibliometric indicators. The h-index reflects productivity and citation impact; the g-index gives more weight to highly cited papers; the m-index adjusts for career length. Total citations and the number of publications are also shown.

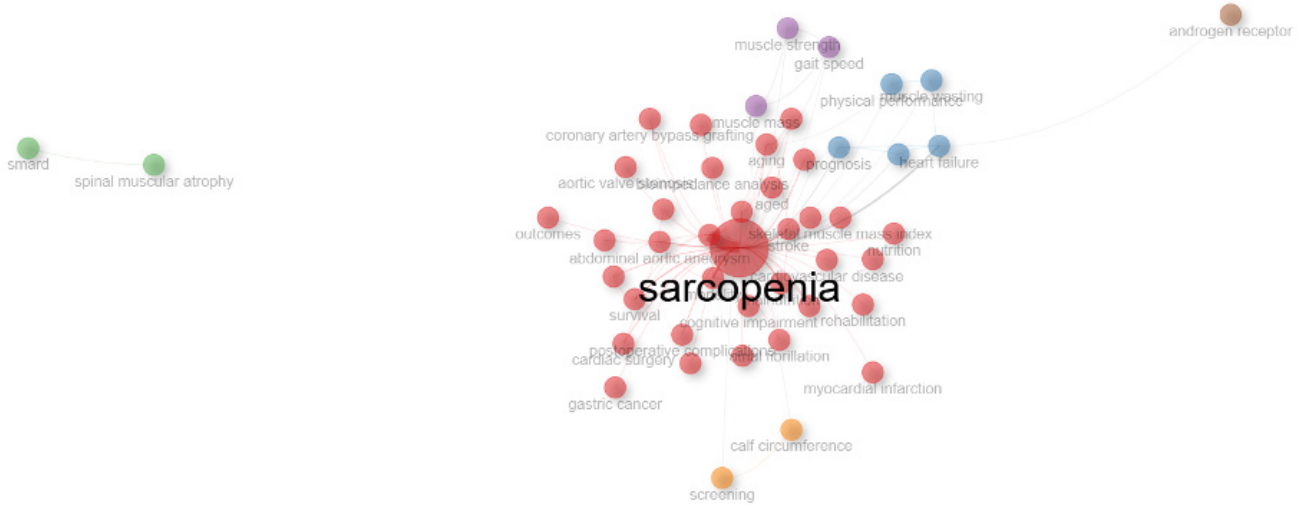


Fig. 6. Co-word network analysis of sarcopenia and cardiovascular disease research. The network analysis, conducted using Bibliometrix, identifies six clusters representing key research themes. Cluster 1 (red) centers on sarcopenia and its links to frailty, aging, and cardiovascular disease. Other clusters focus on heart failure and muscle wasting (blue), neuromuscular disorders (green), muscle function (purple), screening (orange), and hormonal influences (brown). Due to the nature of the visualization, some words may be unclear or overlap with others, affecting their visibility on the map.

nosis, and osteoporosis, emerged, indicating a shift toward imaging-based diagnostics and long-term outcome evaluations. While SMA was already a recurring topic before 2021, its sustained prominence across all periods demonstrates its continued relevance. In addition, some topics, such as cardiac surgery, have transitioned from being primary focal points to becoming interlinked with sarcopenia and geriatric outcomes. Overall, the field has evolved from generalized aging-related studies to more specialized prognostic and diagnostic approaches, underscoring the trend toward precision medicine.

3.3 Impact of the COVID-19 Era

The influence of the COVID-19 pandemic on the thematic evolution is shown in Fig. 7B. Before the pandemic (1970–2020), research largely focused on foundational areas such as aging, nutrition, cardiac surgery, and sarcopenia. However, post-pandemic research (2021–2024) has shown a notable shift toward recovery-focused topics, including grip strength, rehabilitation, and postoperative complications. These developments underscore the increased emphasis on functional assessments, long-term patient outcomes, and the integration of sarcopenia screening into broader cardiovascular care frameworks. The continued presence of SMA and sarcopenia in both periods confirms their central role in the research, while new priorities such as frailty and malnutrition reflect the long-term health implications of COVID-19 in aging populations.

Emerging themes in sarcopenia and CVD research have evolved since 2020, as analyzed using Bibliometrix

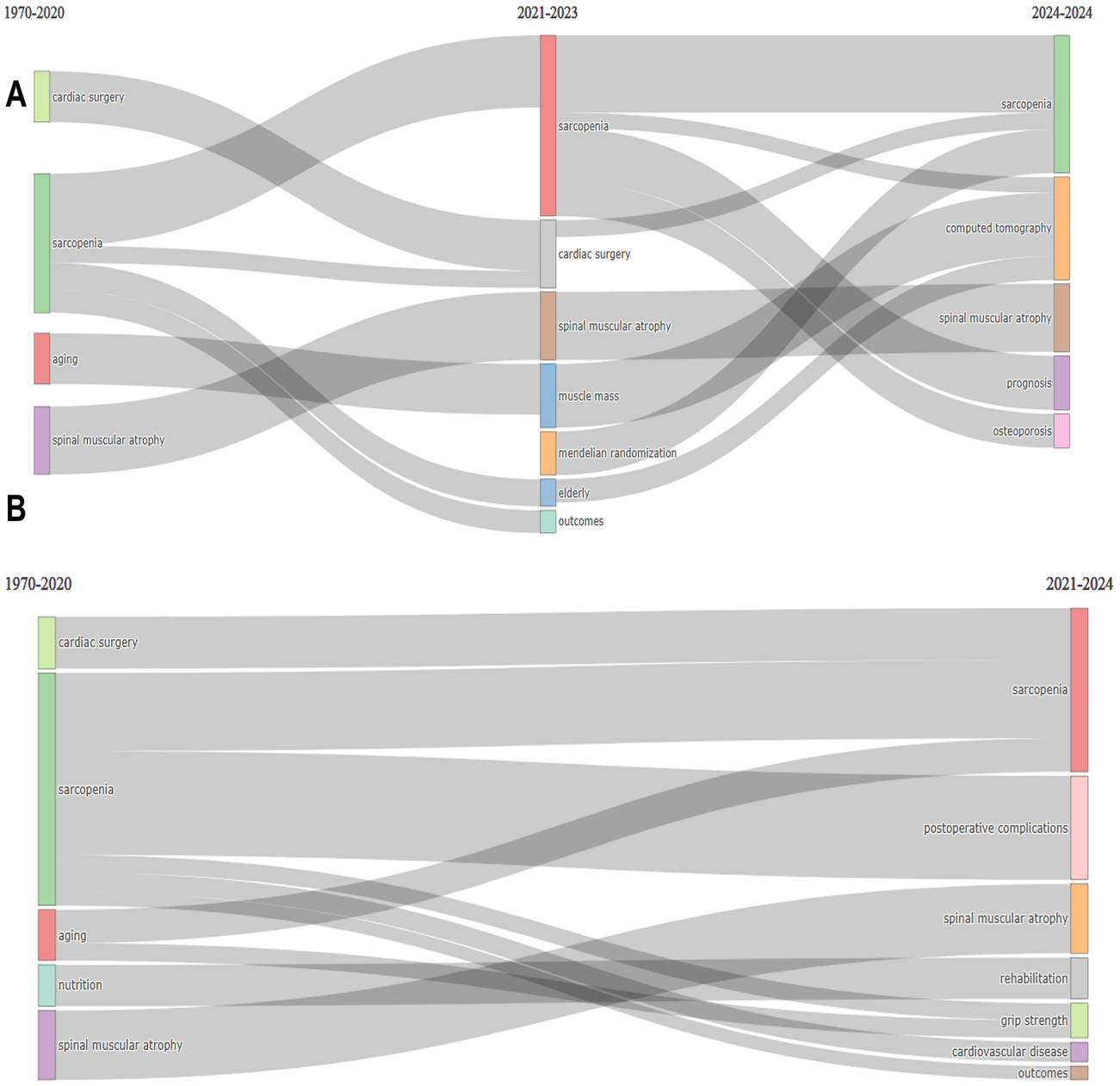


Fig. 7. Thematic evolution of sarcopenia and cardiovascular disease (CVD) research. This diagram, generated using Bibliometrix, illustrates thematic shifts in sarcopenia and CVD research over time. (A) (1970–2024) highlights emerging topics like computed tomography, prognosis, and osteoporosis, reflecting a shift toward advanced diagnostics and outcomes. (B) explores the impact of COVID-19, showing a transition from research on aging and nutrition to that related to postoperative complications, rehabilitation, and grip strength (2021–2024). Persistent topics include sarcopenia and spinal muscular atrophy, emphasizing their continued relevance.

(Fig. 8). Author keywords (Fig. 8A) highlight key topics, such as MR, cardiac surgery, muscle mass, survival, atrial fibrillation, nutrition, sarcopenia, frailty, and mortality. Unigram terms (Fig. 8B) focused on cohort studies, coronary diseases, cancer, and sarcopenia, reflecting foundational research. Bigram terms (Fig. 8C) emphasized prospective and retrospective cohort studies, MR, cardiac surgery, endovascular procedures, and aortic aneurysms, whereas trigram terms (Fig. 8D) refined these into specific interventions, including transcatheter aortic valves and endovascular aortic repairs. These themes underscore the growing importance of cohort-based research, cardiovascular interventions, and the clinical impact of sarcopenia in recent studies.

4. Discussion

Sarcopenia is an aging-associated disease that frequently coexists with other conditions. Numerous studies

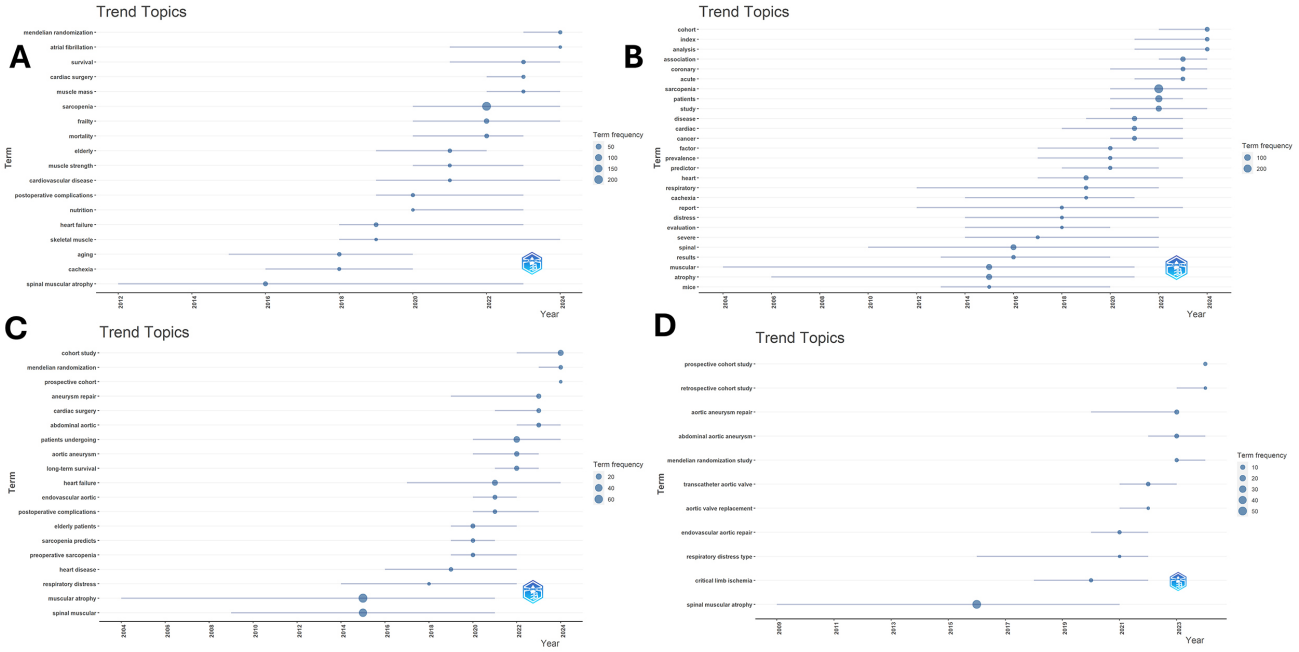


Fig. 8. Emerging themes in sarcopenia and cardiovascular disease research. Analyzed using Bibliometrix, the lines represent theme lifespan, while circles indicate frequency. (A) shows author keywords, and (B–D) present unigram, bigram, and trigram terms, respectively. These figures emphasize the recent shifts toward cohort studies, cardiovascular interventions, and the clinical implications of sarcopenia.

have demonstrated that CVDs are associated with an increased prevalence of sarcopenia [8,22]. The pooled prevalence of sarcopenia was shown to be highest in patients with acute decompensated heart failure (61%) and lowest in those with unclassified CVDs (12%), with the overall prevalence in patients with CVD being approximately twice that in the general population (13%) [22]. This study aimed to explore the intersection of sarcopenia and CVD by applying bibliographic techniques beyond traditional review methods, which are limited to a specific number of scientific papers. Researchers could not read all relevant research documents, i.e., 348 original studies. Therefore, we used text mining and novel software to analyze these studies and extract information that can be used by healthcare providers, research sponsors, and decision-makers. This study also recognizes the importance of original studies for analysis, rather than other types of documents such as reference papers and book chapters. This approach yields information that reflects actual research.

4.1 Research Growth and Regional Contributions

The significant acceleration (Fig. 2) in research on sarcopenia and CVD over the past decade underscores the increasing recognition of the role of sarcopenia in cardiovascular health. This field has gained considerable scientific momentum in recent years. Despite this growth, the total number of articles remains relatively limited, indicating that sarcopenia remains an emerging but underexplored topic in cardiovascular research. Compared with other CVD-related areas that have demonstrated higher publication volumes in bibliometric studies [39,40,41], research on sarcopenia has shown lower productivity. Nevertheless, the dominance of recent publications reflects the ongoing advancements and rising clinical interest. The high citation impact of the field highlights its growing relevance, despite its lower overall productivity. These findings emphasize the need for continued research and interdisciplinary collaboration to integrate sarcopenia research into mainstream cardiovascular research.

Asia, North America, and Europe have led the research on sarcopenia and CVD, possibly owing to their advanced healthcare systems, significant research funding, and aging populations, which have fostered interest in sarcopenia-related studies. Japan had the highest number of documents (74), reflecting its strong geriatric health research endeavors and demographic shift towards an aging population [42]. The USA and Europe have made significant contributions owing to their existing networks and collaborations in CVD research. Moreover, there is an increased focus on the interplay between CVD and age-related muscle atrophy in these domains, owing to their widespread occurrence.

4.2 Journal Impact and Thematic Relevance

Researchers can use results from Bradford's law to identify core journals for targeted publishing, optimize literature search methods, and ensure comprehensive coverage of high-impact studies. This helps streamline re-

source allocation, enhance citation strategies, and prioritize key sources [43] in sarcopenia and CVD research. The major journals in Zone 1 (Fig. 4), which included vascular surgery, geriatrics, nutrition, endocrinology, cardiology, and oncology, indicated a significant overlap between sarcopenia and CVD research. The existence of journals on gerontology, clinical nutrition, and cachexia underscores the marked concern regarding muscle wasting and its metabolic phenomena in CVD in the aging population. Furthermore, the presence of cardiovascular and surgical journals underscores the relevance of sarcopenia to cardiovascular outcomes, perioperative risks, and rehabilitation. This pattern demonstrates the increasing awareness of sarcopenia as a fundamental issue in cardiovascular health, especially among elderly individuals. Like previous studies of this nature, the current study has used Bradford's law to identify influential journals on pediatrics, neurosurgery, DM, and CVD [43,44,45,46].

4.3 Post-COVID-19 Shifts and Emerging Topics

Research on sarcopenia and CVD in the years following the COVID-19 outbreak has indicated a distinct shift towards functional assessments, rehabilitation, and long-term outcomes. Prior to the pandemic, research mostly focused on aging, nutrition, heart surgery, and sarcopenia, addressing the genesis and clinical dimensions of muscle atrophy and cardiovascular illness [47,48]. After the pandemic, there was an increased emphasis on rehabilitative strategies, grip strength, and surgical problems arising from the enduring effects of COVID-19 on muscular and cardiovascular functions. The persistent predominance of sarcopenia and SMA underscores their importance in pre- and post-pandemic studies [49]. Furthermore, the increased focus on frailty, heart failure, and undernutrition highlights a growing therapeutic interest in those at risk, particularly in elderly patients affected by COVID-19 and its consequences [6,11,49]. These modifications indicate an increased recognition of the significance of comprehensive strategies for patient recovery that integrate nutrition [49] with muscular [6] and cardiovascular [22] therapies. This change in theme organization is seen in several studies [38,50,51], demonstrating that the COVID-19 pandemic has substantially influenced changes and the emergence of new research trends.

Since 2020, the emerging themes in sarcopenia and CVD research have included MR, cardiac surgery, muscle mass, survival, atrial fibrillation, nutrition, frailty, mortality, cohort studies, coronary diseases, cancer, endovascular procedures, aortic aneurysms, transcatheter aortic valves, and endovascular aortic repairs, highlighting advancements in cardiovascular interventions and the clinical impact of sarcopenia (Fig. 8). The bigram terms (Fig. 8C) emphasize MR as an emerging theme. MR is an instrumental variable analysis method designed to evaluate causal hypotheses using non-experimental data. In MR studies, genetic variations, often single-nucleotide polymorphisms, serve as instrumental variables for hypothesized risk factors. MR pertains to Mendel's second rule of independent assortment of genetic alleles during the transmission of DNA from parents to offspring during gamete development [52]. MR has been progressively utilized in recent years to assess the efficacy and safety of both existing and new pharmaceuticals aimed at cardiovascular risk factors, and to investigate the repurposing potential of existing medications [53,54]. MR studies have provided insights into the causal relationships between sarcopenia-related traits and cardiovascular diseases (CVDs). Farmer et al. [27] found no support for the "healthy obese" hypothesis but confirmed a link between low grip strength and increased mortality. He et al. [29] and Liu et al. [20] demonstrated that increased muscle mass and grip strength reduced the risk of coronary heart disease (CHD) and myocardial infarction, whereas sarcopenia may predispose individuals to CVD. Ou and Pan [32] confirmed a causal relationship between sarcopenia-related traits and cardiocerebrovascular diseases. Du et al. [26] found no direct causal link between sarcopenia and venous thromboembolism but suggested indirect effects through diabetes and hypertension. Fu et al. [28] linked sarcopenia traits to electrocardiographic indices that affect cardiac electrical activity. Michaëlsson et al. [55] explored shared biological links between CVD and fragility fractures. These studies highlight the role of sarcopenia in cardiovascular health, as well as potential intervention targets.

The current study also revealed that endovascular procedures are becoming increasingly common. Endovascular procedures are minimally invasive treatments performed inside blood vessels using catheters, stents, or other devices to treat conditions such as aneurysms, arterial blockages, and varicose veins [56]. These procedures, guided by imaging techniques like fluoroscopy or ultrasound, include angioplasty, stent placement, embolization, and transcatheter aortic valve replacement (TAVR) [57]. Several studies have investigated the association between endovascular procedures and sarcopenia [58,59]. These studies demonstrate the role of sarcopenia in influencing outcomes following endovascular procedures. Sarcopenia has been consistently associated with increased mortality, poor long-term survival, and adverse clinical outcomes in patients undergoing various endovascular interventions. For example, sarcopenia significantly increases the risk of mortality in patients with chronic limb-threatening ischemia after endovascular revascularization [60] and in those undergoing elective endovascular aortic repair [61]. Preoperative sarcopenia and malnutrition are independent predictors of poor survival after endovascular aneurysm repair [62]. Other studies have linked sarcopenia to postprocedural complications, such as dysphagia following endovascular thrombectomy [63] and muscle deterioration following iliac artery embolization [64]. These findings highlight sarcopenia as an important risk factor that should be considered in preop-

Table 2. Representative cohort studies on the association between sarcopenia and cardiovascular diseases.

Author	Country	Type of CVD outcome
Boonpor J et al. [65]	UK	CVD, stroke, heart failure, myocardial infarction
Huang W et al. [66]	USA	Cardiovascular mortality
Jang HY et al. [67]	South Korea	Tetralogy of Fallot surgical outcomes
Jiang L et al. [68]	China	Major adverse cardiovascular events (MACE) in hemodialysis patients
Jiang M et al. [69]	China	Cardiovascular diseases, heart disease, stroke
Lai Z et al. [70]	UK	Ischemic heart disease (IHD)
Lim TS et al. [47]	UK	Cardiovascular diseases in MASLD patients
Liu W et al. [72]	China	Atrial fibrillation risk
Shim GY et al. [73]	South Korea	Atrial fibrillation
Steinmetz C et al. [74]	Germany	Cardiac rehabilitation outcomes
Yuenyongchaiwat K and Akekawatchai C [76]	Thailand	Sarcopenia and physical activity-related CVD risk
Yuenyongchaiwat K et al. [75]	Thailand	Sarcopenia in open-heart surgery patients
Zhang X et al. [77]	China	Cardiovascular disease, stroke, multimorbidity
Li S et al. [71]	China	Acute Ischemic Stroke and Transient Ischemic Attack

Note: This table summarizes key cohort studies investigating the relationship between sarcopenia and various cardiovascular outcomes across different countries. Each entry includes the first author, year, study location, and type of cardiovascular condition evaluated. The complete references are available in the reference list. MASLD, metabolic dysfunction-associated steatotic liver disease.

erative assessments and postprocedural care strategies for patients undergoing endovascular interventions.

Cohort studies are a trending topic in sarcopenia and CVD research, revealing the associations between sarcopenia and heart failure, stroke, myocardial infarction, atrial fibrillation, and ischemic heart disease (Table 2, Ref. [47,65,66,67,68,69,70,71,72,73,74,75,76,77]). Studies across various populations highlight the role of sarcopenia in increasing CVD risk, emphasizing the need for early detection, prevention strategies, and targeted interventions to improve outcomes [47,65,66,67,68,69,70,71,72,73,74,75,76,77].

4.4 Limitations

This study has some limitations. First, it relies on a single database, Scopus, which may have missed the opportunity to include research documents from other databases. Additionally, it was restricted to English articles and excluded original articles published in other languages. Analyzing the data using only two types of software may reduce the number of insights that could be useful to the reader. In addition, despite our efforts to be concise, the keywords may not have captured all the necessary documents. Multiple databases, languages, and analysis software can address these shortcomings, and should be considered in the future.

5. Conclusion

This bibliometric analysis highlights the increasing but underdeveloped research on sarcopenia and cardiovascular diseases (CVDs). Although the number of publications has surged in the last decade, productivity has remained lower than in other CVD-related areas. Asia, North America, and Europe have led research, with Japan at the forefront. Post-COVID-19, studies have shifted focus toward rehabilitation, functional assessments, and long-term outcomes. The key gaps include an insufficient understanding of the role of sarcopenia in CVD progression, limited cohort studies in diverse populations, and unclear genetic or mechanistic pathways. Future research should prioritize standardized diagnostic criteria, longitudinal studies, and precision medicine approaches. Expanding MR, investigating the impact of sarcopenia on endovascular procedures, and integrating artificial intelligence (AI)-driven predictive models will enhance early detection and personalized treatment. Addressing these gaps will improve clinical outcomes and solidify the relevance of sarcopenia in cardiovascular research. Our findings emphasize the importance of early screening for sarcopenia in patients with CVD, especially in the post-COVID-19 era, when muscle loss and frailty may complicate recovery. Promoting collaborative research across the geriatrics, cardiology, and rehabilitation sciences could address existing knowledge gaps and support the development of integrative care models. These results underscore the need for future studies to bridge epidemiological insights into clinical practice and ensure that sarcopenia is appropriately considered in cardiovascular risk management.

Key Points

- This bibliometric study mapped global research trends in the bidirectional relationship between sarcopenia and cardiovascular disease from 1970 to 2024.
- The analysis included 348 original English articles retrieved from Scopus and highlighted a significant surge in publications after the COVID-19 pandemic.

• The major research themes included sarcopenia-related traits, cardiac surgery, Mendelian randomization, cohort studies, endovascular procedures, and cardiovascular interventions.

• The USA, Japan, China, Italy, and Germany have been identified as the most productive countries with strong collaborative research networks.

• These findings underscore the importance of early sarcopenia screening in patients with cardiovascular disease and call for further multidisciplinary, collaborative, and longitudinal research.

Abbreviations

CVD, cardiovascular disease; CHD, coronary heart disease; COVID-19, coronavirus disease 2019; IHD, ischemic heart disease; MACE, major adverse cardiovascular events; MASLD, metabolic dysfunction-associated steatotic liver disease; MR, Mendelian randomization; NP, number of publications; SMA, spinal muscular atrophy; TC, total citations; TLS, Total Link Strength.

Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization, SIA and MIA; methodology, SIA and MIA; software, SIA; validation, SIA and MIA; formal analysis, SIA; investigation, SIA and MIA; resources, SIA and MIA; data curation, SIA; writing—original draft preparation, SIA and MIA; writing—review and editing, SIA and MIA. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work to take public responsibility for its content and have agreed to be accountable for all aspects of the work, including ensuring the accuracy and integrity of any part of the work.

Ethics Approval and Consent to Participate

Not applicable. This bibliometric study did not involve human participants, data, or clinical interventions and therefore did not require ethical approval.

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Conflicts of Interest

The authors declare no conflicts of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/BJHM62015.

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