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Adherence to iron supplementation among anemic pregnant women during 1964-2022: A bibliometric analysis

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Abstract

Background: High maternal morbidity and mortality are brought on by the worldwide public health issue of iron and folic acid deficient anemia. The risk to pregnant women's and their unborn children's health is reduced when they correctly get and take iron and folic acid supplements. However, people's inability to adhere to the supplement frequently results in an immense burden.

Objective: This analysis focused on describing the field of adherence to iron among pregnant mothers with anemia using bibliometric analysis of the literature from 1981 to 2022 and on analyzing the scientific trends.

Methods: We used Scopus as the search engine, using the keywords: Adherence OR Compliance AND Pregnancy OR Pregnant women AND Iron OR Ferrous AND anemia. English journal articles from journals were selected.

Results: We retrieved 360 documents during 1981-2022. The result showed trends topics mentioned, mostly pregnancy, anemia, and iron supplementation. The most published articles were from Australia and USA, with Quartal 1 source as the most relevant journal.

Conclusion: Although the quantity of publications has increased regularly, it remains below 40 each year. The topic intervention or experimental study, or adherence were still low. Some countries with significantly increased anemia in the last ten years, with the number of publications and collaboration studies remaining high. The modest number indicates that researchers still have many chances to develop better, more productive techniques to enhance adherence and decrease anemia.

Keywords: bibliometric; adherence; iron; anemia; pregnant women

Background

Anemia is a sign of poor health and nutrition (Effendy et al., 2020). Anemia contributes to half a billion women in their reproductive age globally.

Worldwide, 38% (32.4 million) of pregnant mothers and 29% (496 million) aged 15 to 49 non-pregnant women had anemia in 2011 (Stevens et al., 2013). The regions with the highest anemia prevalence were South Asia and Central and West Africa

(Stevens et al., 2013). ¹³ Though there are many other causes of anemia, iron deficiency is believed ²⁴ to be responsible for half of all instances. One of the most common ¹² nutrient deficiencies in the world, iron deficiency affects more than 2 billion people and is thought to be responsible for 20% of maternal fatalities (World Health Organization, 2008). Significant decreases in the prevalence of anemia have been made in some circumstances; however, there hasn't been enough improvement.

In Indonesia, with every 100,000 live births, there are 305 maternal deaths (UNFPA Indonesia, 2018). According to Riskesdas (Basic Health Research), in 2018, pregnant women suffered from anemia were almost 50% and 40% of anemia was another condition that affected women at maternity age (Kementerian Kesehatan Republik Indonesia, 2018). Stunting in children is also correlated with anemia. Low birth weight, which primarily affects anemic women, was one ⁷ factor in the prevalence of stunting (Ruaida, 2013). Reaching the World Health Assembly's goal of a 50% decrease in anemia in women of reproductive age by 2025 will require further initiatives (World Health Organization, 2014).

¹⁶ The most common way to treat iron deficiency, iron deficiency anemia, and neural tube anomalies is by supplementing with iron and folic acid, both internationally and domestically (World Health Organization, 2012). Oral iron tablets of 400 μg of folic acid and 30 to 60 mg of elemental iron (IFA) have been suggested by the WHO as a standard component of prenatal treatment beginning in the second trimester (World Health Organization, 2020). According to systematic evaluations, taking 90 or more iron-containing tablets throughout pregnancy has been shown to prevent anemia by up to 70% (Abraha et al., 2019; Peña Rosas et al., 2015b). Efforts made by the Indonesian government to protect pregnant mothers from iron deficiency anemia are carried out by giving one tablet of blood boost every day during pregnancy, at least 90 tablets, started as early as possible and continued until postpartum (Kementerian Kesehatan Republik Indonesia, 2021). To avoid anemia and enhance pregnant women's nutritional status, nutrition is included in Indonesia's aim to overhaul the health sector through micronutrient treatments (Kementerian Kesehatan Republik Indonesia, 2021). Following iron and folic acid recommendations throughout pregnancy boosts

output and avoids iron deficiency anemia, which lowers the risk of bleeding, sepsis, and maternal death (World Health Organization, 2012).

Despite the fact that IFA supplement programs are widely used and have the potential to be a very affordable method of treating anemia in pregnant women (da Silva Lopes et al., 2021; Kashi et al., 2019), the programs haven't always worked as well as their supporters had planned. Programs for IFA supplements run into a problem in that giving pregnant women access to IFA supplements does not guarantee that they will take them (Kurzawa et al., 2021). People's inability to adhere frequently results from their lack of understanding of the advantages or dangers of the supplements. A study in North Wollo Zone, Ethiopia, examined 43.1% compliance of expectant mothers visiting prenatal clinics (Demis et al., 2019). Poor adherence negatively impacts productivity and energy levels, as well as the physical, mental, and immunological systems (Rahmati et al., 2016). However, an essential strategy for lowering the risk of unfavorable pregnancy outcomes is maintaining adherence to iron-folic acid supplements (IFAS) (World Health Organization, 2012). Some pieces of literature investigated the effect of an intervention program to enhance adherence among pregnant women who use blood boost supplementation. For instance, Iran's research analyzed the impact of Short Message Service messaging on compliance (Khorshid et al., 2014). Indonesia's deployment of mobile management software to monitor the compliance of Fe supplementation (Rukmaini, 2018), a low- to middle-income country's usage of packing in blisters for Iron and Folate in an IFAd trial (Byamugisha et al., 2022), and the use of integrated pictorial handbook counseling (Nahrisah et al., 2020). However, some interventions did not improve anemia after the end of the experiment (Byamugisha et al., 2022; Rukmaini, 2018).

To analyze iron-folic acid supplementation adherence, few systematic reviews ⁴ and meta-analyses have been conducted (Akibu et al., 2018; Saragih et al., 2022; Sendeku et al., 2020). However, the study found evidence that anemia, one pregnancy, and adequate awareness of anemia and iron-folic acid supplementation were all related to higher adherence to the supplements. Additionally, educational factors, early time to the registration of ANC, number of ANC visits, and pregnant women in Ethiopia who received health education about the

advantages of IFAS were more likely to follow it. Furthermore, systematic reviews and meta-analyses intended to determine determinants towards compliance to iron-folic acid found that mothers from the municipal administration showed high compliance with iron-folic acid supplementation when they used antenatal care more than four times. Finally, there was less current compliance with the World Health Organization's advised level of iron-folic supplementation (Workineh et al., 2019).

Bibliometric methods are used to quantitatively assess the productivity of scientific outputs (Dervis, 2019). Additionally, it could evaluate the caliber of the studies, analyze the primary study topics, and forecast the course of future investigations. But until now, no bibliometric research has been published on pregnant women who are anemic and who adhere to iron supplementation. An urgent need exists for a bibliometric study because anemia among expecting mothers has not yet been fully managed. Additional information should be gleaned from these references. Therefore, our study was conducted to give a comprehensive grasp of the optimal program to increase adherence and future research prospects.

Review Questions

1. What are the top 10 most contributively authors (publication and citation), and how are the collaborative patterns of iron adherence studies among anemic pregnant women researchers?
2. What are the top ten most productive nations and organizations?
3. What are the most frequently used keywords, and how is the trending topic in iron adherence studies among anemic pregnant women research?
4. In what particular favorite sources would iron adherence studies among anemic pregnant women researchers like to publish their work results?

Methods

Study Design

Bibliometric analysis was used to review literature outlining established knowledge and other information trends regarding global publications (for example, information about keyword co-occurrence, citation, publication year, and authorship). R Studio

(Biblioshiny) was used to identify the most productive authors, countries, and organizations based on publication and citations. Meanwhile, VOS viewer (version 1.6.18) was used to visualize Co-authorship and Co-occurrence. Biblioshiny and VOS viewer was already conducted from previous bibliometric studies (Dervis, 2019; Gautam et al., 2020; Maula et al., 2018; Perwitasari et al., 2022; Yu et al., 2020).

Data Sources

Information was obtained from the Scopus database on June 10, 2022. The years covered in Scopus were from the oldest, 1989, to the newest, 2022. The Scopus database is the most comprehensive database of citations and abstracts for peer-reviewed literature with a wide range of them (Ali et al., 2021; Khudzari et al., 2018). Besides Web of Science (WoS), PubMed, and Google scholar, Scopus is a prominent database for conducting bibliometric analysis. Scopus was used because other topics may not be found in WoS, PubMed, or Google Scholar (Ali et al., 2021).

Bibliometric Screening Strategy

The Global massive literature about Adherence OR Compliance AND Pregnancy OR Pregnant women AND Iron OR Ferrous AND anemia published between 1981 to 2022 was searched in the Scopus database. Those terms were used as the keywords in the Scopus search page. The information from the documents, including author, title, affiliation, keywords, citation, type of journal, language, and year of publication, was entered and then exported to CSV. The document type (articles), language (English), and source type (journals) were extracted from the Scopus database.

The inclusion criteria for searching methods in the database are all iron adherence studies among anemic pregnant women during all years (1989 until 2022). Reviews articles (systematic review and meta-analysis, books, conference paper, erratum, editorial, letter, and note were excluded. The final 360 journal articles from the Scopus database were analyzed to see the number of publications every year, the year of publication, the trend of keywords being used, authorships, citations, organizations, and countries (Figure 1). The article screening technique was carried out separately by two authors of this study to verify the reliability and consistency of the results. Then they compared their results to

see if they agreed, and any inconsistencies were ironed out at this point (Huang et al., 2022).

Statistical Methods

Descriptive statistical analyses were conducted to display the publications' timing and distribution.

Ethics Statement

There was no need for informed consent because this study did not involve human participants.

Results

Metadata Analysis Results

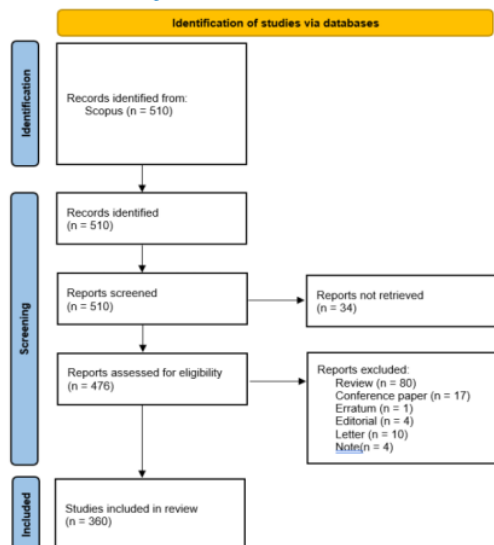


Figure 1 Bibliometric screening strategy

The results from the Scopus database assessed 510 articles according to the mentioned keywords. Five hundred ten articles exclude 150 articles and left 360 articles as final data. The first paper appeared in Scopus in 1981 with 1 article. Figure 2 shows a fluctuating graphic in the number of papers published in Scopus from 1981 to 2022. However, there has been an increasing article in the last ten years, from 2011 until now. The most published article between those years was in 2021, with 37 articles. The average number of publications per year is less than 40 articles. The analysis using bibliometrics showed that articles published about adherence towards iron among anemic pregnant women are still low, even though there have been more publications over the past ten years. This condition showed that there are still many

opportunities to conduct research on intervention studies among anemic pregnant women.

Table 1 Top 10 most productive authors

| Rank | Author | TP |
|------|----------------|----|
| 1 | Pasricha S-R | 5 |
| 2 | Biggs B-A | 4 |
| 3 | Casey GJ | 4 |
| 4 | Dickin KL | 4 |
| 5 | Kamau MW | 4 |
| 6 | Martin SL | 4 |
| 7 | Martorell R | 4 |
| 8 | Mirie W | 4 |
| 9 | Ramakrishnan U | 4 |
| 10 | Auerbach M | 3 |

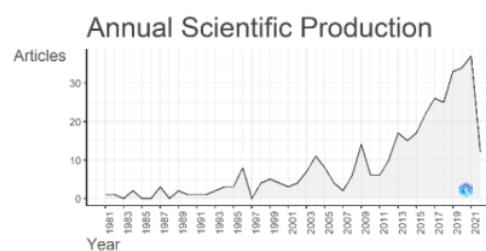


Figure 2 Publication distribution over the years

Bibliometric Analysis of the Authorship and Citations

The researcher has a vital role in evaluating the development of an academic field, as selected in articles published in some databases (Guo et al., 2021; Xu et al., 2020). Therefore, in this study, not only the authors but also co-authorship is analyzed to see the authors that have good publication ability and good contribution in this field. The entire number of articles and citations was examined to see the author's contribution to a particular scientific topic. The top ten contribution authors are reflected in Table 1. Authorship style reveals that the top ten authorship styles have a sizable number of publications. The leading seven writers' collaborative patterns were with more than four authors. Interestingly, author Kamau MW was single authorship with one publication in 2020. Meanwhile, Auerbach M stays in the tenth position with two authorships in one publication, and Mirie W publication authorship has similar patterns with three authorships in their two publications.

The top 10 articles in this field with the most citations are listed in Table 1. Intriguingly, every one of the top ten articles was released before 2020. However,

the publication significantly increased after 2020. This shows that the citation patterns are still low from 2020 until 2022. The top three documents in **Figure 3** were published in the British Journal of Haematology, Circulation Journal, Social Science,

and Medicine. Additionally, **Figure 3** shows Galloway R's remarkable work with his two publications in 1994 and 2002, with 212 and 169 citations, respectively.

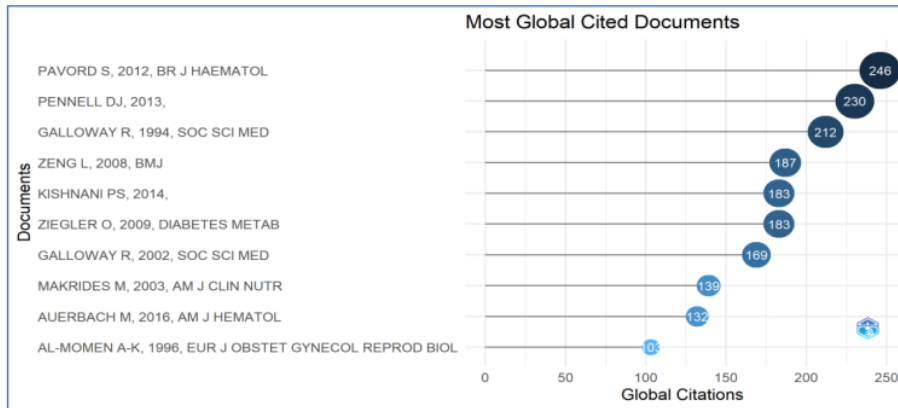


Figure 3 Top 10 most globally cited

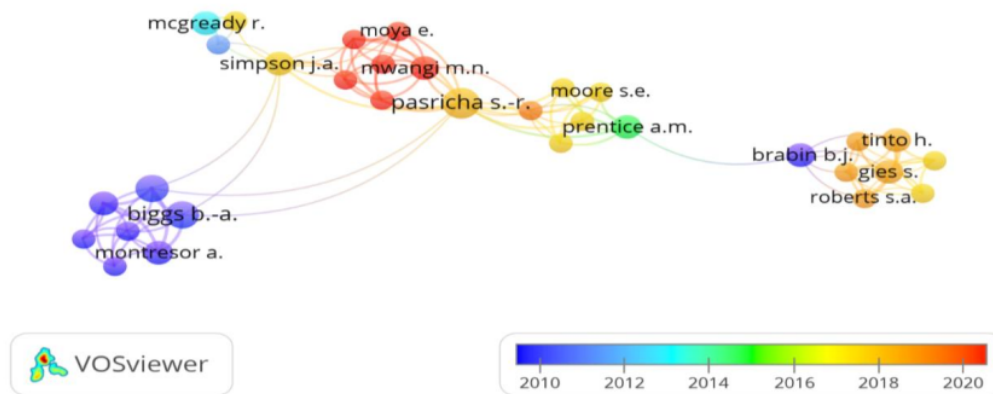


Figure 4 Visualization of article authors distribution 2010-2020

Figure 4 shows the distribution of authors in publishing articles on adherence to iron supplementation among anemic pregnant women based on the number of publications and the year of publication. The analysis' findings utilizing bibliometrics show that Pasricha, Biggs, and Casey are the three authors with the highest number of publications from 2009 to 2019. Meanwhile, Mwangi M.N and Moya E have more recent publications. However, the number is still small, so the results of the articles from the three authors can be used as a reference because of their consistency in conducting research on intervention studies among

pregnant women with anemia. VOS viewer visualized authors with at least two documents published during the period. **Figure 4** shows a bigger circle meaning a higher number of publications. Additionally, the color difference indicates the year of publications; for example, from 2010 until 2011, the color is dark blue, and the red meaning of a recent year (2020, 2021, 2022).

Most Productive Countries and Organizations

Figure 5 shows the distribution of authors by country. Most of the authors were from the USA (310 articles), India (204 articles), and Australia (102

articles). The author's distribution picture shows that the authors do not come from all countries in the world, even though one of the global health problems is anemia (Jose et al., 2019). Seventy-two countries worldwide participate in studies on adherence to iron supplementation among anemic pregnant women. However, the number of publications in each country is still small. Based on the author's data, some productive writers have few publications which do not reach ten articles. It becomes essential for each country to conduct this research because iron deficiency anemia is the most

common dietary deficit affecting both industrialized and developing nations (Jose et al., 2019). Figure 6 also shows the country collaboration map figured pattern of global collaboration related to those fields. The USA has the greatest number of collaborations with other countries, followed by the UK and Australia. Of the top 10 organizations, Thomas Jefferson University produced 30 publications, followed by the University of Melbourne with 17 and the University of Tasmania with 11 publications (See Figure 7).

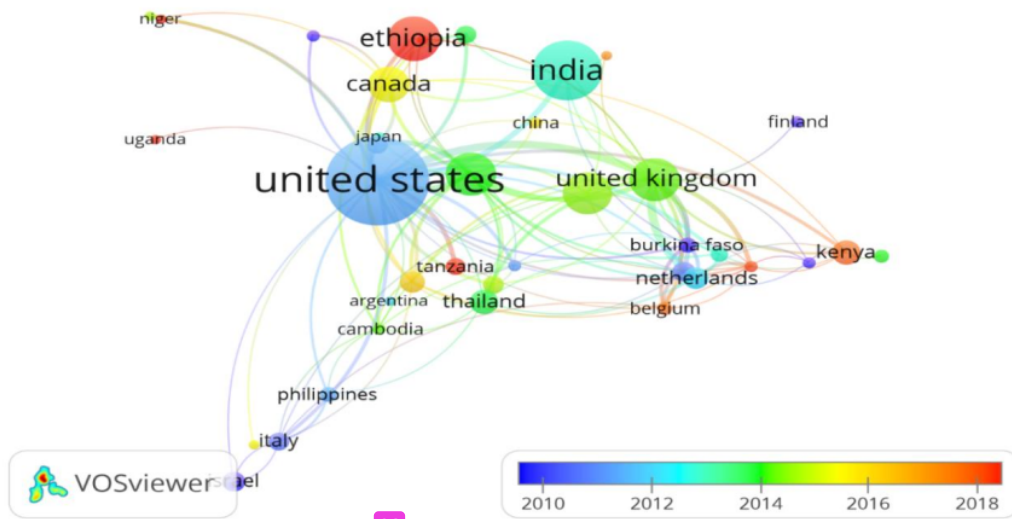


Figure 5 Visualization of country distribution based on the number of publications, and year of publication from 2010-2018

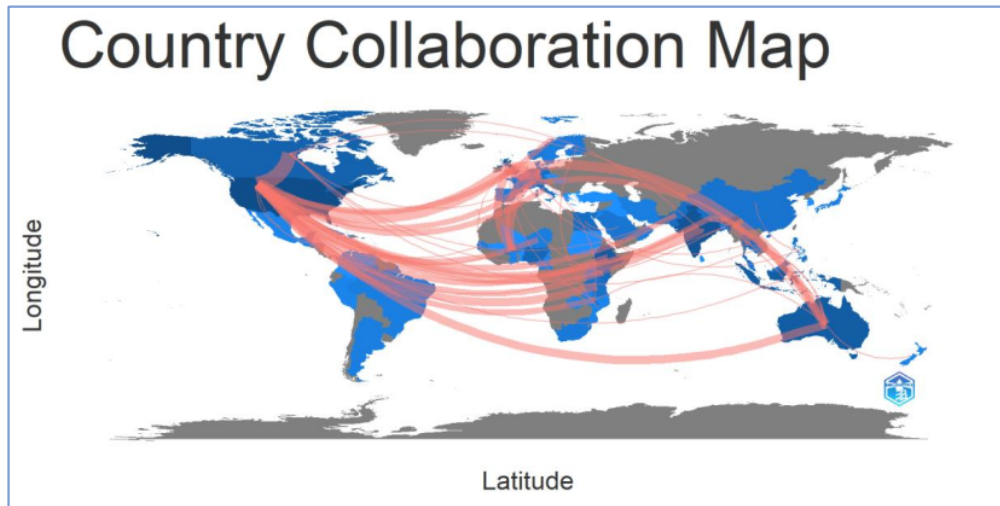


Figure 6 Visualization of country collaboration distribution based on number of collaboration frequency

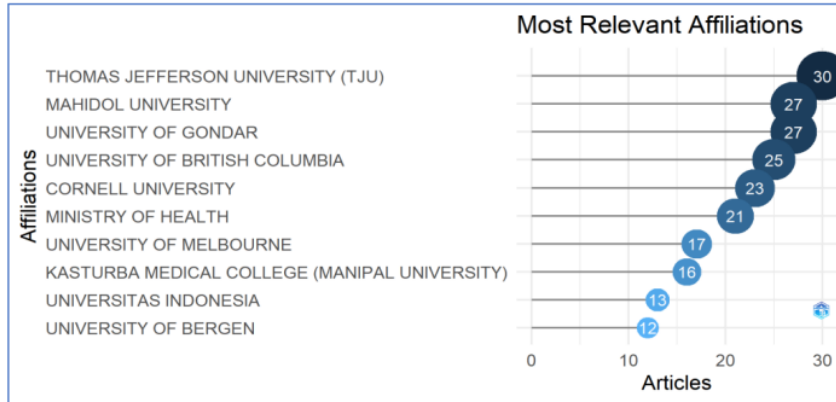


Figure 7 Distribution of the most relevant affiliation

Bibliometric Analysis of Themes and Trend Topics

Figure 8 shows the result of visual analysis carried out with VOSviewer on the words used by the author and Scopus. In the analysis and visualization, keywords appeared at least five times in each piece of literature. The word size indicates how often a word appears; when it appears multiple times in a manuscript, it counts as one. Meanwhile, the bubble's shade of color denotes the term's median annual quote rate. Figure 8 shows that in 2018 the trending keyword being used by the authors were, for example, intravenous iron and iron supplements.

Meanwhile, the biggest bubble remains from 2012 to 2014. The purple bubbles showed author keywords about pregnancy, anemia, and compliance. Adherence was figured in the yellow-orange bubble.

Figure 8 shows that intervention-related adherence toward iron supplementation remains low. The bubble can be seen during the 2018 period (red bubble), for example, iron and folic acid and iron supplements. However, there is still a lack of words mentioning intervention, randomized control trials, or quasi-experimental studies related to adherence to iron supplementation. Adherence appeared in an orange bubble; compliance appeared in a light blue bubble. The trends topic visualized using Biblioshiny is also the same when analyzed using the VOSviewer tool. Figure 9 shows trending topics recently mentioned about public health, epidemiology, pregnancy, iron supplement, and iron and folic acid. Keyword pregnancy is the highest frequency from 2012 to 2014. Additionally, adherence showed not more than 25 times during this period (the term frequency).

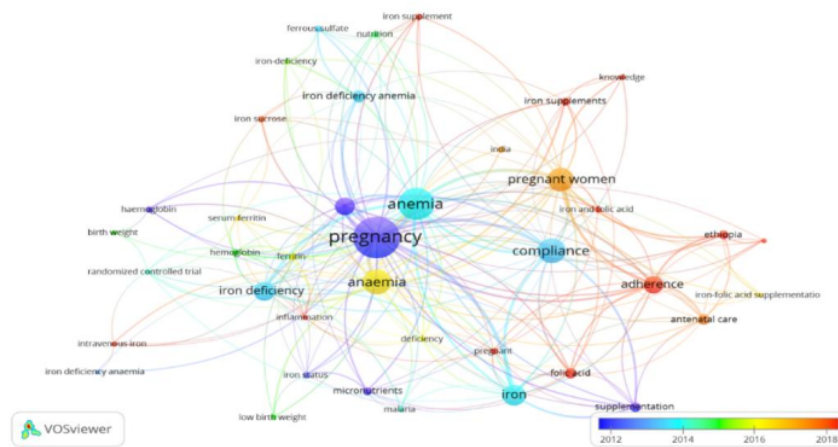


Figure 8 Distribution of the author keywords from 2012 until 2018

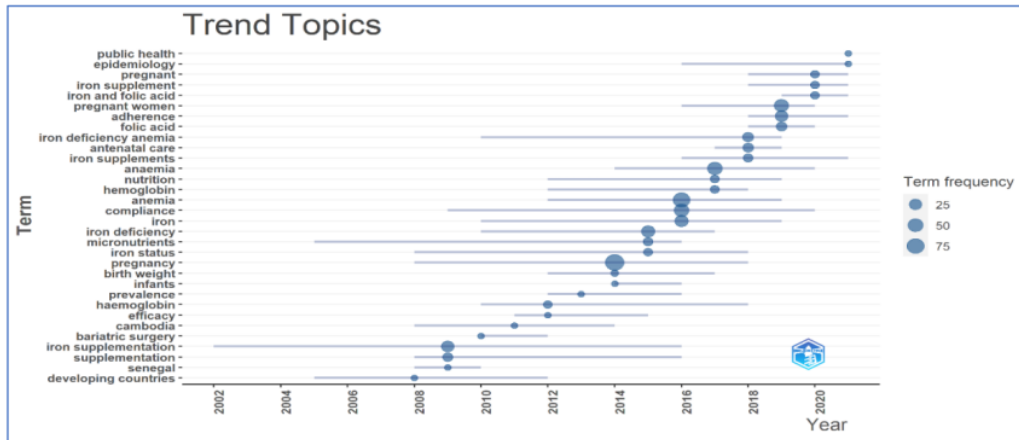


Figure 9 Trends topic 1964-2022

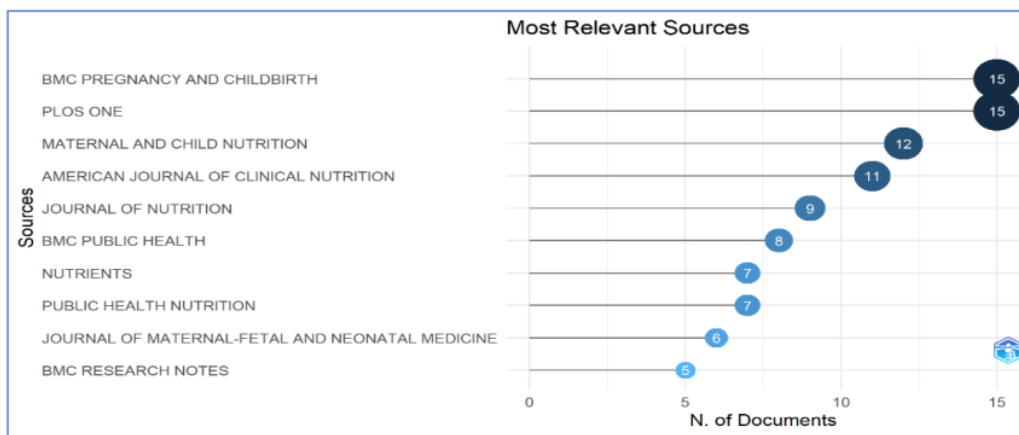


Figure 10 Most relevant sources

Bibliometric Analysis of Source

Figure 10 shows the top 10 most relevant sources in the world related to these trends of topics. The highest ranking for relevant sources is BMC Pregnancy and Childbirth and Plos One, with 15 articles, followed by Maternal and Child Nutrition, American Journal of Clinical Nutrition, and Journal of Nutrition, with 12, 11, and 9 articles, respectively. Two journals with the highest publication in this trend are Quartal 1 and belong to the USA. Maternal and Child Nutrition belongs to the United Kingdom and is included in Quartal 1. Meanwhile, the fourth and fifth ranks are both Quartal 1 and also belong to the USA.

Discussion

In general, the investigation identified the primary authors, the most-cited documents, trend topics and

keywords of publication, the most productive country and organization, global collaboration patterns, relevant journals, and other statistics that contribute to developing a picture of the literature. The various research on anemic pregnant women's adherence to iron supplementation is represented in the current data analysis, which comprises the top authors, nations, organizations, and publications' originating sources. Review trends and advancements in many fields and research areas are increasingly done using bibliometric analysis (Farooq et al., 2021). This study shows the significant growth of adherence studies among pregnant women with anemia by authors worldwide. According to estimates, maternal anemia affects 32 million pregnant women worldwide (Stevens et al., 2013). Women's physiological need for the iron rise during pregnancy to promote fetal (Bothwell, 2000), and

iron deficiency is a key factor in anemia in many settings (Kassebaum et al., 2014). Trends topics mentioned mostly about pregnancy and anemia.

Compliance, iron supplementation, and folic acid are also frequently mentioned. However, little keyword intervention or experimental study is still mentioned in this study. Therefore, future intervention programs or experimental studies are needed to decrease anemia and enhance adherence to iron-folic acid supplementation among pregnant women. Regarding authors, Pasricha, with the highest documents so far, is interested mostly in randomized control studies regarding supplemental iron dosage, IV route of Iron, and treatments to combat iron-deficiency anemia. Pasricha is one of the researchers from the University of Melbourne, Melbourne, VIC, Australia. On the other hand, the most cited author, Galloway, with the highest cited documents in 1994 and 2002.

The publication was related to factors influencing pregnant women's compliance with iron supplementation, women's perception regarding the iron supplement, and how to prevent anemia in eight developing countries. Unlike Pasricha, Galloway is from The World Bank, WHO, and the USA. The publication frequency and collaboration frequency regarding this topic from USA and Australia were the three highest in this result. Regarding research on these subjects, the USA tops the list of these nations, followed by India and Australia. Although India has produced relatively number 2, the highest publications, its collaboration has obtained significantly lower than UK and Australia. Indian researchers now have a great deal of responsibility to collaborate with other researchers across the country. Our findings are consistent with those of Tao and Farooq, who found that the USA is the most productive nation; however, related to Covid-19 bibliometric analysis (Farooq et al., 2021). Data from World Bank showed the prevalence of pregnant mothers with anemia worldwide. Although USA and Australia have a low percentage of Anemia, the data from The World Bank showed a significant increase during the last ten years (the previous data was from 2019) and the United Kingdom.

Meanwhile, India, the number 2 highest productive country, still shows a high percentage of anemia prevalence, with 50% in 2019, even though the percentage is decreased. This data proved that

anemia is still a significant health issue, particularly for girls in developing nations (Safiri et al., 2021). Therefore, consideration should be given to the establishment of preventive initiatives with an emphasis on expanding access to iron supplements, early hemoglobinopathies diagnosis, and treatment.

Interesting patterns regarding adherence or compliance were analyzed in this study. From 1981 until 2022, there were several methods to capture adherence or compliance regarding iron among anemic pregnant women. There was a cross-sectional study, quasi-experimental, and randomized control trial. Although most nations give the iron supplements (Elsharkawy et al., 2022) and as part of antenatal treatment, to reduce the risk of low birth weight, maternal anemia, and iron deficiency, it is recommended that women take daily oral iron and folic acid supplements (World Health Organization, 2014), the fundamental problem is inadequate or absent compliance (Peña Rosas et al., 2015a). One study from WHO in 1981 is the first recorded publication of this study. The study was "The role of WHO in the control of nutritional anemia." Example publication with an Intervention study related to adherence or compliance started in 2014 comparing the impact of SMS messaging on Iranian pregnant women's compliance with iron supplementation: A randomized controlled trial (Khorshid et al., 2014). There were studies in these recent years regarding the trial to enhance anemic pregnant women who take their iron supplements as prescribed; for instance, using a picture book or mobile technology to monitor iron consumption at home (Nahrisah et al., 2020; Rukmaini, 2018). Recently developed methods demonstrate the importance of a new program to improve compliance. However, the small number shows that there are still many opportunities for researchers worldwide to find more effective and efficient methods.

Since articles that are only indexed in papers commonly utilize bibliometric analysis from the Indonesian journal database, they could not be included in this study because bibliometric is commonly used in journals that are included in an international database such as PubMed, Scopus, or Web of Science (Maula et al., 2018). However, some issues exist with employing a local journal for bibliometric investigations. The local language presents particular challenges in identifying articles

for analysis when searching for specific articles. The language barrier makes the hole even more comprehensive because there is one chance that other articles regarding such keywords published in the Indonesian language could not be detected. However, when researchers try to find a local article from Indonesia, the Google Scholar database has this way. The bibliometric study can easily be analyzed using the Google scholar database in English or Indonesia.

Conclusion

Although the number of publications rose each year, there are still fewer than 40 publications annually. Pregnancy, anemia, and compliance were still the most frequent keywords. However, word intervention or experimental studies were still low. Therefore, future intervention programs or experimental studies are needed to decrease anemia and enhance pregnant women's adherence to iron-folic acid supplementation. This data mentioned some countries with a low percentage of anemia among pregnant women. However, throughout the previous ten years, anemia has remained a significant health problem, as evidenced by the high number of publications and collaborative studies. The value of a new program to increase compliance is shown through created methodologies. The modest number indicates that researchers still have many chances to develop better, more productive techniques. This research was done by extracting the database from Scopus only. However, other databases might have different results. Therefore, the authors suggest other bibliometric studies using WoS, PubMed, and other databases.

Declaration Conflicting Interest

None to declare.

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Author Contribution

RNA developed a research model by searching the literature, reviewing the literature, analyzing the data, and writing the manuscript. LMI contributed to reviewing the method and re-analyzed the data. DAP contributed to the development of the manuscript and checked the final

implications and final structure of the paper. A contribu¹⁰ to reviewing the literature, and SU contributed to the manuscript finalization. All authors approved the final version of the article to be published.

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