GLOBAL RESEARCH TRENDS ON FACTORS AFFECTING TUBERCULOSIS (TB) ADHERENCE AND DROPOUT: A BIBLIOMETRIC STUDY

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ABSTRACT

Tuberculosis (TB) remains one of the significant global health challenges, especially in resource-limited countries. Adherence to TB treatment is key to successful therapy and preventing the emergence of drug resistance. However, dropout rates or discontinuation of treatment before completion remains a major problem that needs to be addressed. This study aims to analyze global trends in research focusing on factors affecting TB treatment adherence and dropout through a bibliometric approach. Using the Publish or Perish application, relevant scientific articles with keywords such as treatment adherence, tuberculosis, treatment dropout, and influencing factors were searched from 2017 to 2024. A total of 50 articles from Google Scholar were further analyzed to identify by publication year, country, publisher, citation, and article type. The data was then processed using VOSviewer to visualize the relationship between keywords and research trends through Network Visualization, Overlay Visualization, and Density Visualization. The results of the analysis showed that Indonesia is the country with the highest number of publications, demonstrating a great commitment in addressing the TB challenge. Articles published in reputable journals, especially those adopting systematic and meta-analysis approaches, show great impact with a high number of citations. Bibliometric visualizations reveal that the focus of research lies on factors such as treatment, adherence, health workers, and access. In addition, family and community support was also found to be an important element in ensuring treatment adherence. In conclusion, this study emphasizes the need for a comprehensive and collaborative approach in improving TB treatment adherence and preventing dropouts. Further research in this area is needed to address existing gaps and develop more effective strategies in the fight against TB.

Keywords: Treatment Adherence, Tuberculosis, Dropout, Influencing Factors, Health Worker

INTRODUCTION

Infectious diseases are still a public health problem that causes high morbidity, mortality and disability so it is necessary to organize countermeasures through effective and efficient prevention, control and eradication efforts. Tuberculosis is an infectious disease that is still a public health problem and one of the causes of death, so it is necessary to implement tuberculosis control programs on an ongoing basis.

Tuberculosis (TB) is a highly contagious disease caused by the Mycobacterium Tuberculosis germ where most TB germs attack the lungs, but can also affect other organs. The source of transmission can occur when patients with BTA positive TB (acid-resistant bacilli) cough or sneeze, spreading germs into the

air (droplet nuclei) (Kemenkes RI, 2011). Pulmonary tuberculosis (TB) is an infectious disease that is a public health problem worldwide. Pulmonary TB ranks second only to HIV infection, causing millions of deaths each year. Pulmonary tuberculosis is caused by Mycobacterium tuberculosis which is transmitted through sputum droplets from positive TB patients (Ministry of Health of the Republic of Indonesia, 2014). A 2015 WHO report estimated that globally there were 9.6 million new TB cases. TB in Indonesia ranks third after India and China, with 824 thousand cases and 93 thousand deaths per year, or 11 per hour. In Indonesia, most TB cases occur in the productive age group, especially at the age of 45-54 years (Karuniawati et al., 2015, 2019; Karuniawati, Sudjono et al., 2017; Indonesian Ministry of Health, 2023).

Non-adherence to treatment impacts the patient and their contacts. The individual remains ill and the chain of transmission is not broken. Furthermore, persistent infection leads to drug resistance and disease recurrence, which hinders the recovery process and increases treatment time and costs (Lucena, et al 2023).

Research on TB treatment adherence and the factors that influence it has been a major focus of global efforts to tackle TB. However, understanding how these factors interact and influence treatment outcomes still needs to be improved. To gain a clearer picture of trends and developments in this area of research, it is important to conduct a bibliometric analysis that can identify patterns, trends, and relationships between various elements in the scientific literature.

This study aims to conduct a bibliometric analysis of global trends in research on factors affecting TB treatment adherence and dropout. Using data obtained from various scientific publications, this analysis will identify key topics, research patterns, and development trends in this field. Through this approach, it is hoped to provide in-depth insights into an area that has been intensively researched as well as identify potential research gaps that still require further exploration. This study not only aims to map the existing research landscape but also to provide recommendations that can help in formulating more effective intervention strategies in improving TB treatment adherence and reducing dropout rates.

OVERVIEW

Tuberculosis (TB) is still a public health problem in Indonesia and worldwide and is one of the Sustainable Health Development Goals (SDGs). Tuberculosis is one of the top 10 causes of death and the leading cause of infectious diseases in the world. The prevalence of tuberculosis patients in 2020 was 929 patients who took medication regularly for less than 6 months, which amounted to 48.87%. Tuberculosis is a disease caused by Mycobacterium bacteria and is still a disease with a high burden on Indonesian society. The increasing burden of TB disease is caused by poverty, the failure of TB control activities that have been caused by political commitment and inadequate funding, the unavailability of services in the community leads to reduced problem innovation and inappropriate diagnosis, reduced drug supplies, and, reduced reporting of TB patients. Lack of surveillance, lack of discourse on case recording and reporting, treatment management and unreported movement of patients (Director General of Disease Control and Environmental Health, 2015).

This disease is transmitted by fetopositive patients, spread by droplet nuclei that come out when the patient coughs or sneezes (Mar'iyah & Zulkarnain, 2021). After entering the body, TB bacteria can cause infection both in the lungs and outside the lungs (extra-pulmonary TB). Pulmonary TB accounts for 80% of all cases, with the remaining 20% being extra-pulmonary TB, including lymph node TB, TB spondylitis and TB

meningitis. Pulmonary TB is characterized by typical symptoms, namely coughing with phlegm for more than three weeks and other additional symptoms such as shortness of breath, weight loss, night sweats, malaise and decreased appetite (Aini & Rahmania Hatta, 2017).

TB transmission occurs through droplet nuclei emitted by patients infected with TB. Droplet nuclei can hold 1-5 bacteria and are highly infectious and can survive at room temperature for up to 4 hours. The very small size of the bacteria (<5µm) enters the airway easily and manages to pass through all the protections in the airway to the alveolus to replicate. One patient coughing can release up to 3,000 droplet nuclei and one patient sneezing can release up to 1 million droplet nuclei. The dose needed to cause infection in humans is 1-10 bacterial bacilli (Ministry of Health of the Republic of Indonesia, 2020),

If patients stop taking TB medication too soon, they may fall ill again; if they do not take their medication properly, the surviving TB bacteria may become resistant to TB drugs. In addition, if treatment is not taken regularly and within the prescribed time, it will lead to treatment failure in patients, increasing the risk of morbidity and mortality and may lead to resistance. Resistance can occur to multiple drugs simultaneously, called Multi Drugs Resistance (MDR) and Extended Drugs Resistance (XDR). In addition, TB bacteria that are resistant to TB drugs will be harder and more expensive to treat (CDC, 2016). This will complicate the eradication of pulmonary tuberculosis in Indonesia and increase the burden on the government (Ministry of Health of the Republic of Indonesia, 2014).

Non-adherence to treatment affects the patient and their contacts. The patient remains sick and the chain of transmission is not broken. Furthermore, persistent infection leads to drug resistance and disease recurrence, which hinders the recovery process and increases the time and cost of treatment (Lucena, et al 2023).

Adherence to TB treatment is an important factor in preventing relapse and avoiding drug resistance. A study revealed that high rates of TB treatment dropout (17%) and treatment incompleteness (45%) will affect treatment success. One of the main TB treatment programs is DOTS (Directly Observed Treatment, Short-course) which prevents patients from dropping out of treatment, thus avoiding drug resistance. However, a study states that the DOTS program has not achieved 100% treatment adherence and a large proportion of patients drop out of treatment. The Community-Based DOTS (CB DOTS) approach will provide more effective treatment outcomes than Facility-Based DOTS, because Community-Based DOTS is more patient-centered (Efendi et al, 2022).

In a study conducted by (Apay & Rohmani, 2022) it was found that there were 3 factors that influenced the success of Lung TB treatment at the Rimba Jaya Health Center, namely education, economic status and access to treatment. While those that do not affect the success of Lung TB treatment are age, gender, occupation, type of drug-taking supervisor, role of drug-taking supervisor, knowledge.

Age, race, education, income, smoking and drug use, HIV infection, and treatment category showed statistically significant associations with TB treatment dropout in the unadjusted analysis, but gender and DM status did not. After adjustment, only income, smoking status, drug use, and treatment category remained associated with treatment dropout. On the other hand, age, race, education, HIV infection lost significance. Factors associated with a higher likelihood of non-adherence to ATT were, after adjustment, living in a low-income area, substance abuse, poor adherence to previous ATT regimens, and smoking history. Among patients undergoing re-treatment, three other variables were

associated with a higher risk of non-adherence: young age, male gender, and low education level. (Madeira O et al, 2018).

Another study emphasized the importance of addressing knowledge gaps, providing comprehensive patient education, effectively managing drug side effects, and fostering a strong family support system to improve TB treatment adherence and completion rates. These insights can inform healthcare strategies aimed at optimizing TB patient care and improving treatment outcomes (Zuhair RD & Ismah I, 2024).

Knowledge plays an important role in the successful treatment of tuberculosis. TB patients and their families should always be given counseling during patient visits or when health workers conduct contact investigations in the field to increase their understanding of TB. In order for tuberculosis patients to adhere to their treatment, cooperation from various parties including family, community and private practitioners is needed (Manurung etal, 2020).

Family support can reduce the effects of anxiety by directly improving individual mental health. Family support is a very important family coping strategy, because family support is support that is seen by family members as something that families can get to overcome their problems. Through family support a person feels comfort, attention, appreciation and can accept his condition. Family support shows that the onset of pain experienced by patients is lower, compliance with taking medication increases so that patients recover faster from their illnesses (Nasution & Tambunan, 2020).

One of the factors supporting successful TB treatment is medication adherence. The long duration of TB treatment, at least 6 months, causes patients to drop out. In addition, if the patient has taken anti-tuberculosis drugs (OAT), TB symptoms such as coughing, shortness of breath, decreased appetite and weight loss will decrease. If information is not provided adequately, patients may make assumptions that they are cured so they no longer need to take medication (Andri et al., 2020). The TB treatment process that lasts long enough requires support from various parties including family support. Family support during the treatment period can be provided in various forms, including as a supervisor of swallowing drugs and a motivator for patients to complete the treatment process (Sahlan et al, 2023).

RESEARCH METHODOLOGY

This study used a bibliometric approach to analyze global trends in factors affecting tuberculosis (TB) treatment adherence and treatment dropout. The method began with an article search using the Publish or Perish (PoP) application, which was integrated with Google Scholar as the main database. The main focus of the search was relevant articles with the keywords "*treatment adherence," "tuberculosis (TB)," "treatment dropout," "influencing factors," "family support," "health worker support," and "accessibility of health services*." The time span selected for the article search was from 2017 to 2024, with a total of 50 articles to be analyzed. The use of these specific keywords aims to highlight aspects that influence TB treatment continuation, including internal factors such as family and health worker support, as well as external factors such as accessibility of health services.

After collecting articles from the initial search results, the next step was to conduct a more in-depth selection to ensure that the selected articles were relevant to the research topic. The selection process involved reading the abstract, keywords, and conclusion of each article to determine its suitability. Articles were selected that specifically addressed TB treatment adherence, treatment dropout, and the various factors that influence patient behavior in undergoing TB treatment. At this stage,

the relevance of the content to the main focus of the study was the main criterion in the selection process. Articles that were not directly related or did not provide significant discussion of the topic under study were excluded from the list of articles to be analyzed.

The data obtained through the Publish or Perish (PoP) application was then categorized based on several important dimensions, namely year of publication, country of publication, publisher, number of citations, and type of article. Grouping data by year of publication provides an overview of the temporal development of research related to factors affecting adherence to TB treatment and treatment dropout during the selected time period. Meanwhile, grouping by country of publication allows for the identification of geographical patterns of research and the contribution of different countries to the study. In addition, classification by publisher and article type helped in understanding the main sources of publication and dominant research formats on this topic. Citation analysis was used to identify articles that had a significant impact in the literature and influenced the development of research on this topic.

The next stage in this research was bibliometric network analysis using VOSviewer software, which allows visualization of network maps based on the relationships between articles, authors and keywords. In this analysis, settings with a minimum occurrence parameter of 4 and a term count of 20 were used. This means that only words or terms that appear at least four times in the articles analyzed will be included in the network map. This analysis aimed to identify research trends, emerging clusters, and key topics of focus in the scientific literature on TB and factors affecting treatment adherence. VOSviewer was used to visualize this data in three types of maps: Network Visualization, Overlay Visualization, and Density Visualization.

Network Visualization produces a map that shows the relationships between elements in the research, be it between authors, articles, or keywords. In this visualization, larger nodes indicate elements that appear more frequently or that have many relationships with other elements. This map provides an overview of research groups or clusters formed based on the proximity of topics or authors that are connected to each other. Overlay Visualization provides an overview of changing research trends over time using color gradations. It allows researchers to see which topics have received more attention in the past and which are growing at the moment. Meanwhile, the Density Visualization displays the density of the elements in the map, where high-density areas indicate more dominant themes or topics in the analyzed literature.

Using a combination of analysis from Publish or Perish and VOSviewer, this study sought to map global trends in studies of TB treatment adherence and treatment dropout. It also sought to identify key actors (such as authors or institutions) in these studies, as well as patterns of collaboration among researchers. The results of this analysis are expected to provide deeper insights into the dynamics of research in this area, as well as help direct the focus of future research. The visualizations generated from VOSviewer will also help in conveying the research findings in a more intuitive and easy-to-understand manner, both for researchers and policy makers in the health sector.

RESULTS AND DISCUSSION

The results of this study will be discussed in several key aspects, including the temporal distribution of research, geographical origin of articles, publishers, as well as citation patterns. A bibliometric network visualization will also be outlined to show how authors, keywords, and research topics related to factors affecting TB treatment adherence and treatment dropout are interconnected. This analysis will shed light on the main clusters in the

study, topic trends over time, and the most dense and dominant areas of research. In addition, the discussion will explore the implications of these results for knowledge development in the field of TB treatment adherence, as well as how these findings can contribute to improving health interventions and policies related to TB management in different countries.

Discussion and Analysis of Publication Trends by Year of Publication

From the data that has been analyzed, there are fluctuations in the number of publications related to research on factors affecting adherence and dropout in tuberculosis (TB) treatment from 2017 to 2024. In 2017 and 2018, the number of publications was stable with 6 articles each. However, there was a significant decrease in 2019 with only 3 publications. This decline may reflect a period where attention to this topic may have waned or there may be other factors affecting the number of studies published.

2020 showed a slight increase with 5 publications, but interestingly there was a significant spike in 2021 with 11 publications. This spike could be due to the increasing global awareness of the importance of TB treatment adherence, possibly influenced by the COVID-19 pandemic situation which has led to an increase in research in the health field. Although there was a slight decrease in 2022 with 5 publications, a positive trend was again seen in 2023 with 10 publications, suggesting that this topic remains relevant and a focus of attention within the scientific community.

In 2024, although the number of publications decreased to 4, this does not necessarily indicate a significant decrease in interest, as the data may not fully reflect the number of publications that will be published during that year.

Overall, these data suggest an increasing trend of research focusing on factors affecting TB treatment adherence and dropout, especially in 2021 and 2023, indicating the importance of this topic in a global context.

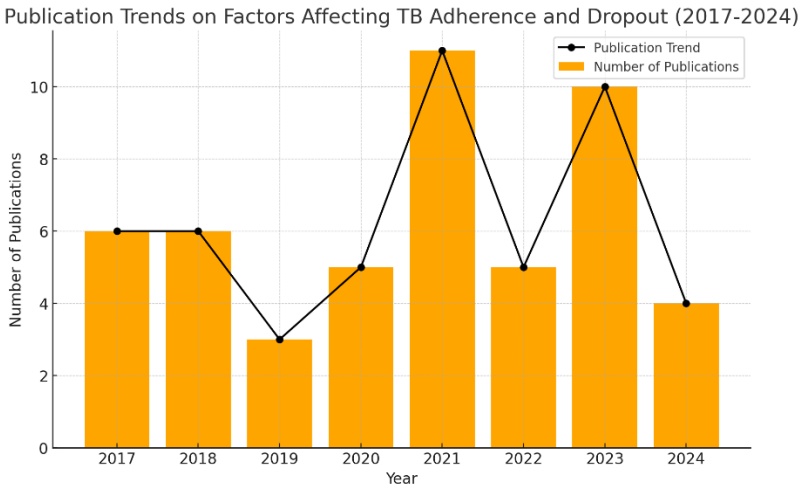

Figure 1. Related Publication Trends From Google Schollar Databases Using Pop Application

This figure shows fluctuations in the number of publications each year, with significant increases in 2021 and 2023, and some decreases in 2019 and 2022. This visualization provides a clearer picture of the dynamics of publications in this field over the analyzed period

Discussion and Analysis of Publication Trends by Country

Trend analysis of publications related to factors affecting TB treatment adherence and dropout showed significant variation between the countries involved in the study.

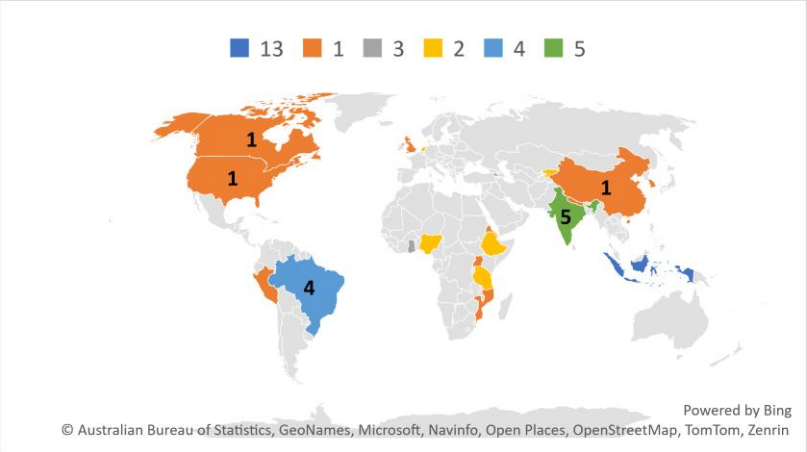

Figure 2. Distribution Of Countries That Publish Related Research

Indonesia emerged as the country with the largest contribution of publications, reaching 13 articles. This suggests that Indonesia pays great attention to the issue of TB treatment adherence, which may be due to the high incidence of TB in the country. Indonesia is known to have a high TB burden, and this has led to many local studies focusing on efforts to improve patient adherence to treatment.

India also showed significant contributions with 5 articles. Just like Indonesia, India also faces a very high TB burden, and much of the research in the country focuses on understanding and solutions to improve treatment adherence. India, with its large and diverse population, faces challenges in ensuring that TB patients complete their treatment, so a lot of research is being done to find effective ways to overcome this challenge. Brazil recorded 4 publications, showing that South America also faces TB treatment adherence issues that require attention. The existence of these publications reflects the efforts of the scientific community in Brazil to understand and address TB treatment adherence issues in the country.

Other countries such as Ghana (3 publications), Nigeria, the Netherlands, Kyrgyzstan, Tanzania, South Africa, and Ethiopia (2 publications each) show significant though lower contributions than Indonesia and India. These countries are located in different continents, indicating that the TB problem is a global concern and not just concentrated in one particular region. For example, Africa has several countries with relevant publications, such as Ghana and Nigeria, which may indicate specific challenges in the region related to TB treatment. Countries such as USA, Uganda, Eritrea, UK, Mozambique, South Korea, Costa Rica, China, Timor Leste, Peru, Nepal, Armenia, and Canada have only one publication each. This could indicate that while there is awareness of the importance of adherence to TB treatment, there may be limitations in the number of studies conducted or publications produced. It could also reflect different research priorities or lower TB prevalence rates in some of these countries.

From this analysis, it can be concluded that Indonesia leads in the number of publications related to TB treatment adherence and dropout, reflecting the country's great attention to

the health challenges caused by TB. India and Brazil also show strong contributions, which is in keeping with the epidemiological challenges they face. The lower distribution of publications in other countries suggests opportunities to scale up research and interventions in these regions, especially in countries with only one publication. This highlights the importance of international collaboration to strengthen global research capacity in the fight against TB, with a particular focus on improving adherence to treatment and reducing dropout rates, which are key challenges in global efforts to control the disease.

Discussion and Analysis of Publication Trends by Publisher

From the available data, it can be seen that publications related to research on factors affecting TB treatment adherence and dropout are spread across various publishers. The publisher that published the most related articles was journals.plos.org with a total of 5 publications, followed by bmjopen.bmj.com and Springer which published 4 articles each. Taylor & Francis also showed a significant contribution with 3 publications.

Other large publishers such as Elsevier, ingentaconnect.com, bibalex.org, academia.edu, and ncbi.nlm.nih.gov each published 2 articles. While the remaining publishers such as academic.oup.com, ajpojournals.org, and nature.com only published 1 article each.

he wide distribution of publications indicates that TB-related research has considerable interest among scientific publishers. Large, reputable publishers such as journals.plos.org, Springer, and Elsevier appear to be the top choices for researchers to publish their research. This also reflects the significant global recognition and reach of this topic in the scientific community.

In addition, the presence of other publishers, including those based in smaller institutions or journals, indicates the contribution of diverse sources in disseminating knowledge related to TB treatment adherence. This indicates that the study attracted a wide range of academic interest, both from large international publishers as well as from specific journals and institutional repositories.

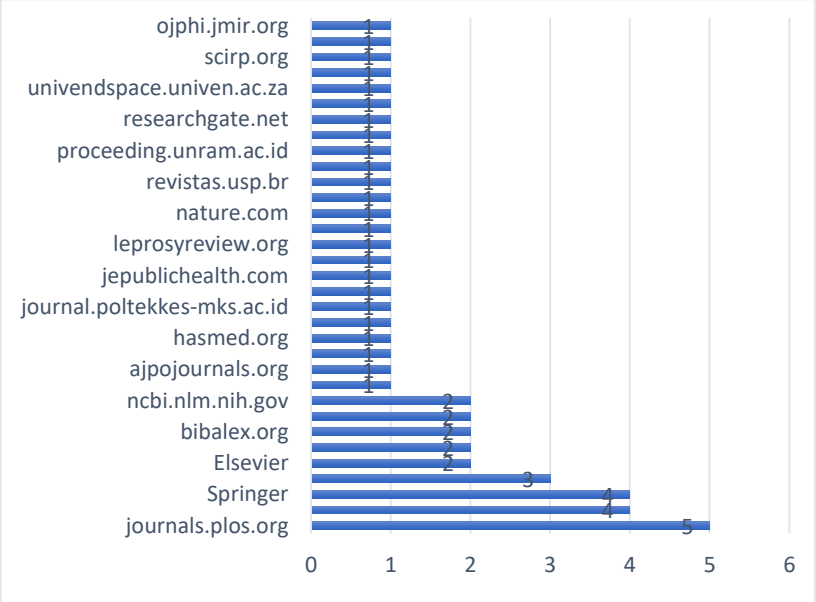

Figure 3. Distribution Of Publishers That Publish Related Research

From the publication analysis by publisher, it can be seen that journals.plos.org dominates with the highest number of publications related to research on factors affecting TB treatment adherence and dropout, followed by bmjopen.bmj.com and Springer. Major publishers such as Taylor & Francis and Elsevier also have significant contributions.

This spread shows that TB-related topics are attracting interest from a wide range of publishers, from large and established, to smaller institutions and journals. It also reflects how the topic of TB treatment adherence is a global concern across multiple scientific publication platforms.

If you still need a visualization in the form of a graph, I recommend double-checking the data to ensure there are no discrepancies, or if you would like me to merge and check the data, I can assist in doing so.

Discussion and Analysis of Publication Trends by Citation

Citation analysis is one way to measure the impact and influence of a publication in the scientific community. From the available data, we can see how some publications gain wide recognition through the number of citations received.

Table 1. Publication Trends by Citation

Citation	Author	Title	Year	Publisher	Country
443	N Alipanah, L Jarlsberg, C Miller, NN Linh...	Adherence interventions and outcomes of tuberculosis treatment: A systematic review and meta-analysis of trials and observational studies	2018	journals.plos.org	USA
204	FH Gebreweld, MM Kifle, FE Gebremicheal...	Factors influencing adherence to tuberculosis treatment in Asmara, Eritrea: a qualitative study	2018	Springer	Eritrea
111	JA Nhavoto, Å Grönlund, GO Klein	Mobile health treatment support intervention for HIV and tuberculosis in Mozambique: Perspectives of patients and healthcare workers	2017	journals.plos.org	Mozambique
102	IS Pradipta, D Houtsma, JFM van Boven...	Interventions to improve medication adherence in tuberculosis patients: a systematic review of	2020	nature.com	Indonesia

		randomized controlled studies			
46	D Dilas, R Flores, WC Morales-García...	Social support, quality of care, and patient adherence to tuberculosis treatment in Peru: the mediating role of nurse health education	2023	Taylor & Francis	Peru
37	KD Gashu, KA Gelaye, R Lester...	Effect of a phone reminder system on patient-centered tuberculosis treatment adherence among adults in Northwest Ethiopia: a randomized controlled trial	2021	ncbi.nlm.nih.gov	Ethiopia
36	AA Beraldo, RLP Andrade, NH Orfão...	Adherence to tuberculosis treatment in primary health care: perceptions of patients and professionals in a large municipality	2017	SciELO Brazil	Brazil
36	NM Parwati, IM Bakta, PP Januraga...	A health belief model-based motivational interviewing for medication adherence and treatment success in pulmonary tuberculosis patients	2021	mdpi.com	Indonesia
30	S Wen, J Yin, Q Sun	Impacts of social support on the treatment outcomes of drug-resistant tuberculosis: a systematic review and meta-analysis	2020	bmjopen.bmj.com	China
23	S van de Berg, N Jansen-Aaldring, G de Vries...	Patient support for tuberculosis patients in low-incidence countries: A systematic review	2018	journals.plos.org	The Netherlands

The Highest Cited article titled "Adherence interventions and outcomes of tuberculosis treatment: A systematic review and meta-analysis of trials and observational studies" published in 2018 by journals.plos.org has the highest number of citations with 443. This article originated from the USA and focuses on TB treatment interventions and outcomes through a systematic review and meta-analysis. The high number of citations of this article indicates that the study is highly influential and widely used as a reference in future research on TB treatment adherence. Another highly cited article from Eritrea published by Springer in 2018 titled "Factors influencing adherence to tuberculosis treatment in Asmara, Eritrea: a qualitative study" came second with 204 citations. This shows that qualitative studies on factors influencing TB treatment adherence in Eritrea also have a significant impact in the research community. An article from Mozambique published by journals.plos.org in 2017 with 111 citations also showed that treatment support interventions through mobile health (mHealth) technology for TB and HIV had a major impact, reflecting the growing interest in the use of technology in supporting the treatment of chronic diseases.

A Medium Impact article from Indonesia published by nature.com in 2020 on interventions to improve TB treatment adherence also received attention with 102 citations. This shows that Indonesia is not only the country with the highest number of publications, but also with articles that have a significant impact in the scientific community. Other articles from Peru, Ethiopia, Brazil, and China each had citations that varied between 23 and 46 citations. Although not as high as the previously mentioned articles, these publications still make an important contribution to enriching the TB-related literature.

Articles with lower citations (e.g. 23 citations from the Netherlands) still demonstrate the importance of contributing to an emerging topic, especially in the context of countries with low TB incidence. Despite the lower citations, these articles can form the basis for future research or for relevant policies in the context of low-risk countries.

From this analysis, we can conclude that articles with the highest number of citations tend to come from systematic reviews and meta-analyses that offer a comprehensive view of TB treatment adherence interventions. Articles published in high-impact journals such as journals.plos.org, Springer, and nature.com also tend to receive more citations, indicating that publishing in reputable journals can increase the visibility and influence of an article.

Publications from countries such as Indonesia, USA, and Eritrea show that even from different geographical backgrounds, solid and relevant research can be widely recognized by the global scientific community. This emphasizes the importance of research quality and relevance in gaining recognition through citations, which can ultimately influence clinical policies and practices in different countries.

Discussion and Analysis of Publication Trends by Article Type

From the data obtained, it can be seen that the majority of publications focusing on factors affecting TB treatment adherence and dropout are research articles (Research Articles), with a total of 44 publications. Meanwhile, publications in the form of literature reviews only amounted to 6 publications.

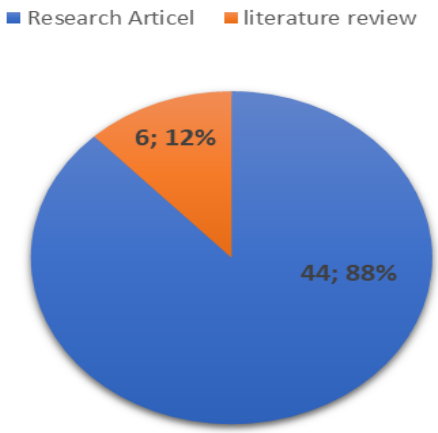

Figure 4. Distribution Of Countries That Publish Related Research

The figure above illustrates the distribution of publications by article type. From this diagram it can be seen that research articles dominate with 88% of the total publications, while literature reviews account for only 12% of the publications. This diagram clarifies the dominance of empirical research in topics related to factors affecting TB treatment adherence and dropout.

The dominance of research articles indicates that the field is characterized by empirical research that generates new data and findings. This indicates that TB-related research is still in an active exploratory stage, with researchers seeking to discover and test new hypotheses, as well as develop more effective solutions to improve adherence to TB treatment.

On the other hand, the relatively small number of literature reviews suggests that despite some efforts to integrate and review existing findings, the main focus of the scientific community is still on new explorations rather than summarizing existing knowledge. This could be an opportunity for future research to develop more literature reviews that can provide a comprehensive overview of the latest developments in this topic.

VOSviewer Network Visualization Discussion: Publication Overview

The network visualization generated by VOSviewer provides an in-depth look at how various topics in research related to tuberculosis (TB) treatment adherence and dropout are interconnected. In this visualization, terms that appear frequently in the literature are connected, forming clusters that show how these topics are interrelated in the broader context of research.

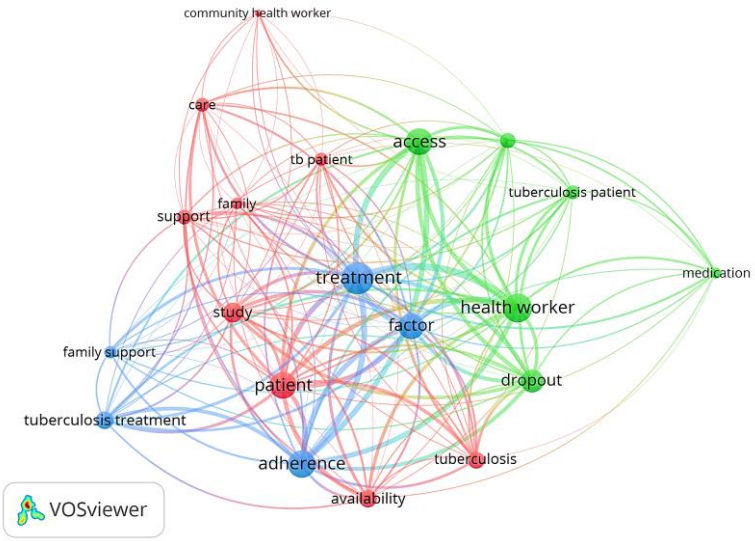

Figure 5. Network Visualization Overview Publications

a. Green Cluster: Access and Health Workers

Clusters marked in green indicate strong relationships between terms such as "access," "health worker," "tuberculosis patient," and "medication." This shows that studies often link access to health services and the role of health workers with patient adherence to TB treatment. Good access to health services and support from health workers are key factors in ensuring that TB patients complete their treatment appropriately.

b. Red Cluster: Support and Family

The red cluster focuses on "support," "family," and "community health worker," suggesting that social support, both from family and community health workers, plays an important role in patient adherence to TB treatment. Studies in this cluster tend to explore how the support provided to patients can influence their treatment outcomes.

c. Blue Cluster: Factors and Compliance

The blue cluster includes terms such as "factor," "adherence," "patient," and "treatment." This highlights that many studies focus on factors that influence patient adherence to TB treatment. Adherence to treatment is often a major challenge in TB treatment, and many studies seek to identify factors that can improve this adherence.

d. Yellow Cluster: Interventions and Studies

Some of the visible terms associated with the yellow cluster, such as "study" and "availability," indicate a focus on the availability of interventions and research efforts undertaken to understand more about the effectiveness of different approaches in TB treatment.

Overall, this visualization shows the complex interconnections between the various elements that influence TB treatment. This suggests that adherence to TB treatment does not depend on just one factor, but is the result of interactions between various elements such as access to health services, social support, and individual factors. Research conducted in this context reflects the importance of a multi-disciplinary approach to improving TB treatment outcomes. This visualization also indicates areas where research is more concentrated, and may highlight research gaps that require further exploration. By understanding these patterns, researchers can direct their

efforts towards filling existing gaps and strengthening aspects that have already proven effective in TB treatment.

VOSviewer Overlay Visualization Discussion: Publication Overview

This overlay visualization from VOSviewer provides a more dynamic view of how research trends in TB treatment adherence and dropout have evolved over time. In this visualization, key terms are mapped based on their year of occurrence, represented by color gradations from purple to yellow.

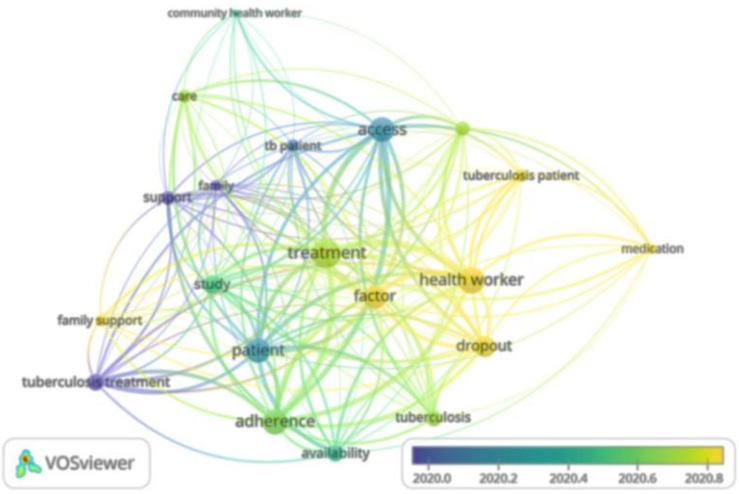

Figure 6. Overlay Visualization Overview Publications

e. Initial Cluster (Dark Blue and Green Colors)

Terms such as tuberculosis treatment, support, family support, and community health worker appear early in the time spectrum (marked in blue to dark green). This suggests that initially, research focused on aspects of social support and the role of community health workers in TB treatment adherence. The focus on family support and community health workers is an important first step in understanding how social and community factors influence treatment outcomes.

f. Medium Cluster (Light Green Color)

Terms such as patient, adherence, and treatment are seen in the middle of the spectrum, indicating that attention to these factors has increased in recent years. Research in this cluster tends to explore more deeply the interactions between patients and the healthcare system, and how adherence to treatment can be improved. The terms patient and adherence are taking center stage as more and more studies seek to identify the barriers patients face in completing their treatment.

g. Newest Cluster (Yellow Color)

Terms such as health worker, dropout, medication, and access at the yellow end of the spectrum indicate that the focus of recent research tends to shift to access to medication, the role of health workers, and the dropout phenomenon in TB treatment. This indicates a shift in research focus away from social and community support towards more specific aspects of the health system, such as treatment accessibility and how this affects patient adherence. Notably, dropout is becoming a major area of concern reflecting the growing awareness of the importance of

addressing the problem of dropout among TB patients.

This overlay visualization illustrates the evolution of research focus in the context of TB treatment, showing that initially, more attention was paid to social and community support, while recent trends show a shift towards issues related to access and the role of health workers in preventing treatment dropout. The yellow color that appears around terms such as health worker and dropout indicates that these issues have become more prominent in recent publications.

As such, this visualization provides important insights for researchers and health practitioners into areas that have been extensively studied and areas that are just beginning to receive attention. It also shows the potential for further research to focus on emerging aspects, such as improving treatment access and dropout prevention, to support successful TB treatment globally.

VOSviewer *Density Visualization* Discussion: Publication *Overview*

This *density* visualization from VOSviewer provides a strong view of the concentration of research and how various topics related to TB treatment adherence and *dropout* are distributed in the literature. In this visualization, terms that appear frequently and are more concentrated in studies are depicted with brighter colors (red and yellow), while areas with less dominant terms appear with darker colors (blue).

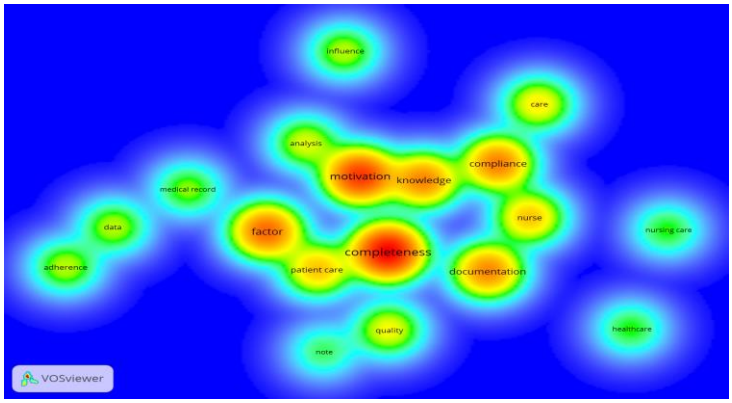

Figure 7. Density Visualization Overview Publications

a. High Density Areas (Red and Yellow) Terms such as *treatment*, *health worker*, *adherence*, *factors*, and *dropout* occupy the center of attention with very high density, marked in red and yellow. This indicates that the main focus of research lies on these topics, with researchers often exploring how these factors affect TB treatment success. In particular, the terms *treatment* and *adherence* are highly dominant, reflecting that research is intensively trying to understand and improve adherence to TB treatment, as well as how treatment interventions can be optimized.
b. Areas of Medium Density (Green) Terms such as *access*, *patient*, *support*, and *family* appear with medium density, depicted in green. This indicates that while important, these topics are slightly less focused on than the core clusters (*treatment* and *adherence*). *Access* and the role of *health workers* are also of significant concern, reflecting the importance of access to health services and support from health workers in ensuring adherence to treatment.

c. Low Density Area (Blue) Terms such as *medication*, *community health worker*, and *family support* are in the low density area, shown in blue. Although these areas are less dominant in the literature, they remain relevant, particularly in the context of how family and community support and access to medicines play a role in TB treatment. This low density may indicate research gaps or opportunities for further exploration in the future (Manurung, 2024).

Conclusions and Implications This *density* visualization provides a clear picture of where TB research has focused and where there is room for further development. High-density areas indicate topics that have been researched in depth and are recognized as key elements in TB treatment *adherence*, such as *treatment*, *health worker*, and *adherence*. Meanwhile, medium and low density areas indicate topics that may require more attention in the future, such as *medication* and *family support*. With this understanding, researchers and health practitioners can identify areas that require additional research or more robust interventions, to improve the overall effectiveness of TB treatment.

CONCLUSIONS

From a thorough analysis of research trends in tuberculosis (TB) treatment adherence and *dropout*, it is clear that the field has undergone significant development and covers a wide range of important aspects. Indonesia emerged as the country with the largest contribution in related publications, showing great concern for the health challenges caused by TB. It was followed by countries such as India and Brazil, which also showed active participation in the study, reflecting global efforts to address the TB epidemic.

Publications with a high number of citations, especially those published in reputable *journals* such as *journals.plos.org*, *Springer*, and *nature.com*, show that research with a systematic approach and meta-analysis has a great impact in the scientific community. This study is an important reference for further development in efforts to improve adherence to TB treatment.

Through VOSviewer's *network*, *overlay*, and *density* visualizations, topics such as *treatment*, *adherence*, *health workers*, and *access* were the main focus of this study. Meanwhile, family and community support and access to health services were also identified as important factors affecting TB treatment success. This visualization not only identifies topics that have been researched in depth but also shows research gaps that still require further exploration, such as *medication* and *family support*.

Overall, this analysis highlights the importance of a multi-disciplinary approach and international collaboration in addressing the TB challenge. Efforts focused on improving treatment adherence and preventing *dropouts* should continue to be encouraged, taking into account the social, economic, and health system factors that affect TB patients. As such, this study not only provides deep insight into existing trends and patterns, but also paves the way for more effective intervention strategies in the fight against TB in the future.

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