BIBLIOMETRIC ANALYSIS OF RISK FACTORS CONTRIBUTING TO MATERNAL MORTALITY: TRENDS AND RESEARCH DIRECTIONS

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ABSTRACT

Maternal mortality remains a significant global health challenge, with high maternal mortality rates in many parts of the world being a key indicator of disparities in maternal health care. While great efforts have been made to reduce these mortality rates, the various contributing risk factors remain a major focus of efforts. This study aimed to conduct a bibliometric analysis of the scientific literature addressing risk factors contributing to maternal mortality over the period 2017 to 2024. In this study, data was obtained from 50 relevant articles retrieved from Google Scholar using Publish or Perish software. The articles were filtered based on relevance and analyzed in depth. The data collected included information on publication year, country of origin, publisher, number of citations, and article type. To generate a comprehensive bibliometric map, VOSviewer was used with the parameters of occurrence of at least 4 and 19 terms, as well as network visualization, overlay, and density. The analysis showed that research on maternal mortality has consistently focused on various risk factors and aspects of maternal health, with a significant emphasis on factors related to pregnancy complications, postnatal care, and socioeconomic health conditions. Developed countries such as the United States are often the primary location of research, indicating a high concentration of studies in these countries. In addition, the research highlighted consistent attention to the importance of adequate health care and specific health issues faced by pregnant women. The analysis also revealed that key themes in the current literature include the management of postpartum hemorrhage, postpartum infections, and the influence of socio-economic factors on maternal health. This study provides valuable insights into current research directions and trends in maternal health and underscores the importance of continuing to identify and mitigate risk factors that contribute to maternal mortality. The findings are expected to guide the development of more effective interventions and health policy strategies that can reduce maternal mortality globally and improve maternal health outcomes worldwide.

Keywords: *Maternal Mortality, Risk Factors, Bibliometric Analysis, Healthcare Interventions, Research Trends*

INTRODUCTION

Maternal health, particularly maternal mortality, remains a significant global issue despite advances in health services. Despite great efforts to reduce maternal mortality worldwide, it remains a serious challenge especially in developing countries. To address this issue, an in-depth understanding of the risk factors that contribute to maternal mortality is crucial.

Maternal deaths are deaths of women that occur during pregnancy or within 42 days of pregnancy. These deaths are caused by pregnancy or its management. In addition, maternal deaths can be defined as deaths that occur regardless of the age and location of the pregnancy and are not caused by incidents and accidents (Sembring et al., 2022).

Based on WHO, it is known that every year there are almost 210 million women around the world and more than 20 million women experience pain caused by pregnancy. The maternal mortality rate or MMR worldwide can be predicted at 400 per 100,000 KH and 98% occurs in developing countries (Shanty, 2023). In Southeast Asia, it is known that there are 240,000 maternal deaths each year or 210 per 100,000 KH. This MMR is a measure that illustrates the risk of obstetrics experienced by pregnant women. This risk will increase often the number of pregnancies experienced. The high MMR is caused by poverty and the status of women. This indicates injustice in access to health services and inequality (Sulistyorini et al., 2023).

According to the World Health Organization (WHO), maternal mortality is defined as maternal death, which is a death that occurs during pregnancy or during the 42 days from the termination of pregnancy, but not caused by accident or chance (WHO, 2019). The indicator used in maternal mortality is the Maternal Mortality Rate (MMR). MMR is the number of maternal deaths during a certain period of time per 100,000 live births during the same period of time. This indicator is also able to assess the degree of public health,

The large number of maternal deaths in developing countries indicates that there are large differences between countries. The risk of maternal mortality is highest among those under 15 years of age and complications in pregnancy and childbirth are the leading cause among adolescent girls in developing countries (Rachmantiawan & Rodiani, 2022).

This bibliometric study aims to conduct an in-depth analysis of the existing scientific literature on risk factors contributing to maternal mortality. Using a bibliometric approach, this study will identify recent research trends, key research foci, and emerging research directions in this field. The information obtained is expected to provide strategic guidance for global health policy and assist in the development of more effective interventions to reduce maternal mortality.

This approach uses bibliometric analysis tools to map and analyze the existing research network, with a particular focus on risk factors such as postpartum hemorrhage, postpartum infections, pregnancy complications, and socio-economic factors that affect maternal health. By understanding the current research landscape, it is hoped that this study can make a valuable contribution to improving understanding and addressing maternal health in the future.

OVERVIEW

because of its sensitivity to improvements in health services, both in terms of accessibility and quality (MOH RI, 2019).

Maternal mortality is a complex event caused by various causes that can be divided into close determinants, intermediate determinants, and distant determinants. Near determinants that are directly related to maternal mortality are obstetric disorders such as bleeding, preeclampsia/eclampsia, and infections or diseases suffered by the mother before or during pregnancy that can worsen

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pregnancy conditions such as heart disease, malaria, tuberculosis, kidney disease, and *acquired immunodeficiency syndrome*. Near determinants are directly influenced by intermediate determinants related to health factors, such as maternal health status, reproductive status, access to health services, and health facility use behavior. Distant determinants are related to demographic and socio-cultural factors Low public awareness of maternal health, low women's empowerment, educational background, family socio-economic, community and political environment, and policies are thought to indirectly contribute to the increase in MMR (Ministry of Women's Empowerment, 2023).

Maternal mortality can be prevented through early detection, including in the period leading up to pregnancy. Women of childbearing age face very high uncertainty, therefore the aim of this study was to analyze maternal complications and possible high risk factors associated with maternal mortality. Potential risk factors for maternal mortality include nutritional status, anemia, medical history, age, ANC examination, mode of delivery, late referral, employment status, and pregnancy complications, which are specifically the most dominant factors (Diana S et al, 2020). Meanwhile, in another study, it was found that risk factors that contribute to maternal mortality include pregnancy complications, labor complications, puerperal complications, maternal age, previous medical history, antenatal care, and area of residence (Astuti et al, 2017).

Early identification of risk factors is essential for developing comprehensive intervention strategies that prevent pregnancy-related complications. The *Maternal and Neonatal Health Registry* (MNHR) *research* identifies preventable causes of maternal deaths across low- and middle-income settings. MNHR can be used to monitor public health strategies and determine their association with reducing maternal mortality. (Bauserman, M et al, 2015). In addition, cultural factors and traditions still play a role in the postpartum care process through the influence of families who play a role in postpartum care. Some of these practices include abstinence and/or the consumption of certain foods. During the postpartum period, mothers eat only white rice without animal protein and limit water consumption because it is thought to slow down the wound healing process. This can reduce the condition of postpartum women who need adequate nutritional intake to restore the body's condition and help the breastfeeding process (Kartini, 2022).

Research conducted by Chandra et al (2019) states the level of education with maternal mortality cases. The level of education also has a relationship with the level of health. The higher the level of education, the easier it is to accept the concept of healthy living independently, creatively and continuously. The level of education also greatly affects the ability to receive nutritional information, determines or influences whether or not a person receives a knowledge, the higher the education, the easier it is for someone to receive nutritional information.

Research conducted by Fransisika et al (2022) also stated that there was a relationship between income and maternal mortality. Low family income will lead to low purchasing power for food so that mothers cannot meet their food needs and subsequently lead to a lack of food consumption in mothers. Family income also affects the quality of food consumed so that pregnant women get adequate nutrition during their pregnancy. Low income is also because they do not help their husbands to find additional sources of income, so the family income only relies on the husband's income.

Maternal health status can be in the form of nutritional status, anemia, history of illness suffered by the mother, and history of complications suffered. Nutritional status is an important thing to consider during pregnancy. This is because nutrition has a major influence on the health status of pregnant women and the growth and development of the fetus. The needs of pregnant women in general are

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folic acid, energy, protein, iron (Fe), calcium, vitamin D supplementation, especially in groups at risk of sexual diseases (STIs) and in countries with long winters and iodine administration in areas endemic to cretinism (Maslikhah et al, 2023).

Women under the age of 20 have a high risk of becoming pregnant because the reproductive organs for girls under 20 are not ready to have sex or conceive so that if pregnancy occurs, it is risky because of physical readiness and reproductive health that has not reached the peak of development, then physiologically, the immune system of pregnant women will decrease. This is due to the tolerance of the mother's immune system to the baby who is a semi-allogeneic tissue. The intauterine baby forms an immune system when the gestational age is around 12 weeks and increases when the pregnancy is 26 weeks. During the perinatal period the baby will get antibodies owned by the mother and cause after 2 months the antibodies will decrease. In addition, based on the anatomy and physiology of pregnant women, it is easier for infections caused by viruses, bacteria, and parasites (Handriani & Melaniani, 2015). Other reasons are premature birth, low birth weight, and risk of cervical cancer. (Dewi, 2016).

Research conducted by Sari et al (2022) also states that there is a relationship between parity and the incidence of postpartum hemorrhage which causes maternal death. Based on this study, it is known that mothers with high parity tend to experience complications in pregnancy which affect the outcome of labor. High parity allows for high involution disorders due to less than optimal uterine contractions, thus increasing maternal and infant mortality and morbidity.

Maternal mortality due to pre-pregnancy illnesses can basically be prevented by early detection. This does not seem to be a concern for health workers who conduct antenatal check-ups. Observation of the pregnancy examination books in the case group found that almost all of them did not include a history of infectious diseases. Family interviews and observations revealed that the mother had a history of infectious diseases before pregnancy. The most common infectious diseases were tuberculosis and pneumonia (Rohati et al, 2023).

Research conducted by Ermiati et al (2020) states that there is a relationship between family support and the behavior of pregnant women with preeclampsia which causes maternal mortality to increase. The results of this study indicate that family support is related to the coverage of antenatal care. Some factors associated with the selection of ANC services in pregnant women are role models, the number of family members, the role of parents / in-laws, the role of husbands and the role of siblings. These factors include family support for a mother.

Improving the quality of counseling on the importance of pregnant women consuming a balanced diet, especially one that contains a lot of iron and protein is needed. Early detection of risk factors such as complications and history of infectious diseases is needed so that optimal prevention efforts can be made.   It is necessary to improve the quality of antenatal and postnatal services, among others, by improving the quality of health workers through the provision of technical and non-technical skills, especially for midwives working in villages (Aryani et al, 2024).

RESEARCH METHODOLOGY

This research is a bibliometric study with the title "Bibliometric Analysis of Risk Factors Contributing to Maternal Mortality: Trends and Research Directions." This method uses a quantitative analysis approach to scientific literature that aims to identify research trends, geographical distribution, author contributions, as well as collaboration patterns and research directions related to risk factors affecting maternal mortality.

The first stage in this research begins with collecting literature data using the Publish or Perish (PoP) application. This application serves to extract bibliometric data from Google Scholar. The keywords used in the search process were "Risk Factors," "Maternal Mortality," "Maternal Health," and "Maternal Mortality Rate." The search was conducted with a set time limit, from 2017 to 2024, with the aim of obtaining as many as 50 articles relevant to the research topic.

After collecting the articles, the next stage was the article selection process. This selection was done by looking at the suitability of the discussion of each article obtained, ensuring that the selected articles discuss topics that are relevant and similar to the research focus. Articles that were not relevant or had discussions outside the context of this research were eliminated to maintain the quality of the analysis.

Data from the Publish or Perish application is then processed with distribution based on several categories, namely Year of Publication, Country of Publication, Publisher, Number of Citations, and Article Type. This classification aims to identify publication and citation patterns in various regions and determine the articles and authors with the highest impact on the topics discussed. This data distribution provides greater insight into the dynamics of research in maternal mortality and its risk factors in different parts of the world.

After the data distribution is done, the next step is data processing through the VOSviewer application, which is used to visualize the bibliometric network map of the selected articles. In this study, the parameters used were occurrence of at least 4 and terms of 19. VOSviewer allows visualization of the relationship between various elements in scientific literature, such as authors, articles, or keywords that often appear together. This tool can help researchers to map emerging research trends, identify prominent groups or clusters, and understand patterns of collaboration between researchers or institutions within a field of study.

In the analysis process using VOSviewer, several types of visualizations are generated, including Network Visualization, Overlay Visualization, and Density Visualization. Network Visualization is used to illustrate the relationship between the elements under study, such as keywords that often appear together or collaboration between authors. Overlay Visualization provides an overview of the development of research trends over time, by displaying color changes that indicate the time of publication or intensity of research on a topic. Meanwhile, Density Visualization displays the density of terms in the literature, allowing researchers to identify the most and least researched topic areas.

This approach allowed us to gain a comprehensive picture of the direction of research in the field of maternal mortality risk factors, identify under-explored research gaps, and uncover patterns of collaboration between researchers and institutions around the world. As such, this study makes an important contribution to mapping and guiding the future of research on maternal health and maternal mortality reduction.

RESULTS RESEARCH AND DISCUSSION

The results of this study reveal various trends, distribution, and collaboration patterns in research related to risk factors that contribute to maternal mortality. Based on bibliometric analysis conducted through the Publish or Perish and VOSviewer applications, we found varied geographical distribution, evolving publication trends, and significant contributions from various authors and

institutions in the field of maternal health. The resulting network visualization illustrates the relationship between key terms and research clusters, which helps in identifying dominant topics as well as areas that have received less attention. This discussion will explore key findings related to the distribution of articles by year, country, publisher, most cited, as well as collaboration patterns identified through the bibliometric network map.

Publication Trend Analysis By Country Of Publication

Based on the data analyzed, publications related to risk factors contributing to maternal mortality are spread across different countries, with an uneven distribution. The United States (USA) dominated the number of publications with 15 articles, indicating that this topic is of great interest in the country. The United Kingdom (UK) also had a significant number of publications with 6 articles, followed by Ethiopia and Nigeria with 4 articles each.

Other countries such as Brazil (3 articles), Tanzania, South Africa, Canada and Nepal have 2 publications each. Meanwhile, Indonesia, Iran, Japan, Ireland, Netherlands, Kenya, Congo, Israel, Florida and Pennsylvania had only 1 publication each. This distribution shows that developed countries such as the United States and the United Kingdom publish more research related to maternal health, while developing countries, although affected by maternal mortality issues, have a lower contribution to the scientific literature.

These publications from different countries reflect regional focus and research priorities. The United States may have greater resources and access to scientific research and publications, while countries in Africa such as Ethiopia and Nigeria have a greater interest in this topic as they may experience higher maternal mortality rates and need more research to address this issue.
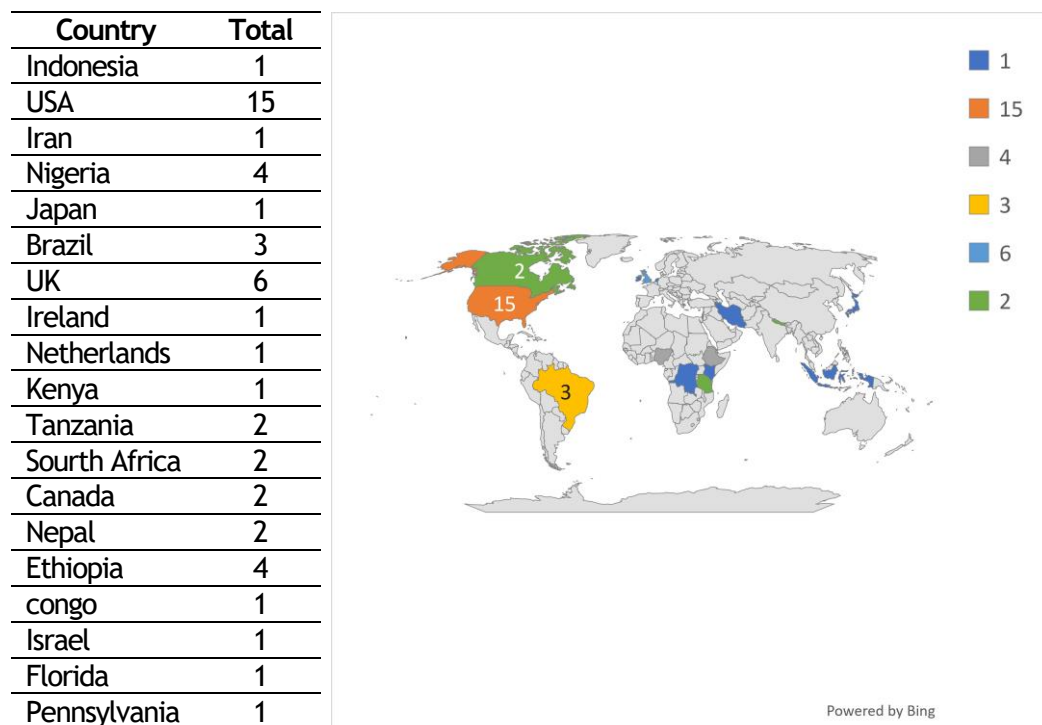
Country	Total
Indonesia	1
USA	15
Iran	1
Nigeria	4
Japan	1
Brazil	3
UK	6
Ireland	1
Netherlands	1
Kenya	1
Tanzania	2
South Africa	2
Canada	2
Nepal	2
Ethiopia	4
congo	1
Israel	1
Florida	1
Pennsylvania	1

Figure 1. Distribution Of Countries That Publish Related Research

The table and figure above show the number of publications by country related to risk factors that contribute to maternal mortality. The United States (USA) dominates with 15 publications, followed by the United Kingdom (UK) with 6 publications. Ethiopia and Nigeria have 4 publications each, indicating a significant research focus on maternal health in Africa. Brazil came next with 3 publications, while countries such as Tanzania, South Africa, Canada and Nepal had 2 publications each.

Other countries such as Indonesia, Iran, Japan, Ireland, Netherlands, Kenya, Congo, Israel, Florida and Pennsylvania have smaller contributions, with 1 publication each. This distribution suggests that developed countries, especially the United States and the United Kingdom, have a greater interest in maternal health-related research, although some developing countries such as Ethiopia and Nigeria are also active in this topic. Overall, despite the variation in the number of publications per year and per country, these findings underscore the importance of continued research into risk factors for maternal mortality worldwide. Countries that have greater challenges in maternal health issues should continue to be supported to improve their research and publication capacity, in order to reduce maternal mortality globally.

Trend Analysis of Publications by Year of Publication

Based on the analyzed data, publication trends related to risk factors that contribute to maternal mortality show significant fluctuations from 2017 to 2024. 2017 was the year with the highest number of publications, with 17 articles. This shows that during this period, the topic of maternal mortality and its risk factors became a big concern among researchers. However, this trend decreased quite drastically in 2018, where there were only 6 publications. 2019 showed a slight increase with 10 publications, but again decreased to 8 publications in 2020.

An even sharper decline occurred in 2021, with only 2 publications produced. This could be due to a variety of factors, including a possible shift in research focus to other issues such as the COVID-19 pandemic which was then a global concern. In 2022, there was a slight resurgence with 6 publications appearing, but the trend drastically declined again in 2023, where only 1 article was published. Until 2024, no related publications were found.

The number of publications listed for the year 2024 is 0, most likely due to the fact that the year 2024 is still ongoing or has just started at the time this data was captured. Therefore, scientific publications for that year may not have been fully indexed or published in significant numbers. In bibliometric research, data for ongoing years is often not fully represented as new articles usually take time to go through the publishing and indexing process. This could explain why the publication figure for 2024 is recorded as 0.

Overall, these data suggest that while there was a surge of interest in the topic of maternal mortality at the beginning of the study period, the interest has been inconsistent and has tended to decline in recent years. This dramatic decline may indicate that the topic requires further attention or there may be a shift in priorities in maternal health research.

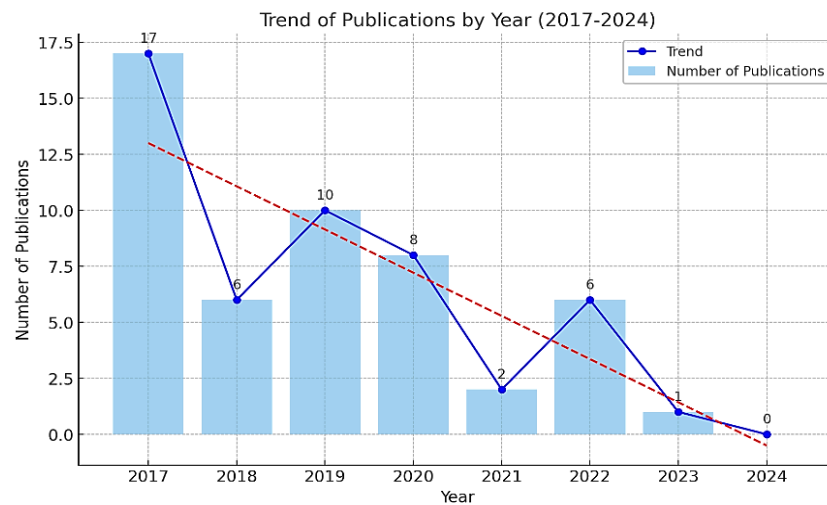Here is an illustration of the publication trend based on the data:

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Figure 2. Related Publication Trends from Google Schollar databases using PoP application

The figure above shows the trend of article publications by year of publication from 2017 to 2024. The bar chart displays the number of publications each year, with the highest number of publications in 2017 (17 publications). The numbers above each bar indicate the number of publications for that year. In addition, the blue line graph illustrates the trend in the number of publications over the time period, while the red dashed line shows the overall trend with linear regression. From this visualization, there is a general decline in the number of publications, although there are some years where there is an increase, such as in 2019 and 2022.

This consistent decline may reflect a change in research focus or decreased interest in the topic of maternal mortality and its risk factors in recent years. This trend shows the unstable dynamics of researchers' interest in maternal mortality and its risk factors, with a significant decline especially after 2017.

Analysis of Publication Trends by Article Type

Based on the data displayed, publications related to risk factors that contribute to maternal mortality are dominated by research articles, with the number of publications reaching **35 articles**. This reflects that empirical and data-driven research is the most commonly used approach in studies related to maternal health. These research articles usually include primary and secondary data analysis, hypothesis testing, and systematic scientific methodology.

In addition to research articles, there were also **literature reviews**, which amounted to **11 publications**. Literature reviews play an important role in analyzing and summarizing existing research results, providing a comprehensive overview of research trends and directions in the field of maternal health. The existence of a significant number of literature reviews demonstrates the scientific community's efforts to integrate existing findings and identify gaps or challenges in previous research.

Finally, there were **4 publications** in **the form of books**. Books generally present a more comprehensive and in-depth discussion of certain topics. Although relatively small in number compared to research articles, books are often a more durable reference source and

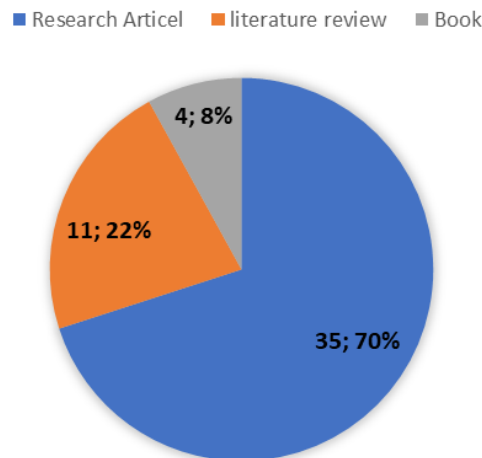can reach a wider audience, including practitioners and policy makers in the health sector.

Figure 3 Distribution Of Countries That Publish Related Research

The figure above shows the number of publications by type. The graph shows that Research Article dominates with **35 publications**, followed by **Literature Review** with **11 publications**, and **Book** with **4 publications**.

This indicates that empirical research-based approaches are still the main form of scientific contribution in maternal health topics. Research articles often contain primary or secondary data analyzed with in-depth methodology, making a real contribution to understanding the risk factors that influence maternal mortality.

On the other hand, **Literature Reviews** were also significant, with the number reflecting the need to integrate and evaluate existing research. Books, although small in number, still contribute by providing a comprehensive review and broader discussion of issues related to maternal health.

This distribution shows that direct and comprehensive research is more commonly published compared to reviews and books, but all types of publications play an important role in

the advancement of science in this field.

Publication Trend Analysis by Publisher

Based on the data analyzed, there are several publishers or platforms that dominate publications related to maternal mortality risk factors. From the table, **Springer** publisher contributed the most publications with 12 articles. This shows that Springer is one of the main publishers in this topic, which is widely recognized as one of the largest scientific publishers in the world with many journals in various disciplines. Other publishers such as **Taylor & Francis**, **journals.plos.org**, and **Elsevier** also made significant contributions with 5 articles each. Taylor & Francis and Elsevier are two other major academic publishers with large portfolios in health and medicine, while PLOS is known as an open access platform that promotes the wide dissemination of research results.

Wiley Online Library contributed 3 articles, while **ncbi.nlm.nih.gov** and **researchgate.net** each contributed 2 articles. Sites such as NCBI and ResearchGate are commonly used for the distribution of scientific papers,

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with NCBI focusing on biomedical research and ResearchGate serving as a social networking platform for researchers. Other publishers or platforms such as **books.google.com**, **publications.aap.org**, **obgyn.theclinics.com**, **liebertpub.com**, **thelancet.com**, and **mdpi.com** each had only one published article related to this topic. This suggests a diversification in publications with contributions from a smaller variety of sources. This distribution suggests that most publications related to maternal mortality and its risk factors are generated by large publishers, but are also supported by a variety of other smaller, more specialized platforms from both commercial and non-commercial publishers.

The following is an illustration in the form of a bar chart depicting the number of publications by publisher:
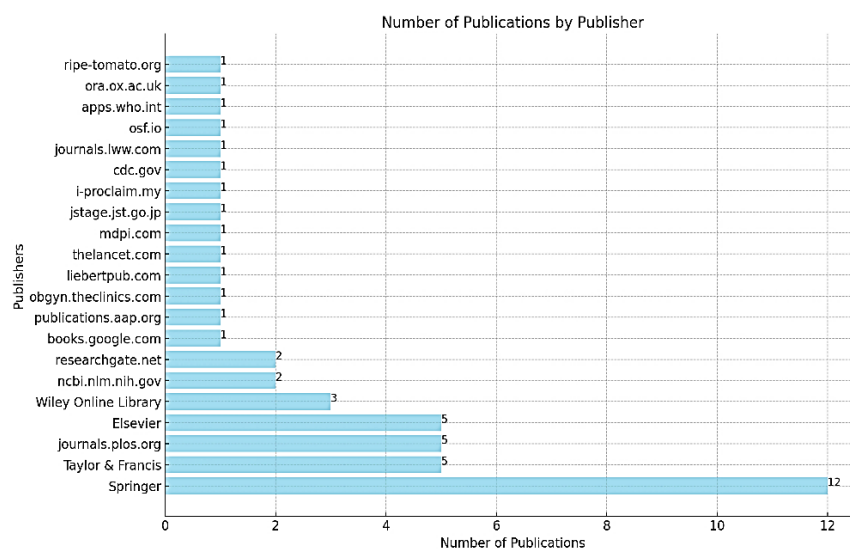

Figure 4. Distribution Of Publishers That Publish Related Research

The graph above illustrates the distribution of publications by publisher. It is clear that **Springer** dominates with the highest number of publications, with 12 articles. In addition, **Taylor & Francis**, **journals.plos.org**, and **Elsevier** each contributed 5 publications, placing them as significant publishers in maternal mortality-related topics. **Wiley Online Library** came next with 3 articles, while **ncbi.nlm.nih.gov** and **researchgate.net** had 2 articles each. Most other publishers such as **The Lancet**, **MDPI**, and **books.google.com** only had 1 article published on this topic.

This analysis shows that large publishers and open access platforms play an important role in disseminating scientific research results related to maternal health. Although some smaller publishers have only one publication, their contribution is still valuable in enriching the available literature in this field.

Analysis of Publication Trends by Citation

Based on the available data, there are several articles that get very high citations related to the topic of maternal mortality and its risk factors. The article with the highest number of citations was written by the **World Health Organization (WHO)** in 2019 with the title "Trends in maternal mortality 2000 to 2017," which received **1248 citations.** This article

was published on the **apps.who.int** platform and focused on global estimates of maternal mortality. The high number of citations reflects the great influence of this global report in the field of maternal health.

The second highest-cited article had **1150 citations** and was written by **AA Creanga et al.** in 2017. The article is titled "Pregnancy-related mortality in the United States, 2011-2013" and was published by **journals.lww.com**. The focus on pregnancy-related mortality in the United States shows the high relevance of the study in the country. Another highly **cited** article was by **DL Hoyert and AM Miniño** in 2020 with **1050 citations**. This article was published on **stacks.cdc.gov** and discussed changes in the coding and publication of data related to maternal mortality in the United States. In addition, articles from authors such as **M Knight et al.** with **926 citations** focusing on improving maternal care in

the UK and Ireland, as well as **EE Petersen**'s article with **913 citations** on pregnancy-related deaths in the United States, also show significant influence in this area.

Lower-citation articles, such as the work of **J Crear-Perry et al.** (624 citations) on inequalities in maternal health, or **J Daru et al.** (458 citations) on the risk of maternal mortality due to severe anemia, are also major contributions to the scientific literature despite their lower citation counts compared to the WHO global report. From this analysis, it appears that global reports from large organizations such as the WHO and studies focusing on maternal healthcare in developed countries, especially the United States and the United Kingdom, tend to get more citations, indicating their great impact in the scientific community.

Table 1: Publication Trends by Citation

Citation	Author	Title	Year	Publisher	Country
1248	World Health Organization	Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.	2019	apps.who.int	USA
1150	AA Creanga, C Syverson, K Seed	Pregnancy-related mortality in the United States, 2011-2013	2017	journals.lww.com	USA
1050	DL Hoyert, AM Miniño	Maternal mortality in the United States: changes in coding, publication, and data release, 2018	2020	stacks.cdc.gov	USA
926	M Knight, S Kenyon, P Brocklehurst,	Saving lives, improving mothers' care: lessons learned to inform future maternity care from the UK and Ireland confidential enquiries into maternal deaths and ...	2017	ora.ox.ac.uk	UK
913	EE Petersen	Vital Signs: Pregnancy-Related Deaths, United States, 2011-2015, and	2019	cdc.gov	USA

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		Strategies for Prevention, 13 States, 2013-2017			
624	J Crear-Perry, R Correa-de-Araujo,	Social and structural determinants of health inequities in maternal health	2021	liebertpub.com	USA
458	J Daru, J Zamora, BM Fernández-Félix	Risk of maternal mortality in women with severe anaemia during pregnancy and post partum: a multilevel analysis	2018	thelancet.com	UK
383	SE Geller, AR Koch, CE Garland, EJ MacDonald,	A global view of severe maternal morbidity: moving beyond maternal mortality	2018	Springer	USA
355	S Sobhy, D Arroyo-Manzano, N Murugesu	Maternal and perinatal mortality and complications associated with caesarean section in low-income and middle-income countries: a systematic review and meta	2019	thelancet.com	UK
263	World Health Organization	Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division	2023	books.google.com	USA

The graph above illustrates the distribution of citations based on published articles on maternal mortality. The article with the highest number of citations, **"Trends in maternal mortality 2000 to 2017"** published by the **World Health Organization (WHO)** in 2019, led the way with 1248 citations, showing the great influence of this global report in the scientific community.

The second article with a high number of citations was by **AA Creanga et al.** titled **"Pregnancy-related mortality in the United States, 2011-2013"** which received **1150 citations** and was published in 2017. Other significant articles include those by **DL Hoyert and AM Miniño** (1050 citations) and **M Knight et al.** (926 citations), which also contributed greatly to the scientific literature in this field.

This study highlights the importance of global and national reports focusing on maternal health and maternal mortality risk, particularly in the United States and United Kingdom. Lower-citation articles, while not as popular as these global reports, still have a significant impact on maternal health research and policy. This distribution of citations reveals a trend that large reports from global organizations such as WHO and research focused on developed countries tend to get more attention and citations in the scientific community.

Publication Trend Analysis Based on VoS Viewer Network Visualization

The network visualization generated by VOSviewer provides an in-depth insight into the relationships between terms or keywords that frequently co-occur in scientific publications related to maternal mortality and its risk factors. In this graph, each node represents a term or keyword, while the lines connecting the nodes illustrate the relatedness or co-occurrence of these

terms in scientific articles. These relationships help identify key trends and foci in research related to this topic. The visualization is divided into color clusters that represent groups of closely related terms.
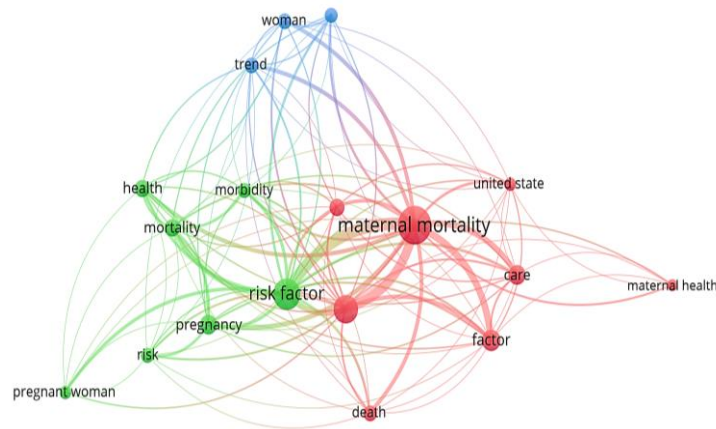

Figure 5. Network Visualization Overview Publications

1. Cluster 1 (Red):

    The red cluster is the largest in this visualization and includes terms such as maternal mortality, maternal health, care, death, and united state. The term maternal mortality is the main center of this network, indicating that maternal mortality is one of the most dominant research focuses in the scientific literature analyzed. The strong association between maternal mortality and terms such as care, death, and maternal health suggests that the topic of maternal mortality is often associated with maternal health care and various risk factors for death. The United States also appears in this cluster, indicating that much of the research on maternal mortality is conducted in this country. This may reflect the high attention paid to maternal health in the United States, including efforts to reduce maternal mortality through empirical studies and evidence-based health policies.

2. Cluster 2 (Green):

    The green cluster focuses on terms more related to general health and pregnancy, including terms such as health, mortality, pregnancy, risk, and risk factors. Within this cluster, risk factors are at the center, highlighting that the identification of risk factors is an important element in maternal health-related research. This suggests that maternal health studies often highlight factors that increase the risk of mortality or morbidity during pregnancy. Other terms such as pregnant woman and mortality also indicate that this research is relevant to vulnerable populations, particularly pregnant women, who often face significant health risks. This cluster reflects the global focus on identifying factors that may increase or decrease the risk of maternal mortality, which is critical in developing more effective health interventions.

3. Cluster 3 (Blue):

    The blue cluster is the smallest of the three, but includes very specific terms such as severe maternal morbidity, trend, and woman. These terms highlight a deeper research focus on severe maternal morbidity, a condition that is life-threatening but does not

necessarily result in maternal death. The relationship between the terms woman and trend suggests that the research is not only focusing on medical conditions, but also identifying patterns and trends in women's health, particularly in the context of pregnancy and childbirth. This cluster provides insight into how research continues to evolve and try to understand more complex and comprehensive issues in maternal health, including global trends in the management of maternal morbidity.

From this network visualization, it can be seen that research on maternal mortality tends to focus heavily on developed countries such as the United States, with maternal health, risk and risk factors being the most frequently discussed themes. The term maternal mortality is at the center of attention, indicating that this issue is one of the most studied health problems. This visualization assists researchers in identifying key focus areas in research, as well as highlighting the close relationship between maternal mortality and a range of risk factors and broader health.

The network also underscores the importance of research based on trends and patterns in maternal health. The terms trend and woman that appear in the blue cluster reflect studies that aim to understand the changing dynamics of women's health in the context of pregnancy over time. This suggests that in addition to understanding risk factors, researchers are also looking to see how these trends are evolving around the world and potentially influencing future maternal health care policies and practices.

Overall, the VOSviewer Network Visualization shows a map of the complex interconnections between different aspects of maternal mortality research, with a range of interrelated themes and issues. The visualization provides a comprehensive overview of the research focus, helping researchers to identify knowledge gaps as well as potential research areas that need further attention.

Publication Trend Analysis Based on VoS Viewer Overlay Visualization

The overlay visualization from VOSviewer provides a more in-depth look at the development of research related to maternal mortality and its risk factors over time. The colors in this visualization reflect the timeframe of the research, with dark blue indicating older publications and yellow indicating more recent publications. Terms that appear in the dark blue to dark green sections, such as **woman**, **trend**, **health**, **morbidity**, and **mortality**, indicate that the focus of early research was more on general health, trends in women's health, and maternal morbidity. The terms **maternal mortality** and **risk factors** also fall within this color spectrum, confirming that attention to maternal mortality and its risk factors has been an integral part of research over the past few years, well before 2019.
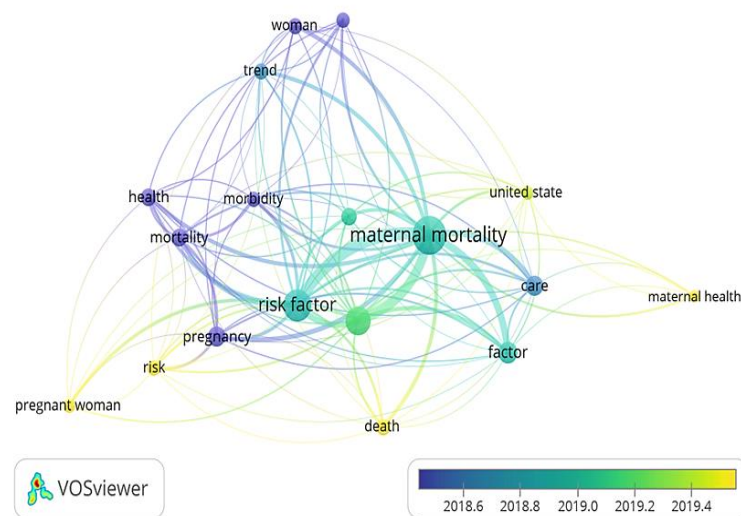
Figure 6 Overlay Visualization Overview Publications

On the green spectrum, terms such as **pregnancy**, **care**, **factor**, and **death** indicate consistent attention to maternal health care and mortality risk over the past few years. This reflects that although the research is no longer new, the topics have received continued attention. The term **maternal health** also falls into this category, indicating that attention to maternal health in general has continued, albeit more predominantly in relatively recent times.

On the other hand, terms that appear in yellow, such as **pregnant woman**, **risk**, and **death**, indicate that research into the risks faced by pregnant women has recently received increased attention, especially after 2019. This suggests a shift in research focus towards specific risks during pregnancy, as well as new healthcare measures developed to reduce the risk of maternal mortality.

Cluster-based analysis shows that there are several major groups in this visualization. The **main cluster** (dark green to dark blue) focuses on **maternal mortality**, which is the largest node and most connected to other terms such as **risk factor**, **care**, and **death**, indicating that this topic is still at the center of research attention. **The morbidity and general health cluster** (dark blue) includes terms such as **health**, **morbidity**, and **mortality**, illustrating the long-term focus on general health and the impact of morbidity on pregnant women. **The recent cluster** (yellow) includes terms such as **pregnant woman** and **risk**, indicating the recent increased attention to the specific risks faced by pregnant women, particularly in relation to maternal mortality.

Overall, this overlay visualization shows how research on maternal mortality has evolved from an initial focus on morbidity and general health, to more specific attention on risk factors and care during pregnancy. Recent trends indicate that the study of maternal mortality risk and preventive measures to protect pregnant women has taken center stage, as better health interventions have developed in recent years.

Publication Trend Analysis Based on VoS Viewer Density Visualization

VOSviewer's Density visualization provides a clearer understanding of the density of keyword occurrence in scientific publications related to maternal mortality. The colors in this visualization are an indicator of how

often a keyword appears in the analyzed literature. Bright colors such as yellow and red indicate high density, meaning that the keyword appears frequently and is at the center of

research attention. Conversely, darker colors such as blue and green signify lower density, indicating that the keyword is discussed less frequently but is still relevant.
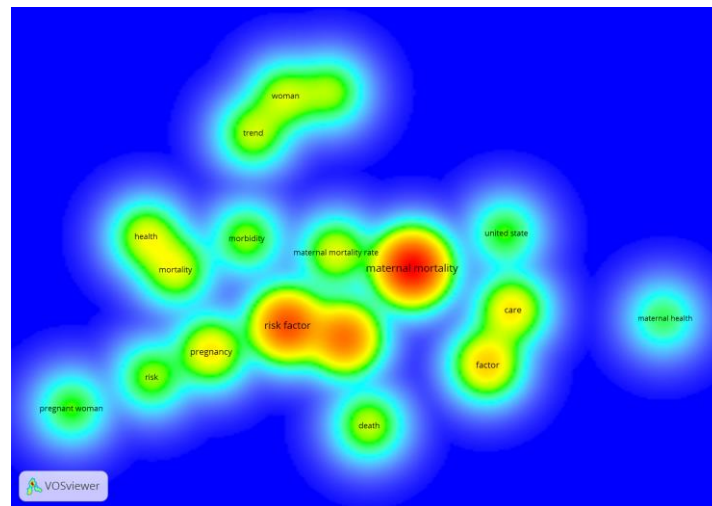

Figure 7. Density Visualization Overview Publications

In high-density areas (red to yellow), the term maternal mortality has the highest density, indicating that maternal mortality is the most frequently discussed topic in research. The close relationship between maternal mortality and risk factors also indicates that many studies focus on identifying risk factors that contribute to maternal mortality. Other terms such as care, factor, and death also appeared with significant density. This suggests that aspects of care, risk factors and death are central components in the maternal health literature.

On the other hand, in medium-density areas (green), terms such as pregnancy, mortality, morbidity, and health appear frequently, but not to the same extent as maternal mortality and risk factors. This suggests that while these topics remain an important part of the scientific literature, the main focus of this study is more on maternal mortality and its risk factors. The term pregnant woman also appears in green, indicating that

pregnant women are an important subject in this study, but tend to be discussed in the context of more specific risks.

Low-density terms (blue) such as maternal health, united state, and trend indicate that while these topics remain relevant in scientific discussions, they appear less frequently compared to key terms such as maternal mortality and risk factors. This lower density may indicate that despite their importance, these topics have not been a major focus in recent research or may have received more attention in the past.

Overall, this density visualization reveals that the main focus in the analyzed scientific literature is on maternal mortality and the risk factors associated with it. Maternal care and health also play an important role in this discussion, but their density of occurrence is relatively lower compared to the main topic. This suggests that current research tends to focus more on identifying specific risk factors that contribute to maternal

mortality, as well as interventions that can reduce these risks. With the help of VOSviewer Density Visualization, researchers can identify key areas of research interest, as well as discover gaps that may require more research in the future to enrich understanding and more effective interventions in the field of maternal health.

CONCLUSIONS

In conclusion, the overall analysis of this article shows that research on maternal mortality and its risk factors has been a major focus in the scientific literature over the past few years. From the visualizations generated using tools such as VOSviewer, it is clear that **maternal mortality** and **risk factors** are the most discussed topics, indicating that identifying risk factors and understanding the causes of maternal mortality is a priority in this research. These studies, especially those conducted in developed countries such as the United States, often highlight the importance of maternal health care and the impact of morbidity and mortality during pregnancy. The network-based visualization shows how these themes are interconnected, with aspects of maternal care and health closely linked to maternal health risks and outcomes.

In addition, temporal trend analysis through overlay visualization shows how the focus of research has shifted from an initial focus on general health and maternal morbidity to a more specific focus on risk factors faced by pregnant women, especially in recent years. Recent research has placed more emphasis on preventive measures and treatments that can reduce maternal mortality, while the density visualization shows areas of high concentration of research that continue to focus on maternal mortality and the factors that influence it (Indrayani, 2024).

Overall, this study shows that there has been significant progress in efforts to understand and address maternal mortality. However, there are still gaps in the literature that could be filled with more research, especially focusing on preventive care and more effective intervention strategies to reduce maternal mortality worldwide. As research in this area continues to grow, it is hoped that more findings will be applied globally to improve maternal health and reduce the risk of death during pregnancy and childbirth.

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