International Journal of
Active & Healthy Aging

e-ISSN :3023-6045
https://ndpapublishing.com/index.php/ijaha

Scientometric Analysis of Surgical Methods for Hip Fractures in the Elderly

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Article Info
Received: 30 November 2025
Revised: 16 December 2025
Accepted: 18 December 2025
Published: 30 December 2025

Keywords
Citespace
Economic Burden
Health Systems
Hip Fracture
Surgical Methods

ABSTRACT
Hip fractures in the elderly are a significant health problem that leads to increased morbidity and mortality rates and higher healthcare costs. This study aims to analyze the dynamics and structure of the scientific literature on surgical methods for hip fracture treatment using scientific metrics. The objectives include identifying the main themes in this field, investigating their relationships, and highlighting the most active research topics and important articles. A dataset of 9,162 articles published in the WOS database between 2010 and 2024 was analysed. The findings show a significant increase in publications on hip fractures in elderly patients since 2016, peaking at 827 articles in 2022. The emergence of nomogram-based prognostic models indicates that the personalized medicine approach is becoming widespread in assessing post-fracture mortality and complication risk. In addition, the relationships between nutrition, vitamin D, and osteoporosis highlight the multidimensional nature of fracture prevention strategies. A separate cluster created by the COVID-19 pandemic underscores the fragility of healthcare services during crises. Furthermore, it has been concluded that large-scale international data platforms, such as NOREPOS and CHANCES, have increased knowledge production in hip fracture epidemiology, and that similar collaborations are of strategic importance for countries like it is recommended that studies be conducted to determine the cost-effectiveness of surgical methods for hip fractures in the elderly and their economic burden on healthcare systems.

1. INTRODUCTION

Hip fractures are a significant public health issue among older people [1]. With an ageing population, the number of hip fractures worldwide is increasing annually, and the number of cases, which was approximately 1.6 million in 1990, is expected to reach 6 million by 2050 [1,2]. The incidence of hip fractures increases rapidly with age and is higher in women than in men [1,3]. The prevalence of hip fractures varies considerably by region. Scandinavian countries and North America have the highest incidence, while countries such as Southern Europe and Türkiye traditionally report lower rates [4,5]. For example, in Türkiye, there were approximately 255.000 hip fracture cases in 2019, with 73% of these fractures occurring in women. The number of hip fractures in Türkiye is estimated to increase by 166% between 2009 and 2035 [5,6]. In contrast, approximately 250.000-300.000 cases are reported annually in the United States, and approximately 76,000 cases in the United Kingdom [7,8].

The economic burden of hip fractures is also extremely high. In the United States, due to the high costs of acute and post-acute care, annual healthcare expenditures related to hip fractures are estimated to be between $10 billion and $15 billion [7]. A study conducted in Türkiye found that, as of 2011, the average direct hospital cost per hip fracture patient was approximately $3,119 [9]. However, generalising these data to the entire country is limited. In the United Kingdom, the cost of inpatient treatment for one year after a hip fracture is $14,642 per patient, reflecting an average hospital stay of 32 days [10]. These per-patient costs are relatively high compared to the costs of the most common diseases. Hip fractures represent a significant economic burden, costing billions of pounds annually in the United Kingdom

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How to cite this article
Kutlu, G., & Akbulut, Y. (2025). Scientometric Analysis of Surgical Methodsfor Hip Fractures in the Elderly. Int. J. Act. Health Aging, 3(2), 120-128.

Research Article/ DOI: 10.5281/zenodo.18022072

and tens of billions of dollars in the United States. Therefore, hip fractures impose a significant financial burden on healthcare systems worldwide.

Surgical intervention is currently considered the "gold standard." Depending on the type of fracture and the patient's overall health, surgical methods such as osteosynthesis (plates, screws, pins) or joint replacement (hemiarthroplasty or total hip replacement) are preferred [11,12].

Bibliometric analyses conducted over the past few years show that scientific interest in hip fracture surgery is rapidly increasing. A study examining 7,684 publications from 2000 to 2019 found that scientific output in this field has increased exponentially [13]. Although the United States produced the most publications, European countries collectively published more. Research has focused primarily on surgical approaches, rehabilitation, osteoporosis, complications, and epidemiology. Surgical techniques and geriatric perioperative care (orthogeriatric), mortality, and functional recovery were among the main themes of these publications [14,15]. All these scientific measurement studies reveal that hip fracture surgery is a rapidly growing field of academic research, reflecting its clinical importance. In this clinical field, where incidence is increasing, and surgical intervention is considered the "gold standard" for treatment, the economic burden on health systems is growing heavier each year.

This study aims to evaluate scientific production in this medical field by analysing the scientific structure and developmental dynamics of the literature on surgical methods for hip fracture treatment using scientometric methods. The main objectives of the research include identifying the key themes in the field, elucidating their relationships, determining the most intensive areas of research, and systematically examining the most influential publications.

2. MATERIALS AND METHODS

A collection of 9,162 studies was compiled by extracting relevant articles from the Web of Science (WOS) database between 2010 and 2024. Studies included in the SCIE, SSCI, and ESCI citation indexes within the Web of Science Core Collection were analysed. The search and data download process was completed within a single day to minimize potential biases.

2.1. Analysis and Assessment of Data Quality

Descriptive statistics were visualized using the WOS database and "CiteSpace" software to identify the most influential authors, institutions, and journals.

The document co-citation analysis (DCA) method was applied to identify highly cited important literature, and articles were categorised by theme to highlight prominent research within a specific time frame. In these analyses, clusters representing the field's fundamental components were created using keywords and titles. Labels were assigned to each cluster using the log-likelihood ratio (LLR) method, and the integrity of the clusters was evaluated using the silhouette score. The LLR method, which provides reliable results, was used to extract cluster labels automatically [16]. The study's findings were evaluated for reliability using the modularity Q index and the average silhouette value.

2.2. Literature Search Strategy and Eligibility Criteria

Within the scope of this study, a literature review was conducted using the WOS Core Collection database. Key concepts such as "hip fracture," "femoral fracture," "surgical treatment," "operation technique," and "arthroplasty" were used at the topic level in the review. Only research articles were included as publication types, and Turkish and English publications were selected as language filters. The study focuses on the last 15 years, specifically 2010 to 2024. This search strategy aims to comprehensively and systematically analyse scientific publications on the surgical treatment of hip fractures.

2.3. Ethics

As the research was classified as non-human subject research, no institutional ethics committee approval was required. All stages of the research were conducted in accordance with the principles of the Declaration of Helsinki.

3. RESULTS

According to publication data from 2010 to 2024, there has been a noticeable upward trend in the number of scientific publications on the surgical treatment of hip fractures. The number of publications, which was 438 in 2010, gradually increased in the following years, reaching 660 in 2017, and then rose sharply after 2020, peaking at 827 in 2022. This increase indicates that research interest in the field has not declined despite the COVID-19 pandemic, and that research production has accelerated due to the ageing population and the burden on healthcare systems (Figure 1).

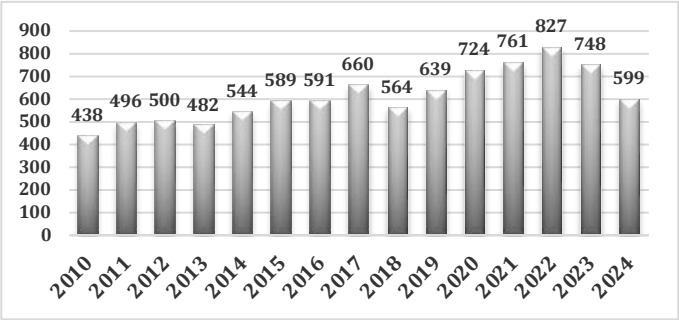

Figure 1. Number of publications (2010–2024)

The Fig. 2 shows the institutions that produce the most scientific publications in hip fracture surgery and reveals that research output is concentrated in the world's leading universities and medical schools. The University of California's record of publications demonstrates its leadership among major research centers in the United States in this field. The high ranking of Harvard University and Harvard Medical School is consistent with their strong academic foundations in orthopaedic surgery and geriatrics. The notable contributions of European centers such as Karolinska Institutet, Lund University, the University of Oslo, and Skåne University Hospital show that hip fracture research is not limited to North America, but that the Scandinavian countries also have a significant research tradition in this field. Overall, the graph shows that academically well-established institutions shape the literature on hip fracture surgery, have high clinical research capacity, and enjoy strong international visibility.

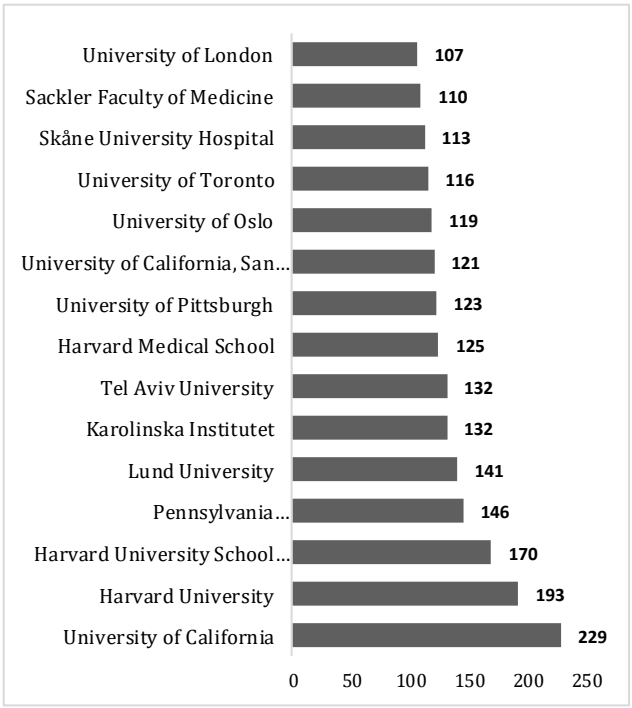

Figure 2. Top contributing institutions

Fig 3 presents the distribution of publications by country in the field of hip fracture surgery. The United States ranks first with 1,861 publications, indicating its dominant role in global research output. China follows with 1,525 publications, reflecting a rapidly expanding scientific contribution. The United Kingdom, Italy, Japan, and Germany constitute the next group of leading contributors, each producing between 450 and 700 publications. Other countries with significant outputs include South Korea, Australia, Canada, Sweden, and the Netherlands. This indicates that research activities are concentrated in technologically advanced and academically strong countries. Countries such as Spain, Türkiye, France, and Taiwan also make significant contributions to the literature, but these contributions are relatively lower.

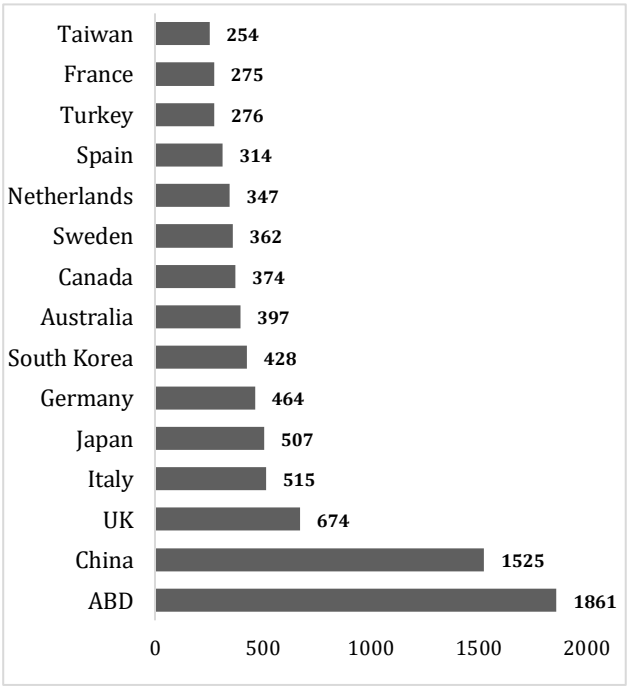

Figure 3. Publications by country

Fig 4. shows the funding agencies that provide the most support for hip fracture research. The data shows that the United States Department of Health and Human Services and the National Institutes of Health (NIH) are the two institutions that contribute the most to the field, with 479 and 466 publications, respectively. The data reveal that hip fracture research is largely financially supported by countries with strong research ecosystems, such as the United States, China, Japan, and the United Kingdom.

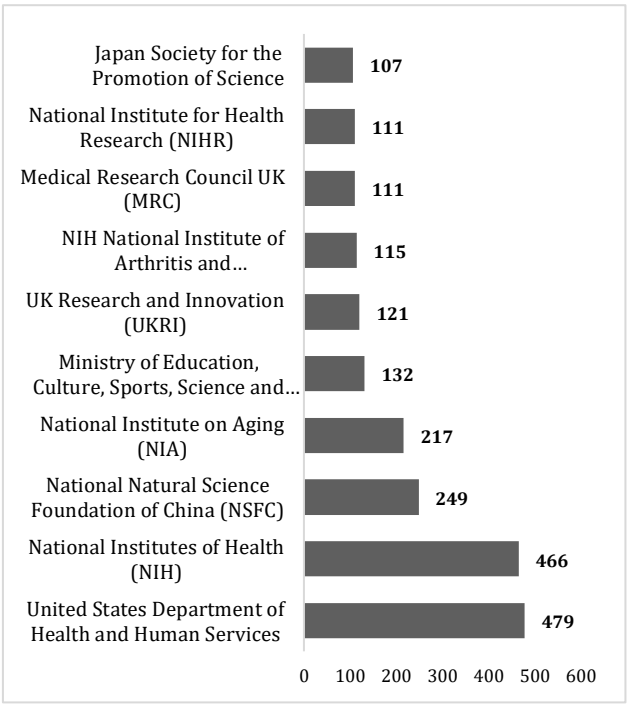

Figure 4. Top Funding agencies

When examining the clustering map (Fig. 5), it is observed that the themes that form the backbone of the hip fracture literature focus particularly on elderly individuals (#1 Elderly patient) and elderly women (#3 Elderly women), as well as on femoral neck fractures (#4 Femoral neck fracture). This reflects the high incidence of hip fractures in the elderly population and the increased risk in women due to osteoporosis, which is strongly reflected in the research. Another dominant cluster is formed around the tags #2 Hip fracture surgery, #5 Total hip arthroplasty, and #8 Internal fixation | hip replacement, which focus on treatment methods. These clusters reveal that surgery remains the "gold standard" treatment and that fixation and arthroplasty techniques are widely studied in the literature. Additionally, the #6 Norepos study (Norwegian Epidemiologic Osteoporosis Studies) cluster, representing large-scale Norwegian bone health databases, reflects the strong position of Scandinavian countries in epidemiological data production. Similarly, the #12 Chances project cluster represents a large research consortium bringing together numerous elderly cohorts from Europe and the US, playing a critical role in assessing the effects of multi-cohort data on fracture risk, mortality, and comorbidities. The #9 Covid-19 pandemic cluster, which examines the pandemic's impact on trauma surgery, shows intensive research on the increased risk of complications, rising mortality rates, and prolonged hospital stays resulting from delayed surgeries during the pandemic. In addition to these clusters, more specific sub-themes, such as the #11 Glycemic control cluster, which represents comorbidities such as diabetes management, and #7 Reverse shoulder arthroplasty, which indicates multiple joint problems in the elderly, demonstrate that the literature covers a broad clinical scope.

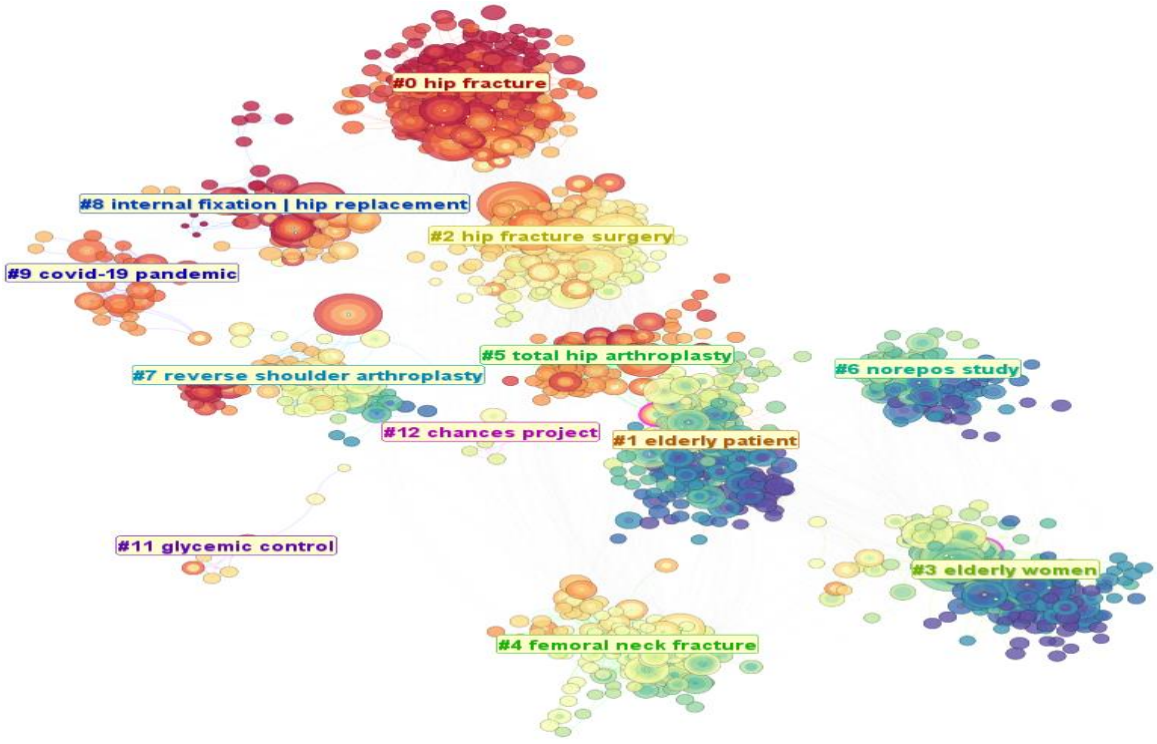

Figure 5. Cluster analysis (*Selection criteria: g-index (k = 25), LRF = 3, L/N = 10, LBY = 5, e = 1.0; Modularity Q = 0.6969; Weighted mean silhouette S = 0.8719; Harmonic mean (Q, S) = 0.7746).*

The #0 nomogram, the largest cluster in the clustering map (Fig. 6), reveals relationships and demonstrates that modern approaches to clinical risk prediction and prognosis modelling are gaining increasing importance in the hip fracture literature. Nomogram-based models have become critical tools for patient-specific prediction of post-fracture mortality, complications, and readmission risks, reflecting the shift in research towards personalized medicine applications. The #2 hip fracture cluster at the center of the map serves as the central axis of the literature, encompassing comprehensive research on the definition, epidemiology, clinical characteristics, and treatment of hip fractures. Various sub-themes related to clinical parameters, systemic factors, and treatment methods branch out from this central structure as side clusters. Themes related to functional status and nutrition reveal critical determinants of post-fracture recovery. The #1 Barthel Index cluster focuses on assessing functional independence and activities of daily living. In contrast, the #5 malnutrition and #12 nutrition clusters encompass a broad literature emphasizing the impact of malnutrition on prognosis. This theme group demonstrates that nutritional status directly affects both the risk of complications and the success of rehabilitation. Clusters centered on metabolic health and bone structure shed light on the biological basis of fracture risk. The #3 osteoporosis cluster includes extensive studies demonstrating that osteoporosis is a key risk factor for hip fractures. In contrast, the #6 vitamin D cluster reveals the role of vitamin D deficiency in fracture incidence and the healing process. The more minor but significant #11 type 1 diabetes cluster addresses the effects of diabetes on bone health and fracture risk as an independent area of research. Overall, this thematic structure demonstrates that the hip fracture literature is not solely focused on surgical techniques; it has become more comprehensive and multidisciplinary, enriched by multidimensional areas such as risk prediction, functional status, nutrition, metabolic factors, and individualized prognostic tools (Fig. 6).

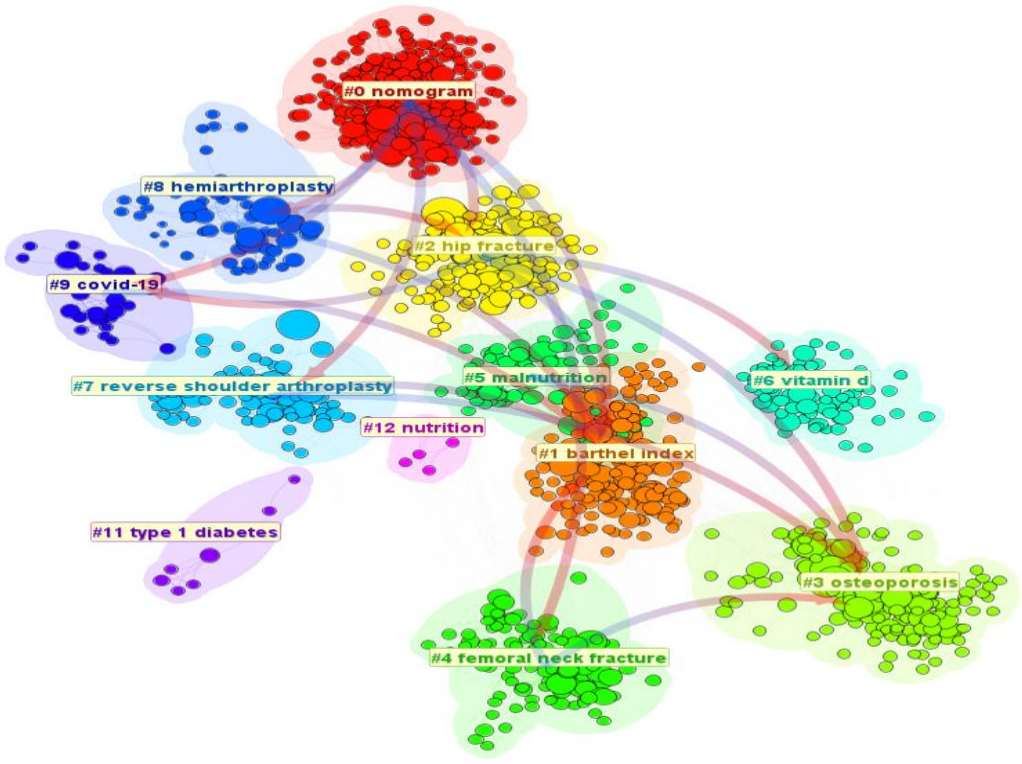

Figure 6. Cluster visualization analysis

Each cluster represents a specific research area, and the citation density of publications within a cluster reflects the impact and visibility of that topic in the literature (Fig. 7). For example, the multicentre randomized controlled trial conducted by Dolatowski et al. (2019) compared hemiarthroplasty with screw fixation and has become one of the most cited studies in the field [17]. The positioning of this study at the center of cluster #8hemiarthroplasty in the network analysis also demonstrates that it has become a decisive reference point in both clinical decision-making and academic discussions.

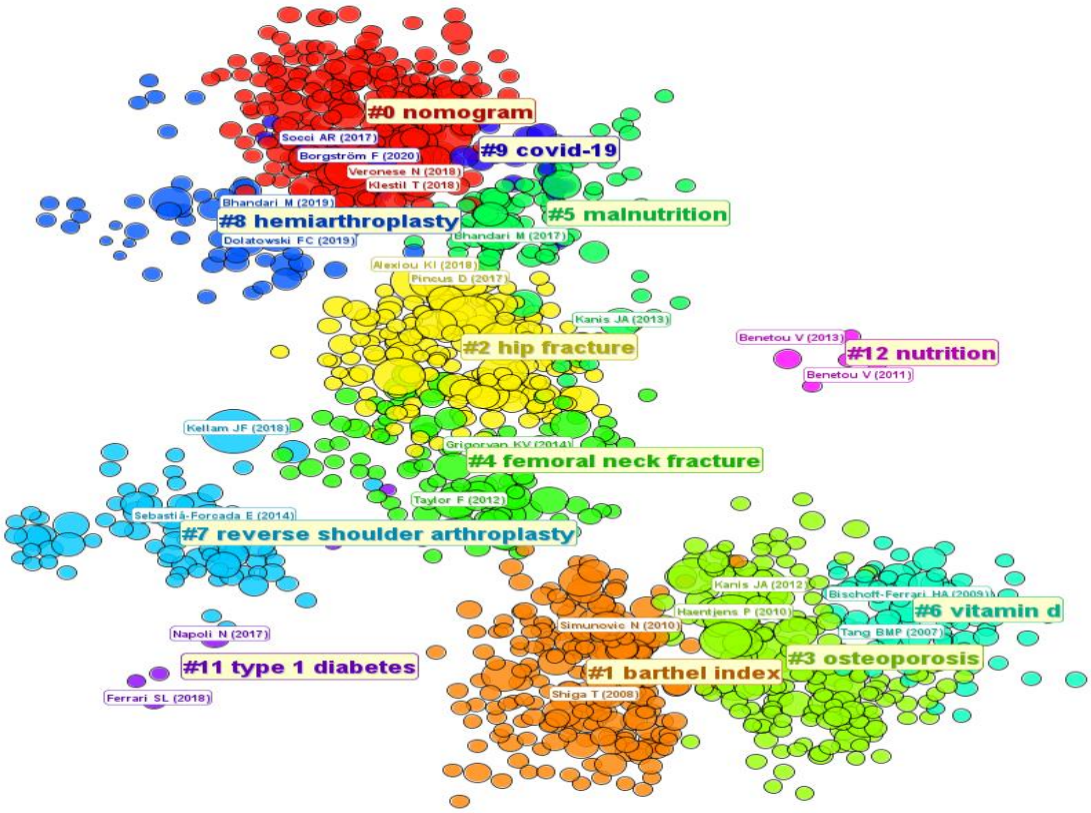

Figure 7. Citation networks

A citation burst is a publication that receives an exceptionally high number of citations within a specific time frame, thereby creating a significant impact in a short period. The study with the strongest citation burst during the period examined was Grigoryan et al. (2014), which had the highest impact in the literature with a burst power of 24.49 between 2015 and 2019. The research by Grigoryan et al. (2014) revealed that orthogeriatric care models applied to hip fracture patients significantly reduced both in-hospital and long-term mortality; this finding was one of the main reasons the publication achieved broad academic impact in a short time [18].

4. DISCUSSION

Recent bibliometric analyses show that hip fracture research has diversified far beyond traditional surgical topics. Instead, researchers are increasingly focusing on patient-centered aspects such as individualized risk classification, functional recovery, and overall health status [1,19]. For example, frailty indices, comorbidities, and nutritional status are being examined as important predictors of outcomes alongside surgical factors [20]. This reflects a growing consensus that effective hip fracture treatment requires not only technical surgical expertise but also an interdisciplinary approach involving orthopaedics, geriatrics, rehabilitation, and nutrition [21,22].

A prominent topic is the use of predictive nomograms and other risk models to guide treatment. Nomogram tools incorporate multiple patient variables (age, laboratory values, comorbidities, etc.) into a single score to predict outcomes such as postoperative mortality or complications. Recent studies have developed and validated hip fracture nomograms, demonstrating that they can accurately classify patients into low-, intermediate-, and high-risk groups. The increasing adoption of these models indicates that clinicians are turning to data-driven, personalized decision support tools. In fact, several studies have noted that “a growing number of researchers and policymakers are tending to rely on prediction models” and that nomograms have become a “reliable tool for creating a simple and intuitive graph” that shows a patient's risk. This trend highlights the shift towards precision medicine in hip fracture treatment and enables more personalized treatment planning for the elderly [23,24].

The Barthel Index (BI), a standard measure of basic activities of daily living, has been shown to predict survival after hip fracture. For example, in a study involving 444 patients, those with a high BI score (≥50) at discharge had a significantly lower one-year mortality rate [19]. This highlights that

physical function at discharge is directly related to long-term prognosis. Malnutrition is also now quite common in elderly hip fracture patients and is associated with poorer outcomes. A low preoperative Prognostic Nutritional Index reflecting low albumin and lymphocyte levels, predicts a higher risk of postoperative delirium, complications, and long-term dependency [25,26]. In response, experts recommend routine nutritional screening and supplementation. For example, perioperative care should include protein and vitamin D supplementation, as well as personalized nutrition plans, to accelerate recovery. These findings emphasize that adequate physiological reserves and nutritional optimization are crucial not only for the surgical repair itself but also for rehabilitation [19].

Osteoporosis and related metabolic factors continue to occupy a central place in the literature. It is well known that osteoporosis is a significant risk factor for hip fractures [27]. Consequently, fracture prevention strategies emphasize bone health through screening, pharmacotherapy and fall prevention programs. Vitamin D supplementation is often included in these preventive measures to increase bone mineral density. Furthermore, metabolic diseases are increasingly being studied: for example, diabetes is known to increase fracture risk significantly. Meta-analyses show that diabetes increases the overall fracture risk by 20-300% and is particularly associated with hip fractures [19]. The emergence of distinct “diabetes” and “metabolic” clusters in bibliometric maps reflects growing awareness that systemic disorders (e.g., type 1 diabetes and thyroid disease) can affect bone strength. In summary, this research demonstrates that managing osteoporosis, correcting vitamin D deficiency, and controlling metabolic comorbidities are essential for preventing hip fractures and improving bone health.

Classic topics such as hemiarthroplasty and femoral neck fracture fixation remain important, underscoring that arthroplasty is generally the “gold standard” for displaced hip fractures in the elderly. However, even surgical research has addressed systemic issues. A notable example is the COVID-19 pandemic, which has become a separate subject of study. Analyses have revealed that outcomes for hip fracture patients treated during the pandemic were significantly worse. A recent meta-analysis reported approximately 10% excess mortality for hip fractures during COVID-19 (rate ≈2.0 compared to pre-pandemic controls) [28]. Critically, the 30-day mortality rate for hip fracture patients also infected with SARS-CoV-2 was ~38%, which was approximately four times higher than for non-COVID patients [28]. These studies attribute such excess deaths to delayed surgeries, overburdened hospitals, and overlapping risk profiles. Thus, pandemic-era research has exposed weaknesses in the healthcare system's care for this vulnerable population. This underscores the importance of healthcare capacity and process optimization (e.g., hip fracture treatment pathways and shared management models) even in surgical care [29].

NOREPOS and CHANCES are two major multi-center cohort collaborations that have significantly shaped the scientific literature on hip fractures. In our study, these initiatives stand out as distinct research clusters, characterized by comprehensive, coordinated outputs and strong internal networks. NOREPOS (Norwegian Epidemiological Osteoporosis Studies) is a national research collaboration linking five major institutions across Norway. Since 1997, it has combined epidemiological studies of osteoporosis to create large population-based datasets and a comprehensive hip fracture database [30]. CHANCES (Health and Aging Consortium: Cohort Network in Europe and the United States) was an international consortium of 16 partner organizations that integrated cohort data from Europe and the US to investigate ageing-related outcomes [31]. NOREPOS studies provide a comprehensive framework for why hip fracture incidence in Norway is among the highest in the world. The consortium systematically documented hip fracture risk factors [32], thoroughly examining geographical differences and environmental factors [33]. These findings reveal that fracture dynamics across the country are determined not only by biomedical factors but also by environmental and sociodemographic factors, contributing to a more comprehensive understanding of hip fracture epidemiology.

5. Conclusions

In conclusion, this scientific analysis highlights the expanding scope and multidimensional nature of hip fracture research. It reveals a shift from traditional surgery-focused approaches toward personalized, multidisciplinary, and preventive approaches. The importance of nomogram-based prognostic models, nutritional indices, and geriatrics-focused themes demonstrates the increasing emphasis on individualized risk classification and functional recovery. International collaborative cohorts such as NOREPOS and CHANCES have emerged as effective research clusters, providing robust data infrastructures that shed light on regional

inequalities, environmental exposures, and socioeconomic determinants of fracture risk. The success of these clusters demonstrates how large-scale, harmonized datasets can contribute to both scientific discovery and public health planning. For countries like Türkiye, facing rapid population aging and high osteoporosis prevalence, there is an opportune moment to establish or join similar research networks by integrating national data into global efforts to improve fracture prevention, care, and policies. These emerging research trends require a comprehensive, forward-looking framework for hip fracture management that is data-driven, patient-centered, and internationally collaborative. Also, it is recommended that studies be conducted to determine the cost-effectiveness of surgical methods for hip fractures in the elderly and their economic burden on healthcare systems.

Acknowledgement

This study was presented orally at the 8th International and 18th National Health and Hospital Management Congress on October 9–11, 2025. I would like to thank all the organizers and participants who contributed to the congress for their scientific support and constructive feedback.

Conflict of Interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Ethics Committee

This study does not require ethical committee approval as it does not involve any human or animal experiments. All stages of the research were conducted in accordance with the principles of the Declaration of Helsinki.

Author Contributions

Study Design, GK, YA; Data Collection, GK, Statistical Analysis, GK, Data Interpretation, GK, YA; Manuscript Preparation, GK, YA; Literature Search, GK, YA. All authors have read and agreed to the published version of the manuscript.

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