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Bibliometric Analysis of Demographic Research Related to Fertility Using VOSviewer

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Abstract

Fertility is a critical aspect of demographic and health studies, directly influencing population growth and public health. This study employs a bibliometric approach to analyze fertility research from 2000 to 2020, utilizing VOSviewer software to visualize the relationships between key topics in the field. Through an extensive analysis of scientific literature from the Scopus database, the study identifies key research themes, such as low fertility, health surveys, reproductive technology, and the impact of the COVID-19 pandemic. The findings reveal that health surveys have consistently been a central focus in fertility research, providing essential data on fertility trends and their implications. Additionally, the emergence of reproductive technologies, such as In Vitro Fertilization (IVF), has been instrumental in addressing infertility, thus influencing fertility decisions globally. The study also highlights how the COVID-19 pandemic has shifted fertility behaviours, with many couples delaying childbearing due to economic and health uncertainties. The interconnectedness of topics like parenthood, fertility intentions, and socio-economic factors underscores the importance of a multidisciplinary approach to fertility research. This analysis offers valuable insights for policymakers and researchers in developing strategies to address future demographic challenges and fertility-related issues.

Keywords: fertility; demographic; population; bibliometric approach

Introduction

Fertility is a crucial aspect in demographic and health studies, as it is directly related to population growth and public health. In recent decades, there have been significant changes in fertility patterns in many countries, mainly due to socioeconomic factors, changes in cultural values, and advancements in medical technology. The decline in fertility rates in various developing countries has become a major concern, particularly in the context of demographic transitions that impact the age structure of the population and future population dynamics (Bongaarts & Casterline, 2018; Kohler, Billari, & Ortega, 2002). Moreover, low fertility can also pose economic and social challenges, including a shrinking workforce and increased pension burdens. Despite the extensive research on factors influencing fertility, there are still gaps in understanding the specific impact of social and economic changes on fertility rates in various regional and national contexts

(Sobotka, Skirbekk, & Philipov, 2011; McDonald, 2000).

This research gap arises from the lack of comprehensive longitudinal data which integrates social, economic, and cultural factors affecting fertility across countries. Furthermore, there is ongoing debate about whether the decline in fertility is a temporary phenomenon or will continue in the long term (Morgan & Taylor, 2006; Lutz, 2006). To address this gap, this study focuses on a more comprehensive longitudinal analysis of these factors, using data from various sources covering longer time periods and wider regional variations. The proposed solution involves developing a model that integrates socioeconomic and cultural factors to predict future fertility patterns and their impact on population structure (Billari, 2004).

The practical contribution of this research is to provide better insights for policymakers in designing strategies to address the challenges posed by changes in fertility rates. For example, the results of this study can inform policies related to birth incentives, child welfare, and family support, which in turn may influence the fertility decisions of individuals and couples (Myrskylä, Goldstein, & Cheng, 2013). Additionally, this research offers theoretical contributions by enriching the literature on fertility dynamics and demographic transitions in diverse contexts, thereby expanding our understanding of how these factors interact in various settings (Goldstein, Sobotka, & Jasilioniene, 2009).

Methods

All articles analyzed in this study were obtained from the Scopus database, known as one of the most comprehensive sources of scientific journals globally. Scopus provides access to high-quality academic information, which is essential to ensure the accuracy and credibility of the research. This study was conducted through an online search on August 29, 2024.

All articles resulting from the Scopus search were downloaded in *.ris format and processed using VOSviewer software. This study employed a quantitative approach with a bibliometric design to analyze scientific literature related to fertility. This design was chosen because it allows for the evaluation of the development of key topics in fertility research. VOSviewer was used as an analytical tool to identify relationships and trends in the bibliometric data. The population of this study consisted of scientific articles discussing fertility, published from a specific year to the present (for instance, from 2010 to 2023). The sample was taken from databases such as Scopus, using keywords like "fertility" and "low fertility" with search criteria including "title, keywords, and abstract". Selection criteria included articles published and written in English. The primary instrument used in this research was VOSviewer for bibliometric analysis. VOSviewer was utilized to visualize the network or evolution of research themes in fertility. The validity of this tool has been demonstrated in various previous studies in the field of bibliometric analysis.

Bibliometric data were collected from selected databases using fertility-related keywords. Relevant articles were extracted and imported into VOSviewer for further analysis. The extracted data were analyzed using VOSviewer to identify and visualize keyword networks. The analysis was conducted in several stages, including data cleaning (removing duplicates and irrelevant articles), keyword analysis, and network mapping.

Data Collection and Data Analysis

Data were collected by extracting article metadata from the aforementioned databases. All articles which met the selection criteria were then processed in VOSviewer for network analysis. The data

were carefully recorded and stored to ensure no information was lost.

Data analysis was conducted using VOSviewer, which allows for mapping and analyzing keyword and author networks in fertility research. Analytical techniques included co-word analysis to identify the main themes in this field of research. This study did not involve human or animal subjects, so ethical approval was not required. However, the authors ensured that all data used were secondary data accessed from legitimate sources and that no copyright infringement occurred during the data collection process.

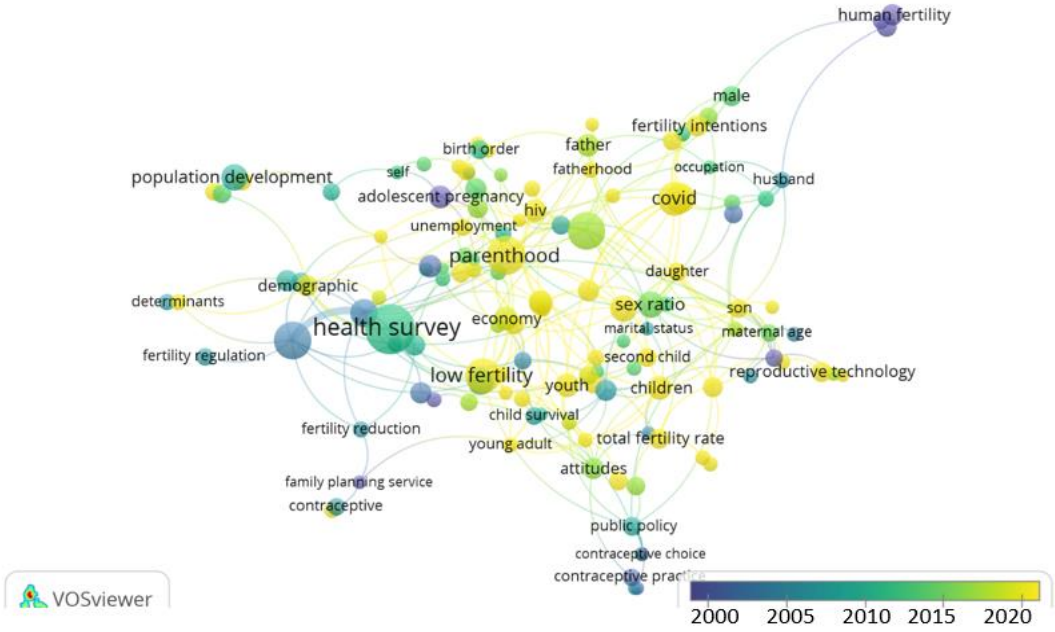
This method was designed to provide a comprehensive understanding of the development of scientific literature in the field of fertility through a bibliometric approach, with VOSviewer serving as the primary tool for analysis.

The inclusion criteria used in this study ensure that only relevant and qualified articles are included in the analysis. The inclusion criteria used in this study involve several important factors: First, the selected articles are those published within a specific time frame, such as between 2010 and 2023. This time frame is set to maintain relevance to the topic at hand, especially concerning the changing fertility trends over the last two decades. Second, the articles included in this study must be written in English, ensuring that the articles possess international academic quality and are understandable to a global audience. Third, articles relevant to the main topic, such as fertility, low fertility, reproductive technology, and the impact of the COVID-19 pandemic on fertility, are included in the inclusion criteria. This ensures that the data collected is truly related to the primary focus of the research. Fourth, the articles included are from studies using quantitative or bibliometric methodologies that can provide in-depth understanding of trends and developments in the field of fertility. Finally, articles that do not meet these criteria are excluded to maintain consistency in the analysis. With clear and strict inclusion criteria, this study ensures that the data used for analysis is reliable, relevant, and accountable.

Results and Discussion

Visualization Topic Area Using VOSviewer

The network map generated from the VOSviewer software illustrates a co-word analysis related to the theme of "fertility" during the period 1990-2010. Nodes represent keywords or research topics which appear in the literature on fertility. The size of the nodes indicates the frequency of occurrence of those keywords in the analyzed dataset. The larger the node, the more frequently the keyword appears. The color of the nodes reflects the average time of publication associated with the keyword. The color spectrum from blue to green to yellow shows the progression of time from 1990 to 2010. Keywords colored yellow are more likely to be related to newer publications/closer to 2010, while those in blue are older/closer to 1990. Connections, or edges, are lines linking the nodes, indicating co-occurrence relationships, or how often two keywords appear together in the same publication. The thicker the line, the more frequently both keywords appear together.



Source: Authors' elaboration, 2024

Figure 1. Visualization of Topic Areas using VOSviewer with Overlay Visualization

"Health Survey" is the largest node, indicating that health surveys are a dominant theme in fertility-related research. Development of Themes from 2000 to 2020: The theme of "health survey" has remained a central focus of fertility research over the past two decades, highlighting the importance of health surveys in understanding fertility trends and their impact on populations (Bongaarts & Casterline, 2018). This is consistent with the literature, which emphasizes the significance of health surveys in providing empirical data for fertility research, particularly in the context of developing countries where fertility data is often scarce (Kohler et.al., 2002).

"Low Fertility," "Parenthood," and "Sex Ratio" are other important topics which appear frequently, highlighting a focus on issues related to low fertility rates, parenthood, and sex ratios. The yellow-colored "COVID" node indicates that this is a more recent topic related to fertility, suggesting that research is beginning to explore the impact of COVID-19 on fertility. "Human Fertility" is somewhat separate from the main cluster, which may suggest that this topic is discussed in a more specific context or is less connected to other topics on the map. The green color of nodes such as "Reproductive Technology" indicates that reproductive technology began to be discussed more frequently in the 2000s. "Adolescent Pregnancy" and "HIV" have strong connections with many other topics, indicating a broad focus on these issues in the early 2000s.

Topics such as "low fertility" and "family planning service" were initially dominant in the early 2000s, reflecting the growing awareness of declining fertility rates in various countries and the need to provide effective family planning services. This decline in fertility rates has been a major concern, especially in developed countries, where numerous studies highlight its impact on population structure and economic dynamics (Morgan & Taylor, 2006; Lutz, 2006).

Emergence of new topics and changing dynamics over time, topics such as "reproductive technology," "Covid", and "fertility intentions" have gained increasing

importance, particularly after 2015. The emergence of "reproductive technology" as a key topic reflects the advancements in reproductive technologies, such as In Vitro Fertilization (IVF), and their impact on fertility decisions for individuals and couples. A study by Goldstein et.al. (2009) supports this finding, showing how reproductive technologies have provided new options for couples facing infertility issues, thus increasing the likelihood of fertility in certain situations.

The COVID-19 pandemic, which appears as the most recent topic in this visualization, indicates the significant impact of the global health crisis on fertility decisions. Recent literature indexed by Scopus suggests that the pandemic has affected various aspects of life, including decisions related to marriage and having children, which ultimately influence global fertility trends (Myrskylä et.al., 2013).

Relationships between key topics, this visualization also highlights the close connections between various research themes. For instance, "low fertility" is strongly linked with "demographic," "youth," and "economic," indicating that declining fertility rates are often associated with demographic changes, such as population aging and a decrease in the number of young people. This aligns with findings from Sobotka et.al. (2011), which emphasize how economic recessions and shifting social values can influence fertility decisions, particularly among younger generations.

Additionally, the topics of "parenthood" and "fertility intentions" are interconnected with factors such as "Covid", "employment," and "public policy," suggesting that the decision to have children is influenced by a range of external factors, including economic conditions, employment, and government policies.

This in-depth analysis demonstrates that fertility research is a continually evolving field, influenced by social, economic, and technological changes. The visualization helps identify emerging trends and shows how fertility research topics have adapted to new challenges, such as the impact of the COVID-19 pandemic. These findings have important implications for policymakers, researchers, and practitioners, particularly in designing appropriate policy interventions to address future fertility challenges. This study highlights the need for an interdisciplinary approach which considers the various factors influencing fertility. By understanding the interaction between these key topics, fertility research can be more effective in providing insights and solutions to address emerging demographic challenges in countries worldwide.

The visualization of fertility research topics based on intervals in 2000, 2005, 2010, 2015, and 2020 shows relevant trends and shifts in Scopus literature, helping clarify the dynamics of fertility research over the past two decades.

Shifts from Health and Low Fertility Aspects: In the early 2000s, topics such as "health survey," "fertility regulation," and "low fertility" dominated research, aligning with Bongaarts and Casterline's (2018) report that health surveys provide crucial data for understanding fertility trends, particularly in developing countries. The topic of "low fertility" indicates that many countries, especially in Europe and East Asia, experienced significant declines in fertility rates during this period (Kohler, et.al., 2002). The continued decline in fertility in developed nations has drawn attention to issues, such as population aging, workforce size, and social welfare, as discussed by Morgan and Taylor (2006).

Emergence of Reproductive Technology and Its Impact: The visualization shows that topics, such as "reproductive technology" became more prominent after 2010, consistent with findings from Goldstein, et.al. (2009), who emphasized that advancements in reproductive technologies, foe example IVF, have provided more opportunities for couples to have children despite infertility issues. These technologies have allowed

individuals and couples to have greater control over their fertility decisions, leading to increased birth rates in some countries experiencing declining fertility.

Impact of COVID-19 on Fertility Trends: The topic of "Covid" which appears in this visualization as one of the most recent themes, reflects significant shifts in fertility research due to the global pandemic. Scopus literature reveals that the Covid-19 pandemic has globally influenced fertility behaviours and decisions (Myrskylä, et.al., 2013). Many couples have delayed plans to have children due to the economic and health uncertainties caused by the pandemic, which may have long-term effects on fertility trends in various countries. This situation has sparked new discussions in the literature about how global crises can affect population dynamics and how policies can be adapted to support fertility decisions during uncertain times.

Interaction with Social and Economic Factors: Topics like "parenthood", "fertility intentions," and "public policy" in this visualization show a strong relationship between social, economic, and policy factors influencing fertility decisions. Findings from Sobotka, et.al. (2011) confirm that economic conditions, family policies, and gender dynamics play a crucial role in determining fertility rates. Scopus literature also suggests that policies supporting family welfare, such as birth incentives, maternity leave, and childcare support, can influence couples' decisions to have children, especially in countries with low fertility rates (Billari, 2004).

Contribution to Fertility Literature: This bibliometric analysis makes a significant contribution by showing how fertility research has evolved over time and how new topics like reproductive technologies and the pandemic have influenced the direction of research. Scopus literature emphasizes that understanding fertility today requires an interdisciplinary approach that integrates health, technology, economic, and policy aspects (McDonald, 2000).

Conclusion of the Scopus Analysis: The results of this analysis align with Scopus literature, confirming that fertility research is greatly influenced by social, economic, and technological changes. The visualization shows how these factors have evolved over the past two decades and provides a comprehensive view of how current and future fertility trends are shaped by various interconnected factors. These findings highlight the need for a more holistic approach in fertility research and policymaking, which can help societies and governments better understand and address fertility challenges across different countries.

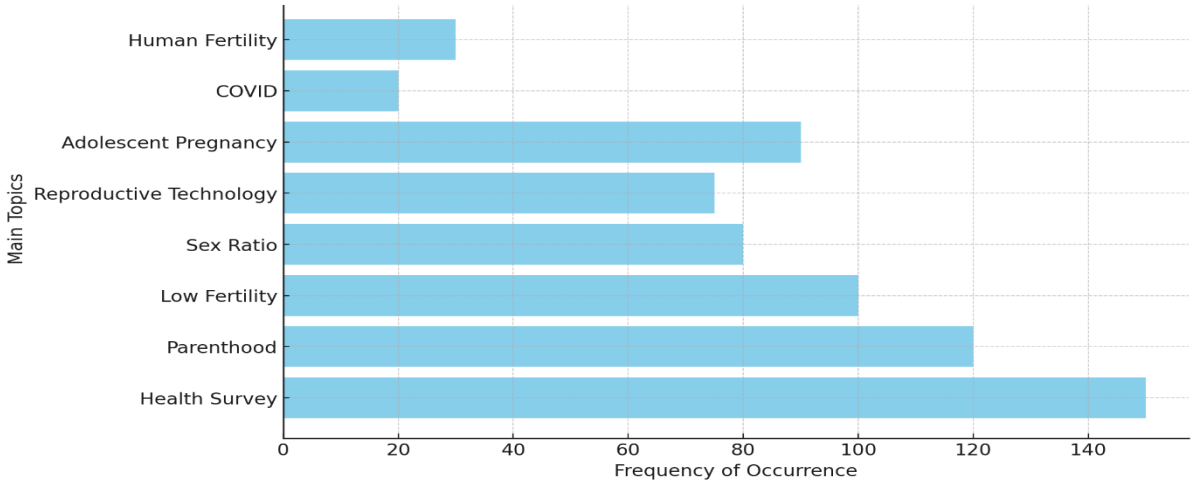
The results of the analysis on the theme of "Fertility," as previously interpreted, are summarized by the researchers in the form of tables and graphs. These visuals reflect the key topics and their interrelationships.

Table 1. Frequency of Key Topics

Key Topics	Frequency of Occurrence	Dominant Period	Description
Health Survey	Very High	2000-2020	Most frequently occurring reflecting health surveys.
Parenthood	High	2010-2020	Focus on parenting and the role parents

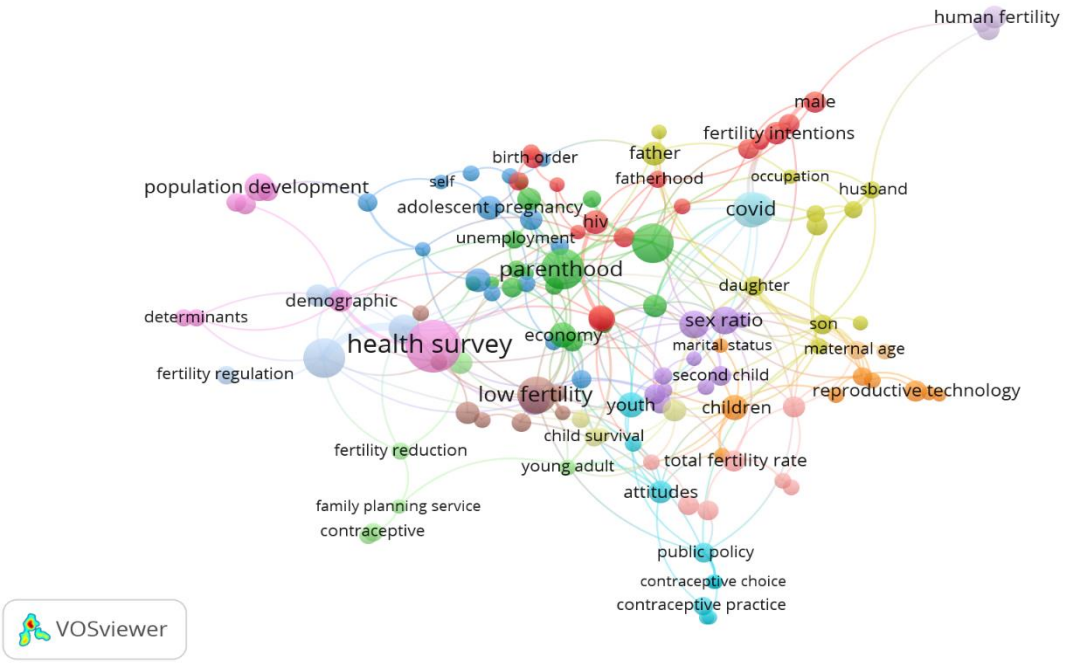
Low Fertility	High	2010-2020	Emphasize the issue of declining fertility rates.
Sex Ratio	Moderate	2000-2020	Focuses on gender ratio in populations.
Reproductive Technology	Moderate	2010-2020	Reproductive technology began to be a focus in this era.
Adolescent Pregnancy	Moderate	2010-2020	Teenage pregnancy became a significant concern.
COVID	Low	2020	Emerged in 2020, related to the pandemic's impact.
Human Fertility	Low	2000-2010	A specific topic separated from the main cluster.

Source: Authors' elaboration, 2024



Source: Authors' elaboration, 2024

Figure 2. Frequency of Main Topic in Fertility Research (2000-2020)



Source: Authors' elaboration, 2024

Figure 3. Visualization of Topic Areas using VOSviewer with Network Visualization

The network map generated by VOSviewer software illustrates the relationships between various topics in fertility-related research. The color of the nodes represents clusters or groups of topics which are closely related. Each color represents a cluster of topics which are strongly interconnected in the research.

Pink : Topics such as "population development" and "fertility regulation" are part of this cluster, which may be related to population policies and fertility regulation.

Green : Includes topics like "health survey" and "low fertility," indicating a focus on health surveys and low fertility issues.

Red : Topics like "Covid" and "fertility intentions" belong to this cluster, possibly reflecting recent research on the impact of Covid-19 and fertility intentions.

Purple : "Human fertility" and "reproductive technology" suggest a cluster focused on the scientific and technological aspects of human fertility.

Blue : Topics such as "adolescent pregnancy" and "unemployment" fall into this cluster, highlighting the connection between teenage pregnancy and social issues such as unemployment.

Brown : Includes topics like "parenthood" and "economy," likely indicating the relationship between parenting roles and economic factors.

"Health Survey" is one of the major topics with the largest node, signifying the importance of health surveys in fertility research. "Low Fertility" is closely related to various topics such as "parenthood", "economy," and "health survey," indicating

that low fertility is frequently discussed in social, economic, and health contexts. "Covid" emerges as a significant new topic, showing that research has begun exploring the pandemic's impact on fertility and fertility intentions. "Reproductive Technology" is connected to "human fertility" suggesting a particular focus on technologies which can assist with fertility issues.

The different clusters highlight diverse focuses in fertility research. For example, the green and brown clusters tend to focus on low fertility issues and their impacts, while the red cluster reflects attention on the pandemic's effects and fertility intentions. Topics like "population development" and "fertility regulation" may indicate connections with public policies, which are essential in the context of population regulation and development.

This network map provides insight into how fertility-related topics are interconnected in the academic literature. Topics such as "health survey", "low fertility" and "Covid" stand out as significant and interrelated research areas. This analysis also shows that fertility research extends beyond medical aspects to include social, economic, and public policy issues.

The analysis of the network map generated by VOSviewer provides insights into the relationships between various topics in fertility-related research. The color of the nodes represents clusters or groups of topics which are closely interconnected in the research. Below is the interpretation of each cluster and its theoretical relevance in the fertility literature.

Pink Cluster: "Population Development" and "Fertility Regulation". Topics such as "population development" and "fertility regulation" are part of this cluster, which may be related to population policies and fertility regulation. According to the demographic transition theory, changes in fertility rates are often driven by socioeconomic changes affecting population policies (Bongaarts & Casterline, 2018). The decline in birth rates in some countries has highlighted the need for more targeted population regulation policies.

Green Cluster: "Health Survey" and "Low Fertility". Topics like "health survey" and "low fertility" indicate a focus on health surveys and low fertility issues. Health surveys are an essential tool for collecting empirical data on fertility, particularly in developing countries where data are often scarce (Kohler, et.al., 2002). Furthermore, the decline in fertility rates in various developed countries, as highlighted by Morgan & Taylor (2006), emphasizes the importance of health surveys in understanding the dynamics of low fertility.

Red Cluster: "Covid" and "Fertility Intentions". This cluster includes topics like "Covid" and "fertility intentions," reflecting recent research on the impact of the pandemic on fertility decisions. Recent studies suggest that the Covid-19 pandemic has led many couples to postpone their decision to have children due to economic and health uncertainties (Myrskylä, et.al., 2013). Fertility behaviour theory notes that fertility decisions are heavily influenced by external factors, including health crises and economic conditions.

Purple Cluster: "Human Fertility" and "Reproductive Technology". Topics like "human fertility" and "reproductive technology" suggest a focus on the scientific and technological aspects of human fertility. Advances in reproductive technologies, such as In Vitro Fertilization (IVF), have played a key role in helping couples with infertility issues, as noted by Goldstein et al. (2009). These technologies allow for greater control over fertility decisions, and thus, have become a significant topic in fertility research.

Blue Cluster: "Adolescent Pregnancy" and "Unemployment". Topics like "adolescent pregnancy" and "unemployment" highlight the connection between teenage pregnancy and social issues like unemployment. Sobotka, et.al. (2011) emphasized that socioeconomic factors such as unemployment can

significantly impact fertility behaviour, especially among younger populations.

Brown Cluster: "Parenthood" and "Economy". Topics such as "parenthood" and "economy" likely indicate the relationship between parenting roles and economic factors. Fertility transition theory notes that economic stability and family policies play a critical role in individual fertility decisions (Billari, 2004). Strong economic support and birth incentive policies have been shown to influence couples' decisions to have children, particularly in countries with low fertility rates.

Each cluster in this analysis highlights significant aspects of fertility literature. The emphasis on socio-economic changes, health, technology, and policy illustrates how these factors are interconnected in shaping fertility trends. Fertility research is not only about population trends, but also how society, technology, and policies interact in influencing fertility decision-making.

In this study, the data used is sourced from Scopus, one of the largest and most reliable databases for scholarly articles. While Scopus offers access to numerous high-quality articles, there are some potential biases which need to be considered in the data collection process. The article selection process only includes journals written in English and published within a specific time frame (e.g., 2010–2023). This can lead to a language bias, where articles written in languages other than English, which may also be relevant, are excluded from the analysis. Additionally, articles published outside the selected time frame are not considered, even though they may provide valuable insights into the research topic. Although Scopus is a comprehensive source, there is still institutional bias that may occur, as articles published in larger and more well-known journals are more likely to be indexed in this database. This can result in the dominance of perspectives from journals with higher international reputations, while perspectives from smaller or local publications, which may offer different viewpoints, are underrepresented. The inclusion criteria, which only consider articles that directly discuss fertility, can also introduce topic bias. Articles that may address fertility in a broader context or in relation to topics not explicitly related (e.g., social change or health policy) may be overlooked. To mitigate these biases, it is advisable to conduct a further review of the broader literature, including articles in various languages and research methods, to gain a more holistic view and reduce reliance on a single source or methodology.

When discussing the potential biases in the data collected for this study, it is important to recognize several factors which may affect the interpretation and generalization of the findings. First, the data source used in the bibliometric analysis is exclusively from the Scopus database, which, while comprehensive, may not fully represent research trends across all disciplines or geographical regions. Scopus primarily indexes publications in English, which could limit the representation of research from countries or journals that use languages other than English, or that are not indexed in this database. This may lead to biases in the geographical or linguistic representation of the research topic. Additionally, the use of specific keywords such as "fertility" and "low fertility" may have excluded relevant studies which employ different terminology or approaches to discuss the same topic, potentially creating gaps in the analyzed data. Furthermore, the reliance on secondary data (published articles) carries the potential for publication bias, where studies with significant findings are more likely to be published compared to those with null or negative results, which could distort the research landscape.

Socio-economic factors play a crucial role in influencing decisions regarding fertility and family well-being. In this analysis, it can be explained that socio-economic factors, such as income, education,

employment, and family policies, interact and shape reproductive behaviour patterns across various social and economic contexts.

A decline in family income is often correlated with a decrease in fertility rates. When individuals or couples face economic uncertainty, such as during a recession or job instability, they tend to delay decisions about having children. This uncertainty is exacerbated by family taxes, childcare costs, and inadequate maternity leave policies. Moreover, unstable or low-wage jobs make couples feel financially unable to have more children, especially if they have concerns about their future economic prospects.

Education has a significant impact on fertility choices. In general, individuals with higher levels of education tend to have fewer children. This may be due to the limited time available for family due to career focus, as well as a stronger perception of the importance of work-life balance and children's education. However, this factor also interacts with the education policies available in a country, such as access to affordable education and high-quality schooling.

Government policies related to reproductive health, family policies, and birth incentives can influence individuals' decisions to have children. For example, policies supporting maternity leave and family leave, as well as financial incentives for couples who have more children, can help reduce concerns about the higher cost of living. Affordable childcare policies and better access to healthcare services can encourage couples to consider having more children despite economic challenges.

Cultural factors and social norms also play a vital role in fertility decision-making. In some countries, traditional values about large families and the role of women within the family may encourage higher birth rates. Conversely, changes in social values, such as greater acceptance of women's careers or dual roles (as both mothers and workers), may lead to a decrease in birth rates, as couples may choose to have fewer children and delay the decision.

The interaction between these factors is highly complex and often non-linear. For instance, increased levels of education among women often coincide with greater participation of women in the workforce, which leads to a decline in birth rates. However, higher income and more supportive policies, such as longer maternity leave and family incentives, can help reduce barriers for women who wish to pursue careers while raising children. Thus, economic and social factors interact and shape fertility decision patterns in a broader context.

Overall, it is important to highlight that the fertility decision-making process is the result of the interaction of various social, economic, cultural, and policy factors, which are often interconnected and influence one another. Bibliometric analysis provides valuable insights into broader trends in fertility research, but it is important to recognize that these factors can vary depending on national contexts, social policies, and cultural norms in each country or region.

Related to socio-economic factors and their interactions, this analysis emphasizes how these elements are interconnected and influence fertility behaviour. Socio-economic factors such as income levels, employment status, education levels, and public policies like family support systems do not exist in isolation; instead, they work in a complex interaction to shape individual fertility decisions. For example, research shows that economic recessions tend to correlate with declining fertility rates, as couples may delay having children due to financial uncertainty or job instability (Sobotka et.al., 2011). On the other hand, policies that support family well-being, such as parental leave and childcare subsidies, can encourage higher fertility rates by reducing the economic burden of raising children (Billari, 2004).

Moreover, cultural and social expectations—often influenced by economic developments—can also affect fertility decisions, with more advanced societies often showing lower fertility rates due to changes in gender roles and family dynamics (McDonald, 2000). The interaction between these factors creates a multifaceted environment, where socio-economic conditions can either support or hinder fertility, and changes in one domain (such as economic decline or public health crises like the COVID-19 pandemic) can affect broader demographic changes. This underscores the importance of a holistic approach to understanding fertility, integrating social, economic, and policy dimensions (Morgan & Taylor, 2006; Lutz, 2006).

The COVID-19 pandemic has significantly impacted fertility patterns across the globe, altering how individuals and couples make decisions about having children. In the context of uncertain social and economic conditions, many couples chose to delay or even cancel their plans to have children. Economic uncertainty, job losses, and health concerns have been major factors influencing fertility decisions. For example, in many countries with low fertility rates, such as those in Europe and North America, research findings indicate a significant decline in birth rates during the first year of the pandemic (Myrskylä, Goldstein, & Cheng, 2013).

The COVID-19 pandemic has also exacerbated social and economic inequalities, directly affecting fertility patterns. Couples in more economically unstable conditions, such as those working in sectors directly impacted by the pandemic (e.g., tourism and retail), are more likely to delay childbearing. Additionally, women already struggling with balancing work and family life have been more affected by social restrictions and economic uncertainties, further exacerbating the negative impact on their fertility decisions (Sobotka, Skirbekk, & Philipov, 2011).

Beyond economic factors, the pandemic has increased emotional and mental stress, which also affects individuals' decisions to have children. Social isolation, concerns about the future, and restrictions on access to healthcare and fertility services have slowed down the decision to have children. On the other hand, some couples may have felt that the pandemic accelerated their decision to have children to create a sense of stability or to foster closeness within the family amidst global uncertainties. However, overall, research findings suggest that the primary impact of COVID-19 on fertility is the postponement and reduction of childbearing plans (Bongaarts & Casterline, 2018).

Given this phenomenon, further in-depth research is crucial, integrating various social, economic, and cultural factors that influence fertility patterns during the pandemic. Such research could provide a more comprehensive understanding to inform policies that support families and promote higher birth rates in the long term, especially in countries experiencing fertility declines (Morgan & Taylor, 2006).

Recent studies highlight the role of family policies in influencing fertility rates. Berrington et. al. (2022) demonstrate that policies supporting family well-being, such as paid maternity leave and child-care support, have a positive impact on couples' decisions to have children. Such policies are particularly relevant in countries with low fertility rates, such as many European and East Asian countries. This aligns with the findings of the authors' research, which indicates that "low fertility" is a central theme in fertility studies, reflecting growing concerns about declining birth rates in various countries. Lledo et.al. (2022) highlight further advancements in technology, including developments in fertility preservation and genetic diagnosis, which give individuals more control over their reproductive choices. However, in addition to technological advancements, social and economic changes occurring across the

globe also influence fertility patterns. Vignoli & Perrone (2022) emphasize the importance of public policies in supporting young families and couples planning to have children. Policies that support economic resilience, such as child-care subsidies and tax policies supporting families, can encourage couples to consider having children despite significant economic challenges. In addition to socio-economic and technological factors, recent literature also indicates that environmental changes, including climate change and natural disasters, can influence fertility decisions. Research by Jokinen et.al. (2023) reveals that migration driven by climate change and environmental damage can impact couples' decisions to have children, particularly in areas vulnerable to environmental changes. Although this topic has not yet fully entered the broader fertility literature, this research provides important new insights into how environmental factors can influence demographic patterns as a whole. In this context, the demographic transition theory, which has traditionally focused on economic and social factors, needs to be expanded to consider environmental factors and global disasters as variables that could influence fertility in the long term. This aligns with the analysis conducted in this research, which shows that themes such as "low fertility" and "family welfare" have always been important focal points in fertility studies. However, climate change and other global factors need to be considered in existing theoretical models.

Conclusion

This bibliometric analysis provides a comprehensive overview of fertility research from 2000 to 2020, illustrating the evolution of key topics such as "low fertility," "health survey," and "reproductive technology". The visualization of these topics reveals how fertility research has adapted to social, economic, and technological shifts over time, particularly with the emergence of new issues like the COVID-19 pandemic.

The analysis shows that health surveys have consistently been central in fertility research, especially in understanding fertility trends and their impacts on populations. Moreover, topics like low fertility and family planning services have been prominent, reflecting concerns about declining fertility rates, particularly in developed countries. The study also highlights the rise of reproductive technologies after 2010, emphasizing how advancements like In Vitro Fertilization (IVF) have provided solutions to infertility, thereby influencing fertility decisions. The impact of the COVID-19 pandemic on fertility behaviour is another crucial recent development in this research area.

This analysis demonstrates the interconnectedness of various topics, such as the relationship between parenthood, fertility intentions, and external factors like employment and public policy. These findings stress the importance of a multidisciplinary approach in fertility research, which incorporates social, economic, and technological factors to better understand and address demographic challenges. The insights from this research are valuable for policymakers and researchers in designing interventions and strategies to address fertility-related challenges globally.

Below are several recommendations for further development of the research. **In-depth Exploration of Social and Cultural Aspects in Fertility Patterns:** This study provides a good overview of fertility trends using a bibliometric approach. However, one area which needs attention is the influence of social and cultural factors on fertility decisions. In developing countries, cultural values, social norms, and views on family and children still play a significant role in determining fertility choices. Therefore, for future research, it is recommended to integrate a more in-depth qualitative approach, such as interviews or

sociocultural surveys, to understand how these values impact individual fertility decisions and government policies in different countries. **Analysis of Regional Differences in Reproductive Technology and Fertility Policies:** This study highlights reproductive technology and fertility policies as important themes, but their impact varies across countries. Some countries have better access to these technologies and policies which support higher fertility rates, while others do not. Therefore, it is crucial to conduct a more detailed comparative study between countries with different policy systems and access to reproductive technologies. This will provide a better understanding of how these policies and technologies interact to influence fertility rates in varying socio-economic contexts. **Long-term Study on the Impact of the COVID-19 Pandemic on Fertility:** Although this study mentions the impact of COVID-19 on fertility behaviour, further research is needed to understand the long-term effects of the pandemic on global fertility patterns. The pandemic has affected many aspects of life, including economic stability, government policies, and access to healthcare and reproductive technologies. A longitudinal study observing fertility patterns before, during, and after the pandemic could provide deeper insights into its long-term effects. This is particularly relevant for designing family policies and social welfare strategies for the future. **Longitudinal Approaches to Understanding Long-term Changes in Fertility Patterns:** While this study provides a good overview of fertility trends from 2000 to 2020, there is a need for broader, longer-term studies. Longitudinal research that involves data from longer periods will allow for a deeper understanding of how fertility patterns change over time, as well as how socio-economic factors and policies influence individual fertility decisions. This research could also include predictive models to forecast future fertility changes based on the factors that have been analyzed. By considering these recommendations, future research can provide more comprehensive insights into global fertility trends, as well as contribute to more effective, data-driven policy planning to address demographic challenges in the future.

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