

Mapping the Research Landscape of Ambulatory Blood Pressure Monitoring in Pregnancy (2000-2025): A Bibliometric Study

Ismawi HR^a, Mohd Zainudin M^a, Zulkiflee K^a, Mohd Said MR^b,
Abd Malik NR^c, Haydar Ali Tajuddin A^b

^aDepartment of Basic Medical Sciences, Kuliyah of Medicine, International Islamic University Malaysia (IIUM), Pahang, Malaysia

^bDepartment of Internal Medicine, Kuliyah of Medicine, International Islamic University Malaysia (IIUM), Pahang, Malaysia

^cDepartment of Obstetrics & Gynaecology, Kuliyah of Medicine, International Islamic University Malaysia (IIUM), Pahang, Malaysia

ABSTRACT

Ambulatory blood pressure monitoring (ABPM) has gained recognition as a valuable tool for diagnosing and managing hypertensive disorders during pregnancy. However, the research landscape and emerging trends in this field have not been comprehensively mapped. This study aimed to conduct a bibliometric analysis to evaluate global research trends, scientific productivity, collaboration patterns, and thematic developments related to ABPM in pregnancy. Publications were retrieved from the Scopus database and analysed using bibliometric mapping and visualisation tools. Bibliometric indicators included publication output, citation patterns, co-authorship networks, and keyword co-occurrence analyses to identify research themes and emerging trends. The analysis revealed 148 original articles and 26 reviews from 2020-2025. Research productivity increased steadily over the past two decades, with the United States, United Kingdom, Spain, and Australia emerging as the most influential contributors. Collaboration networks revealed strong regional clusters, particularly across Europe, with the United States serving as a central hub for international partnerships. Keyword analysis identified five thematic clusters: clinical aspects of ABPM, pregnancy complications and outcomes, cardiovascular and metabolic risk factors, maternal–foetal characteristics, and methodological and interventional studies. Term co-occurrence analysis highlighted interconnected themes spanning maternal outcomes, cardiovascular risk predictors, and clinical management. Research on ABPM in pregnancy has expanded in scope and depth, reflecting its growing clinical importance. Nonetheless, contributions remain concentrated in high-income countries, with limited representation from low- and middle-income regions. Future research should emphasise broader international collaboration, standardisation of ABPM protocols, and investigation into long-term maternal and offspring cardiovascular outcomes.

Keywords

Blood Pressure Monitoring, Ambulatory, Hypertension, Pregnancy-Induced, Pre-Eclampsia, Bibliometrics

Corresponding Author

Asst. Prof. Dr. Hidayatul Radziah Ismawi
Department of Basic Medical Sciences,
Kuliyah of Medicine, International
Islamic University Malaysia (IIUM),
Pahang, Malaysia
E-mail: hidayatulradziah@iium.edu.my

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INTRODUCTION

Hypertensive disorders of pregnancy (HDP), including pregnancy-induced hypertension (PIH) and pre-eclampsia (PE), remain a leading cause of maternal and

perinatal morbidity and mortality worldwide.¹ Accurate blood pressure measurement is crucial for early detection and risk stratification in this population.

Conventional clinic-based blood pressure monitoring often underestimates true risk due to phenomena such as white-coat and masked hypertension, potentially leading to misclassification of patients.² Ambulatory blood pressure monitoring (ABPM) has emerged as a valuable tool, offering 24-hour assessment of blood pressure variability and nocturnal patterns that are not captured by office readings.³ Recent systematic reviews and meta-analyses have demonstrated that ABPM provides more reliable prognostic information during pregnancy and the postpartum period, with superior predictive value for adverse outcomes compared to clinic measurements.⁴ Additionally, recent narrative reviews emphasise the potential of ABPM in optimising risk stratification and guiding management of HDP.⁵

Ambulatory blood pressure monitoring (ABPM) has emerged as a critical tool in pregnancy, improving detection of masked and white-coat hypertension beyond office readings.^{6,7} Early studies demonstrated its diagnostic value, and recent work has reinforced its role in clinical practice while revealing regional disparities in use.^{8,9} However, a gap persists between evidence and routine obstetric application.¹⁰ Research has advanced from small cohorts to systematic reviews and meta-analyses, strengthening guideline recommendations, while new wearable and digital technologies enable continuous monitoring for personalised care.^{4,11} Increasingly embedded in risk prediction and precision medicine, ABPM is becoming integral to maternal cardiovascular research and the management of HDP.

Despite increasing clinical evidence supporting the utility of ABPM in pregnancy, the broader scientific landscape in this field has not been systematically mapped. Previous systematic reviews and meta-analyses have primarily synthesised clinical outcomes and diagnostic accuracy, while narrative reviews have highlighted methodological considerations and optimisation strategies.^{2,4,5} However, little is known about the publication trends, influential contributors, collaborative networks, and evolving research themes related to ABPM in pregnancy. Without such insights,

it is difficult to identify research gaps, guide funding priorities, or foster global collaboration. A bibliometric analysis is therefore warranted to complement existing clinical syntheses by providing a macroscopic overview of how the field has evolved, who the key contributors are, and where future research directions may be most impactful. This study aims to provide a bibliometric overview of research on ambulatory blood pressure monitoring (ABPM) in pregnancy between 2000 and 2025. Specifically, it examines trends in publications and citations, identifies leading authors, institutions, and countries, and maps patterns of collaboration within the field. In addition, it highlights the most highly cited papers and influential journals while tracing the evolution of research themes to uncover emerging topics and underexplored areas.

This study will address the following research questions:

1. How has research output on ambulatory blood pressure monitoring (ABPM) in pregnancy evolved between 2000 and 2025 in terms of publication and citation trends?
2. Who are the most influential authors, institutions, and countries contributing to this field?
3. What patterns of collaboration exist among researchers, institutions, and countries?
4. Which journals and publications have had the greatest impact on advancing knowledge of ABPM in pregnancy?
5. How have research themes and keywords developed over time, and what emerging areas can be identified for future investigation?

METHODS

This bibliometric analysis investigated trends of ABPM in pregnancy research. We followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) reporting guidelines.¹² We collected data from the Scopus database, a well-regarded source of peer-reviewed publications on 14th August 2025.¹³ The keyword search strings used were as

follows: (TITLE-ABS-KEY ("ambulatory blood pressure") AND TITLE-ABS-KEY (pregnancy)) AND PUBYEAR >1999 AND PUBYEAR <2026 AND (LIMIT-TO (SUBJAREA , "MEDI") OR LIMIT-TO (SUBJAREA , "BIOC") OR LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "HEAL") OR LIMIT-TO (SUBJAREA , "IMMU")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")). In total, we identified 273 documents from the Scopus database in our initial dataset.

Data Screening

We screened the dataset to ensure relevance and accuracy, as shown in Figure 1. Publications unrelated to medicine and health, such as those in mathematics, computer science, and engineering, were excluded, narrowing the final dataset to 266. We also excluded non-empirical materials such as technical reports, letters and editorials, leaving 242 publications. We then restricted the dataset to English-language publications and further narrowed it to 220. Following a thorough review, 174 articles published between 2000 and 2025 were included in the final analysis. The dataset on these publications was exported from Scopus database in comma-separated values (.csv) format for further analyses.

Data Analysis

We carried out data analyses and generated graphic visualisation of our dataset using several tools designed for bibliometric research, which are Scopus analyser and VOSviewer (<http://www.vosviewer.com>) software.¹⁴ The .csv file was imported into VOSviewer. These tools supported the identification of keyword patterns, keyword co-occurrence, citation trends, thematic clusters, and network visualisation to explore research connections and patterns. The resulting dataset offered a clear basis for understanding the relationships and thematic areas within the literature, shedding light on ABPM in pregnancy research.

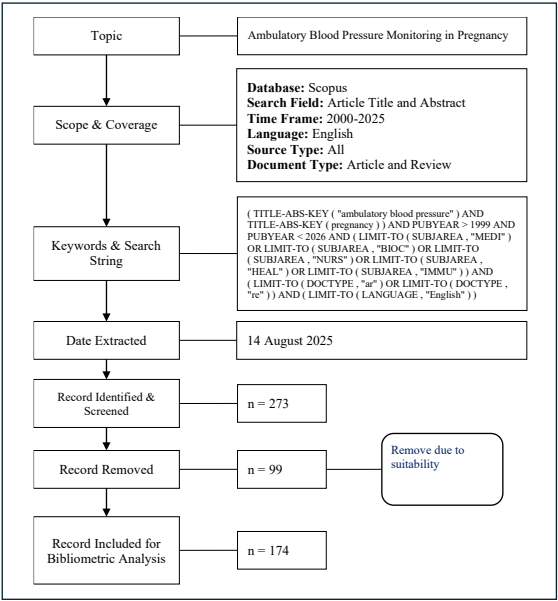


Figure 1: Flow diagram of the search strategy. Source: Zakaria et al. (2021)¹⁵

RESULTS

Publication profiles and trends

We retrieved a total of 148 original articles and 26 reviews. All were journal articles written in English. These articles were published in 101 different journals. Most of the publications covered Medicine (72.1%), Biochemistry, Genetics and Molecular Biology (18.0%), and Nursing (3.4 %) as the topics. The publication trend from 2000 to 2025 shows fluctuating activity with notable peaks in 2001 (12 articles) and 2013 (13 articles), followed by periods of decline. However, from 2018 onwards there has been a sustained increase, with outputs stabilising at a higher level and peaking again in 2018, 2023, and 2024 (Figure 2). This pattern indicates a renewed and growing research interest in recent years.

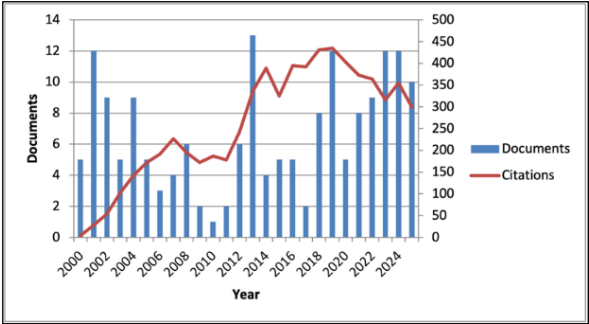


Figure 2: Total Publications and Citations by Year

Citation metrics and highly cited documents

The citation metrics indicate that a total of 155 documents were published on ambulatory blood pressure monitoring in pregnancy between 2000 and 2025, collectively receiving 6,710 citations (Figure 2). This corresponds to an average of approximately 43.3 citations per document. The field has an h-index of 34. Annual citations steadily increased from 2000, peaking between 2013 and 2016 with over 450 citations per year. Although a gradual decline has been observed since, citation levels remain relatively high (300-400 annually).

The most highly cited documents are dominated by guideline and position papers authored by O'Brien et al., including the 2003 European Society of Hypertension (ESH) recommendations, the 2013 ESH position paper, and the 2000 British Hypertension Society recommendations.¹⁶⁻¹⁸ Other influential works on pregnancy-induced hypertension, aspirin chronotherapy in pregnancy, and other studies are listed in Table I.¹⁹⁻²⁵

Publications by Authors, Source, Institutions, and Countries

The most productive authors in this field include Ayala D.E. and Hermida R.C. from the University of Vigo, Spain, each with 13 publications, 449 citations, and an h-index of 10. Brown M.A. from the University of New South Wales, Australia, contributed 9 papers with the highest citation count (488) and the highest citation rate (54.2 per paper; 61 per cited paper), with an h-index of 8. From Argentina, Espeche W.G. and Salazar M.R. of Universidad Nacional de La Plata each published 8 papers, garnering 90 citations (11.3 per paper; 12.9 per cited paper) and an h-index of 5. The most active sources for publications with a minimum of five publications are listed in Table II.

The most productive institution is the University of Vigo (Spain) with 13 publications, 449 citations, and an h-index of 10. In Australia, both St George Hospital and

the University of New South Wales are highly active, each producing 9 papers; the University of New South Wales has the highest citation count (505) and h-index (9), while St George Hospital shows strong impact with 488 citations and a high citation rate per cited paper (61). From Argentina, the Universidad Nacional de La Plata contributed 7 publications with 87 citations and an h-index of 5. Remarkably, although producing only 5 papers, IRCCS Istituto Auxologico Italiano (Italy) achieved exceptional influence with 2,837 citations averaging 567.4 citations per paper and 709.3 per cited paper.

Table I: Top 10 highly cited articles

No.	Authors	Title	Cites	Cites per Year
1	O'Brien et al. (2003) ¹⁶	European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement	1513	58.2
2	O'Brien et al. (2013) ¹⁷	European society of hypertension position paper on ambulatory blood pressure monitoring	1200	46.2
3	O'Brien et al. (2000) ¹⁸	Use and interpretation of ambulatory blood pressure monitoring: Recommendations of the British Hypertension Society	400	15.4
4	Kintiraki et al. (2015) ¹⁹	Pregnancy-Induced hypertension	225	8.7
5	Ayala et al. (2013) ²⁰	Chronotherapy with low-dose aspirin for prevention of complications in pregnancy	164	6.3
6	Higgins & de Swiet (2001) ²¹	Blood-pressure measurement and classification in pregnancy	150	5.8
7	Head et al. (2012) ²²	Ambulatory blood pressure monitoring in Australia: 2011 consensus position statement	119	4.6
8	Lazdam et al. (2012) ²³	Unique blood pressure characteristics in mother and offspring after early onset preeclampsia	109	4.2
9	Brown et al. (2005) ²⁴	The natural history of white coat hypertension during pregnancy	107	4.1
10	Tenhola et al. (2006) ²⁵	Maternal preeclampsia predicts elevated blood pressure in 12-year-old children: Evaluation by ambulatory blood pressure monitoring	100	3.8

Table II: Most active source titles with a minimum of 5 publications

Source Title	TP	TC	Publisher	Cite Score	SJR 2024	SNIP 2020
Journal of Hypertension	17	3193	Wolters Kluwer Health	7.8	1.097	1.634
Pregnancy Hypertension	8	92	Elsevier	5.4	1.102	1.132
Hypertension	7	329	Wolters Kluwer Health	13.1	2.788	2.101
Blood Pressure Monitoring	5	67	Wolters Kluwer Health	2.1	0.330	0.433
Hypertension Research	5	96	Springer Nature	7.0	1.071	1.058
Hypertension in Pregnancy	5	106	Taylor & Francis	2.8	0.522	0.424
Journal of Human Hypertension	5	39	Springer Nature	6.5	0.937	0.943

The United States leads in output with 25 publications and 3,009 citations, with an h-index of 11. Spain follows with 21 publications and 3,212 citations, achieving the highest h-index (13) alongside the United Kingdom, which, despite fewer publications (17), has the strongest citation impact with 3,735 citations. Australia also demonstrates high influence, producing 19 publications with 3,532 citations and the highest h-index (14). Italy contributed 14 papers and 2,964 citations with a moderate h-index of 9, while Argentina, though with 11 publications, recorded only 139 citations and an h-index of 7.

Co-authorship by countries

Analysis of country-level co-authorship revealed strong international collaboration within the field. The United States emerged as the principal collaboration hub, maintaining extensive research partnerships with Spain, the United Kingdom, Australia, and Italy. European countries, including Spain, Italy, the United Kingdom, the Netherlands, Switzerland, and Greece, demonstrated particularly strong regional collaboration, while Australia maintained active links with both Europe and the United States. In contrast, countries such as Argentina, Brazil, Turkey, China, and Canada exhibited comparatively fewer international collaborations. Overall, research in this field is largely driven by collaborative networks spanning North America, Europe, and Australia, with

more limited participation from South America and Asia.

Co-occurrence Analysis

Co-occurrence analysis of author's keywords

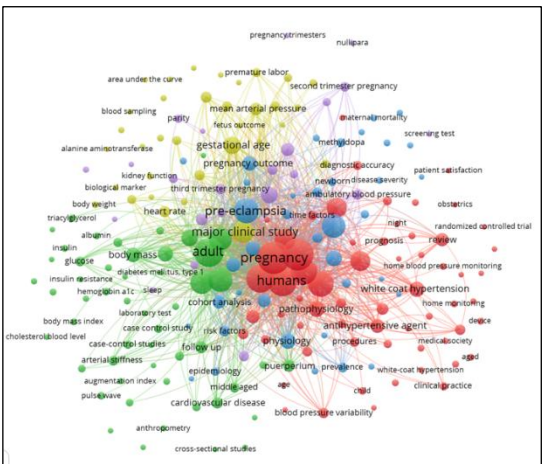


Figure 3: Network visualisation of the author’s keywords

The co-occurrence analysis of author keywords revealed five main thematic clusters (Figure 3). The largest cluster centred on clinical aspects, including humans, pregnancy, antihypertensive agents, pathophysiology, and white coat hypertension. A second cluster focused on pregnancy complications and outcomes, with keywords such as pre-eclampsia, gestational age, pregnancy outcome, and maternal mortality. The third cluster highlighted metabolic and cardiovascular risk factors, including body mass index, glucose, insulin resistance, arterial stiffness, and cardiovascular disease. Another cluster was linked to maternal and foetal characteristics and measurements, such as mean arterial pressure, parity, trimesters of pregnancy, and foetal outcome. The final cluster reflected methodological and interventional studies, with terms like methyl dopa, randomised controlled trial, and screening test.

Co-occurrence analysis of terms based on title and abstract

The network visualisation of term co-occurrence based on title and abstract fields reveals three major thematic clusters (Figure 4). The green cluster is centred on pregnancy-related terms such as delivery, gestational age,

trimester, and normotensive women, reflecting research on maternal outcomes and comparisons between hypertensive and normotensive groups. The blue cluster includes terms like age, body mass index, cardiovascular disease, and arterial stiffness, highlighting demographic and clinical predictors associated with blood pressure variation and cardiovascular risk. Meanwhile, the red cluster comprises terms such as diagnosis, blood pressure measurement, treatment, management, and white coat hypertension, representing studies on the clinical use, diagnosis, and management of hypertension with ambulatory blood pressure monitoring. The strong interconnections across clusters indicate that research in this field integrates maternal health, risk predictors, and clinical management into a closely related body of evidence.

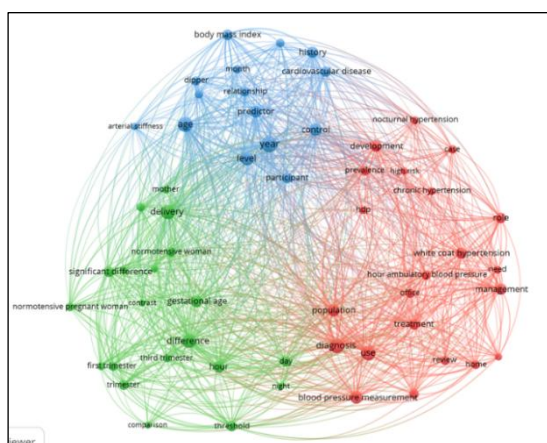


Figure 4. Network visualisation of a term co-occurrence network based on title and abstract fields

DISCUSSION

Evolving Citation Patterns in ABPM and HDP

The citation analysis demonstrates that research on ABPM in pregnancy has established a strong academic footprint. A total of 155 publications from 2000 to 2025 accumulated 6,710 citations, averaging 43.3 citations per paper, with an h-index of 34. Annual citations steadily increased from 2000, peaking between 2013 and 2016, driven mainly by influential guidelines and position papers.¹⁶⁻¹⁸ These documents remain the most cited, reflecting their pivotal role in shaping clinical practice and consolidating ABPM as a recommended tool in maternal care. Although citation rates have gradually

declined since the peak, they remain consistently high (300-400 annually), indicating the field's sustained relevance.

More recently, contemporary studies have highlighted the evolving role of ABPM in refining risk stratification and long-term follow-up of HDP. For instance, one study examined postpartum ABPM patterns, demonstrating its potential for predicting persistent cardiovascular risk after delivery.²⁶ Another used ABPM to detect hypertension and atypical blood pressure phenotypes in women with prior HDP, reinforcing its value in early detection and prevention strategies.²⁷ Similarly, a different study emphasised the optimisation of ABPM protocols during pregnancy to improve management and risk stratification.⁵ The emergence of such recent evidence reveals a shift in the field: while guideline papers dominated earlier citations, newer studies are increasingly applying ABPM in longitudinal, mechanistic, and precision-medicine contexts.^{9,11,27,28}

Patterns of Research Productivity in ABPM and Pregnancy

The distribution of productivity and impact in ABPM research reflects the influence of a small number of highly active authors, institutions, and countries. What is striking is that scholarly impact does not always align with publication volume. For example, institutions with relatively few outputs, such as those in Italy, achieved disproportionately high citation counts, suggesting that landmark studies can elevate visibility and shape the field more effectively than sheer productivity.^{22,21} This pattern highlights the value of quality over quantity in niche areas such as ABPM during pregnancy, where seminal papers can become central references in subsequent clinical and methodological research.

The geographical patterns also reveal that research leadership is largely concentrated in high-income regions particularly North America, Europe, and Australia. This concentration may be explained by the availability of ABPM technology, established maternal cardiovascular research networks, and greater funding opportunities in

these regions.^{19,21} The dense European collaboration clusters further demonstrate the role of regional networks in accelerating methodological refinement and clinical application of ABPM. Conversely, more limited engagement from South America and Asia suggests barriers such as resource constraints or competing research priorities. Nonetheless, the contributions from Argentina and Brazil indicate growing participation, which may enhance the diversity of study populations and clinical perspectives.^{29,30}

The co-authorship network shows how ABPM research in pregnancy is being shaped through collaborative models. The United States emerges as the central connector, linking researchers across continents, while European countries form a tight-knit cluster of mutual collaboration. Australia holds a bridging position, maintaining strong ties with both Europe and North America. Such patterns reflect a maturing research ecosystem where international partnerships are essential for conducting large-scale studies and validating findings across diverse populations.^{20,27}

Importantly, these collaborative and citation trends align with the trajectory of recent research. Contemporary studies have extended the utility of ABPM beyond diagnosis to risk stratification and long-term follow-up. For example, ABPM has been used to refine the detection of blood pressure phenotypes, optimise monitoring protocols during pregnancy, and characterise postpartum trajectories following HDP.^{5,26,27} These directions illustrate how international collaboration is not only increasing productivity but also fostering innovation in the use of ABPM, which has the potential to change clinical management strategies for women with HDP.

Interpretation of Thematic Trends

The thematic clusters identified through both keyword co-occurrence and title/abstract analysis provide a comprehensive picture of the evolving research landscape on ABPM in pregnancy. The strong presence of pregnancy-related terms such as delivery, gestational

age, trimesters, and normotensive women shows that the central focus is on maternal outcomes and comparisons across hypertensive and normotensive groups. This reflects how ABPM has become an indispensable tool for distinguishing physiological adaptations of pregnancy from pathological conditions, thereby supporting timely diagnosis and management strategies.²⁵⁻³¹ The second thematic focus on demographic and cardiometabolic predictors including age, body mass index, insulin resistance, and arterial stiffness demonstrates a shift toward understanding the broader determinants of HDP. These patterns reinforce pregnancy as a unique “window” into a woman’s future cardiovascular health. For instance, the association of non-dipping blood pressure patterns with higher risk of pre-eclampsia and subsequent hypertension suggests that ABPM offers valuable prognostic insights that extend beyond the perinatal period.^{32,33} Meanwhile, the third cluster centred on diagnosis, blood pressure measurement, treatment, and management highlights the clinical utility of ABPM. This focus indicates that research is not only descriptive but also oriented toward improving practice. The inclusion of terms such as white coat hypertension and screening test reflects the recognition that traditional office-based measurements may be inadequate, and that ABPM provides superior risk stratification for both maternal and foetal outcomes. Such insights align with recent protocols like PREECARDIA, which position pre-eclampsia as a predictor of early-onset cardiovascular disease, thereby broadening the scope of ABPM research from pregnancy-specific care to long-term health surveillance.¹¹ The interconnections across clusters suggest that the field is increasingly interdisciplinary. Maternal health, demographic risk factors, and clinical management are no longer studied in isolation but rather as part of an integrated framework of evidence. This convergence reflects broader global trends in maternal health research, where pregnancy is conceptualised as both a clinical event and a sentinel marker for chronic disease prevention.

The patterns revealed by co-occurrence networks show that ABPM research in pregnancy is at a transitional stage. It is moving from descriptive and clinical applications toward predictive and preventative frameworks, yet still faces gaps in interventional evidence and global applicability.^{34,35} Bridging these gaps through more diverse population studies, technology-driven monitoring, and long-term follow-up will be critical in ensuring that the field delivers on its promise of reducing maternal and cardiovascular risk across the life course.

Future Research Directions

Future research on ABPM in pregnancy should prioritise expanding global participation, as current evidence is largely driven by North America, Europe, and Australia, leaving Asia, South America, and Africa underrepresented despite their high burden of hypertensive disorders.^{11,32} Strengthening international collaborations with regions most affected by HDP would not only enhance external validity but also promote equity in maternal health research.¹¹ Beyond refining diagnostic applications, studies should explore innovative therapeutic approaches and digital health solutions informed by ABPM data, as well as adopt longitudinal designs to clarify how hypertensive changes in pregnancy evolve into long-term cardiovascular risk.⁵ Investigating the effect of maternal comorbidities such as pregnancy-onset obstructive sleep apnoea and extending ABPM beyond the postpartum period for the detection of masked hypertension are also critical directions, particularly given evidence linking non-dipping blood pressure patterns in pregnancy to future hypertension and adverse maternofetal outcomes.^{31,32,36,37}

This study has several limitations that should be acknowledged. This bibliometric analysis was dependent on the coverage and indexing practices of Scopus, which may have excluded relevant publications not indexed or those published in non-English journals. Citation counts are also influenced by the time since publication, potentially underestimating the impact of

more recent studies. Furthermore, co-authorship and co-occurrence analyses capture structural patterns of collaboration and thematic focus but may not fully reflect the quality or clinical impact of the research.

CONCLUSION

This bibliometric analysis highlights the evolving research landscape of ABPM in pregnancy, revealing growing productivity, significant international collaboration, and diverse thematic directions. Citation and productivity metrics indicate that a small number of highly influential studies have shaped the field, while recent increases in output suggest a sustained interest in ABPM as both a diagnostic and prognostic tool for HDP. Collaboration networks reflect the leading role of high-income countries such as the United States, the United Kingdom, Spain, and Australia, with more limited but emerging contributions from South America and Asia. Thematic mapping demonstrates three interconnected research foci: maternal outcomes, cardiovascular risk predictors, and clinical diagnosis and management, reflecting a holistic integration of epidemiology, clinical care, and maternal health outcomes. Together, these findings emphasise that research on ABPM in pregnancy is both multidisciplinary and collaborative, with a strong translational potential for improving risk stratification, diagnosis, and long-term cardiovascular health in women. ABPM research in pregnancy is gaining momentum, bridging clinical care and maternal cardiovascular health, with clear opportunities for broader global engagement and innovation.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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