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REVIEW

# Trends of Low Back Pain Research in Older and Working-Age Adults from 1993 to 2023: A Bibliometric Analysis

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**Abstract:** Although the number of publications focusing on low back pain in older adults (LBP-O) and working-age adults (LBP-W) has been growing for decades, comparative research trends in these two populations, which may help to guide future investigation, have not been rigorously explored. This analysis aimed to describe publication patterns and trends of research targeting LBP-O and LBP-W over the last three decades. Peer-reviewed LBP-O and LBP-W articles published between 1993 and 2023 were retrieved from the Web of Science, which provided the details of annual publication volume, and prominent journals/countries/institutions. The relationship between the annual publication volumes and years was analyzed by Spearman correlation analysis. The hot topics and emerging trends were analyzed by VOSviewer and CiteSpace, respectively. A total of 4217 LBP-O-related and 50,559 LBP-W-related documents were included. The annual publication volumes of LBP-O and LBP-W articles increased over the years ($r$=0.995 to 0.998, $p$<0.001). The United States had the highest number of prominent institutions publishing relevant articles. The most prolific journal for LBP-O (5.4%) and LBP-W-related (6.1%) papers is the journal "Spine". Cognitive behavioral therapy, intervertebral disc (IVD) degeneration, physiotherapy, physical activity, and walking were the recent hot topics and physical activity was an emerging trend in LBP-O, while surgery and IVD degeneration (also a hot topic) were emerging trends in LBP-W. This study highlights the paucity of LBP-O-related research in the past. The United States and the journal *Spine* stand out in LBP research. The research trend of physical activity in LBP-O is consistent with the recognized importance of physical activity for older adults in general, and for managing LBP-O in particular. Conversely, the emerging trends of surgery and intervertebral disc degeneration in LBP-W research highlight a focus on the biomedical model of LBP despite LBP being a biopsychosocial condition.

**Keywords:** low back pain, older adults, working-age adults, bibliometrics, intervertebral disc degeneration, physical activity, surgery

## Introduction

Low back pain (LBP) is one of the most common biopsychosocial problems in high- and low-income countries.[1,2] It is the main cause of years lived with disability at all ages.[3] The reported prevalence of LBP in working-age adults (LBP-W) aged 18–64 years is between 4.2% and 19.6%, whereas that in older adults (LBP-O) aged ≥65 years is up to 36.1%, although this varies across countries, cultures, and races.[4–7] While LBP-W is the fourth largest productivity burden for the United States, LBP-O is the third leading cause of chronic disability in Canada.[3,8]

Given the high prevalence and negative impacts of LBP, numerous LBP-related clinical studies have been conducted. However, recent systematic reviews reveal a lack of research specifically on LBP-O. Paeck et al[3] and Levy et al[9] found

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that up to 53% of randomized clinical trials excluded adults aged 65 years and older. Many clinicians assume that findings from LBP-W studies can be generalized to LBP-O.[3] Because older adults have a greater burden of physical and cognitive comorbidities than working-age adults, they may respond differently to medications, surgery, exercise, and other forms of interventions, thus an effective treatment for LBP-W may not be equally effective for LBP-O.[10] Therefore, clinical trials should include an adequate number of LBP-O and LBP-W to afford meaningful subgroup analyses, although this rarely has been the case.

Several notable research trends and characteristics have been noted in the LBP-W literature. For example, Modic changes, intervertebral disc (IVD) degeneration, and paraspinal muscles have become common research focuses in LBP-W.[4,11–13] Further, given the relatively small or no effects of some pain medications (eg, nonsteroidal anti-inflammatory drugs[14] or paracetamol[15]), recent research has been conducted to quantify the effects of using exercises to treat LBP-W.[16,17] However, whether similar research trends occur in LBP-O remains unclear. Some potential old age-related topics, such as physical inactivity, and cognitive decline have seldom been highlighted.[18–20]

Bibliometric analysis is a quantitative and pragmatic approach to visualize the publication patterns and trends in a given field. It can identify the leading journals, countries, institutions, and research foci.[21–23] CiteSpace and VOSviewer are freely available tools for bibliometric analysis. Web of Science (WoS), a multidisciplinary platform encompassing different categories of scientific knowledge,[24,25] is considered as the preferred bibliographic source for bibliometric analysis.[22,26] Huang et al[25] and Guo et al[27] also conducted bibliometric analyses using records from WoS to analyze the research trends of LBP from 2000 to 2022, and the evolution of LBP-W-related publications between 2000 and 2020, respectively. However, they were limited by no direct comparisons of publication trends between LBP-O and LBP-W research, which may inform knowledge gaps in both fields.

Against this background, comprehensive investigations of research trends in LBP-O and LBP-W fields are warranted to summarize previous research foci, as well as to inform future research priorities and allocations of research resources to key LBP-related research areas. Importantly, the current bibliometric analysis can foster collaborations among researchers and provide information regarding relevant LBP-related journals. This study aimed to: (1) reveal the publication characteristics of LBP-O and LBP-W-related articles since 1993; (2) compare the research topics; and (3) identify potential emerging trends.

# Materials and Methods

## Literature Search and Retrieval

Two researchers (KZ and AW) and two experienced research librarians (LD and JB) developed the search strategy (Supplementary Material 1). The search was conducted in the Web of Science (WoS) Core Collection (Figure 1). The keywords and medical subject headings included LBP, working-age adults, and older adults. As CiteSpace only allows bibliometric analysis over a 31-year period, the search was conducted from January 1, 1993, to May 14, 2023. Using the "Article and Review" filter,[22] relevant papers were identified for inclusion because they were peer-reviewed and could be considered "certified knowledge", enhancing the results credibility. The full record and cited references of the search results were downloaded in a plain text format. LBP-O and LBP-W papers were searched and analyzed separately.

## Data Processing

The relevant information of the included articles (eg, journals, countries, institutions, and keywords) and their statistics (eg, number of included papers, total number of citations, average citations per paper, journal impact factor (IF)) were extracted by an independent researcher (KZ) from WoS. This was followed by a verification process involving the corresponding author (AW) and obtaining the agreement from all co-authors. Based on the number of included papers, the most prolific journals, countries, and institutions were identified.[28] For the comparisons of countries and institutions, all authors in the included publications were taken into account. The annual publication volumes were plotted against time using an Excel program. SPSS version 23.0 software (SPSS Inc., Chicago, IL, USA) was used to measure the strength and direction of the association between the annual publication volumes and years by Spearman correlation analysis with correlation coefficient ($r$) (where 0.8–1.0, 0.6–0.8, 0.4–0.6, 0.2–0.4, and 0.0–0.2 mean very strong, strong,

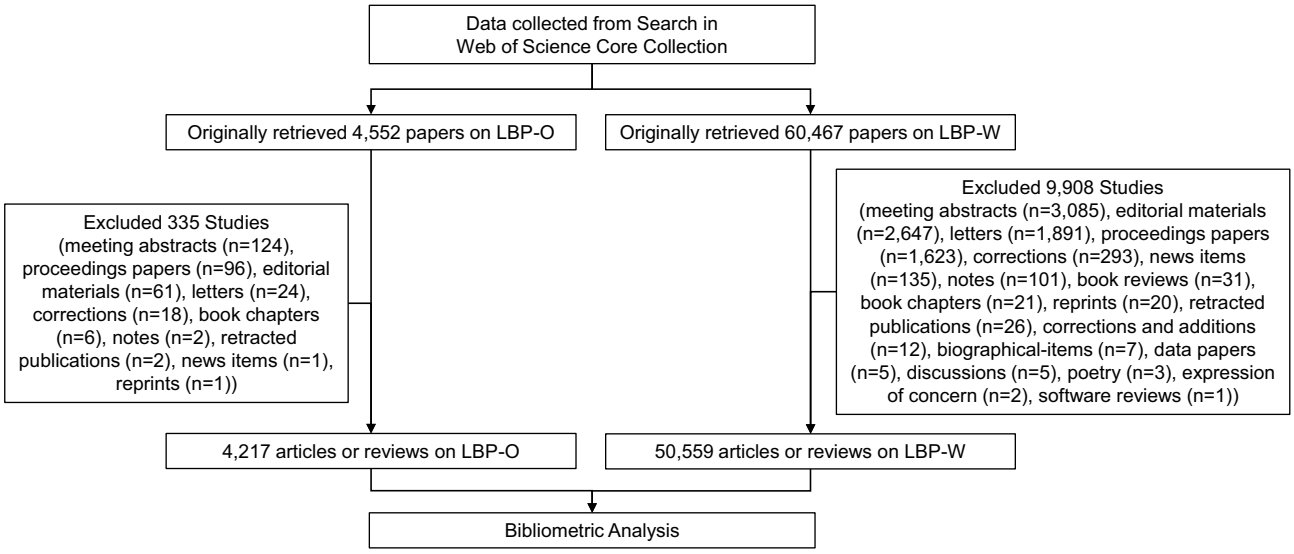


**Figure 1** Literature retrieval flow chart.
**Abbreviations**: LBP-O, low back pain in older adults; LBP-W, low back pain in working-age adults.

moderate, weak, and no to very weak correlation, respectively).[29] The annual publication trends for each population were evaluated and fitted a variation curve using local polynomial regression (locally estimated scatterplot smoothing, LOESS) with R (version 4.3.0).[28] The number of citations may indicate the impact of a given paper, while the average citations per paper measures the average impact of its authors.[30] Higher citation counts implied that an author's scientific works were more acknowledged by his/her peers, although outcome measure-related papers or reviews are more likely to be cited. Additionally, the journal's IF was calculated based on the latest edition of the Journal Citation Reports. IF was regarded as an indicator of the academic influence of a scientific journal. The analysis of journals, countries and institutions can help researchers to select journals for future submissions and promote international collaboration.

The search results were further analyzed by VOSviewer (version 1.6.19, Universiteit Leiden) and CiteSpace (version 6.2.2, Drexel University). Specifically, VOSviewer was used to count the frequency of keywords and to determine the average publication year in which a keyword or a term occurs or the average publication year of the documents published by a source (eg, a country). CiteSpace was applied to identify keywords with co-occurrence burst, which implies an explosive increase of co-occurrence frequency of keywords in a certain period of time.[31] Co-occurrence burst has two characteristics, namely strength and duration, which indicate that researchers pay more attention to a specific research work or topic over a particular time period. Compared to keywords with the latest average publication year, latest burst keywords have stronger timeliness. The keywords with the strongest co-occurrence burst lasting until 2023 represent potential emerging trends.[28]

# Results

The search resulted in 4217 LBP-O-related and 50,559 LBP-W-related articles for the bibliometric analysis.

## Chronological Changes in Publications

The chronological distributions of papers are plotted in Figure 2, where a geometric growth could be clearly observed for both LBP-O and LBP-W. The cumulative number of LBP-O-related papers was 4217, which was only 8.3% of that of LBP-W-related papers. The annual publication volume of LBP-O-related papers started to grow rapidly in the past decade and reached its highest volume (383 papers) in 2022, averaging 136 papers per year. Likewise, the annual number of LBP-W-related articles was 290 in 1993, and it increased by around 14 times (4105 papers) in 2021, averaging 1631 papers per year. There were very strong correlations between years and annual publication volume in both fields from 1993 to 2022 ($r$ of LBP-O and LBP-W were 0.995 and 0.998, respectively).

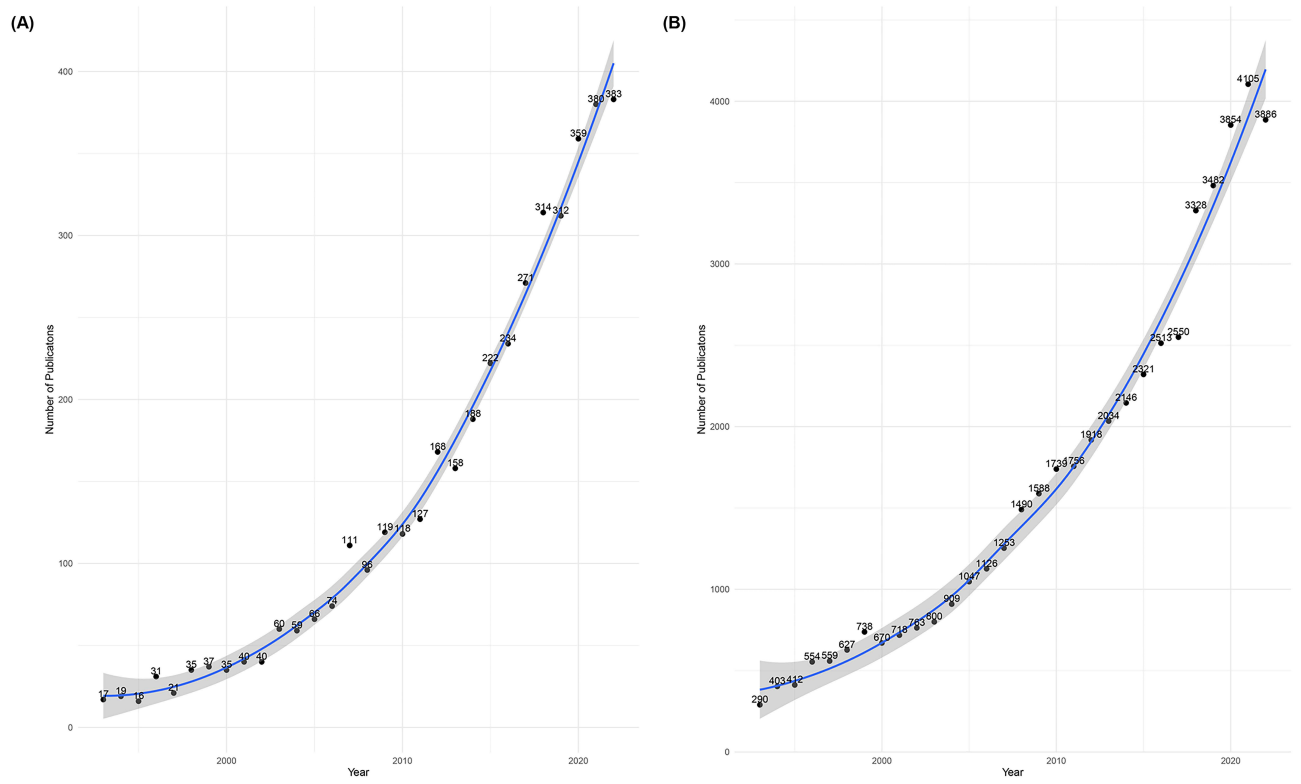


**Figure 2** Yearly publication trends. (**A**) The yearly publication trend regarding low back pain in older adults; (**B**) The yearly publication trends concerning low back pain in working-age adults.
**Notes**: The gray area represents the 95% confidence interval. For the lack of full-year data and a better fitted curve, data for 2023 (107 for low back pain in older adults and 980 for low back pain in working-age adults) are not shown in this figure.

## Comparisons of Journals

A total of 996 journals published LBP-O-related papers, whereas 3571 journals published LBP-W-related papers. Of the top 10 prolific journals (Table 1), *Spine* published the greatest volume of LBP-O and LBP-W-related papers, accounting for 5.4% (228 publications) and 6.1% (3066 publications), respectively. Ranked Quartile 1 in the Anesthesiology, Clinical Neurology, and Neurosciences categories, *Pain* was the journal with the highest IF (7.4) in the top 10 list of LBP-O research, followed by The *Spine Journal* (IF = 4.5) and *PLOS One* (IF = 3.7). The IFs of the top 10 prolific journals for LBP-W research were very similar, ranging from 1.3 to 7.4.

## Comparisons Across Countries

Figure 3 shows that a total of 90 and 157 countries contributed to LBP-O- and LBP-W-related publications indexed in WoS in the last three decades, respectively. Many countries in Asia and Africa were not involved in the LBP-O research. Compared to LBP-O-related research, LBP-W-related research was conducted more globally, but half of African countries were still not involved. Among the top 10 countries in Table 2, the United States published the highest paper volume, while researchers in the Netherlands had the highest average citations per paper in both fields. Although China and the UK had similar numbers of papers in the second and third place in both fields, respectively, the UK had nearly three times more total citations and average citations than China. The average publication years of British LBP-O- and LBP-W-related studies were 2014 and 2012, respectively, while the average publication year of articles from China in both fields was 2018.

## Comparisons of Institutions

Our analysis identified 4213 and 25,058 institutions contributing to LBP-O- and LBP-W-related research, respectively. Of the top 10 productive institutions for LBP-O-related research, University of California was the most active institution

**Table 1** Top 10 Prolific Journals from 1993 to 2023

| Rank | Low Back Pain in Older Adults | | | | | Low Back Pain in Working-Age Adults | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Journal | Papers (%) | IF 2022[a] | 5-Year IF[b] | WoS Categories (Q)[c] | Journal | Papers (%) | IF 2022[a] | 5-Year IF[b] | WoS Categories (Q)[c] |
| 1 | *Spine* | 228 (5.4) | 3 | 3.5 | Clinical Neurology (3); Orthopedics (2) | *Spine* | 3066 (6.1) | 3 | 3.5 | Clinical Neurology (3); Orthopedics (2) |
| 2 | *Pain Medicine* | 125 (3.0) | 3.1 | 3.4 | Anesthesiology (2); Medicine, General & Internal (2) | *European Spine Journal* | 1435 (2.8) | 2.8 | 3.2 | Clinical Neurology (3); Orthopedics (2) |
| 3 | *European Spine Journal* | 105 (2.5) | 2.8 | 3.2 | Clinical Neurology (3); Orthopedics (2) | *BMC Musculoskeletal Disorders* | 1016 (2.0) | 2.3 | 2.8 | Orthopedics (2); Rheumatology (4) |
| 4 | *BMC Musculoskeletal Disorders* | 93 (2.2) | 2.3 | 2.8 | Orthopedics (2); Rheumatology (4) | *Pain* | 911 (1.8) | 7.4 | 7.7 | Anesthesiology (1); Clinical Neurology (1); Neurosciences (1) |
| 5 | *Pain* | 81 (1.9) | 7.4 | 7.7 | Anesthesiology (1); Clinical Neurology (1); Neurosciences (1) | *Spine Journal* | 760 (1.5) | 4.5 | 4.6 | Clinical Neurology (2); Orthopedics (1) |
| 6 | *Spine Journal* | 75 (1.8) | 4.5 | 4.6 | Clinical Neurology (2); Orthopedics (1) | *Pain Medicine* | 684 (1.4) | 3.1 | 3.4 | Anesthesiology (2); Medicine, General & Internal (2) |
| 7 | *Clinical Journal of Pain* | 55 (1.3) | 2.9 | 3.8 | Anesthesiology (2); Clinical Neurology (3) | *Clinical Journal of Pain* | 644 (1.3) | 2.9 | 3.8 | Anesthesiology (2); Clinical Neurology (3) |
| 8 | *Osteoporosis International* | 48 (1.1) | 4 | 4.6 | Endocrinology & Metabolism (2) | *Journal of Manipulative and Physiological Therapeutics* | 640 (1.3) | 1.3 | 1.8 | Health Care Sciences & Services (4) Integrative & Complementary Medicine (4); Rehabilitation (4) |
| 9 | *PLOS One* | 47 (1.1) | 3.7 | 3.8 | Multidisciplinary Sciences (2) | *Journal of Back and Musculoskeletal Rehabilitation* | 545 (1.1) | 1.6 | 1.7 | Orthopedics (3); Rehabilitation (3) |
| 10 | *Journal of Manipulative and Physiological Therapeutics* | 45 (1.1) | 1.3 | 1.8 | Health Care Sciences & Services (4) Integrative & Complementary Medicine (4); Rehabilitation (4) | *Pain Physician* | 522 (1.0) | 3.7 | 3.9 | Anesthesiology (2); Clinical Neurology (2) |

**Notes**: [a,b]IF and [c]Q in category according to Journal Citation Reports ™ 2022.
**Abbreviations**: [a]IF, impact factor; [b]5-year, 2018–2022; [c]Q, quartile.


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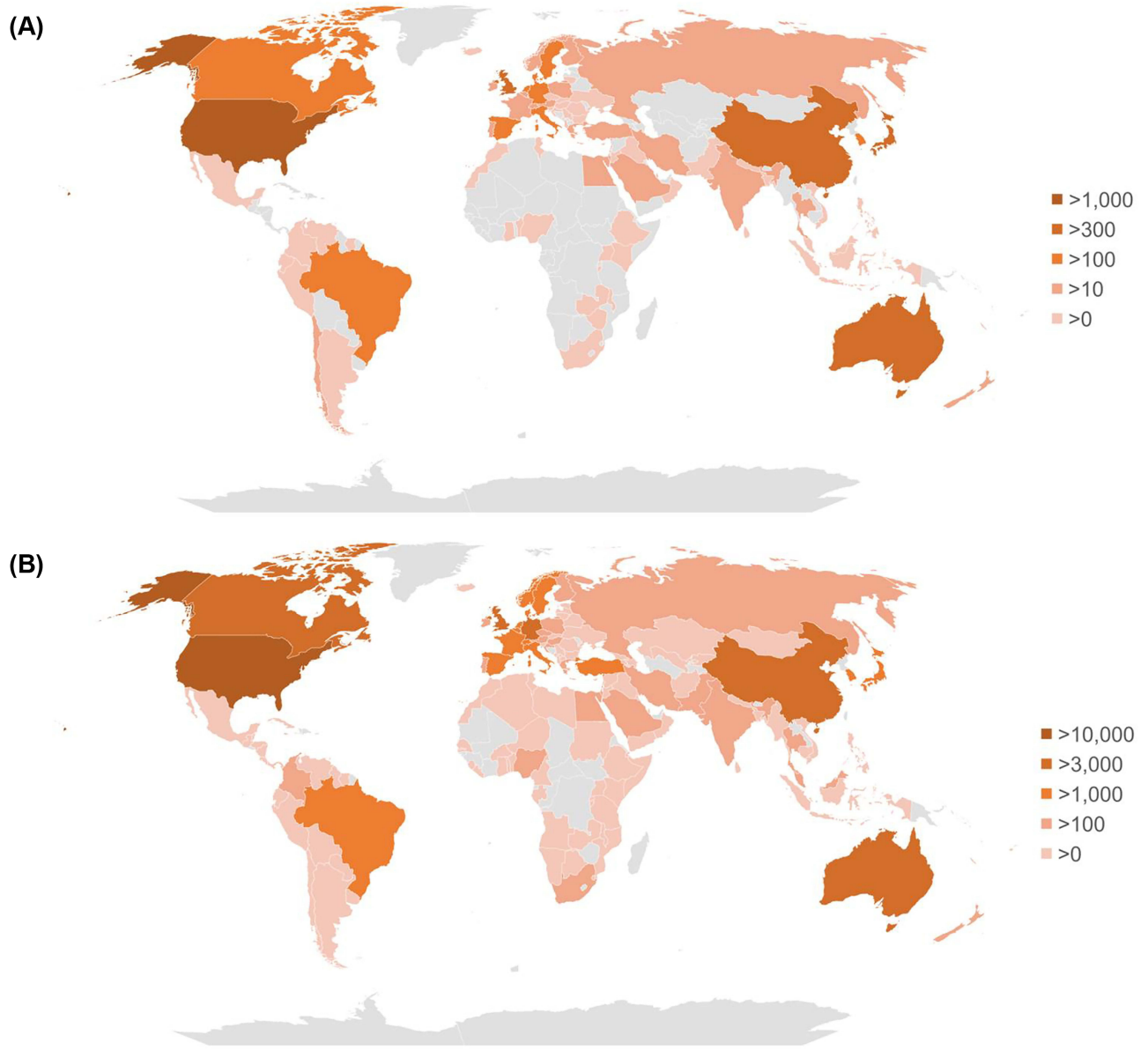


**Figure 3** Distribution of countries/territories. (**A**) Distribution of countries/territories based on the accumulative number of publications concerning low back pain in older adults from 1993 to 2023; (**B**) Distribution of countries/territories based on the accumulative number of publications concerning low back pain in working-age adults from 1993 to 2023.

**Notes**: Papers from Hong Kong, Macau and Taiwan were reclassified to China, although Taiwan was not highlighted in the figure because of flaws in the mapping software; papers from England, Scotland, North Ireland, and Wales were reclassified to the UK.

with 157 papers and approximately 62 citations per paper (Table 3). In the LBP-W-related field, Harvard University was ranked number one with 1248 relevant papers, while the University of Washington had the highest average citations per paper (800 papers with approximately 91 citations per paper).

## Analyses of Keywords

Table 4 shows the 20 most common keywords. Papers dealing with surgery were more common in LBP-O-related field (7.4%) than in LBP-W-related field (5.2%), as were osteoarthritis (7.1% in LBP-O, 2.6% in LBP-W) and spinal stenosis (7.1% in LBP-O, 3.5% in LBP-W). Figure 4 presents the time-based keyword analysis by average publication year, where the colors of keywords evolve from purple to yellow, indicating changes in hot topics over time. Cognitive-behavioral therapy, intervertebral disc (IVD) degeneration, physiotherapy, physical activity, and walking were the recent

**Table 2** Top 10 Prolific Countries from 1993 to 2023

| Rank | Low Back Pain in Older Adults | | | | | Low Back Pain in Working-Age Adults | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Country | Papers (%) | Citations (WoS)[a] | Citations Per Paper | Average Publication Year | Country | Papers (%) | Citations (WoS)[a] | Citations Per Paper | Average Publication Year |
| 1 | USA | 1522 (36.1) | 59,006 | 38.77 | 2013 | USA | 15,348 (30.4) | 609,476 | 39.71 | 2012 |
| 2 | China | 464 (11.0) | 6975 | 15.03 | 2018 | China | 4747 (9.4) | 71,865 | 15.14 | 2018 |
| 3 | UK | 375 (8.9) | 18,763 | 50.03 | 2014 | UK | 4701 (9.3) | 219,361 | 46.66 | 2012 |
| 4 | Japan | 344 (8.2) | 7252 | 21.08 | 2015 | Canada | 3940 (7.8) | 178,660 | 45.35 | 2012 |
| 5 | Australia | 303 (7.2) | 10,455 | 34.5 | 2016 | Australia | 3820 (7.6) | 156,418 | 40.95 | 2014 |
| 6 | Germany | 274 (6.5) | 8031 | 29.31 | 2013 | Germany | 3714 (7.3) | 110,639 | 29.79 | 2013 |
| 7 | Canada | 243 (5.8) | 9901 | 40.74 | 2014 | Netherlands | 2882 (5.7) | 158,089 | 54.85 | 2012 |
| 8 | South Korea | 163 (3.9) | 2215 | 13.59 | 2016 | Japan | 2012 (4.0) | 39,521 | 19.64 | 2014 |
| 9 | Netherlands | 134 (3.2) | 6864 | 51.22 | 2014 | Sweden | 1869 (3.7) | 82,339 | 44.06 | 2011 |
| 10 | Sweden | 131 (3.1) | 3698 | 28.23 | 2014 | South Korea | 1785 (3.5) | 26,338 | 14.76 | 2015 |

**Notes**: Papers from Hong Kong, Macau and Taiwan were reclassified to China; papers from England, Scotland, North Ireland, and Wales were reclassified to the UK.
**Abbreviation**: [a]WoS, Web of Science.


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**Table 3** Top 10 Prolific Institutions from 1993 to 2023

| Rank | Low Back Pain in Older Adults | | | | | Low Back Pain in Working-Age Adults | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Institution | Country | Papers (%) | Citations (WoS)[a] | Citations Per Paper | Institution | Country | Papers (%) | Citations (WoS)[a] | Citations Per Paper |
| 1 | University of California | USA | 157 (3.7) | 9716 | 61.89 | Harvard University | USA | 1248 (2.5) | 70,583 | 56.56 |
| 2 | Harvard University | USA | 139 (3.3) | 6624 | 47.65 | The University of Sydney | Australia | 1124 (2.2) | 59,387 | 52.84 |
| 3 | University of Pittsburgh | USA | 139 (3.3) | 7438 | 53.51 | University of California | USA | 1088 (2.2) | 53,428 | 49.11 |
| 4 | The University of Sydney | Australia | 120 (2.8) | 4637 | 38.64 | Vrije Universiteit Amsterdam | Netherlands | 940 (1.9) | 60,251 | 64.1 |
| 5 | University of Washington | USA | 117 (2.8) | 6934 | 59.26 | University of Washington | USA | 800 (1.6) | 73,105 | 91.38 |
| 6 | Duke University | USA | 75 (1.8) | 2477 | 33.03 | University of Toronto | Canada | 796 (1.6) | 53,896 | 67.71 |
| 7 | Keele University | UK | 65 (1.5) | 2454 | 37.75 | University of London | UK | 719 (1.4) | 35,287 | 49.08 |
| 8 | University of Southern Denmark | Denmark | 65 (1.5) | 3124 | 48.06 | Karolinska Institutet | Sweden | 652 (1.3) | 24,141 | 37.03 |
| 9 | University of London | UK | 64 (1.5) | 2427 | 37.92 | The University of Queensland | Australia | 645 (1.3) | 40,225 | 62.36 |
| 10 | University of Toronto | Canada | 62 (1.5) | 2637 | 42.53 | Maastricht University | Netherlands | 622 (1.2) | 47,948 | 77.09 |

**Abbreviation**: [a]WoS, Web of Science.

**Table 4** The Top 20 Keywords Ranked by Frequency from 1993 to 2023

| Rank | Low Back Pain in Older Adults | | Low Back Pain in Working-Age Adults | |
|---|---|---|---|---|
| | Keyword | Co-Occurrences (%) | Keyword | Co-Occurrences (%) |
| 1 | Low-back-pain | 1578 (37.4) | Low-back-pain | 20,196 (40.0) |
| 2 | Older-adults | 796 (18.9) | Low back pain | 8239 (16.3) |
| 3 | Prevalence | 638 (15.1) | Disability | 5215 (10.3) |
| 4 | Back-pain | 544 (12.9) | Management | 4633 (9.2) |
| 5 | Disability | 544 (12.9) | Back-pain | 4509 (8.9) |
| 6 | Low back pain | 528 (12.5) | Prevalence | 4311 (8.5) |
| 7 | Management | 407 (9.7) | Spine | 3522 (7.0) |
| 8 | Pain | 382 (9.1) | Pain | 3472 (6.9) |
| 9 | Health | 359 (8.5) | Back pain | 3188 (6.3) |
| 10 | Quality-of-life | 347 (8.2) | Reliability | 3102 (6.1) |
| 11 | Risk-factors | 313 (7.4) | Lumbar spine | 3063 (6.1) |
| 12 | Surgery | 312 (7.4) | Chronic pain | 3011 (6.0) |
| 13 | Osteoarthritis | 301 (7.1) | Risk-factors | 2912 (5.8) |
| 14 | Spinal stenosis | 296 (7.0) | Surgery | 2609 (5.2) |
| 15 | Chronic pain | 291 (6.9) | Outcomes | 2593 (5.1) |
| 16 | Back pain | 284 (6.7) | Rehabilitation | 2377 (4.7) |
| 17 | Outcomes | 264 (6.3) | Questionnaire | 2146 (4.2) |
| 18 | Elderly | 263 (6.2) | Health | 2075 (4.1) |
| 19 | Exercise | 262 (6.2) | Follow-up | 2068 (4.1) |
| 20 | Population | 253 (6.0) | Therapy | 1967 (3.9) |

hot topics with the latest average publication year in the LBP-O-related field (Figure 4A). For LBP-W, IVD degeneration and nucleus pulposus cells were the recent hot topics (Figure 4B). In the LBP-O-related field, some recent burst keywords (ie, lumbar spinal stenosis, and physical activity) were expected to be used more frequently in the coming years, which signified potential emerging trends, while "surgery" was a burst keyword during 1993–2005 and 2007–2010 (Table 5). For the LBP-W-related field, some recent burst keywords, such as surgery and IVD degeneration, signified potential emerging trends (Table 6).

## Discussion

This is the first bibliometric analysis to comprehensively map LBP research over the past 3 decades and compare the similarities and differences in the development of LBP-O- and LBP-W-related research. Compared to LBP-W, LBP-O has not been prioritized, which does not reflect the demographic development. The number of journals, countries, and institutions dedicated to the LBP-O-related field was far less than that to the LBP-W-related field. Moreover, the research focuses of LBP-O-related studies differed from those of LBP-W-related research.

The analysis of temporal publication distribution revealed similar increasing annual trends in both fields, with pronounced escalations in the annual publication output after 1993. These surges might be attributed to the publications of many seminal studies after 1990, which laid the conceptual and methodological foundation for clinicians and researchers to develop.[32,33] For example, Boden et al identified surgical indications (eg, herniated nucleus pulposus, spinal stenosis) in people without symptoms of LBP, sciatica, or neurogenic claudication, and concluded that imaging abnormalities had to be clearly associated with symptoms before surgery;[34] Jensen et al linked LBP to disc pathology and concluded that bulges or protrusions in patients with LBP may often be coincidental.[35] The disproportionally small number of LBP-O-related studies mirrors the relative lack of clinical interest in managing LBP-O, possibly due to the high prevalence but lack of understanding of its severity and burden, increased comorbidities, and/or lack of funding opportunities.[3,10,36] Furthermore, it may be partly attributed to the fact that Geriatric Medicine is a relatively young field that arose out of a need rather than a unique body of knowledge. Thus, related research is also relatively new as

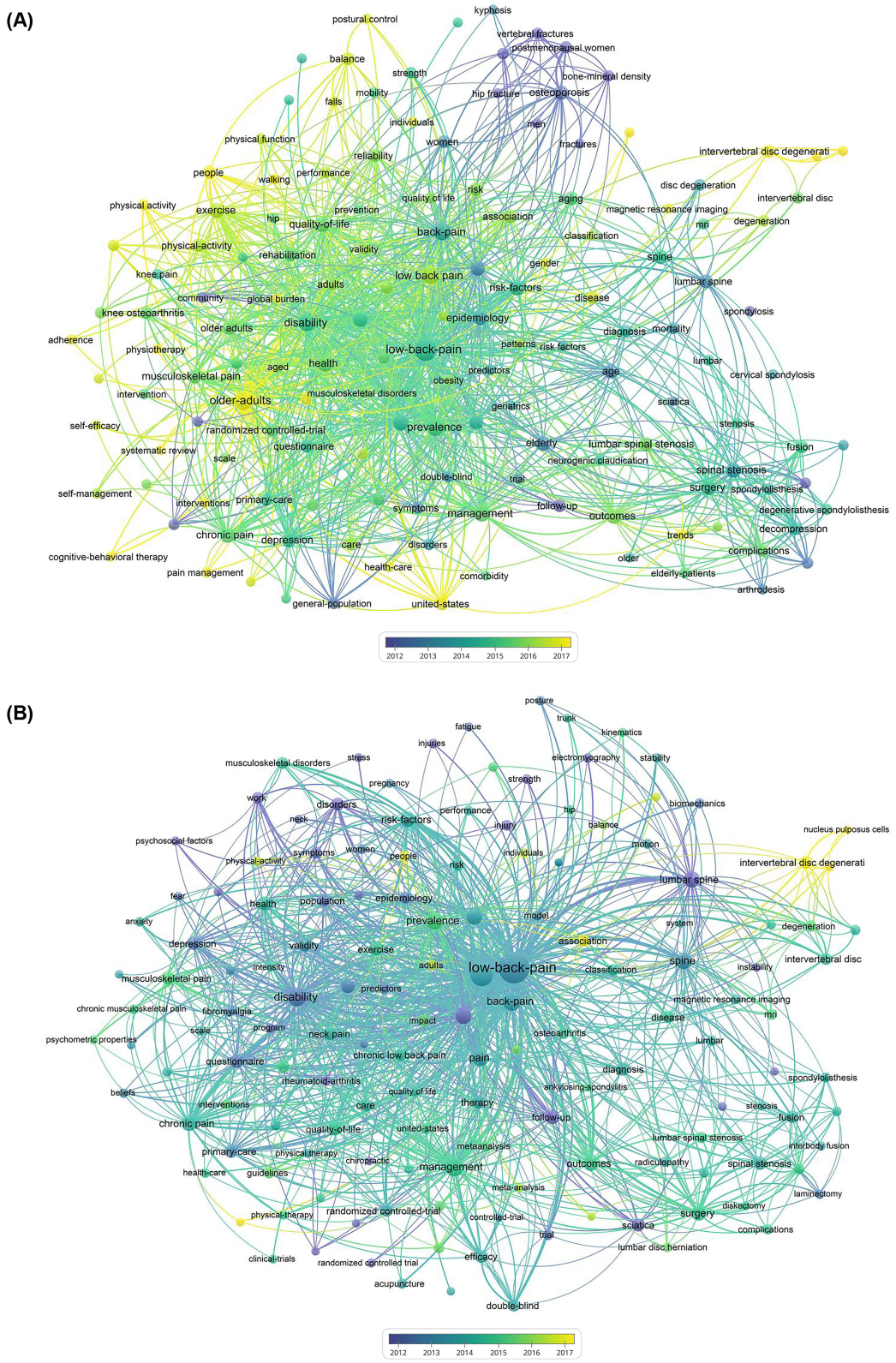


**Figure 4** Evolution of keywords based on the average publication year. For studies involving: (**A**) low back pain in older adults; and (**B**) low back pain in working-age adults.
**Notes**: The year here represents the average publication year, that is, the average year of the articles related to the keywords.

**Table 5** Keywords with the Strongest Co-Occurrence Burst on Low Back Pain in Older Adults from 1993 to 2023

| Keywords | Year | Strength | Begin | End | 1993–2023 |
|---|---|---|---|---|---|
| Surgical treatment | 1993 | 7.22 | 1993 | 2005 | |
| Osteoporosis | 1994 | 12.28 | 1994 | 2005 | |
| Symptoms | 1995 | 8.36 | 1995 | 2009 | |
| Epidemiology | 1995 | 6.19 | 1995 | 2004 | |
| Disorders | 1995 | 4.58 | 1995 | 1999 | |
| General population | 1996 | 8.93 | 1996 | 2008 | |
| Decompression | 1996 | 8.84 | 1996 | 2010 | |
| Bone mineral density | 1997 | 18.65 | 1997 | 2008 | |
| Vertebral fractures | 1997 | 10.85 | 1997 | 2005 | |
| Diagnosis | 1997 | 7.69 | 1997 | 2004 | |
| Laminectomy | 1997 | 6.5 | 1997 | 2004 | |
| Deformity | 1998 | 9.25 | 1998 | 2005 | |
| Rheumatoid arthritis | 1998 | 8.67 | 1998 | 2008 | |
| Nursing home | 1998 | 5.04 | 1998 | 2002 | |
| Spondylolisthesis | 1998 | 4.91 | 1998 | 2003 | |
| Community | 2000 | 7.75 | 2000 | 2007 | |
| Disc degeneration | 2000 | 6.04 | 2000 | 2009 | |
| Compression | 2000 | 4.33 | 2000 | 2004 | |
| Fusion | 2001 | 4.65 | 2001 | 2002 | |
| Postmenopausal women | 2002 | 16.14 | 2002 | 2011 | |
| Lumbar spine | 1996 | 22.17 | 2003 | 2014 | |
| Validity | 2004 | 6.12 | 2004 | 2007 | |
| Spinal stenosis | 1993 | 3.9 | 2006 | 2008 | |
| Surgery | 1997 | 5.97 | 2007 | 2010 | |
| Arthrodesis | 2008 | 8.65 | 2008 | 2010 | |
| Primary care | 2000 | 24.7 | 2011 | 2016 | |
| Questionnaire | 2000 | 8.71 | 2011 | 2012 | |
| Depression | 1995 | 11.92 | 2012 | 2013 | |
| Osteoarthritis | 2001 | 4.7 | 2013 | 2014 | |
| Chronic pain | 1995 | 7.78 | 2015 | 2016 | |
| Risk | 2000 | 28.06 | 2019 | 2021 | |
| **Lumbar spinal stenosis** | **1993** | **15.05** | **2019** | **2023** | |
| Reliability | 1998 | 16.53 | 2020 | 2021 | |
| **Physical activity** | **2000** | **10.97** | **2020** | **2023** | |
| Musculoskeletal pain | 2002 | 3.54 | 2020 | 2021 | |
| **Association** | **2000** | **13.16** | **2021** | **2023** | |

**Notes**: The red bars indicate that the keywords occurred the most frequently; the green bars indicate that the keywords occurred infrequently. Bold keywords represent the potential emerging trends.

compared with the field of pain. Our findings concurred with a previous systematic review that revealed the paucity of clinical trials involving LBP-O.[3]

LBP-related studies were published in multiple journals. Similar to previous bibliometric analysis studies,[33,37] our study revealed that *Spine* published the highest publication volume in both fields, accounting for 5.4% and 6.1% of the total number of LBP-O- and LBP-W-related papers, respectively. *Spine* is an international, peer-reviewed, bi-weekly journal focusing on the management of spinal disorders. Among the top 10 journals with the largest number of LBP publications, most have IF < 5.000 and *Pain* has the highest IF in both fields of LBP-O and LBP-W.[31] *Pain* publishes basic science and clinical research related to the nature, mechanisms, and treatment of pain, which attracts more readers from various disciplines. Journals focusing on LBP treatments (pharmaceutical research in LBP-O and physical rehabilitation in LBP-W) published relatively more LBP-related papers. Although LBP is the number one cause of people living with disabilities and the number of LBP-related publications has been growing exponentially over the last three decades, only a few papers were published in

**Table 6** Keywords with the Strongest Co-Occurrence Burst on Low Back Pain in Working-Age Adults from 1993 to 2023

| Keywords | Year | Strength | Begin | End | 1993–2023 |
|---|---|---|---|---|---|
| Rheumatoid arthritis | 1993 | 65.45 | 1993 | 1997 | |
| Depression | 1993 | 52.61 | 1993 | 1997 | |
| Low-back pain | 1993 | 33.88 | 1993 | 1995 | |
| Computed tomography | 1993 | 12.98 | 1993 | 1994 | |
| Diagnosis | 1994 | 47.96 | 1994 | 1999 | |
| Strength | 1994 | 19.48 | 1994 | 1996 | |
| Work | 1995 | 81.15 | 1995 | 2002 | |
| Sciatica | 1996 | 42.18 | 1996 | 1999 | |
| Primary care | 1998 | 152.93 | 2000 | 2017 | |
| Population | 1995 | 42.42 | 2002 | 2004 | |
| Symptoms | 1995 | 39.83 | 2002 | 2003 | |
| Injury | 1993 | 41.13 | 2003 | 2004 | |
| Lumbar spine | 1993 | 8.37 | 2003 | 2004 | |
| Randomized controlled trial | 2004 | 174.01 | 2005 | 2018 | |
| Disorders | 1993 | 40.88 | 2006 | 2007 | |
| Double blind | 2007 | 67.29 | 2007 | 2008 | |
| Spine | 1993 | 3.98 | 2007 | 2008 | |
| Questionnaire | 1994 | 68.67 | 2012 | 2013 | |
| Follow up | 1994 | 5.05 | 2015 | 2016 | |
| **Surgery** | **1996** | **146.19** | **2016** | **2023** | |
| **Outcome** | **2006** | **144.08** | **2016** | **2023** | |
| **Therapy** | **2000** | **158.45** | **2018** | **2023** | |
| **Intervertebral disc degeneration** | **2017** | **315.35** | **2019** | **2023** | |
| Health | 1995 | 123.81 | 2019 | 2020 | |
| **Association** | **2021** | **183.39** | **2021** | **2023** | |

**Notes**: The red bars indicate that the keywords occurred frequently; the green bars indicate that the keywords occurred infrequently. Bold keywords represent potential emerging trends.

prominent mainstream medical journals (eg, *Lancet, The New England Journal of Medicine, Annal Internal Medicine*, and *JAMA Internal Medicine*).[29,33,38–45] This observation may be ascribed to the perception that LBP is a ubiquitous, but non-life-threatening ailment. Further, LBP research is more related to rehabilitation, which may not be considered for publications in mainstream or specialty medical journals. Despite LBP being a highly costly and debilitating health condition and the fact that primary care providers are nearly always the point of first contact for these patients, insufficient attention is paid to LBP in the general medical literature.[41–43] In the future, more high-quality LBP studies should be conducted to increase the awareness of medical professionals regarding the prevention and management of LBP.

The highest number of publications in the LBP-O- and LBP-W-related fields over the last three decades originated from the United States because it may have more funding opportunities, and prominent research institutions, which may hire more researchers.[27,46] Most LBP-O- and LBP-W-related publications were prepared by researchers in developed countries. These papers were cited frequently, which might be attributed to their earlier publication dates. Although the prevalence of LBP is found to be higher in developing countries,[47] only China was among the top 10 most LBP-prolific countries. The geographical distribution results clearly showed that there were regional differences in the extent of LBP research, and the publication output might be related to the economy and culture.[25] Although the incidence of LBP is higher in low-income countries, researchers in these countries may have less funding, interest in, and attention to LBP research. China only started to show dramatic increases in LBP-O- and LBP-W-related publications in the last few years, which might explain the relatively low total number of citations or average citations per paper.

The keywords with recent average publication year help identify the current hot topics. Because IVD degeneration may cause LBP through disc compression, prolapse, and herniation, it has become a common hot topic in both fields. Cognitive-behavioral therapy that incorporates skills of activity rhythm, breathing relaxation, distraction, progressive muscle relaxation, and cognitive restructuring,[48] has become one of the recent hot topics in LBP-O-related research, while physiotherapy is another hot topic. Moreover, walking and physical activity have recently been recommended as parts of LBP-O management to counteract physical inactivity.[49] These hot topics highlight the emphasis of conservative LBP management among older adults. Interestingly, nucleus pulposus cells have recently been extensively investigated in LBP-W given their roles in IVD inflammation and degeneration.[50–52]

The current bibliometric analysis identifies several research priorities. First, as a prevalent and disabling back condition, lumbar spinal stenosis (LSS) was one of the emerging trends in LBP-O research.[18,53] For example, recent studies have used machine learning to promote individualized LSS treatment and to predict the LSS development.[54,55] Second, increasing evidence shows that low physical activity is closely related to LBP, although the causation and dose effects remain uncertain.[56–58] Further studies should determine the optimal dosages of physical activity for both populations. Third, although spine surgery has become an emerging trend in LBP-W-related research, some studies found that certain patients with LBP might not experience significant long-term post-surgery benefits.[59–64] Future studies should determine the effectiveness of patient-centered precision LBP treatments. Fourth, IVD degeneration is another emerging research trend in LBP-W-related field. The mechanisms of IVD degeneration (eg, miRNAs dysfunction, immunometabolic alterations) and new therapies (eg, stem cell, gene and molecular therapies) may continue to be discovered.[65–69] Fifth, although our analysis did not reveal any trend in applying artificial intelligence, or big data in LBP research, these approaches have received increasing attention in the last few years,[70–72] future research should refine and adopt these technologies to improve clinical practice.

The current study had some limitations. First, a small number of studies involving LBP-O or LBP-W might have been missed in the search due to its limitation to WoS alone, without including other databases (eg, Medline, and Embase).[22] However, WoS is the most common source for bibliometric analysis and is more advanced in providing detailed information (eg, annual publication volume, journal, country, institution, and citation information).[73,74] Second, some researchers might have published many papers investigating musculoskeletal or chronic pain conditions, which included LBP. However, because these papers did not use LBP as a keyword, they might have been missed in our search. In addition, although the search strategy was determined by two researchers with content expertise and two experienced librarians, it is plausible that some LBP-W-related papers might include older adults as part of their mixed patient cohorts. That is, given the large number of relevant included literature, our findings should have yielded a good overview of the publication patterns and research trends in the LBP-O and LBP-W fields. Third, this current study did not analyze the Altmetric of the included studies, which is a metric used to measure the social media attention and online engagement of academic articles. Although the citation numbers were commonly used to measure the impact of articles[75,76] and were correlated with Altmetric,[77,78] it may not completely represent the impacts of articles. For example, a study about an outcome measure gets cited more frequently, whereas real-life impactful qualitative studies can be cited less. Further studies may consider using Altmetric analysis to evaluate the broader influences of publications. Fourth, there are also some confounding factors, such as the population of the countries and the circulation of the journals, which cannot be excluded.

## Implications

The current study provides an overview of the publication patterns and historical research trends, as well as informs research priorities of LBP-O and LBP-W globally. Our findings showed that although there were similar exponential growths in LBP-W- and LBP-O-related publications over the last three decades, the absolute number of LBP-O research was very low as compared to LBP-W research. A recent global burden of LBP study revealed that the prevalence of LBP increases with age, and the highest prevalence of LBP was found in individuals who were approximately 85 years of age.[79] There is an urgent need to allocate additional research resources towards the prevention and management of LBP-O worldwide (especially in Africa and Asia). Further, our study found that recent research focusing on LBP-W (eg, spinal surgery and IVD degeneration) and LBP-O (eg, physical activity and lumbar spinal stenosis) seemed to be

unrelated to each other. Future efforts should bring researchers in both fields together to discuss the research priorities and synergies so as to optimize the evaluation and management of LBP across the lifespan.

## Conclusions

This is the first bibliometric analysis to systematically compare the publication patterns and research trends in LBP research over the past three decades including in LBP-O and LBP-W. Overall, the discrepancy in the publication volume between the two fields has highlighted a relative paucity of LBP-O research in the past. The United States has the highest number of prominent researchers and institutions publishing relevant articles in both populations. The journal *Spine* stands out in LBP research. The shift in the trend of LBP-O-related research from surgery to physical activity suggests the recognition of the importance of physical activity in managing LBP among older adults. Conversely, the growing emphasis on spine surgery and IVD degeneration in LBP-W-related research highlights the strong biomedical focus despite LBP being a biopsychosocial condition.

## Abbreviations

IF, impact factor; IVD, intervertebral disc; LBP, low back pain; LBP-O, low back pain in older adults; LBP-W, low back pain in working-age adults; LOESS, locally estimated scatterplot smoothing; LSS, lumbar spinal stenosis; Q, quartile; WoS, Web of Science.

## Data Sharing Statement

The data used to support the findings of this study are available from the corresponding author upon request.

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