

ORIGINAL RESEARCH ARTICLE

Mapping structural and research trends in
schizophrenia and metabolic syndrome:
A bibliometric analysisSimin Yi¹, Feihong Weng¹, Nannan Liu^{1,2}, Yanzhe Li^{1,2}, Doudou Zheng^{1,2},
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Abstract

An escalating body of research is directing its focus toward schizophrenia (SZ) patients who grapple with metabolic syndrome (MS). By employing bibliometric approach, this study comprehensively assessed the research landscape and prevailing trends within SZ and MS-related fields. All relevant publications related to SZ and MS were systematically extracted from the Web of Science Core Collection database up to August 15, 2023. Data analysis was conducted using software such as VOSviewer, Citespace, Pajek, and R software, as well as online bibliometric website. A total of 2651 publications on SZ and MS were collected, with the United States emerging as the primary contributor ($n = 1970$). Pivotal international research collaborations were observed, notably between the United States and the United Kingdom ($n = 56$). The French Research Universities exhibited prolific contributions. *Schizophrenia Research* emerged as the foremost influential journal in this domain. In addition to “schizophrenia” and “metabolic syndrome,” keywords such as “atypical antipsychotics” and “body weight” featured prominently within the literature. Our study underscores the growing significance of SZ with MS research. These findings collectively shed light on the dynamic and evolving nature of research pertaining to SZ and MS, reflecting an unwavering commitment to unravel the complexities and implications inherent in these intertwined domains.

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1. Introduction

Schizophrenia (SZ) is a complex psychiatric disorder characterized by both positive and negative psychotic symptoms, as well as cognitive impairments.¹ At present, the global incidence rate of SZ stands at approximately 7.2/1000 individuals.¹ Given its high prevalence, chronic course, and increased risk of recurrence and deterioration, SZ patients often experience mental disability and labor loss, imposing a substantial burden on both their families and society at large.^{2,3} Metabolic syndrome (MS) is a clinical syndrome characterized by central obesity, elevated blood pressure, high glucose

levels, and abnormal blood lipid profiles, frequently referred to as insulin resistance syndrome.⁴ In SZ patients, the incidence of MS is 2 – 3 times higher compared to the general population.⁵ The exact etiology of MS in SZ patients remains elusive, although numerous studies have implicated it as a consequence of side effects associated with second-generation antipsychotic drugs such as clozapine and olanzapine.⁶ SZ patients with MS often experience more pronounced cognitive impairments, with a markedly increased risk of coronary artery disease, cerebrovascular disease, congestive heart failure, and cardiovascular-related mortality; death in people with SZ is significantly higher than that the normal population, second only to suicide as a cause of death among SZ patients.⁷

Bibliometrics, a comprehensive methodology encompassing both quantitative and qualitative approaches, plays a pivotal role in analyzing scientific literature.⁸ The bibliometrics currently used can usually be divided into two categories: evaluative and relational.⁸ Evaluative bibliometrics is used to describe the characteristics and integration results of published information. The most common forms of evaluative bibliometrics are systematic reviews and meta-analyses.⁹ Relational bibliometrics provides an overview of the relationships between different participants. The idea behind relational bibliometrics is that hidden associations can be identified in the metadata collected from various entities, which helps to understand entity sets at a broader level.⁹ It can realize frequently cited research, keywords, and collaborative networks involving countries, institutions, and authors in specific research fields, which help to discover hotspots and shortcomings in related fields.¹⁰ In research, one can employ pertinent bibliometric methods as required, including the use of bibliometric coupling.⁸ Once the research topic is identified, a thorough search is conducted on relevant academic platforms such as PubMed, utilizing specific search queries and years. The retrieved articles are then imported into dedicated bibliometric software, such as R software, CiteSpace,¹¹ online bibliometrics website, and VOSviewer¹² for analysis, followed by targeted refinement and adjustment according to the desired outcomes.¹³

Bibliometrics has been applied in the research on the relationship between SZ and oxidative stress,¹⁴ as well as between SZ and inflammation,¹⁵ and the articles have received widespread attention. However, the burgeoning incidence of MS in SZ patients and the associated body of literature have yet to undergo a systematic analysis. Addressing this knowledge gap, this bibliometric analysis endeavors to construct a comprehensive map of scientific publications pertaining to the intersection of SZ and MS.

2. Methods

2.1. Search strategy

The Web of Science database serves as a prominent academic resource for bibliometric analysis.¹⁵ In this study, we conducted a comprehensive search within the Web of Science Core Collection database, covering literature related to SZ and MS up to August 15, 2023. Our search strategy incorporated the following terms: TS = (SZ OR SZs OR Schizophrenic Disorders OR Disorder, Schizophrenic OR Dementia Praecox) AND TS = (MS OR MSs OR Syndrome, Metabolic OR Syndromes, metabolic OR Insulin Resistance Syndrome). Due to technical and copyright reasons, we only included all related literature within the Web of Science Core Collection database. The relevant articles were subsequently exported and stored in the form of plain.txt, comprising full records and cited references, to facilitate further analyses.

2.2. Data analysis

To conduct this bibliometric analysis, we employed a range of specialized software tools and resources. These included R (version 4.0.4, R Foundation for Statistical Computing, Vienna, Austria), VOSviewer (version 1.6.17, Leiden University, Britain), CiteSpace Software (6.1.R2, The College of Information Science and Technology, Drexel University, America), and Pajek and online bibliometrics website (<https://bibliometric.com/>). The R package, a versatile tool for quantitative bibliometric research, was utilized for (1) summarizing the total number of publications per year and annual publication volumes for each country; (2) identifying authors, institutions, and journals with the highest publication counts and impact; (3) tracking the annual cumulative occurrences of top keywords/terms and references; (4) calculating production and cooperation frequencies among countries; and (5) creating a visual representation in the form of a three-field plot highlighting keywords, references, and authors.

VOSviewer is a specialized software application designed for the visualization of bibliometric networks. It excels at organizing interconnected nodes into distinct clusters, with the nodes of the same hue representing a stronger correlation. In this study, VOSviewer was used to perform: (1) exploration the collaborative network of authors and their institutions and (2) literature co-citation analysis and keyword co-occurrence network analysis. For the study of intricate nonlinear networks, we utilized Pajek, a robust and large-scale complex network analysis tool. It allowed us to enhance images previously processed using VOSviewer and subjected them to further comprehensive analyses. In addition, the freely available Java program CiteSpace played a central role in our research by

emphasizing dynamic visualization and tracking the evolution of bibliometric networks over time. It served as the primary tool for analyzing references and keywords with citation bursts, providing valuable insights into the evolving landscape of scholarly literature.

3. Results

3.1. Publication summary

Our comprehensive analysis encompassed a total of 2651 papers concerning SZ and MS. Figure 1A illustrates the annual publication count, revealing a noteworthy trend. Over time, the volume of annual publications has shown a substantial increase. The trajectory of annual publications began to stabilize around 2015. To discern the relationship between the overall number of articles and the year of publication, we conducted regression analysis. This analysis allowed us to construct a highly predictive model ($R^2 = 0.9481$) that accurately forecasts the ongoing annual publishing pattern.

Our predictions indicate a continued upward trajectory in the annual publication trend for SZ and MS research over the next decade. According to the prediction curve, the number of articles is expected to reach 269 by 2026 and to 362 by 2032. This projection underscores the enduring significance and research activity in this critical area of study.

3.2. Analysis of the production and cooperation among countries

Figure 1B presents a geographical breakdown of article contributions by different nations. The United States leads with the highest number of publications ($n = 1970$), followed by China ($n = 1435$), the United Kingdom ($n = 859$), France ($n = 732$), and Australia ($n = 704$). In contrast, all other nations combined have contributed fewer than 700 articles.

International collaboration patterns are illustrated in Figure S1. Notably, the majority of international research partnerships are observed between nations in the United States, Europe, the United Kingdom, Canada, and China. Prominent collaborations include those between the United States and the United Kingdom ($n = 56$), the United States and Canada ($n = 50$), and the United Kingdom and Belgium ($n = 47$). These collaborative efforts reflect the global nature of research in this field and highlight the fruitful partnerships driving advances in SZ and MS research.

3.3. Analysis of the most productive institutions

A total of 3,551 institutions have actively participated in studies related to SZ and MS. In Table 1, the top 10 most prolific institutions are listed, with the French Research

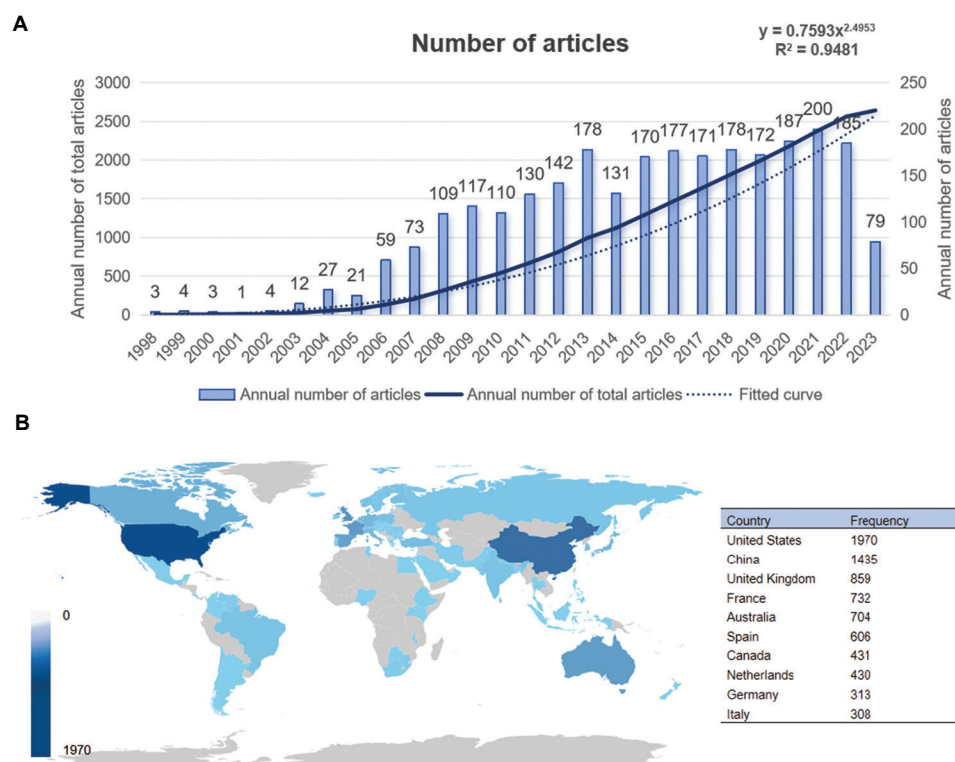


Figure 1. Number of publications by country and year. (A) Annual publications from 1998 to 2023. (B) Publications of top 10 countries

Table 1. Top 10 affiliations with the most publications

Affiliation	Articles
Udice-French Research University	378
University of London	184
King's College London	181
Institut National De La Sante Et De La Revherche Medicale	167
University of Toronto	138
University Paris Cite	130
KU Leuven	112
Cibersam	104
Harvard University	97
Assistance Publique Hopitaux Paris	96

Universities ($n = 378$), University of London ($n = 184$), and King's College London ($n = 181$) occupying the top three positions.

For a comprehensive understanding of institutional collaboration, we visualize the network of collaborative authors. Here, the size of the circles represents the number of publications, the color corresponds to the distinct field of each institution, and the thickness of the connecting lines signifies the intensity of collaboration between institutions. Figure S2A depicts the network of institutional cooperation in this area. It becomes evident that there is ample room for further enhancing global institutional collaboration in this field.

3.4. Analysis of the high-impact journals

A total of 552 journals have actively contributed to the dissemination of research related to SZ and MS. In Table 2, the top 10 journals with the most published papers are included, accompanied by their most recent impact factors (IF) and quartile (Q) ranking in journal citation reports (JCR). Table S1 highlights the most frequently cited journals in this area of study. Of note, 70% of journals in this domain fall within the Q1 category, as per the JCR classification.

Journal *Schizophrenia Research* with an IF of 4.5 leads the way with an annual publication volume of 166, signifying its prominence in the field of SZ and MS. This journal also boasts the highest number of citations, measuring 7,559, and hails from the Netherlands.

3.5. Analysis of influential authors

A total of 11,326 authors have participated in publications related to SZ and MS. In Table 3, the top 10 authors who have made the substantial impact, determined by their productivity, are displayed. The De Hert M. stands out with 70 publications, establishing themselves as the most

renowned authors in this field (h -index = 34) and amassing the highest number of citations at 2146. Correll C.U., with 57 articles published and 1515 citations, holds the second-highest spot (h -index = 30). Vancampfort D., who has 48 articles and 1646 citations, ranks third (h -index = 29).

To identify core authors in accordance with Price's thesis, we considered publications with more than 6 articles as the guiding criterion. In total, there are 225 core authors. The collaboration networks between authors are depicted in Figure S2B, with each author having contributed a minimum of 6 papers. Notably, these core contributors represent 16 distinct research fields, indicating the multidisciplinary nature of SZ- and MS-related research. However, the relatively limited interaction among researchers from diverse domains suggests that collaboration across teams and laboratories engaged in SZ- and MS-related research is still in its nascent stages.

3.6. Analysis of research trends and hotspots

3.6.1. Highly cited references

Citation analysis serves as a valuable method for evaluating the impact of articles within specific research fields, with the frequency of citations often reflecting the influence of particular articles.¹⁶ In Table 4, we present the top 10 most cited articles, all of which were published between 1999 and 2015 and have garnered over 200 citations. The cocited references and their interconnections are visualized in Figure 2. In this graphical representation, colors are employed to denote distinct research fields, and circles represent the citation frequencies. Notably, a robust interconnection is observed among three core research fields.

Topping the list in the red zone is the reference titled "Prevalence of the metabolic syndrome in patients with schizophrenia: baseline results from the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) SZ trial and comparison with national estimates from NHANES III."¹⁷ This reference holds the distinction of being the most cited in this zone. In the blue zone, "The positive and negative syndrome scale (PANSS) for schizophrenia"¹⁸ emerges as the most frequently cited reference. While in the green zone, "Effectiveness of antipsychotic drugs in patients with chronic schizophrenia"¹⁹ takes the lead in terms of citations. These highly cited references signify their significant influence and impact in their respective research domains.

3.6.2. Analysis of references with citation bursts

Figure S3 shows an overview of the top 20 references with the most substantial citation bursts. A minimum duration of 4 years was considered for the citation burst, with the blue line depicting the observed time interval from 1998 to 2023 while the red line representing the duration of

Table 2. Top 10 journals with the most publications

Journals	Articles	IF	JCR quartile	Country
<i>Schizophrenia Research</i>	166	4.5	Q1	Netherlands
<i>Psychiatry Research</i>	80	11.3	Q1	Netherlands
<i>Journal of Clinical Psychiatry</i>	76	5.3	Q1	United States
<i>European Psychiatry</i>	73	7.8	Q1	France
<i>Frontiers in Psychiatry</i>	63	4.7	Q2	United States
<i>European Neuropsychopharmacology</i>	53	5.6	Q1	Netherlands
<i>BMC Psychiatry</i>	50	4.4	Q2	England
<i>Journal of Clinical Psychopharmacology</i>	48	2.9	Q2	United States
<i>Progress in Neuro-Psychopharmacology & Biological Psychiatry</i>	45	5.6	Q1	England
<i>Neuropsychiatric Disease and Treatment</i>	44	3.2	Q2	Netherlands

Abbreviations: IF: Impact factor; JCR: Journal citation reports.

Table 3. Top 10 authors with the most publications

Author	Articles	Local citations	h-index
De Hert M.	70	2146	34
Correll C.U.	57	1515	30
Vancampfort D.	48	1646	29
Stubbs B.	42	734	23
Leboyer M.	31	135	14
Probst M.	30	427	18
Boyer L.	29	115	14
Van Winkel R.	29	1276	21
Lancon C.	28	129	17
Llorca P.M.	27	117	14

the citation burst. Among these references, the article titled “Antipsychotic-induced weight gain: a comprehensive research synthesis” published in the *American Journal of Psychiatry* stands out with the most robust citation burst value observed during the period from 2008 to 2013.²⁰ In addition, the citation burst for articles such as “Comparative efficacy and tolerability of 32 oral antipsychotics for the acute treatment of adults with multi-episode schizophrenia,”²¹ “Metabolic syndrome in psychiatric patients,”²² and “Comparative effects of 18 antipsychotics on metabolic function in patients with schizophrenia, predictors of metabolic dysregulation, and association with psychopathology”²³ is still ongoing, indicating that the subject matter of these articles continues to pique interest and may represent a potential frontier in the field of SZ and MS research in the future.

3.6.3. Analysis of the frequently used keywords

Out of a total of 5906 keywords, we meticulously examined 60 that appeared no <30 times in the literature. The visual

representation of these keywords is shown in Figure 3. Node size corresponds to the frequency of keyword usage, while the co-occurrence of two nodes indicates a robust linkage between them. Similar keywords are strategically grouped, thus shedding light on the primary research domains within SZ and MS.

Cluster 1, denoted by red, encompasses keywords such as “metabolic syndrome,” “prevalence,” “mortality,” “obesity,” “people,” and “bipolar disorder.” This cluster delves into critical aspects pertaining to MS and its prevalence. Cluster 2 places a spotlight on antipsychotics and weight gain, featuring keywords such as “atypical antipsychotics,” “body weight,” “weight gain,” “clozapine,” “risperidone,” and “olanzapine.” Cluster 3, represented in blue, explores the intricate connections between SZ and inflammation, with key phrases such as “schizophrenia,” “association,” “inflammation,” “c-reactive protein,” and “risk” being at the forefront. Cluster 4 centers its focus on metabolic disorders and medication resistance, with key phrases such as “medication-naïve patients,” “dyslipidemia,” “glucose,” and “insulin resistance” occupying the forefront.

To observe the evolving landscape of key terms over time, Figure 4 provides a temporal perspective. Initially, critical keywords included “body weight,” “diabetes mellitus,” “weight gain,” “nutrition examination survey,” and “impaired fasting glucose.” In recent years, “major depressive disorder,” “bipolar disorder,” “risk,” and “life expectancy” have gained significant prominence as hot topics. In Figure 5, a treemap visually represents the prominence of keywords. “Prevalence” reigns as the most frequently used keyword ($n = 489$), closely followed by “risk” ($n = 465$) and “atypical antipsychotics” ($n = 323$). Notably, “schizophrenia” and “metabolic syndrome” remain central to this body of research.

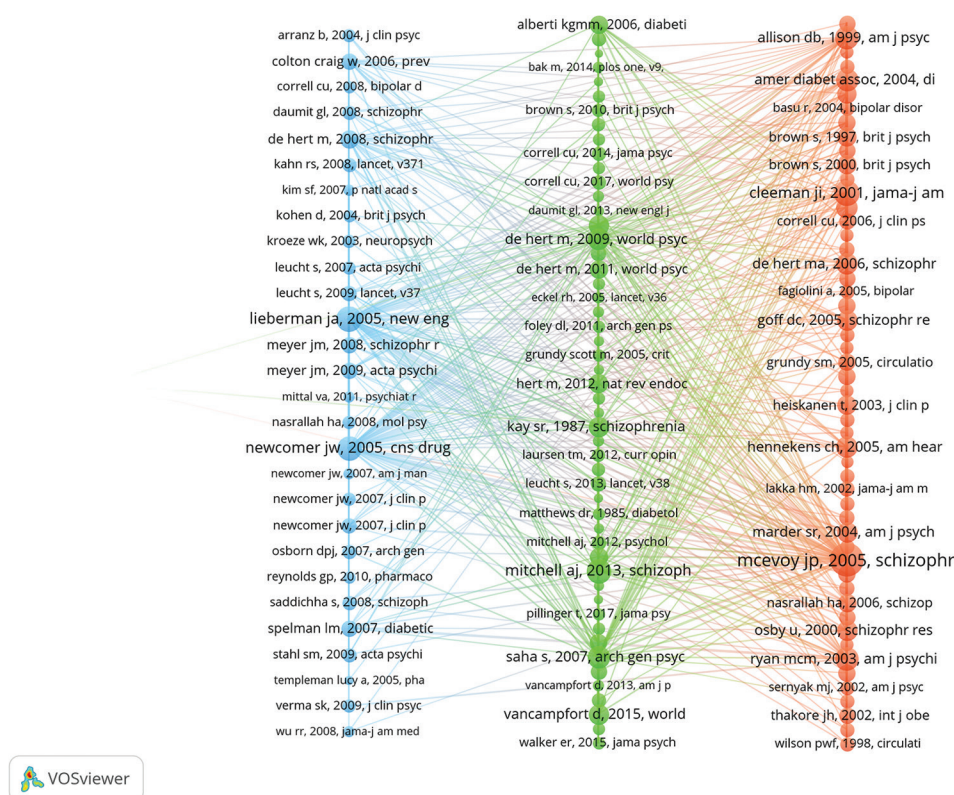


Figure 2. The analysis of co-occurrence citation analysis

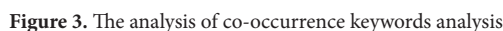
Table 4. Top 10 references with the most citations

Cited references	Citations
Prevalence of the metabolic syndrome in patients with schizophrenia: baseline results from the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) schizophrenia trial and comparison with national estimates from NHANES III.	474
The positive and negative syndrome scale (PANSS) for schizophrenia	310
Prevalence of metabolic syndrome and metabolic abnormalities in schizophrenia and related disorders – a systematic review and meta-analysis.	298
Effectiveness of antipsychotic drugs in patients with chronic schizophrenia	295
Risk of metabolic syndrome and its components in people with schizophrenia and related psychotic disorders, bipolar disorder, and major depressive disorder: a systematic review and meta-analysis	253
Second-generation (atypical) antipsychotics and metabolic effects: a comprehensive literature review	238
Antipsychotic-induced weight gain: a comprehensive research synthesis	222
Metabolic syndrome in people with schizophrenia: a review	216
Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III)	211
Impaired fasting glucose tolerance in first-episode, drug-naïve patients with schizophrenia	203

3.6.4. Analysis of keywords with citation bursts

Figure S4 shows an overview of the top 20 references with the highest keyword bursts. In our analysis, a minimum burst duration of 2 years was considered. The blue line represents

the observed time interval from 1998 to 2023, while the red line represents the specific duration of the burst. Of notable significance is the keyword “atypical antipsychotics” which displayed the most robust citation burst between 2004 and 2012, reaching an impressive value of 27.16.



In this comprehensive bibliometric analysis, we delved into studies pertaining to SZ and MS over the past 25 years. The scholarly landscape in this domain has undergone a remarkable transformation. Notably, the volume of literature has exhibited significant growth over the past few decades since 2008, eventually stabilizing after reaching its zenith in 2013. The expansion can be attributed, in part, to the mounting awareness of the physiological and psychological ramifications of SZ patients with MS. Indeed, this burgeoning understanding has emerged as a catalyst propelling the field forward, aided by an infusion of research funding. Among the countries and institutions actively contributing to this research sphere, the United States and French Research Universities have taken the lead, emerging as prolific contributors. *SZ Research*, as the most frequented journal and a major influencer in this domain, has been instrumental in shaping the discourse. Furthermore, within the realm of influential authors, De Hert M. holds a prominent position, leaving a lasting mark on this body of research. These key facets collectively underscore the

Citation analysis serves as a valuable metric for gauging the academic influence and significance of publications.²⁴ Keyword co-occurrence analysis illustrates the semantic proximity and prevalence of pertinent research terms within a specific scientific domain.²⁵ In our study, the 10 most cited articles shed light on several critical focal points, with an emphasis on the prevalence of MS in SZ patients.¹⁷ Following this, articles examining risk factors²⁶ and atypical antipsychotic drugs (AAPS)¹⁹ emerged prominently. Our literature co-citation analysis revealed three distinct clusters. In the Cluster 1, titled as “*Prevalence of the metabolic syndrome in patients with schizophrenia: baseline results from the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) schizophrenia trial and comparison with national estimates from NHANES III*” published in 2005 stands out as the most cited reference.¹⁷ This pivotal work, involving over 1460 SZ baseline participants in the CATIE study unearthed a staggering prevalence of MS exceeding 40%. Notably, among female SZ patients, this prevalence of MS exceeded 50%,

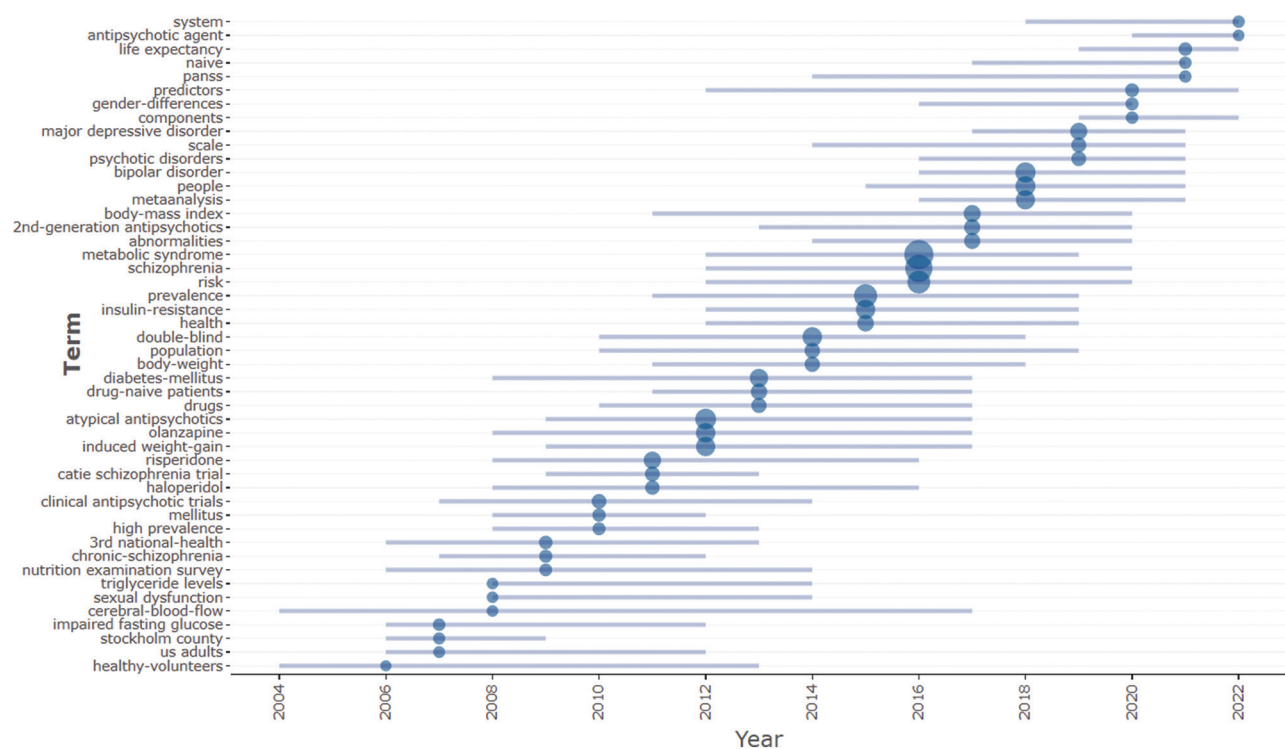


Figure 4. The analysis of keywords evolution

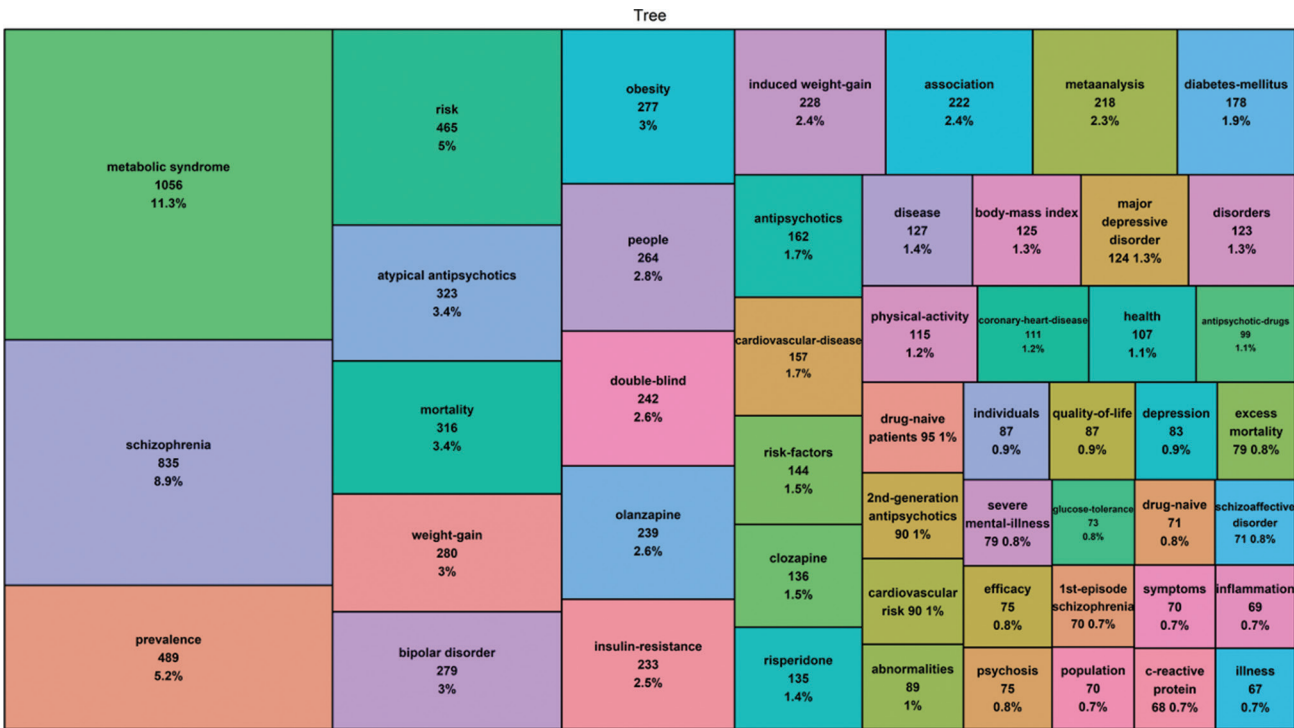


Figure 5. A treemap of keywords

sparking widespread attention to the compelling association between SZ and MS. As Cluster 1 of keyword co-occurrence

analysis also placed a spotlight on the incidence and repercussions of MS in SZ patients. MS had a significant

impact on the general health status of patients with chronic SZ. MS is defined as the presence of metabolic abnormalities such as large waist circumference, dyslipidemia, fasting hyperglycemia, and high blood pressure.²⁷ Compared with the general population, the incidence rate and mortality of SZ patients are higher.²⁷ Cardiovascular problems are the main cause of this death, and the estimated life expectancy has decreased by 10 – 20 years. Therefore, an array of studies was underway to explore avenues for MS prevention.²⁸ These encompass strategies included promoting aerobic exercise and weight loss, dietary recommendations such as limiting saturated fatty acid intake,²⁹ and pharmacological approaches involving antioxidants, melatonin, and probiotics/prebiotics,³⁰ which was selected targeted treatment based on individual differences.

Cluster 2 spotlighted “*The positive and negative syndrome scale (PANSS) for schizophrenia*”¹⁸ as the most frequently cited article. This reference, a requisite source for numerous SZ-related articles, delved into the positive and negative symptoms experienced by SZ patients, also notable in this cluster was research concerning “*Risk of metabolic syndrome and its components in people with schizophrenia*.”²⁶ This meta-analysis highlighted that elderly individuals, those taking AAPS such as olanzapine and clozapine, and patients with severe mental illness constituted high-risk factors for SZ patients with MS. Notably, this meta-analysis represented the first large-scale endeavor to explore MS and its risk factors, revealing that antipsychotic drugs significantly contribute to the risk. Similar to the study in Cluster 2, Cluster 3 extended our understanding of the relationship between second-generation antipsychotic drugs and MS. With this cluster, “*Effectiveness of antipsychotic drugs in patients with chronic schizophrenia*”²² emphasized the duration of treatment cessation for weight gain and MS, notably longer in the olanzapine group compared to quetiapine or risperidone groups. In addition, “*Second generation (atypical) antipsychotics and metabolic effects: a comprehensive quality review*”²⁹ underscores the treatment-specific risk associated with clozapine and olanzapine, revealing the highest risk of clinically significant weight gain, while the risks associated with other drugs remain relatively low. These insights have significantly contributed to the evolving understanding of the impact of antipsychotic medications on metabolic health in SZ patients. In keyword co-occurrence analysis, Cluster 2 also shined a spotlight on keywords such as “atypical antipsychotic,” “weight gain,” and “olanzapine.” Nowadays, the relationship between MS and SZ is complex and multifactorial, and the current mainstream view was that the use of AAPS played a major role.³¹ In addition to the side effects of medication, other factors such as unhealthy lifestyle, reduced physical activity, smoking, improper diet,

and genetic predisposition could also contribute to MS.³¹ Notably, olanzapine, a second-generation antipsychotic drug, was recognized for its propensity to induce weight gain and further contribute to the development of MS.⁶ Research revealed that SZ patients enduring long-term olanzapine use (≥ 48 weeks) experience an average weight gain of 5.6 kg.³² The current research underscored the significant impact of AAPS on various organs, including the brain, liver, and pancreas, as well as their influence on the equilibrium of glucose and lipids in tissues. These drugs exert their effects through interactions with receptors such as dopamine, serotonin, acetylcholine, and histamine receptors in the hypothalamus, culminating in heightened sympathetic nerve stimulation, elevated glucagon levels, and increased liver gluconeogenesis levels.³¹ Concomitant changes in insulin secretion, dyslipidemia, fat deposition in the liver and adipose tissue, and insulin resistance emerged as compounding factor underlying MS.³¹

In delving into research trends, our citation burst analysis elucidates the evolutionary trajectory of this discipline. The surge in high citation rates from 2004 to early 2012 underscores that “atypical antipsychotic drugs” were a central research focus during this period. At that time, MS was deemed a severe side effect of second-generation antipsychotic drugs such as “olanzapine,” “clozapine,” and “risperidone” in critically ill patients³³ These studies all reflected that AAPS was a dominant cause and research hotpot of MS recently.

In keyword co-occurrence analysis Cluster 3, “cognition,” “inflammation,” “depression,” and “association” are more frequent keywords. Research elucidates significant positive associations between genetically predicted depression and the risk of MS, waist circumference, hypertension, and triglycerides.³⁴ This cluster also explores the intricate connections among MS, cognitive function, and inflammation. Additional investigations reveal that MS in middle-aged individuals grappling with depression may potentiate atherosclerosis through inflammatory mechanisms.³⁵ A meta-analysis involving 27 studies and 10,174 patients with SZ showed that SZ patients with MS or obesity or diabetes have significantly greater overall cognitive deficits.²⁸ The current research suggests that cognitive impairments associated with MS risk factors are most likely related to metabolic changes, which are associated with microvascular and macrovascular processes believed to cause brain structural abnormalities and subsequently cognitive impairment.²⁸ In addition, insulin resistance mediates inter-organ communication between adipose tissue and the brain through extracellular vesicles derived from adipose tissue and their cargo microRNAs, leading

to cognitive impairment.³⁶ Hypertension is a major risk factor for both major and minor stroke events, and its most severe form can lead to severe cognitive impairment and vascular dementia.³⁷ Keyword co-occurrence analysis Cluster 4 delves into “drug-naïve patients,” “diabetes,” and “insulin resistance.” Investigations underscore the coexistence of MS, diabetes, and insulin resistance in drug-naïve patients.^{38,39} Notably, research by Chen *et al.* underscores the frequent occurrence of impaired glucose tolerance in first-episode drug-naïve SZ patients, demonstrating associations with clinical symptoms while exhibiting a less pronounced correlation with early-stage cognitive impairment.⁴⁰ At present, research hotspots have shifted toward major depressive disorders, mental disorders, life cycles, and predictive factors, reflecting a transition from mechanistic inquiries to a heightened emphasis on prevention and treatment strategies.³³

This is the first bibliometric analysis delving into the realm of research connecting SZ and MS. While this study contributes to elucidating prevailing research trends in this interdisciplinary domain, it is crucial to acknowledge its principal limitations. First, while Web of Science stands as a reliable and widely used bibliometric database, its utilization may inadvertently omit certain research, particularly those emanating from non-English language sources and drug discovery efforts by pharmaceutical companies/biotech. Second, the challenge arises when research institutions undergo name changes over time, a nuance that existing bibliometric analysis methods may not fully accommodate.

5. Conclusion

Scholarly attention to the intricate interplay between SZ and MS has burgeoned within academic literature. The trajectory of this trend is poised to persist over the forthcoming three decades. Despite the surge in international cooperation increasing the quantity and significance of research in this area, the United States has, so far, spearheaded productivity in this domain. Furthermore, this keyword analysis within this study uncovers that MS intersects with SZ but also extends its influence into the realm of depression patients. Notably, the thematic focus has evolved, transitioning from risk factors to considerations of life expectancy. Therefore, the forthcoming endeavors in this field may increasingly pivot toward intervention research centering on MS and its relationship with SZ, setting a promising direction for future exploration.

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Conflict of interest

Shen Li is an Editorial Board Member of this journal but was not in any way involved in the editorial and peer-review process conducted for this paper, directly or indirectly. Separately, other authors declared that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

Data are available from the corresponding author upon reasonable request.

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