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Maternal and foeto-neonatal characteristics of home childbirth

Ph.D. Dissertation

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Dedication

I would like to dedicate this dissertation to the mothers and families who have chosen homebirth.

…

This study inspires to contribute to the growing body of knowledge on homebirth and its impact on maternal and neonatal health. It may serve as a steppingstone towards further research, policy development, and improvements in maternity and newborn care, ensuring that all women have access to safe and personalized birthing options.

With deepest gratitude!

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Table of Contents

Contents **page**

Dedication I

Acknowledgement II

Table of Contents IV

List of Tables VIII

List of Figures IX

List of Abbreviations X

Chapter 1: Introduction 1

1.1. Background 1

1.2. Epidemiological overview of homebirth practices 3

1.3. Integration of homebirth practices into the healthcare system 4

1.4. Factors related to homebirth practices 6

1.5. Health concerns, adverse outcomes, and safety issues related to homebirth 9

1.6. Problem statement 11

1.7. Research questions 13

1.8. Research objectives 14

1.9. Thesis outline 15

Chapter 2: Sub-study 1: Effects of planned place of birth on obstetric interventions and foeto-maternal birth outcomes in low-risk women: A systematic review and meta-analysis of European studies 16

2.1. Introduction 16

2.2. Review questions 19
2.3. Methods 20
2.3.1. Search strategy and selection criteria 20
2.3.2. Data extraction and Data synthesis 21
2.3.3. Risk of bias (quality) assessment 22
2.3.4. Outcomes 23
2.3.5. Result synthesis 23
2.4. Results 24
2.4.1. Characteristics of the included studies 24
2.4.2. Obstetric interventions and maternal outcomes 37
2.4.3. Foeto-neonatal outcomes 42
2.5. Discussion 48
2.6. Conclusion and Implications for future research 49
Chapter 3: Sub-study 2: Characteristics of homebirth in Hungary: A Retrospective Cohort Study 50
3.1. Introduction 50
3.2. Methods 52
3.2.1. Design and sample 52
3.2.2. Determinants 53
3.2.3. Outcome measures 53
3.2.4. Case-mix adjustment 53
3.2.5. Data analysis 54

3.2.6. Operational definitions....56
3.2.7. Ethical approval....58
3.3. Results....58
3.3.1. Baseline characteristics of participants....58
3.3.2. Foeto-neonatal birth characteristics and outcome....61
3.3.3. Maternal and foeto-neonatal birth outcome conditions and complications....64
3.4. Discussions....70
3.5. Conclusion....74
Chapter 4: Sub-study 3: Maternal and foeto-neonatal characteristics of childbirth in Ethiopia: A multilevel mixed-effect analysis....74
4.1. Introduction....74
4.2. Methods....76
4.2.1. Study design and setting....76
4.2.2. Data source and Sampling procedure....77
4.2.3. Study Variables....78
4.2.4. Data collection procedure....79
4.2.5. Data management and analysis....79
4.3. Results....82
4.3.1. Socio-demographic and Economic characteristics of women....82
4.3.2. Obstetric and health service-related characteristics....84
4.3.3. Newborn related characteristics....87

4.3.4. Community-level characteristics of women 88

4.3.5. Spatial analysis of homebirth practices..... 91

4.3.6. Spatial analysis of institutional childbirths 92

4.4. Discussions 99

4.5. Strengths and limitations..... 101

4.6. Conclusion 102

Chapter 5: Summary of the novel findings 103

Chapter 6: Implementation suggestions and potential strategies to address homebirth-related challenges. 106

Chapter 7: List of publications and scientific activities during Ph.D. course 109

7.1. Published full text articles:..... 109

7.2. Articles related to dissertation currently under review. 109

7.3. Additional articles currently under review 110

7.4. Abstracts chapter in book (conference paper) in “Health sciences”: 110

7.5. Other ongoing research work in “Health sciences”: 111

Chapter 8: References 112

Appendix……...140

List of Tables

Table 1:Characteristics of the included studies.....27

Table 2: Summary of the obstetric interventions and maternal outcome meta-analysis findings for all women by level of midwives' healthcare integration.....39

Table 3:Summary of feto-neonatal outcome meta-analysis findings by level of midwifery health care integration 46

Table 4: Baseline characteristics of women who experienced home births and institutional births. 60

Table 5: Newborn characteristics and outcomes of mothers who experienced home birth and institutional childbirths. 62

Table 6: Comparisons of maternal and foeto-neonatal characteristics of home-and institutional childbirth.....64

Table 7. Summary statistics of women and foeto-neonatal home and institutional birth characteristics and outcomes: Pooled risk measures [Intervention (C/s and AROM) * Perinatal mortality]; using intention-to-treat-like approach and case-mix adjustment. 67

Table 8: Socio-demographic and economic characteristics of women by place of birth (individual level) in Ethiopia 82

Table 9: Obstetric and health service-related characteristics of women (individual level) by birthplace in Ethiopia.....85

Table 10: Child obstetric characteristics by place of birth in Ethiopia 87

Table 11: Community-level characteristics of women by place of birth in Ethiopia .89

Table 12: Multivariable multilevel mixed-effect logistic regression analysis of home birth characteristics in Ethiopia, 2016 95

List of Figures

Figure 1: The PRISMA flow chart illustrates the process of study identification and selection. 25

Figure 2: Funnel plot for publication bias assessment by level of integration and outcomes 36

Figure 3: Forest plot of perinatal mortality meta-analysis stratified by parity. 43

Figure 4: Forest plot of perinatal mortality meta-analysis stratified by the level of midwives' integration into healthcare system after accounting for parity. 44

Figure 5:Trends of homebirth practices by year in Hungary (2012-2020) 59

Figure 6: Birth weight percentiles by place of births in Hungary (2012-2020)..... 64

Figure 7: Proportions of home and institutional births by regions and population sizes in Ethiopia 91

Figure 8: Kriging interpolation analysis of homebirth practices in Ethiopia, EDHS 2016..... 92

Figure 9: Spatial distribution of Institutional childbirths in Ethiopia, EDHS 2016.... 93

List of Abbreviations

AGA- Appropriate for gestational age

ANC-Antenatal care

AOR-Adjusted Odds Ratio

APA- American Psychological Associations

AROM- Artificial rapture of membrane

ART- Assisted Reproductive Technology

BMI-Body Mass Index

CI- Confidence interval

COR- Crude odds ratio

COR-Adjusted Odds Ratio

CSA-Central Statistical Agency

DHS-Demographic and health survey

DPA- Data protection authority

EA-Enumeration Area

EDHS-Ethiopian demographic and health survey

FHR- Foetal heart rate

GDPR- General data protection and regulation

GPS- Global positioning system

Hb- Haemoglobin

HBW- High birth weight

I^2- Heterogeneity

ICC-Intra-cluster correlation coefficient

ICD- International classifications of diseases

IR- Individual record

IUI- Intrauterine insemination

IVF- In-vitro fertilization

LBW- Low birth weight

LGA- Large for gestational age

LLR- Log-likelihood Ratio

MMR- Maternal mortality ratio

MOR-Median Odds Ratio

MSD-Mean standard deviation

NBW- Normal birth weight

NGOs- Nongovernmental organizations

NICU- Neonatal intensive care unit

NOS- New Castle Ottawa Scale

OB- Operative birth

OR- Odds ratio

OVB- Operative vaginal birth

PCV-Proportional change in variance

PNC- Postnatal care

PPH- Postpartum haemorrhage

RCTs- Randomized control trials

RoB- Risk of Bias

RR- Relative risk

SBA- Skilled birth attendant

SD- Standard deviation

SDGs- Sustainable development goals

SGA- Small for gestational age

SNNPR: Southern nations, nationality, and people's region

SPSS- Statistical package for social science

SROM- Spontaneous rapture of membrane

SVB- Spontaneous vaginal birth

tPROM- Premature rapture of membrane at term

UNDP- United nations development programme

VIF- Variance inflation factor

WHO: World Health Organization

X^2 -Chi-square

Chapter 1: Introduction

1.1. Background

Home childbirth, also called homebirth, refers to the practice of giving birth at home, outside of a hospital or healthcare facility, with the assistance of a trained midwife or other healthcare provider (1,2). This is an age-old tradition that predates the establishment of formal healthcare systems and hospitals. Throughout history, homebirth has been the most common method of childbirth among women worldwide (3,4). Recently, we should distinguish two main types of homebirths. Most frequently, it occurs as a natural need, usually in the absence of professional healthcare (5,6), and it could be an individual choice with the background of a developed professional healthcare (7–9).

In many cultures, the idea that homebirth is a natural and normal method of giving birth is based on the notion that women should have autonomy and control over their birthing experiences and that delivering is a natural occurrence. Women can labour and give birth in settings where they feel safe and supported when they give birth at home since it can be a familiar and comfortable atmosphere for them (10–12).

Unlike opponents, homebirth proponents contend that it has a number of possible advantages (13,14). The fact that home birth associated with lesser medical interventions and procedures that are more prevalent in hospital settings, such as epidurals, Caesarean sections, and episiotomies (15). Homebirth is frequently associated with a lower risk of infections, as it is reducing exposure to hospital-acquired pathogens. Additionally, being in a familiar environment can promote a sense of relaxation and reduce stress during labour, potentially leading to a more favourable birth experience (16).

However, home births are not without risks or considerations (17). The safety of homebirth depends on numerous factors, including the availability of skilled birth attendants, access to emergency medical care, and the overall health and risk profile of the mother and newborn (18–20). Obstetrical complications can occur, necessitating prompt medical attention and readily available interventions in a hospital setting. Some complications can be determined before pregnancy (e.g., maternal age, pre-existing diseases, such as hypertension or diabetes mellitus), but some of them develops during pregnancy (e.g., gestational diabetes, pre-eclampsia). Also, serial ultrasound examinations are necessary to evaluate foetal condition (e.g., estimated weight, positioning). Therefore, appropriate prenatal care is essential for the correct patient selection for home birth. Sometimes special examinations, such as evaluation of maternal central haemodynamic, could also be useful for proper evaluation of mothers and foetuses for home delivery (21–24). In situations where complications are present or anticipated, hospital birth is generally recommended to ensure the well-being of both the mother and newborn (25).

The custom of giving birth at home differs throughout nations and cultures (26). In certain regions, homebirth is more usual and culturally accepted, whereas in others, it may be less prevalent or even discouraged by healthcare professionals (14,17,27,28). The choice to have a home birth should be made after careful consideration of individual circumstances, including the accessibility to emergency treatment, the calibre and availability of healthcare services, and the existence of any known risk factors or medical disorders (29,30).

It is important for women considering home birth to consult licensed healthcare professionals who are knowledgeable about homebirth and fully aware of the associated

risks and benefits. Ultimately, the objective is to protect the mother's and the newborn's safety and well-being (3).

1.2. Epidemiological overview of homebirth practices

The magnitude of homebirth practices varied significantly across countries and regions. In some parts of the world, homebirth is relatively common and accepted as a cultural norm, while in others, it may be less prevalent or even uncommon (25,31,32). It is important to note that the prevalence of homebirth can be influenced by factors such as cultural traditions, socioeconomic status, access to healthcare facilities, and availability of skilled birth attendants (11). Homebirth is more common in some parts of the world and among specific cultural or religious groups, while in others, it is a less common choice for childbirth (20,33).

High homebirth prevalence: In certain nations and areas, home birthing is a well-established and socially acceptable practice. For instance, homebirth is a customary and extensively accepted choice for low-risk pregnancies in the Netherlands, which has one of the highest rates of homebirth in developed world (34,35). Similarly, in some rural areas of developing countries with limited access to healthcare facilities, homebirth may be the most feasible option for many women (10,11,36)

Moderate homebirth prevalence: For a woman carrying low-risk pregnancies, homebirth may be an option to hospital deliveries in some nations where it is done to a moderate degree. This includes nations like the UK, Canada, and New Zealand, where some women opt to give birth at home with the help of licensed midwives. (37–40).

Low homebirth prevalence: In other nations, homebirth is rather rare; instead, most deliveries take place in medical institutions like hospitals or birth centers. Frequently,

this is the situation in nations with highly developed healthcare systems that prioritize hospital-based maternity care. The United States, Australia, and several European nations are among the industrialized nations with comparatively low rates of homebirth (9,41,42). This could be attributable to a number of things, such as changes in culture, the medicalization of childbirth, and the preference for hospital deliveries because of the perceived safety and availability of medical care (25).

1.3. Integration of homebirth practices into the healthcare system

The concepts of integrated and unintegrated homebirth relate to the level of coordination and collaboration between homebirth practices and the formal healthcare system (43).

Integrated homebirth: Homebirth practices that are closely coordinated and integrated with the healthcare system are referred to as integrated homebirths (43). This method acknowledges homebirth as a respectable and encouraged method of birthing and fosters cooperation between healthcare practitioners in hospitals and clinics and homebirth providers like midwives (27,44,45). In order to guarantee that mothers and newborns receive the proper medical attention and intervention when necessary, integrated homebirth usually entails a system of referral and transfer of care (19,46–48). This model often includes clear lines of communication, established procedures, and reciprocal respect between homebirth providers and medical personnel, which are frequently included in this paradigm (49,50).

Unintegrated homebirth: This type of care model sees homebirth procedures run separately and autonomously from the official healthcare system (43). In this approach, homebirth may be preferred over hospital birth in cases when there are no close connections to medical services. In situations when homebirth is not officially

acknowledged or encouraged by the healthcare system, or when there are obstacles preventing homebirth providers and medical experts from working together, unintegrated homebirth may take place. This may lead to difficulties in arranging critical interventions, restricted access to emergency medical care, and possible delays in receiving the right medical care in the event of complications (3,51–54).

The distinction between integrated and non-integrated homebirths is important because the level of integration can impact the safety and quality of care provided during homebirth (55). By guaranteeing that the mother and the baby have access to emergency care and the proper interventions when necessary, integrated homebirth models often place a high priority on their well-being (27,56). In addition to establishing procedures for a smooth transition of care in the event of problems, this model recognizes the inherent risks associated with homebirth (57). On the other hand, unintegrated homebirth may have more risks in terms of restricted access to medical interventions and delayed access to emergency treatment (58,59)

It is challenging to provide an exhaustive list of countries with integrated or unintegrated homebirth practices because they are subject to change over time as healthcare policies and practices evolve. Countries with integrated homebirth practices include the Netherlands, New Zealand, United Kingdom, Canada (specifically certain provinces such as British Columbia and Ontario), Australia (with varying degrees of integration across different states) (19), and countries with unintegrated homebirth practices include the United States (varies by state; some states have more integrated practices, while others have less formal recognition and limited integration), Germany (where homebirth is generally not integrated into the healthcare system, but there are initiatives for collaboration in some regions), France (although there have been recent

efforts to increase integration and collaboration between homebirth providers and hospitals), Japan (where homebirth is legal but not widely integrated into the healthcare system), and India (where homebirth practices vary, with some regions having more integration and recognition than others) (43,60). It is important to note that the classification of countries as having integrated or non-integrated homebirth practices can be nuanced and may vary within different regions or subnational contexts (61).

It is noteworthy that different nations and healthcare systems integrate homebirth methods to differing degrees, while homebirth may be less legally recognized or regulated in some countries, leading to a more disjointed approach, in others, frameworks and rules have been constructed to enable integrated homebirth models (27,62).

1.4. Factors related to homebirth practices

The choice to give birth at home is impacted by a number of factors that differ among people, cultures, and healthcare systems. The following are some typical factors that influence homebirth.

Personal preferences and beliefs: Homebirth is a choice that women may make based on their personal ideas about the safety and naturalness of giving birth at home. Some women cherish the independence and control that a homebirth may offer, while others prefer the coziness and comfort of their own surroundings (4,9,12,63).

Cultural and societal factors: A homebirth decision is heavily influenced by cultural customs and beliefs. In certain societies, giving birth at home is regarded as a natural and desirable custom with a long history. Additionally influencing personal decisions are societal conventions and attitudes regarding homebirth (11,59).

Previous birth experiences: Good past birth experiences, particularly those that take place at home, can impact a woman's desire to give birth at home again. When they become pregnant again, women who have had unpleasant hospital experiences—such as interventions or a lack of individualized care—may decide to give birth at home (4,12,20,64,65).

Access to maternity care services: One significant factor influencing homebirth is having access to excellent maternity care services. In certain places, especially isolated or rural ones with little access to medical facilities, giving birth at home could be the only practical choice (14,63).

Availability of skilled homebirth providers: One of the most important factors is the availability of skilled or trained homebirth caregivers, such as midwives, who have expertise giving competent and safe care during home childbirth. The decision to give birth at home may be influenced by these providers' accessibility and availability (64,66–70)

Trust in the healthcare system: Choosing to give birth at home can be influenced by one's level of trust in the medical community and its practitioners. Some women may opt for homebirth as an option because of worries about medical procedures, institutional policies, or unpleasant past experiences (41,64,71).

Perceived safety and risk assessment: Women may weigh the perceived risks and benefits of homebirth compared with hospital birth. Factors such as the woman's health status, previous pregnancy history, and the presence of any high-risk conditions can influence the decision-making process (41,57,71).

Support from partner and family: A woman's decision to give birth at home may be influenced by her husband, family, or close social network's support and involvement. Encouragement and positive reinforcement can strengthen this decision (72–75).

The factors that influence homebirth might differ greatly depending on the situation and the person. Access to healthcare services, including hospitals and birthing centers, may be restricted for those living in rural or isolated areas of developing countries. As a result, when there are few accessible healthcare choices, homebirth becomes a possibility (63,76,77). Developing nations frequently struggle to maintain a sufficient supply of delivery attendants, such as doctors or midwives, especially in rural areas. The prevalence of homebirth may be influenced by the lack of qualified specialists (5,78–80).

Cultural norms and traditional practices also play a role in the preference for homebirth in developing countries. Certain societies have long-standing customs and beliefs about delivery that emphasize and support homebirth as a viable option (4,59,70,73).

The decision to give birth at home can also be influenced by financial constraints in underdeveloped nations, as hospital care and healthcare services may be expensive. Homebirth may be seen as a more cost-effective option for those families (6,75).

Most developed nations have reputable healthcare systems in place, complete with easily accessible hospitals and birthing facilities. The provision of these amenities may increase the accessibility and preference for hospital deliveries, resulting in a decrease in the number of home births (15,27). Women who choose homebirth can receive safer and more comprehensive treatment if they are connected with the healthcare systems of developed nations, which facilitates collaboration and coordination between homebirth providers and medical experts (43).

The number of skilled birth attendants, such as certified midwives who are prepared to offer care during homebirths, is generally higher in developed nations (81–83). The availability of qualified healthcare professionals can support and enhance the safety of homebirth choices. In maternity care, it frequently gives precedence to evidence-based

practice. It's possible that this emphasis on safety and scientific data may make hospital births, where access to emergency care and medical interventions are readily available are more desirable.

1.5. Health concerns, adverse outcomes, and safety issues related to homebirth

While homebirth, when carefully planned and supervised by trained birth attendants, can be a good and safe alternative for low-risk pregnancies (25,84,85), it's crucial to be aware of potential health risks, unfavourable outcomes, and safety hazards. The following are the main concerns.

Health Concerns:

Maternal complications: Maternal complications during homebirth can include postpartum haemorrhage (excessive bleeding after birth), perineal tears, infections, and hypertensive disorders, such as preeclampsia. These conditions require immediate medical attention and may be delayed in a homebirth setting (19,46,82,83,86–88).

Neonatal complications include neonatal asphyxia (insufficient oxygen supply to the newborn), meconium aspiration (inhalation of the newborn's first stool), and birth injuries. Prompt access to resuscitation and specialized neonatal care is crucial for managing these complications (19,83,88,89).

Lack of continuous monitoring: Homebirth may lack continuous monitoring of foetal heart rate and maternal vital signs, which can impede timely detection of potential complications. Monitoring is essential for identifying signs of distress and determining the need for intervention (82,89,90).

Adverse Outcomes:

Neonatal mortality: Research has indicated a marginally higher chance of newborn mortality during the first 28 days of life, when giving birth at home as opposed to in a

hospital. Even though there is little overall danger, it is crucial to take this possible negative effect into account (31,89).

Perinatal morbidity: Perinatal morbidity is the term used to describe health problems or complications in babies that may arise from home birth, such as infection, meconium aspiration syndrome, or low Apgar scores (a measure of newborn health). These illnesses may have long-term effects and necessitate prompt medical intervention (31,91,92).

Maternal morbidity: Infections, protracted labour, or severe bleeding are examples of maternal morbidity that can result from homebirth. Transferring to a medical center for additional management of these issues may be necessary (15,19,83,93).

Safety Issues:

Delayed access to Emergency Care: Access to emergency medical help may be delayed in the event of an unanticipated complication during homebirth. Transferring a mother or newborn to a medical institution takes time, which might affect the results and possibly make issues worse (13,69,94).

Limited availability of medical interventions: Access to medical procedures including assisted vaginal delivery, Caesarean sections, and pain management techniques may be restricted in homebirth settings. The ability to successfully manage emergencies may be compromised in the lack of timely access to these therapies (84,95). Additionally, homebirths might not have the emergency supplies, drugs, or equipment needed to handle difficulties quickly. Ensuring the safety of the mother and newborn requires the availability of resuscitation equipment, drugs to control bleeding, and instruments for neonatal care. Furthermore, there's a chance that homebirths won't have full access to screening and monitoring services like ultrasounds, continuous electronic foetal monitoring, and other regularly offered hospital testing. This may have an impact on

the capacity to identify and manage possible hazards or difficulties during labour and delivery (41,74,85,87,96).

Inadequate skills or training: Safe homebirth practices require the presence of trained birth attendants, such as obstetricians or registered midwives. Birth attendants who lack the necessary skills or training run the risk of causing problems and endangering the health and safety of both the mother and the baby. To ascertain whether a woman is suitable for giving birth at home, appropriate risk assessment and selection criteria are essential. Certain women may not be good candidates for homebirth if they have a history of difficulties, are pregnant at high risk, or have certain previous medical conditions. The probability of unfavourable results can rise in the absence of appropriate risk assessment and selection procedures (27,84,97–100).

1.6. Problem statement

A crucial decision that expectant parents have to make during their pregnancy is where the baby will be born (3,40). Although institutional births, such as those that take place in hospitals or birthing centers, are the most popular option for many families (50,101), homebirth is becoming increasingly popular as a secure and empowering alternative. Homebirth proponents contend that it can offer mothers a more relaxing and customized experience with fewer interventions and a reduced risk of medical issues (61,91). Opponents, on the other hand, raise issues with the preparedness and safety of homebirth attendants, as well as the possibility of a delay in receiving emergency medical assistance in the event of difficulties (94,102,103). Some of these difficulties have been clarified by recent research, which demonstrates that homebirth can be a safe and fulfilling choice for low-risk pregnancies, provided appropriate precautions and guidelines are followed (9,15).

Concerns remain, though, about how safe homebirths are in comparison to hospital births (70,102). Although some researchers have indicated that homebirths with competent birth attendants during low-risk pregnancies can be safe, there are still worries about possible complications, a delay in receiving emergency care, and unfavourable outcomes that could have an impact on the health of mothers and babies (15,55). According to other research, another issue is the absence of uniform risk assessment and homebirth selection standards. To ensure the safety and well-being of mother and newborn, it is imperative to determine whether women are suitable candidates for homebirth, taking into account their medical history, gestational age, and other pertinent criteria (42,104).

The inclusion of homebirth methods in the larger healthcare system is still a challenging problem, which brings us to another important point. To ensure seamless referral systems, prompt care transitions, and access to specialized treatments in the event of difficulties, homebirth providers, midwives, and hospitals must create clear protocols, effective communication, and coordination (31,43,105).

Maintaining safety standards and delivering high-quality care also depend on midwives and other homebirth attendants having the required skills and training. Homebirth providers must participate in ongoing professional development programs and regular evaluations to stay current on best practices and regulations (31,43,105). Other related problems include lack of informed decision-making and support, lack of access to resources and emergency care, stigmatization, and societal attitudes. Stigmatization and cultural views around homebirth are common, and they may make it more difficult for women who prefer this technique to get the support and care they need. To guarantee that women's choices are honoured and their birthing preferences are encouraged,

stigmatization must be addressed and a kind, encouraging environment must be fostered (11,49,97,106).

According to research from the World Health Organization (WHO), nearly 140 million women globally give birth each year, and predicting the outcome of a pregnancy from the start is undoubtedly challenging, despite the fact that there is a wealth of knowledge regarding the clinical treatment of labour and delivery. Clinical therapies aimed at promoting women's safety, comfort, and enthusiasm during childbirth are given less attention (107). Women need to get medical attention both before and throughout pregnancy in order to reduce the likelihood that they will experience difficulties (108). Certain problems or illnesses may get worse during pregnancy. A lot of problems are little and don't become worse, but if they do, the mother and her unborn child could suffer (109,110).

Thus, our studies try to investigate a shred of statistical evidence and insight into maternal and foetal-neonatal characteristics and experiences of home childbirths and related outcomes.

1.7. Research questions

- What are the obstetric history and demographic characteristics of women who choose homebirth?
- What are the maternal and foetal-neonatal outcomes associated with home childbirth, including rates of morbidity, mortality, and birth weight?
- How do the safety and outcomes of home childbirth compare to hospital births in terms of maternal and foetal-neonatal outcomes?

- Are there disparities and associations in the characteristics and outcomes of home childbirth based on geographic location and or other demographic factors?

1.8. Research objectives

1.8.1. *Main Objective*: To investigate the details of home childbirths in developed and developing countries with distinct background and attitudes in order to help making homebirth safer.

1.8.2. Specific Objectives:

- To describe the demographic characteristics of women who choose home childbirth, including age, education level, socioeconomic status, and rural/urban residence.
- To examine the obstetric characteristics of women who opt for home childbirth, including parity, previous birth experiences, and medical history.
- To determine the prevalence of home childbirth in the study population and investigate any temporal trends.
- To assess the maternal outcomes associated with home childbirth, including rates of maternal morbidity, birth experience, and postpartum care.
- To investigate the foeto-neonatal outcomes of home childbirth, including rates of neonatal morbidity, mortality, and birth weight.
- To identify factors associated with successful home childbirth, such as the presence of skilled birth attendants, availability of emergency plans, and access to timely transfer of care in case of complications.
- To compare the safety of home childbirth to hospital births in terms of maternal and foeto-neonatal outcomes.

- To examine potential disparities in the characteristics and outcomes of home childbirth based on geographic location, rural vs. urban areas, or different regions.
- To explore the long-term implications and follow-up care needs for mothers and newborns born through home childbirth.

By addressing these specific objectives, the study aims to provide comprehensive insights into the various aspects of home childbirth, contributing to a better understanding of its outcomes, safety, determinants, and disparities.

1.9. Thesis outline

The current thesis is composed of four chapters.

Chapter 1: It is an introductory chapter that introduces about home birth, including its epidemiology and magnitude of homebirth practices, integration of homebirth practices into the healthcare system, factors related to homebirth practices, health concerns, adverse outcomes, and safety issues related to homebirth practices, the problem statement, and contemporary issues and potential strategies to address homebirth-related challenges. Then, the chapter goes narrower to present our research questions and the research objectives.

Chapter 2: Presents the first part of the current research, which is a systematic review and meta-analysis on effects of planned place of birth on obstetric interventions and foeto-maternal birth outcomes.

Chapter 3: Displays the second part of this research, which is a sub-study assessing characteristics of homebirth in Hungary: a retrospective cohort study.

Chapter 4: Presents another sub-study about maternal and foeto-neonatal characteristics of childbirth in Ethiopia: a multi-level mixed-effect analysis. Chapter five presents the

novel findings of our research, including all the sub-studies, recommendations, and implications for practice and research.

Chapter 2: Sub-study 1: Effects of planned place of birth on obstetric interventions and foeto-maternal birth outcomes in low-risk women: A systematic review and meta-analysis of European studies

2.1. Introduction

The choice of birthplace is a pivotal decision for expectant mothers, one that carries profound implications for both maternal and foetal health outcomes (111,112). In recent years, there has been a growing interest in exploring the effects of planned birthplace on obstetric interventions and foetal-maternal birth outcomes, particularly among low-risk women (81). This systematic review unravels the intricate relationship between the planned birthplace (home, birth centre, or hospital) and the subsequent obstetric interventions and outcomes for this specific cohort of low-risk expectant mothers.

Over the past few decades, childbirth practices have witnessed significant shifts, with increasing recognition of the importance of individualised care tailored to a woman's unique needs and preferences (113). This shift has been paralleled by a resurgence of interest in out-of-hospital births, such as home births and free-standing birthing centre deliveries, which offer women a more personalised and less medicalised approach to childbirth (112). Conversely, hospital births have remained the conventional choice, characterised by ready access to medical interventions and a multidisciplinary team of healthcare providers (111).

As renowned midwife Ina May Gaskin once stated, "Your birthing experience will affect your mind, body, spirit, and emotions for the rest of your life, regardless of when and how you plan to give birth."(114). This sentiment emphasises how crucial it is to

comprehend the effects of planned birthplace on childbirth experiences and outcomes, particularly for low-risk women (115). Low-risk pregnancies are those where there are no identified complications or significant medical concerns that would necessitate intensive medical interventions during childbirth (15).

The choice of birthplace is not only a deeply personal decision but also one influenced by many factors, including cultural norms, geographic location, healthcare provider recommendations, and the mother's beliefs and desires (81). While the majority of pregnant women in low-risk situations opt for hospital births (111), a growing number are choosing out-of-hospital options, often motivated by a desire for a more natural and less intervention-driven birth experience (113). Hospital births have become the norm in many industrialised countries, with obstetric interventions readily available. However, there is a growing movement advocating for a more personalised, woman-centred approach to childbirth, which includes options such as birthing centres and home births. These alternative settings often emphasise a lower rate of interventions and a focus on natural childbirth (90).

The focus on low-risk women is particularly pertinent, as they represent a substantial proportion of expectant mothers, and their choice of birthplace can have an enormous impact on healthcare resources and maternal satisfaction. Understanding the outcomes associated with different planned birthplaces in this population is crucial for informed decision-making by pregnant women and healthcare providers (116).

This systematic review and meta-analysis wanted to create the available evidence from European studies to comprehensively examine the effects of planned birthplace on obstetric interventions and foetal-maternal birth outcomes in low-risk women. Europe has a diverse healthcare landscape, with variations in maternity care practices and

policies across countries. Investigating birth outcomes in this context can provide valuable insights into how different healthcare systems and cultural preferences influence the choice of birthplace and its consequences (117,118).

In this review, we analysed data from a range of European countries to explore whether a planned birthplace impacts the rates of obstetric interventions, such as Caesarean sections, instrumental deliveries, and epidural analgesia, and maternal and neonatal outcomes, including perinatal mortality, Apgar scores, and maternal satisfaction. By synthesising the existing evidence, we aim to thoroughly explain the advantages and disadvantages of different planned birthplaces for low-risk women in Europe. This knowledge can inform evidence-based decision-making by both healthcare providers and expectant mothers, ultimately promoting safer and more satisfying childbirth experiences.

Through a rigorous literature review, data synthesis, and meta-analysis, this systematic review seeks to contribute to the ongoing dialogue surrounding birthplace choices and their implications for maternal and neonatal health outcomes in low-risk European women, draw attention to gaps in the current body of literature and open the door for more study endeavours in the field of obstetric care.

Evidence before this study

Childbirth is among the most common reasons for hospitalisation in well-resourced countries; however, the practice of home births is being considered again in several developed, wealthy nations (14,27). Barbero and Manrique (2021) stated that compared to institutional births, where overtreatment may occur, this is predicated on assertions of equal safety at lower intervention rates (119). Moreover, Kooy, in 2017, also stated

that it predicated on the purported decrease in morbidity between mother and fetus as well as hypothesised psycho-social benefits for the mother (91).

The safety of planned home births and planned hospital births for low-risk women is still up for debate. Scarf (2018) and Reitsma (2020) found no statistically significant impact on neonatal mortality but lower odds of adverse maternal outcomes and obstetric interventions in intended home births, highlighting the need for more systematic reviews and meta-analyses (19,90). Despite fewer maternal interventions and better neonatal outcomes, Wax (2010) reports a tripling of neonatal mortality rates in planned home births (120), and Kooy (2017) concluded that intervention rates affect the amount of care given during intended home births, especially for multiparous women, but less intervention results in higher mortality. These inconsistent results underscore the necessity for more investigation and the importance of considering the quality and context of the studies.

Thus, our study adds to the existing body of knowledge by analysing a comprehensive meta-analysis concerning the planned birthplace by adhering to reputable, published, peer-reviewed studies considering different designs and settings in European countries. We consider parity and jurisdictional support for integrating home birth into the maternity care system. In order to help women, families, and healthcare decision-makers prepare for childbirth, our study offers crucial information.

2.2. Review questions

Does the choice of planned place of birth impact obstetric interventions and foeto-maternal birth outcomes among low-risk women in European countries?

Do parity and jurisdictional support for integrating home birth into the maternity care system have an association with place of birth and perinatal outcomes?

2.3. Methods

The methods used are summarised below by our pre-established registered protocol (http://www.crd.york.ac.uk, PROSPERO CRD42023439378) and summarised below.

2.3.1. Search strategy and selection criteria

A comprehensive search was made in major electronic databases using predefined keywords and subject headings, including PubMed, Ovid MEDLINE, EMBASE, CINAHL, Cochrane Library, Scopus, and Web of Science. Only English language studies were included, and date restrictions were not applied to this search. The study's identification was done using both manual and electronic searching techniques and lists of references of previous relevant published reviews and meta-analyses were also searched. When only abstracts were found, authors of those records were contacted via email, research gate, or available communication methods to request information about any published papers of the abstracts.

for inclusion:

a) studies that used the planned birthplace at the onset of labour as opposed to the actual birthplace among low-risk women in European countries.
b) original articles in English, and
c) studies that used any type of study design without restricting the year of publication (i.e., any studies between 1990-2023 were used).

For exclusion:

a) Studies conducted outside European countries,
b) studies that focus on high-risk or complicated pregnancies,
c) studies that primarily examine unplanned or emergency place of birth,
d) studies that lack relevant data on obstetric interventions or foeto-maternal birth outcomes,

e) review articles, case reports, commentaries, editorials, and letters
f) studies where the birth cohorts are established during pregnancy before the start of labour because they may include women who wanted to give birth at home but who later discovered that giving birth at home was contraindicated in the remaining weeks of pregnancy, and
g) those studies not in English language and considered free-standing birth centres as homebirth were excluded.

The database search output was transferred into Mendeley and then to the Covidence program for deduplication and screening. After deduplication, two authors, GAW and EKK, independently performed title and abstract screening for each study. Cochrane software for systematic reviews (COVIDENCE-www.covidence.org) was also used for full-text screening and extraction. Two authors, (GAW and EKK), also conducted an independent review of each article to determine its eligibility for inclusion. Disagreements on the articles during screening were resolved through discussion and consensus by the two authors. A third reviewer (VP) was engaged where there was no agreement.

2.3.2. Data extraction and Data synthesis

Data extraction was done using a standardised form that extracted the following data from the included articles: the primary author, year of publication, the country where the research was conducted, main aim of the study, study design, sample size, population type, study setting, participant baseline characteristics (age, gestational age, and parity), stratification by parity, obstetric intervention(s) and foetal-maternal outcome characteristics, and the study key findings. There may be more than one comparison group in some research; in these instances, we picked the comparison group that could least likely introduce confounders. For example, if groups are formed based

on the care provider, we will opt for midwife-led care rather than physician/doctor's care. Our study also considers the contextual factors for home birth, defined as "well-integrated" as contrasted to "less well-integrated." A “well-integrated setting” was one in which home birth practitioners could provide or arrange hospital care, access an established emergency transport system, carry emergency supplies and equipment, are recognised by statute within their jurisdiction, and have completed formal training. Settings lacking one or more characteristics were less well-integrated (43). The data were organised into tables, and data synthesis was done qualitatively and quantitatively.

2.3.3. Risk of bias (quality) assessment

The quality assessment was based on the latest Cochrane risk-of-bias tool for Randomised Trials (RoB 2) and used to evaluate the randomisation of the assignment for the following domains: selection bias (generating random sequences, hiding allocations); performance bias (hiding participants and personal identities); detection bias (blinding outcome evaluations); and reporting bias (reporting specific outcomes only) (121). The study is considered at low risk of bias only when all the signalling questions were not of concern, while all other studies were categorised under “unknown risk” or “high risk of bias.” All disagreements were settled through discussion, and ROB 2 figure was generated using robvis visualization tool available at https://www.riskofbias.info/welcome/robvis-visualization-tool.

The risk of bias for observational and non-randomized controlled trials was evaluated using the New Castle Ottawa Scale (NOS) to assess the quality of the included studies (122). Three independent authors evaluated the quality of each study using the Newcastle-Ottawa Quality Assessment Form. Because of its widespread use, researchers and reviewers have grown accustomed to comprehending and accepting its scoring system and criteria. The NOS Form is a well-structured framework for

evaluating multiple domains of study quality. A total of eight items were assessed, which were divided into three categories: 1. Study group selection. 2. The groups' comparability 3. Study outcome. Studies were rated as good if they met 6 to 8 criteria, fair if they met 5 to 7 criteria, and poor if they met 0 or 1 point in the selection category, 0 points in the comparability category, or 0 or 1 point in the outcome category. The subsequent meta-analytic techniques were also used to examine publication bias using inverted Funnel Plots for neonatal or perinatal outcomes using Review Manager Version 5.4.1. Agreement between reviewers was calculated for the study quality measures using Kappa, here having substantial agreement (0.70) (123).

2.3.4. Outcomes

The primary outcome was foetal or neonatal death or perinatal death reported in the study. The secondary outcome includes admission to neonatal intensive care units (NICU), neonatal resuscitation (as defined in the study), neonatal malformation (birth with deformity/congenital anomalies), birth weight, and Apgar scores of <7 at 1 or 5 minutes are additional neonatal outcomes that were analysed. Maternal death, postpartum haemorrhage/bleeding (blood loss >500ml), different degrees of perineal injury/tear, retained placenta, and infection data were additional maternal outcomes. The use of oxytocin for induction of labour, epidural analgesia for pain management, episiotomy, assisted vaginal delivery (forceps and vacuum), and Caesarean sections were also obstetric interventions considered.

2.3.5. Result synthesis

The RevMan statistical software version 5.4.1 is used to count data or ORs and confidence intervals, compute pooled odds ratios (ORs), and match sampling variances for each study. Then, forest plots were made after combining the data by fitting it into a random-effects model. Calculations were made for pooled ORs, 95% confidence

intervals, and heterogeneity indices (I^2) for every outcome, both overall and within strata.

Due to its predictive nature and correlation with birthplace preference, we intended to stratify our analyses based on parity and perinatal mortality, the primary outcome. We employed the total outcome data when parity was taken into consideration. We also stratified all the analyses according to how well-integrated or less-integrated the maternity care system is toward homebirth.

2.4. Results

2.4.1. Characteristics of the included studies

The comprehensive search produced a total of 2,042 articles. A total of 1619 duplicated studies were removed, and 423 studies were screened for title and abstract. After title and abstract screening, 346 studies were excluded, 77 were sought for retrieval, and 61 were assessed for eligibility by full-text screening. The search was completed on August 26, 2023; 36 full-text articles were obtained for review, and 21 studies that met our predetermined inclusion criteria for a systematic review and 20 for meta-analysis of planned birthplace were found (figure 1).

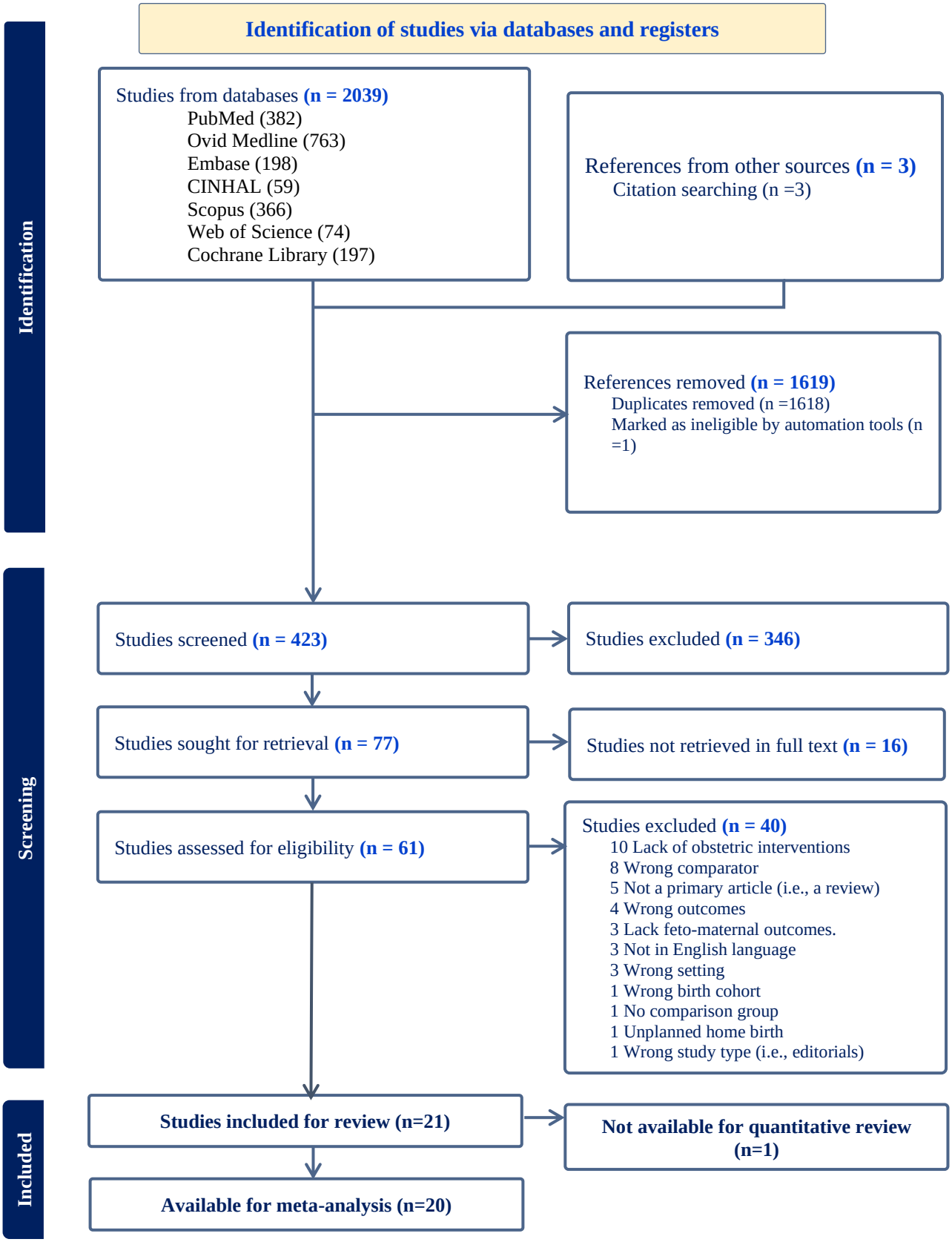


Figure 1: The PRISMA flow chart illustrates the study identification and selection process.

Of 21 studies that meet the criteria for a systematic review of obstetric interventions and foetal-maternal outcomes, one study did not provide any published or author-provided data on perinatal, maternal, or foetal outcomes that could be incorporated into our meta-analysis (124). The meta-analyses comprised 20 original studies published and reported obstetric interventions and foetal-maternal outcomes for ~750,000 intended home births. The exact number of births can be different by analysis, which includes more of the extensive study sample from the same country (The Netherlands), where the data is more substantially overlapped (28,82,91,125–129). Only two randomised controlled trials containing relevant outcomes were included in our analysis (130,131).

With caution, when the multiple comparison groups were selected and compared, strictly consider the used planned home birth group (led by midwifery) and obstetric-led or hospital comparator or conventional centre (led by midwifery) as the institutional group. Out of 21 studies that meet the criteria for a systematic review (of which 20 were included in the meta-analyses), they were in 10 settings. Twelve studies were from a country where home birth was considered to be “well integrated” into the healthcare system (The Netherlands, UK, and Denmark) (15,21–28,30–33); eight of them were in The Netherlands (28,82,132,134,91,124–129,131), and Nine studies from seven settings where home births considered "less well-integrated" settings (15,130,135–140). Although some countries in "less well-integrated" settings were well-integrated, the degree of integration varied by region (Belgium, Spain, Norway, Hungary, Italy, Iceland, and Lithuania), and the I^2 score ranged between 0 and 100% (Table 1).

Table 1: Characteristics of the included studies

Author(s), year, country	**Study design**	**Data source and period**	**Data analysis by parity**	**Place of birth (N)**		**Outcome(s) reported**	**NOS score (4-2-3)**
				Planned homebirth **n/N (%)**	Planned Institutional birth **n/N (%)**		
Isaline et al., 2019, Belgium (135)	Retrospective cohort	MLOZ (Mutualit ØLibres Onafhankelijke Ziekenfondsen) was the third Belgian statutory healthcare insurer from 1 March 2014 until 31 October 2015	Not stratified	59/89 (66.3)	30/89 (33.7)	2-5, 20	3-2-3
A de Jonge, 2013, Netherlands (28)	Retrospective cohort	"LEMMoN" data from 1 August 2004 to 1 August 2006, combined with data from the Netherlands perinatal registry	Adjusted and stratified	92,333/146,752 (62.9)	54,419/146,752 (37.1)	8	3-1-2

A deJonge et al, 2014, Netherlands (125)	Retrospective cohort	National perinatal and neonatal registration data over seven years from 2000 to 2006	Adjusted and stratified	321,307/529,688 (60.7)	63,261/529,688 (30.8)	12, 15, 16	4-2-2
Wiegerinck et al, 2018, Netherlands (126)	Retrospective cohort	National Perinatal Register (PRN) and extra medical information obtained from hospitals and midwifery units in Amsterdam between January 1, 2005, and December 31, 2007.	Not stratified	46,764/57,396 (81.5)	10,632/57,396 (18.5)	2,4, 5, 8, 12, 19	3-2-3
Palau-Costafreda et al, 2023, Spain (136)	Retrospective cohort	Medical history, obstetric characteristics, and maternal and neonatal outcomes were recorded by obstetric health-	NP (not performed)	255/878(29.0)	623/878(71.0)	2-5, 8-11, 16, 19	3-1-3

		care professionals in patient charts and the hospital's information system in MLU and OU between January 2018 and December 2020					
Blix et al, 2012, Norway (137)	Retrospective cohort	Midwives' registers, telephone interviews, and birth protocols were used for homebirth data, and the Medical Birth Registry of Norway (MBRN) was used for institutional data from 1990 to 2007.	Adjusted and stratified	1631/17,941(9.1)	16,310/17,941 (90.9)	2-5, 8, 9, 12, 15, 16, 17, 19	2-1-3
Bolten et al, 2016, Netherlands (82)	Prospective cohort	DELIVER Study participants from 20 midwifery practices between January 2018 and December 2020.	Adjusted and stratified	2050/3495 (58.7)	1445/3495 (41.3)	1, 3-5, 8, 9, 12-18	4-2-2

Dobbie G et al, 1993, UK (131)	Randomised controlled trial	Leicester Royal Infirmary Maternity Hospital and home-like-home delivery scheme from 1 March 1989 until 6 July 1990.	Not stratified	2304/3510 (65.6)	1206/3510 (34.4)	1-5, 8, 10, 12, 13	Rob 2 (see Additional file 2)
Wami et al, 2022, Hungary (15)	Retrospective cohort	Home: Hungarian Tauffer database (perinatal registry) Institutional: University Hospital Gyn/Oby Clinic from 2012-2020	Not stratified	1792/2997 (59.8)	1205/2997 (40.2)	8-14, 17, 19	3-2-2
Campiotti et al, 2020, Italy (138)	Case-control study	All out-of-hospital births reported in birth registry data from 2014 to 2018 were extracted.	Not stratified	848/1099 (77.0)	251/1099 (23.0)	1, 4, 9, 13, 15	3-2-2
Overgaard et al, 2012, Denmark (132)	Prospective cohort	Data were collected in a sparsely populated region of North Denmark from two FMUs and two OUs over 3.5 years (2004-2008).	NP (Not performed)	839/1678 (50.0)	839/1678 (50.0)	1,2, 4,5, 9, 19, 20	3-1-2

Kooy et al, 2017, Netherlands (91)	Retrospective cohort	The Perinatal Registry (PRN) in the Netherlands between 2000 and 2007	Not stratified	402,912/679,952 (59.0)	219,105/679,952 (32.0)	2, 4, 5, 6, 12, 13, 15, 16, 18	4-1-3
Offerhaus et al, 2020, Netherlands (127)	Retrospective cohort	Data from all women who gave birth in 2015 and were registered in the Dutch Perinatal Registry (Perined).	Stratified	657/2611(25.2)	1954/2611(74.8)	3-5, 8, 9, 12-17, 19	3-2-2
VanHaaren-tenHaken et al, 2015, Netherlands (128)	Prospective cohort	A Dutch prospective cohort study involved 150 randomly selected practices to enrol women in midwife care, using a questionnaire and medical records from 2007-2011.	Stratified	226/576 (39.2)	182/576 (31.6)	1-5, 8-16, 18, 19, 21	4-2-2
Wiegerinck et.al, 2015,	Retrospective cohort	Data from hospitals and midwife practices in the catchment area of both academic hospitals linked with	Not stratified	26,128/56,294 (46.4)	30,166/56,294 (53.6)	1-5, 8, 9, 11, 12, 19, 20	3-2-2

Netherlands (129)		the perinatal register (PRN) in Amsterdam between 2005 and 2008.					
Eide et al, 2009, Norway (139)	Prospective cohort	Data from the hospital and pregnancy records were gathered between November 3, 2001, and May 31, 2002	NP (Not performed)	252/451 (55.9)	201/451 (44.6)	2-5, 9	3-1-2
Bernitz et al., 2011, Norway (130)	Randomised controlled trial	Women who delivered at the Østfold Hospital Trust, recorded in the electronic journal system of the department, partus (Clinsoft) from 2006-2009	Not stratified	282/1,111 (25.4)	412/1,111(37.1)	1, 2, 4, 5, 8, 9, 17, 19, 20	Rob 2 (see Additional file 2)
Halfdansdottir et al, 2015, Iceland (133)	Retrospective cohort	An Icelandic electronic birth registry and direct contact with midwives and tertiary/rural secondary hospitals from 2005-2009	Adjusted and stratified	307/1,228 (25.0)	921/1,228 (75.0)	1-5, 8, 9, 13, 17-21	3-1-2

Van der Kooy et al, 2016, UK (134)	Retrospective cohort	Anonymised data of the UK National Perinatal Epidemiology Unit Report and the midwifery-led birth centre Sophia between January 2007 and June 2012	Stratified	443/5,953 (7.4)	1391/5,953 (23.4)	4, 5, 8, 9, 12-16, 18-20	4-2-2
Bartuseviciene et al, 2018, Lithuania (140)	Retrospective cohort	Hospital registry at the tertiary-care women's hospital in Kaunas, Lithuania.	Stratified	477/1,283 (37.2)	806/1,283 (62.8)	3-5, 9, 10, 19	3-2-3
Christensen et al, 2017, Denmark (124)	Retrospective cohort	Data from two freestanding midwifery units and two obstetric units in the North Denmark Region from March 2004 to October 2008.	Adjusted and stratified	839/1,678 (50.0)	839/1,678 (50.0)	1, 2, 4, 5, 9, 19, 20	3-1-2

Outcome variables: 1) Oxytocin administration/Augmentation, 2) Epidural analgesia, 3) Episiotomy, 4) Assisted vaginal delivery (forceps/vacuum), 5) Caesarean section(C/s), 6) Blood transfusion, 7) Maternal death, 8) Post-partum hemorrhage (PPH), 9) 3rd or 4th-degree

perineal tear, 10) Vaginal or perineal laceration, 11) Retained placenta, 12) Perinatal or neonatal or foetal mortality, 13) Low birth weight <2500g or <10%, 14) Large birth weight ≥4000g or >90%, 15) Preterm/premature born, 16) Post-term-born, 17) Non-vertex presentation, 18) Neonatal mal-formations (congenital anomalies), 19) Low Apgar score <7 at one or 5 mins, 20) NICU admission, 21) Neonatal ventilation/resuscitation

For every stratum of analysis, an inverted funnel plot was made to evaluate the publication bias amongst studies on birthplaces. Six major plots were created, and the largest of our plots contained just fourteen studies. Nevertheless, plots with fewer studies (<5) are more challenging to interpret and were not reported (Figure 2). Figure 2 illustrates the funnel plot for evaluation of the publication bias by level of integration and outcomes.

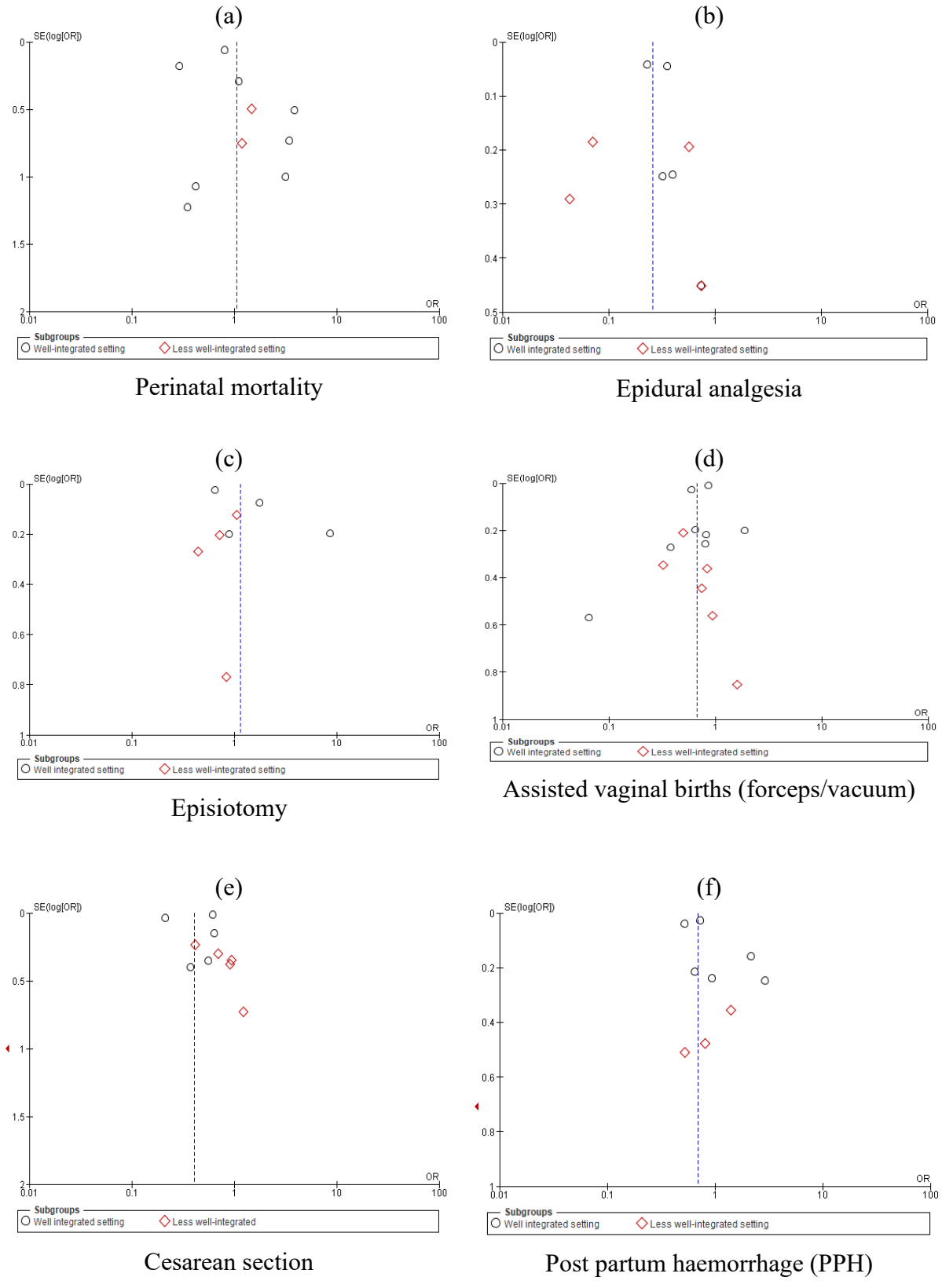


Figure 2: Funnel plot for publication bias evaluation by level of integration and outcomes

2.4.2. Obstetric interventions and maternal outcomes

There were no maternal deaths reported in either group among the nearly 550,000 women included in these studies that specifically reported this outcome. Regarding maternal outcomes and obstetric interventions, homebirths were less likely to report an obstetric intervention. Without stratification by the level of integration and parity, women who are planning a home birth had a 60% lower chance of having a Caesarean section (11 studies, OR 0.40, 95% CI [0.24, 0.68]); 68% fewer women planned assisted vaginal births (vacuum or forceps; 14 studies, OR 0.68, 95% CI [0.55, 0.83]); 74% fewer women planned to use epidural analgesia (9 studies, OR 0.26, 95% CI [0.18, 0.37]); 14% higher likelihood of having an episiotomy (9 studies, OR 1.14, 95% CI [0.66, 0.73]) and 61% less likely had an oxytocin administration for labour induction (9 studies, OR 0.29, 95% CI [0.04, 2.39]). In addition, relatively fewer women who planned to give birth at home experienced adverse maternal outcomes than those who gave birth in an institution, with 59% lesser experience of having retained placenta (5 studies, OR 0.41, 95% CI [0.37, 0.45]) and 31% lesser reported postpartum haemorrhage (10 studies, OR 0.69, 95% CI [0.46, 1.03]), while vaginal/perineal laceration (5 studies, OR 1.22, 95% CI [0.58, 2.57]) and 3rd/4th-degree perineal tear (12 studies, OR 1.04, 95% CI [0.91, 1.19]) have shown no odds of statistical significance.

Compared to women planning an institutional delivery, those planning a home birth in well-integrated settings had a 76% lower chance of having a Caesarean section (6 studies, OR 0.24, 95% CI [0.12, 0.49]); 29% fewer women planned assisted vaginal births (vacuum or forceps) (8 studies, OR 0.71, 95% CI [0.56, 0.90]); 66% fewer women planned to use epidural analgesia (5 studies, OR 0.34, 95% CI [0.24, 0.46]); 59% had experienced retained placenta (3 studies, OR 0.41, 95% CI [0.37, 0.45]) and

10% had 3rd or 4th-degree perineal tear (6 studies, OR 1.10, 95% CI [1.01, 1.20]) and twice more likely had vaginal /perineal laceration (2 studies, OR 2.27, 95% CI [1.13, 4.56]), while episiotomy (4 studies, OR 1.69, 95% CI [0.71, 4.04]); postpartum haemorrhage (2 studies, OR 0.63, 95% CI [0.40, 1.00]) and oxytocin administration for labour induction (5 studies, OR 0.25, 95% CI [0.02, 3.80]) were statistically insignificant.

In less well-integrated settings, women who were planning a home birth had a 69% more likelihood of having a Caesarean section (5 studies, OR 0.69, 95% CI [0.46, 1.01]); 59% more women had assisted vaginal births (vacuum or forceps)(6 studies, OR 0.59, 95% CI [0.41, 0.85]); 19% fewer women planned to use epidural analgesia (4 studies, OR 0.19, 95% CI [0.05, 0.73]); 74% less likelihood of having an episiotomy (5 studies, OR 0.74, 95% CI [0.48, 1.13]); 51% had less likely experienced retained placenta (2 studies, OR 0.49, 95% CI [0.18, 1.36]) and 63% more had 3rd or 4th-degree perineal tear (6 studies, OR 0.63, 95% CI [0.41, 0.97]) and 43% less likely had an oxytocin administration for labour induction (2 studies, OR 0.43, 95% CI [0.23, 0.81]); 92% lesser reported postpartum haemorrhage (3 studies, OR 0.92, 95% CI [0.52, 1.64]) and 84% more vaginal/perineal laceration (3 studies, OR 0.84, 95% CI [0.50, 1.41]) (Table 2).

Table 2: Summary of the obstetric interventions and maternal outcome meta-analysis findings for all women by level of home birth healthcare integration

Outcome (strata)	Number of studies	Place of birth			I^2(%)
		Planned homebirth **n/N (%)**	Planned Institutional birth **n/N (%)**	**OR [95%CI] M-H, Random**	
Obstetric interventions					
Oxytocin administration	9	740/31908	11298/35432	0.29 [0.04, 2.39]	100
Well-integrated	5 (82,128,129,131,132)	556/30648	11158/35014	0.25 [0.02, 3.80]	80
Less-well integrated	2 (130,138)	184/1260	140/418	0.43 [0.23, 0.81]	100
Epidural Analgesics	9	2343/74753	4909/42733	0.26 [0.18, 0.37]	100
Well-integrated	5 (126,128,129,131,132)	2184/73775	4214/41597	0.34 [0.24, 0.46]	93
Less-well integrated	4 (130,135,136,139)	159/978	695/1136	0.19 [0.05, 0.73]	97
Episiotomy	9	3695/31164	5536/37474	1.14 [0.66, 1.96]	98
Well-integrated	4 (127–129,131)	3448/30121	5120/35812	1.69 [0.71, 4.04]	99
Less-well integrated	5 (135,136,139,140)	247/1043	416/1662	0.74 [0.48, 1.13]	68
Assisted vaginal delivery (Vacuum/forceps)	14	34862/480037	24827/266933	0.68 [0.55, 0.83]	94
Well-integrated	8 (91,126–129,132–134)	34734/478036	24670/264960	0.71 [0.56, 0.90]	96

Less-well integrated	6 (130,135,136,138–140)	128/2001	157/1973	0.59 [0.41, 0.85]	27
Caesarean section (C-section)	11	12443/478751	15899/264590	0.40 [0.24, 0.68]	99
Well-integrated	6 (91,126–129,132)	12359/477296	15733/262648	0.24 [0.12, 0.49]	99
Less-well integrated	5 (130,135,136,139,140)	84/1455	166/1942	0.69 [0.46, 1.01]	38
Maternal outcome					
Post-partum haemorrhage (PPH)	10	3905/172115	5107/104358	0.69 [0.46, 1.03]	97
Well-integrated	7 (28,126–129,131,134)	3867/169656	5068/102248	0.63 [0.40, 1.00]	98
Less-well integrated	3 (15,130,136)	38/2459	39/2110	0.92 [0.52, 1.64]	26
3rd or 4th degree perineal tear	12	2002/78532	1099/48133	1.04 [0.91, 1.19]	20
Well-integrated	6 (126–129,132,134)	1960/74798	1045/44891	1.10 [1.01, 1.20]	0
Less-well integrated	6 (15,130,136,138–140)	42/3734	54/3242	0.63 [0.41, 0.97]	0
Perineal or vaginal laceration	5	1275/5831	991/6192	1.22 [0.58, 2.57]	97
Well-integrated	2 (128,131)	961/3307	441/3649	2.27 [1.13, 4.56]	84
Less-well integrated	3 (15,136,140)	314/2524	550/2543	0.84 [0.50, 1.41]	88
Retained placenta	5	939/75136	1221/42765	0.41 [0.37, 0.45]	0
Well-integrated	3 (126,128,129)	933/73089	1205/40937	0.41 [0.37, 0.45]	0

Less-well integrated	2 (15,136)	6/2047	16/1828	0.49 [0.18, 1.36]	14

I^2- Heterogeneity, n-number of cases/outcomes, and N-total number of births

2.4.3. Foeto-neonatal outcomes

Although there was no significant variation in the perinatal mortality outcome by birthplace when the data was stratified by the level of midwives' health care integration and parity, we were limited in our evidence to conclude because additional studies were required for establishing an inference (pooled result stratified by parity: OR 1.87, 95%CI [0.74, 4.72], and by the level of integration: OR 1.05, 95%CI [0.62, 1.79]) (Figure 3 and 4).

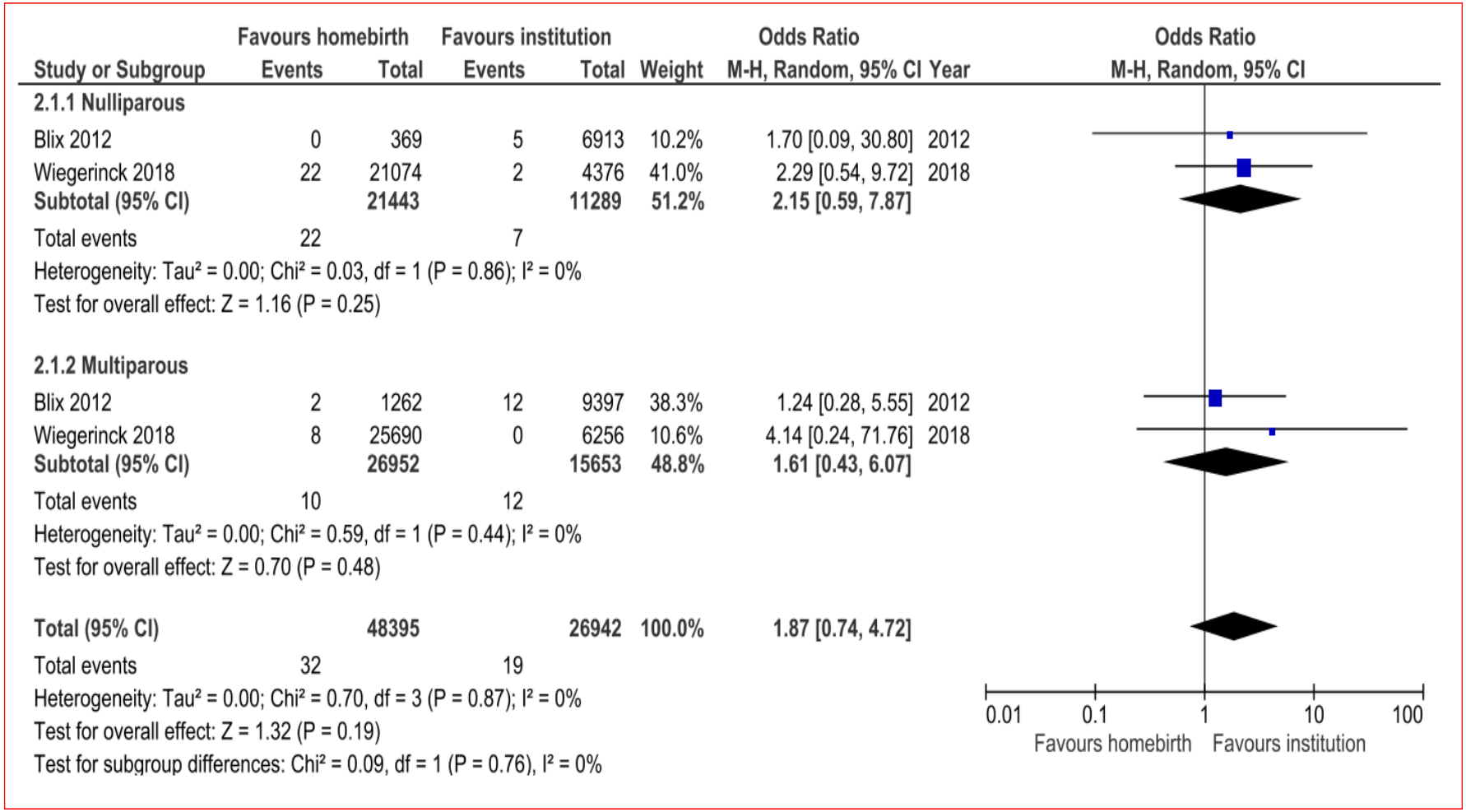


Figure 3: Forest plot of perinatal mortality meta-analysis stratified by parity.

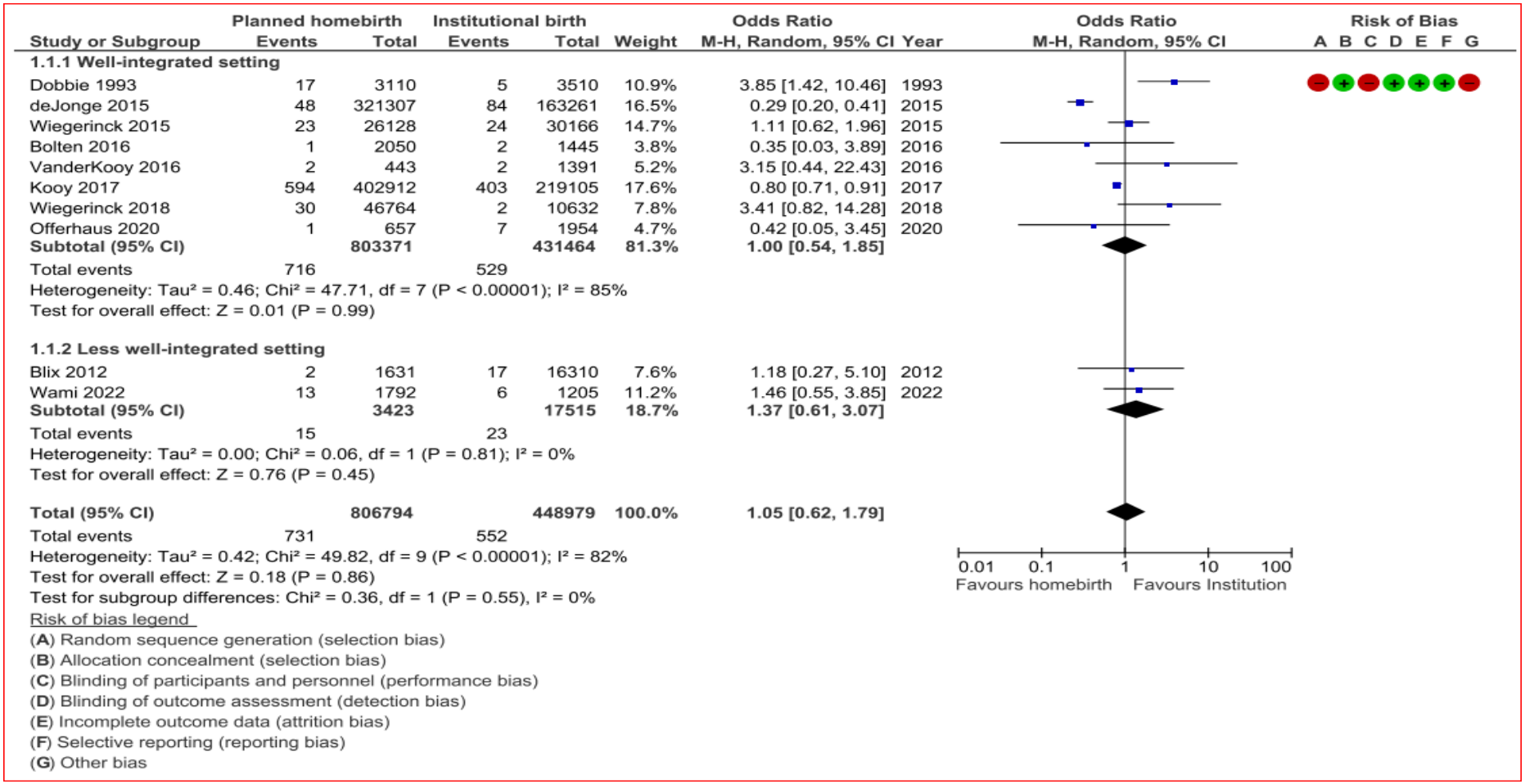


Figure 4: Forest plot of perinatal mortality meta-analysis stratified by the level of midwives' integration into healthcare system after accounting for parity.

The foetal-neonatal outcomes of women planning a home birth demonstrated a 16% lower likelihood of low birth weight babies in well-integrated settings when compared to their comparable peers (5 studies, OR 0.84, 95% CI [0.75, 0.93]); 33% less likely had a non-vertex foetal presentation (3 studies, OR 0.67, 95% CI [0.48, 0.93]); 34% less likely to have an Apgar score of < 7 at 1 or 5 minutes (7 studies, OR 0.66, 95% CI [0.58, 0.76]); 16% more likely to be a post-term born (5 studies, OR 1.16, 95% CI [1.04, 1.28]); 11% more likely had a preterm birth (6 studies, OR 0.89, 95% CI [0.81, 0.98]); 53% of the patients experienced NICU admission (4 studies, OR 0.47, 95% CI [0.34, 0.64]). However, there was no discernible variation in congenital malformations/neonatal abnormalities, which was large for gestational-age newborns by birthplace.

In less well-integrated settings, the foetal-neonatal outcomes of women planning home births, with limited evidence, revealed that there was a twofold increase in the likelihood of having a newborn with large for gestational age (1 study, OR 1.96, 95% CI [1.678, 2.29]) and a 54 per cent reduction in the likelihood of non-vertex foetal presentation (2 studies, OR 0.46, 95% CI [0.16, 1.37]). A lower Apgar score (<7 at 1/5 mins) (4 studies, OR 1.47, 95% CI [0.21, 10.26]); low birth weight babies (2 studies, OR 0.73, 95% CI [0.31, 1.70]); post-term born (1 studies, OR 4.95, 95% CI [0.90, 27.19]); and NICU admission (2 studies, OR 1.11, 95% CI [0.64, 1.93]) did not, however, significantly differ foetal-neonatal outcomes by birthplace and none of the studies from less well-integrated settings has reported congenital malformations/neonatal abnormalities, and preterm/premature births (Table 3).

Table 3: Summary of feto-neonatal outcome meta-analysis findings by level of homebirth to health care integration

Foeto-neonatal outcome (strata)	Number of studies	Place of birth		OR [95%CI] M-H, Random	I^2
		Planned homebirth **n/N (%)**	Planned Institutional birth **n/N (%)**		
Perinatal or neonatal or foetal mortality	10	731/806794	552/448979	1.05 [0.62, 1.79]	82
Well-integrated	8 (82,91,125–127,129,131,134)	716/803371	529/431464	1.00 [0.54, 1.85]	0
Less-well integrated	2 (15,137)	15/3423	23/17515	1.37 [0.61, 3.07]	85
Low birth weight <2500g or <10%	7	28242/407185	18570/225009	0.84 [0.69, 1.03]	46
Well-integrated	5 (91,127,133,134)	28105/404545	18503/223553	0.84 [0.75, 0.93]	9
Less-well integrated	2 (15,138)	137/2640	67/1456	0.73 [0.31, 1.70]	85
Large birth weight ≥4000g or >90%	3	844/2675	444/3341	1.41 [0.83, 2.40]	79
Well-integrated	2 (127,128)	46/883	94/2136	1.04 [0.71, 1.53]	0
Less-well integrated	1 (15)	798/1792	350/1205	1.96 [1.68, 2.29]	Na
Preterm/premature born					
Well-integrated	6 (91,125,127,128,131,134)	20236/728655	12586/389403	0.89 [0.81, 0.98]	80

Less-well integrated	0	-	-	-	-
Post term born	6	77296/725800	36760/386516	1.17 [1.05, 1.30]	81
Well-integrated	5 (91,125,127,128,134)	77292/725545	36758/385893	1.16 [1.04, 1.28]	83
Less-well integrated	1 (136)	4/255	2/623	4.95 [0.90, 27.19]	Na
Non-vertex presentation	5	67/3394	204/4544	0.59 [0.41, 0.85]	33
Well-integrated	3 (127,128,133)	46/1190	173/3057	0.67 [0.48, 0.93]	0
Less-well integrated	2 (15,130)	21/2204	31/1487	0.46 [0.16, 1.37]	71
Neonatal mal-formations (congenital anomalies)					
Well-integrated	4 (91,128,133,134)	4727/403888	2936/221599	0.61 [0.34, 1.08]	62
Less-well integrated	-	-	-	-	-
Apgar score <7 at 1 or 5 mins	11	559/79806	549/49293	0.73 [0.55, 0.96]	44
Well-integrated	7 (82,126–129,132,134)	523/76870	519/46377	0.66 [0.58, 0.76]	0
Less-well integrated	4 (15,130,136,140)	36/2936	30/2916	1.47 [0.21, 10.26]	76
NICU admission	6	186/74415	263/43117	0.60 [0.40, 0.90]	65
Well-integrated	4 (126,129,132,134)	149/73944	241/42805	0.47 [0.34, 0.64]	37
Less-well integrated	2 (130,135)	37/471	22/312	1.11 [0.64, 1.93]	0

I^2- Heterogeneity, n-number of cases/outcomes, and N-total number of births, NICU-Neonatal intensive care unit.

2.5. Discussion

In our discussion, we carefully examine how midwives' integration into the healthcare system and parity are considered as we interpret the results of our systematic review and meta-analysis on planned birthplaces. A solid basis for investigating the effects of planned birthplace on maternal and foetal-neonatal outcomes is provided by the large dataset, which includes 21 studies for systematic review and 20 for meta-analysis.

The distinction between well-integrated and less well-integrated settings emerged as a critical factor influencing outcomes of planned home birth. Midwives attending home births were deeply ingrained in the healthcare system in well-integrated settings, such as the Netherlands, the United Kingdom, and Denmark. This integration is most likely responsible for the observed positive outcomes, highlighting the potential impact of healthcare system integration on the success and safety of intended home births.

Our findings highlight the importance of planned home births in reducing obstetric interventions and improving maternal outcomes. A significant finding is the lower likelihood of Caesarean sections, assisted vaginal births, and the use of epidural analgesia among women who choose home births. Such results are consistent with low intervention and physiological births, frequently associated with planned home births. The difference in outcomes between well-integrated and less well-integrated settings supports the notion that the context in which home births occur is crucial in shaping maternal experiences.

The observed reduction in adverse maternal outcomes, such as retained placenta and postpartum haemorrhage, lends credence to the argument that, under certain conditions, planned home births can contribute to safer maternal experiences. The nuanced findings related to episiotomy, vaginal/perineal laceration, and 3rd/4th-degree perineal tear, on the other hand, require careful consideration. While some outcomes did not show a

statistically significant difference, the context-specific nature of these findings calls for a more in-depth investigation of contributing factors.

Our analysis of foetal-neonatal outcomes revealed intriguing patterns. When stratified by midwives' level of healthcare integration and parity, the lack of significant variation in perinatal mortality across birthplaces suggests that planned home births have a consistent safety profile. Nonetheless, the limited evidence for specific outcomes highlights the need for additional studies to draw definitive conclusions.

In well-integrated settings, the positive outcomes associated with planned home births, such as a lower likelihood of low birth weight and non-vertex foetal presentation, align with the overarching safety narrative and positive neonatal outcomes. Conversely, the increased possibility of newborns being big for gestational age in less well-integrated settings raises concerns about strict risk identification and the impact of healthcare system integration on neonatal outcomes.

Limitations and considerations

Despite the comprehensive nature of our analysis, certain limitations should be acknowledged. As reflected in the I^2 results, the heterogeneity observed across studies introduces a degree of caution in interpreting our findings. The restricted availability of studies, particularly in less well-integrated settings, underscores the need for additional research to enhance the robustness of our conclusions.

2.6. Conclusion and Implications for future research

Our systematic review and meta-analysis indicate that the planned birthplace appears to influence the incidence of obstetric interventions among low-risk women in European countries. While perinatal mortality shows no statistically significant variation, the study highlights distinct outcomes in well-integrated versus “less well-integrated” settings. Therefore, cautious interpretation is needed due to the

heterogeneity across the studies and the limited evidence for some outcomes. Future studies should prioritise exploring contextual factors influencing outcomes and further elucidate the complex interplay between planned home births and maternal and neonatal well-being, considering midwives' integration into the healthcare system and the importance of birthplace in maternity care decision-making.

Chapter 3: Sub-study 2: Characteristics of homebirth in Hungary: A Retrospective Cohort Study

3.1. Introduction

Homebirth for cases with normal pregnancy and managed by a licenced midwife is a safe option for healthy, low-risk women (9,27). Despite this premise, women who choose unregulated birth staff to support a home birth without the use of a registered midwife present is increasing (14). The safest place for a woman to give birth to her baby is believed to be at a functional health facility including a professionally trained birth attendant. However, during the recent global crisis or due to other reasons, many women may result in giving birth at home (141). During the recent pandemic, many women felt detached from sexual and reproductive health services, due to quarantine protocols. Pregnant mothers were unwilling to come into their local health facilities due to transportation disruptions associated with nationwide lockdown measures (142) while others shunned the hospital or clinic due to increased fear of the spread of infections (143). Hence, we noted a trend in soon-to-be mothers preferring to deliver their infants at home (144).

Admittedly, it is not easy to predict the outcome of the pregnancy from its beginning whilst much is known regarding the clinical management of labour and childbirth, less attention is given to what clinical interventions make women feel safe, comfortable and positive regarding the experience in the birth of their babies (107). Women need to

receive health care before and during pregnancy to decrease the risk of pregnancy complications (108). These problems can be caused by or can be made worse while being pregnant. Many problems are mild and do not progress; however, they may harm the mother and her newborn when they do. To cite a specific instance, birthweight which reflects intra-uterine growth retardation is an important determinant factor regarding perinatal morbidity and mortality (109,110) and, in recent years, is a marker in identifying postnatal health risks (145).

In Hungary, home birth is legal and regulated by law after 2012. The law states, a woman has the right to choose where to give birth, however, the law makes no provisions for individuals wishing to assist a birthing woman beyond the hospital environment (34). Interestingly, home birth is not yet widely accepted, in reviewing criminal cases reported in the media before 2012 (146).

Outside of Hungary, several prosperous and high-income countries are considering the reintroduction of home births (14,27). This is based on claims of equal safety at lower intervention rates compared to institutional births in which overtreatment may be present (119). Furthermore, it is based on the stated reduction of maternal-foetal morbidity and suggested psycho-social advantages for the mother (91).

Thus, our study attempts to explore the real maternal and foeto-neonatal conditions and outcome characteristics regarding Hungarian home births as compared with institutional cases, which, contributes to the knowledge of midwives and pregnant mothers. It will benefit midwives to better understand and provide a level of care that is equally safe as institutional births at a lower intervention rate with an improved pregnancy outcome.

3.2. Methods

3.2.1. Design and sample

This study is a comparative retrospective cohort study. We sourced data regarding home births (n=1792 from 2012 through 2020) culled from a nationwide Hungarian obstetric registry, which also is referred to as the 'Tauffer database", and is a compulsory compiled Hungarian obstetric database (92). The 'Tauffer database' is managed and made available to researchers through the efforts of the National Institute for Quality and Organizational Development in Health Care and Medicine (reference 76/2004 ESzCsM, decree regarding the determination, collection and analysis of health-related unidentifiable data; Department of Health Social and Family Affairs, Hungary) (147) and an institutional birth data (n=1205 for the year 2020), which was sourced from a university-linked obstetrical department located in southern Hungary.

All mothers who willingly enrolled in this study were older than 18 years of age yet younger than 40 years old if it is their first pregnancy. Additional prerequisites included soon-to-be mothers within 37-41 weeks of gestation, a singleton pregnancy, the foetus in cephalic position, no prior history of any form of complication(s) during pregnancy and have access to a health facility that is equipped with obstetrical and neonatal services within 20 minutes travel time from the location of the planned birth, in the event, there is a need for assistance during the delivery. These were our criteria and are representative of the five basic permissive standards regarding home birth as stated in Hungarian fundamental Law (147).

Multiple pregnancies, a maternal age <18 and ≥40 years, preterm birth (<37weeks of gestations), post-term birth (≥42 weeks of gestations), non-cephalic presentation and prior pathologic cases were excluded from our study since they were not considered a suitable candidate regarding home birth. Compulsory maternal, foetal and neonatal

outcome conditions and complications, before and during pregnancy, were collected in full accordance to International Classifications of Diseases, 10th revision (ICD-10 codes) (148).

3.2.2. Determinants

Maternal determinants were of maternal age (younger age (<35) and advanced age (≥35)), gestational age (term – 37 to 41weeks), parity (primipara and multi-parous), previous abortion (one time and recurrent (>1)), mode of conception (spontaneous and ART), rupture of membrane (SROM, tPROM and AROM) and mode of birth (SVB and OB).

Foeto-neonatal determinants included the gender of the newborn, stillbirth, Apgar score measured five minutes following birth, postnatal death at <168 hrs, birth weight and birth weight percentiles. They were an independent variable, in which we have a dichotomous dependent variable (birthplaces i.e., home birth and institutional birth). Health care determinants included an intervention.

3.2.3. Outcome measures

Two primary outcomes were identified. First, intervention during birth. Intervention during birth is operational, defined as an intrapartum operative vaginal birth, and/or Caesarean section and intrapartum artificial rapture of the membrane (AROM) represented as 'INTER2'. Secondly, perinatal mortality, in which it becomes operational, is a combination of stillbirths, intra-natal deaths, and early neonatal mortality until 168 hrs following delivery. The pooled outcome measures [Intervention × perinatal mortality case-mix] were used to determine the odds of risks among groups.

3.2.4. Case-mix adjustment

Studies addressing the benefits and drawbacks of home birth can be challenged due to their observational study design without case-mix adjustment regarding interventions

and outcomes, the exclusion of women from the analysis, of which, according to standardized birth guidelines, should have been referred before birth.

The case-mix was represented by the prevalence of the "Big 4" conditions representative of an important risk mediator. The presence of these four conditions is known to precede 85% regarding perinatal mortality. These four-neonatal conditions are congenital abnormalities, Intra-uterine growth restriction (SGA, birth weight percentile <10, gender, and parity specific), preterm and Low Apgar score (<7, measured 5 mins following delivery) neonatal factors. In a system highlighted with optimal risk selection, "Big 4" conditions typically do not occur among low-risk mothers (91). However, since risk selection is not optimal in the Hungarian obstetric care system, "Big 2" conditions [Intrauterine growth restriction (i.e. small for gestational age) and (Low Apgar score)] are still present in this group.

Case-mix adjustment is different regarding the intervention outcome (an intrapartum measurement) and mortality outcome (a postpartum measurement). When comparing mortality rates, the "Big 2" case-mix adjustment is used. However, when comparing intervention rates, the intervention precedes the outcome regarding a low Apgar score. Therefore, a low Apgar score should be excluded, and an analysis compiled. Then, intervention and perinatal mortality rate; adjusted for pooled prevalence [Intervention × mortality case-mix advanced model] were used to determine the odds of risks among groups.

3.2.5. Data analysis

The data were analysed using IBM SPSS statistics version 26. The excel datasets were cleaned and de-identified before exporting to SPSS. First, we compared the maternal characteristics, and then the foeto-neonatal birth characteristics by the planned location of delivery. Descriptive statistics using frequencies, percentages, means, and standard

deviations all were generated. Data of continuous parametric variables were presented as a mean ± standard deviation. Data of both dichotomous and polynomial categorical variables were presented using absolute values (n) and percentages (%). The results of chi-square were presented in American Psychological Association (APA) format (149). In consideration of statistical analysis, we used logistic regression models. The presence of statistical associations and significant differences between maternal and foeto-neonatal birth characteristics and place of births were tested using a binary and multivariable logistic regression analysis model. *Model 1,* a binary logistic regression analysis, was presented as a crude odds ratio (COR), and *Model 2*, the multivariable logistic regression, after adjusting for the confounders, was presented as an adjusted odds ratio (AOR). In our study, a two-sided *P value <0.05* was considered statistically significant at a 95% confidence interval. All the explanatory variables with a threshold of $p < 0.20$ on a binary logistic regression model were fitted to a multivariable regression model and adjusted for confounders. Statistical significance was also cross-checked using backwards and forward stepwise regression analysis and demonstrated the same statistical significance.

Third, we compared the perinatal mortality rates after the "Big 4" adjustment using an intention-to-treat-like approach. The intention-to-treat analysis is primarily used in RCT's (150). However, we used the 'intention-to-treat-like' analysis approach implies that all women having a home or institutional birth outcomes were included, independent from later referral during labour. In consideration of this analysis, a nested multiple stepwise regression model (stepwise analysis; inclusion $p < 0.2$; exclusion $p > 0.20$) was used (i.e., model 1).

Data transformation, recoding and categorization for several polynomial independent variables were made in variables with an observed count less than zero and were an

insignificant fit regarding the model (determined using the Omnibus test for the model coefficient of P<0.05, and Hosmer and Lemeshow goodness of fit for model at P>0.05). Additionally, a pseudo-multicollinearity test (collinearity diagnostic) was performed before running multivariate logistic regression analysis to avoid high correlation among independent variables of maternal and foeto-neonatal birth characteristics, determined at variance inflation factor (VIF) of >10 units and condition index (CI) >30 units and interestingly, none of the variables was multicollinear.

3.2.6. Operational definitions

Assisted reproductive technologies (ART): defined as a mode of conception, either through in vitro-fertilization (IVF), hormonal or intrauterine insemination (IUI) (151).

At term, pre-labour rupture of membrane (tPROM): defined as a rupture in the membrane which occurs at term, either within or 24 hours before the onset of labour (152).

Birth weight percentile (BWP)

Birth weight percentile is calculated following the WHO recommended standards and using the Omni calculator available at https://www.omnicalculator.com/health/birthweight-percentile (153). The calculator considers the 50th percentile as the average weight of the newborn at a specific age. Accordingly, the 50th percentile at 37 weeks of gestations is 2781g, 2961g at 38 weeks, 3132g at 39 weeks, 3288g at 40 weeks, and 3428g at 41 weeks of gestation, respectively. Thus, the birth weight percentile classification is as follows:

1. Small for gestational age (SGA): A baby whose weight is less than 10th percentiles.
2. Appropriate for gestational age (AGA): A baby whose weight is between 10th - 90th percentiles.

3. Large for gestational age (LGA): A baby whose weight is more than 90th percentiles.

Foetal birth weight classifications

1. Low birth weight (LBW): is defined in which the newborn's weight is less than 2,500 g (5.5 lb), with no regard to the gestational age.
2. Normal/average/ birth weight (NBW): is defined in which the newborn's weight is between 2,500 and 4,000 g (5.5 - 8.8 lb).
3. High birth weight (HBW): is defined in which the newborn's weight is more than or equals 4kg (8.8 lb) (154).

Apgar scored at 5 mins:

A low Apgar score- is defined as a score less than seven (<7) when scores of all five indicators regarding the Apgar scoring system at five minutes (following birth) are combined. Unless it was considered as *reassuring* or a *normal Apgar score (≥7)* (155,156).

Low-risk mother: defined as a woman who is free of known disease or pathological condition, has an uncomplicated medical and obstetric history and when there is no risk factor in the family obstetric history (82,157).

Operative birth (OB): also known as assisted vaginal birth, is a type of birth in which the operator extracts the foetus from the vagina using forceps, a vacuum device, or another instrument, with or without concurrent maternal pushing (158).

Spontaneous vaginal birth (SVB): defined as vaginal birth, occurring naturally and independent of any assistance (159).

Stillbirths: defined as a foetal intrauterine death following 24 weeks of gestation (92).

3.2.7. Ethical approval

This study received ethical approval including an assigned approval number, KK/608-1/2021, from the University of Pecs, Ethics Review Committee, and was conducted in full accordance with the Helsinki Declaration (160). All patient/client personal and medical data used for this study were handled in strict accordance with the European General Data Protection Regulation (GDPR), Act CXI of 2011 and Act XLVII of 1997 (161,162), and followed the decrees of the general authorization to process the personal medical data for scientific research purposes by the Hungarian Data Protection Authority (DPA) and the National Institute for Quality and Organizational Development in Health Care and Medicine (GYEMSZI) (147). The study was also fully compliant with the data privacy protocol and the repealing Directive 95/46/EC of GDPR, adopted by the Senate of University of Pécs (163).

3.3. Results

3.3.1. Baseline characteristics of participants

A total of 2997 women were included in our study. During the considered period, 1792 mothers who experienced homebirths were compared with 1205 mothers who experienced an institutionalized birth. Our data have shown, the prevalence of home births slowly increased over time by *2.23%* per year (*95%CI, 0.02-0.24*), on average (Figure 5).

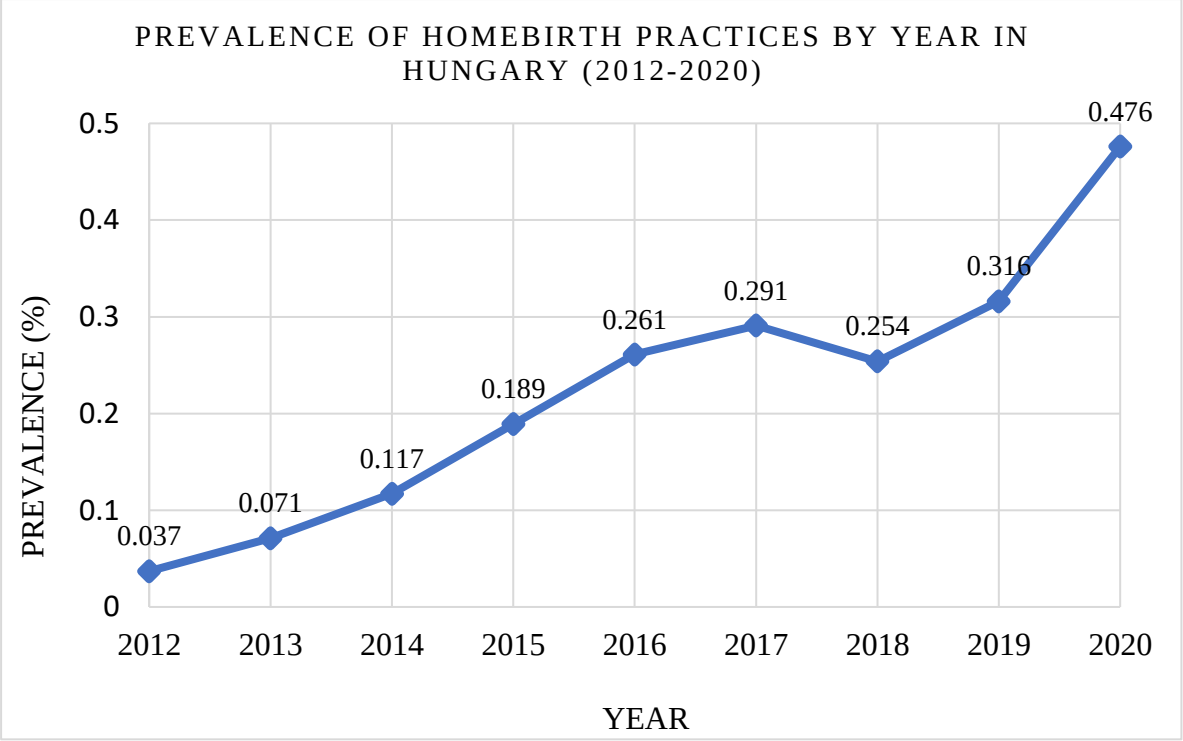


Figure 5: Trends of homebirth practices by year in Hungary (2012-2020)

In consideration of home births, the mean maternal age at first delivery was 33.16±4.71, were multiparous (55.9%) and the majority experienced a spontaneous mode of childbirth (94.01%), whereas 29.69±5.44 regarding institutional births, 55.90% were primiparous and 888 (73.69%) experienced spontaneous vaginal deliveries. The chi-square test of independence showed advanced age mothers (≥35 years) were more likely to deliver at home compared with younger aged women (<35), $X^2(1, n=2997) =85.58, p<.001$. Notably, a mother who experienced a spontaneous mode of conception and had no prior history of previous abortions were more likely to experience homebirths ($p<.001$), whereas nearly 332 (18.50%) women who experienced home births, and 11(0.90%) women who experienced institutional births used assisted reproductive technologies to conceive, $X^2(2, n=2997) =220.56, p<.001$ (Table 4).

Table 4: Baseline characteristics of women who experienced home births and institutional births.

	Place of birth		X2-test of independence
	Home (n=1792)	Institution (n=1205)	(n=2997)
Maternal age (years)	33.16±4.71*	29.69±5.44*	$X^2(1) = 85.58$ $P < 0.001 <$
Younger age (18-34.99)	1154 (64.40%)	965 (80.10%)	0.001 $\varphi=0.17$
Advanced age (≥35)	638 (35.60%)	240 (19.90%)	
Parity			
Primipara	601 (33.50%)	674 (55.90%)	$X^2(1) =147.84$ $P <0.001$
Multiparous	1191 (66.50%)	531 (44.10%)	$\varphi=0.22$
History of abortion			
No	1561 (87.10%)	980 (81.30%)	$X^2(2) =18.67$ $P <0.001$
One-time	186 (10.41%)	181 (15.01%)	$\varphi=0.08$
Recurrent (≥2x)	45 (2.50%)	44 (3.70%)	
Mode of conception			

Spontaneous	1460 (81.50%)	1194 (99.10%)	$X^2(1) = 220.56$ $P < 0.001$ $\varphi = 0.27$
ART	332 (18.50%)	11 (0.90%)	

(*) the result presented as a mean SD, X^2(df) -Pearson-chi square (degree of freedom), and φ-is value of Cramer's V (indicating measures of association). φ=0 depicts no association!

ART-Assisted Reproductive Technology

3.3.2. Foeto-neonatal birth characteristics and outcome

Of the total 2997 newborns, 1537 (51.30) were male, 1460 (48.70%) were woman, (99.89%) were born alive, and 3 (0.11%) were reported fatal cases (stillborn) during childbirth. The mean Apgar score at 5 minutes was 9.87(±0.61) at home and 9.92 (±0.31) at institutions, respectively. Newborns from mothers who experienced home births had a slightly lower Apgar score at 5 minutes than when compared with institutional births $X^2(2, n=2997) = 15.78, p<.001$ (see Table 5). Nine (0.20%) and 2 (0.06%) stillbirths were reported from home and institutions, respectively. Of five early neonatal deaths (<168hrs afterbirth), three (0.20%) were home births and 2 (0.20%) were institution births.

The mean birth weight was slightly higher in-home births (3556.87±439.29) and compared to institutional births (3433.16±426.74), $X^2(2, n=2997) = 22.34, p<.001$, of which, the majority were appropriate and large for gestational age (59.01%, 39.5%) while few where small for gestational age (1.50%) and they were below 10^{th} birth weight percentiles (see Figure 6). Relatively high birth weight newborns were more likely born at home when compared with institutional deliveries, $X^2(2, n=2997) = 22.34, p<.001$ (see Table 5).

Table 5: Newborn characteristics and outcomes of mothers who experienced home birth and institutional childbirths.

	Place of birth		X^2-test of independence
	Home (*n=1792*)	Institution (*n=1205*)	(*n=2997*)
Gender of the newborn			$X^2(1) = 0.68$
Male	908 (50.70%)	629 (52.30%)	$P = 0.411$
Woman	884 (49.29%)	576 (47.79%)	$\varphi = 0.02$
Apgar score (at 5 mins)	9.87(±0.61)	9.92 (±0.31)	$X^2(2) = 15.78$
low < 7 score	27 (1.50%)	1 (0.10%)	$P < 0.05$
Normal ≥ 7 score	1746 (97.43%)	1200 (99.60%)	$\varphi = 0.07$
Missed value	19(1.10%)	4(0.30%)	
Stillbirth			
No	1791 (99.94%)	1203 (99.80%)	-
Yes	9 (0.06%)	2 (0.20%)	
Intra-natal death			
No	1791 (99.94%)	1203 (99.80%)	-
Yes	1 (0.06%)	2 (0.20%)	
Birth weight (grams)	3556.87±439.29	3433.16±426.74	$X^2(2) = 22.34$
Low birth weight (<2500)	6 (0.30%)	11 (0.90%)	$P < 0.001$ $\varphi = 0.09$
Average birth weight (2500-3999)	1503(83.90%)	1070 (88.80%)	

High birth weight (≥ 4000)	283 (15.80%)	124 (10.30%)	
Birth weight percentile			
SGA	26 (1.50%)	37 (3.10%)	$X^2(2) = 40.34$
AGA	1058 (59.01%)	818 (67.90%)	$P < 0.001$
LGA	708(39.50%)	350 (29.01%)	$\varphi = 0.12$
Early neonatal death <168hrs			
No	1789 (99.80%)	1203 (99.80%)	-
Yes	3 (0.20%)	2 (0.20%)	

*AGA-Appropriate for gestational age (weight between 10^{th} -90^{th}percentiles)**,** LGA-Large for gestational age (≥90^{th} percentiles), SGA-Small for gestational age (<10^{th} percentiles),* ***(-)*** *indicates unsuitable regarding the chi-square model and the expected count less than five is >20%, X^2(df)-Pearson-chi square (degree of freedom), φ-is 'phi- or Cramer's V'- indicating measures of association (φ=0 shows no association!)*

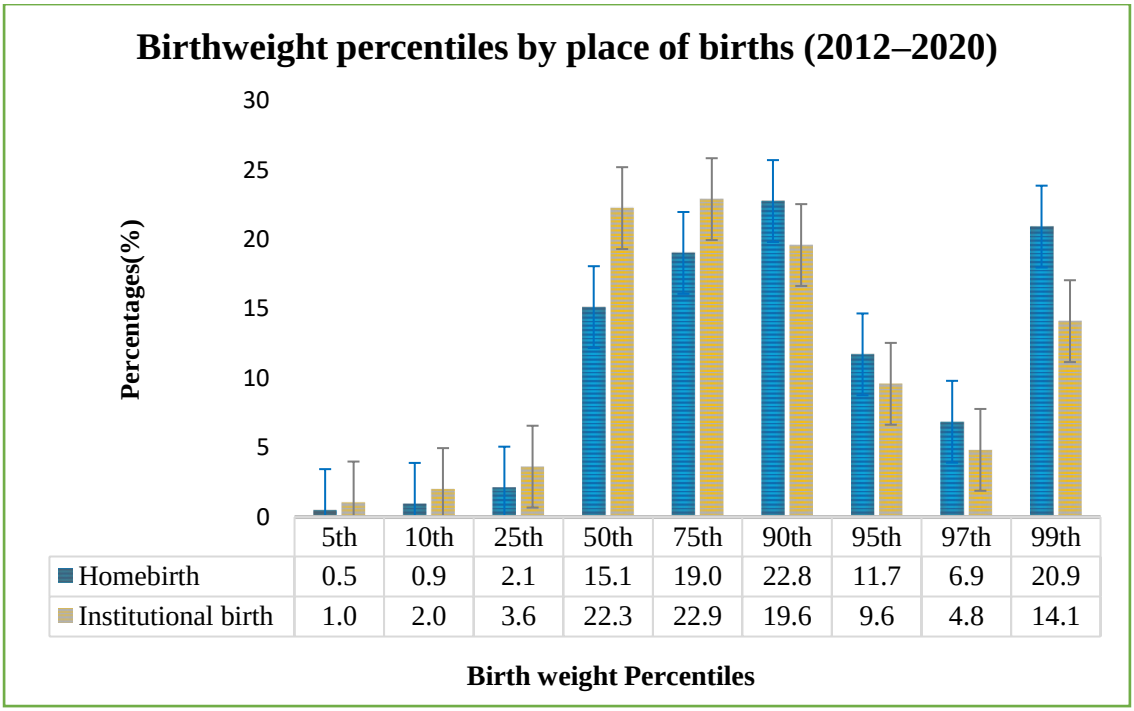


Figure 6: Birth weight percentiles by place of births in Hungary (2012-2020)

3.3.3. Maternal and foeto-neonatal birth outcome conditions and complications

Of the total 2997 singleton births, 1183 (66.02%) home births and 884 (73.36%) institutional births were reported having no obstetric complications. A relatively higher number of mothers who experienced institutional births had prolonged first stage labour 40 (3.32%), perineal laceration during birth (6.72%), obstetric laceration of the cervix (2.91%) and 35 (2.91%) were anaemic ($P<.05$) whereas a relatively higher number of foetal conditions including foetal acid-base imbalance 63(3.52%), foetal heart rate anomaly and meconium-stained amniotic fluid 22 (1.23%) were reported from home birth cases. Third stage haemorrhage delayed and secondary postpartum haemorrhage (1.40%, 0.84%) were prevalent maternal conditions reported from home births (see Table 6).

Table 6: Comparisons of maternal and foeto-neonatal characteristics of home-and institutional childbirth

Birth related conditions and complications (ICD-10)	Place of birth	
	Home (n=1792)	Institution (n=1205)
Non-obstetric complications **	1183 (66.02%)	884 (73.36%)
Primary uterine inertia	18 (1.01%))	5 (0.41%)
Prolonged first stage labour **	10 (0.56%)	40 (3.32%)
The prolonged second stage of labour*	26 (1.45%)	20 (1.66%)
Obstructed labour due to foetal head	2 (0.11%	5 (0.41%)
Obstructed labour due to shoulder dystocia	3 (0.17%)	8 (0.66%)
Obstructed labour due to foeto-pelvic disproportion	3 (0.17%)	7(0.58%)
Intrapartum hemorrhage (other)	5 (0.28%)	2 (0.17%)
Foetal acid-base imbalance*	63 (3.52%)	11 (0.91%)
FHR anomaly and meconium in the amniotic fluid	22 (1.23%)	13 (1.08%)
First-degree perineal laceration during birth**	59 (3.29%)	81 (6.72%)
Second-degree perineal laceration during birth*	9 (0.50%)	14 (1.16%)
Third-degree perineal laceration during birth	9 (0.50%)	7 (0.58%)
Perineal laceration during birth (Unspecified)	8 (0.47%)	6(0.50%)
Obstetric laceration of the cervix	5 (0.28%)	35(2.91%)
Third stage haemorrhage**	25 (1.40%)	12 (0.10%)

Delayed and secondary postpartum haemorrhage	15 (0.84%)	5 (0.41%)
Retained placenta without haemorrhage	3 (0.18%)	7 (0.58%)
Anaemia**	10(0.56%)	35(2.91%)

**p value <0.05, ** p value <0.01, *** p value <0.001 FHR- Foetal heart rate. N.B: ICD-10 codes with frequency (n<5) were not reported.*

Regarding other determinants, the operative birth rate at the institution was 0.26 (26.31%) and about 0.05 (5.39%) were vacuum deliveries, while the institutional Caesarean section rate was 0.21 (20.90%) (see Table 4). Only 24 (1.34%) women who experienced homebirths had an intention to operative birth. On average, the institutional transfer rate was 11.77%.

The intervention rate was lower among homebirth cases (0.11%) compared with institutionalized births (42.57%) ($p < 0.001$). The crude intervention risk was significantly lower for women who experienced homebirths (COR 0.02, [95%CI 0.01–0.06, $p < 0.001$]) compared with women who experienced institutional births (Table 7, model 1). All maternal and neonatal risk factors (except the presence of a history of abortion, mode of birth and ROM) showed a significant difference. The adjusted intervention risk ratio demonstrates the birthplace indeed has a significant effect on the likelihood of intervention (AOR 0.02, [95%CI 0.01–0.05, $p < 0.001$]) (Table 7, model 2). Perinatal mortality was 11 (0.61%) among homebirths and 6 (0.49%) among institutionalized births, however, has not demonstrated any significant association with birthplace (see Table 7).

Table 7. Summary statistics of women and foeto-neonatal home and institutional birth characteristics and outcomes: Pooled risk measures [Intervention (C/s and AROM) * Perinatal mortality]; using intention-to-treat-like approach and case-mix adjustment.

	Total	**Intervention**	**Mortality**	***Model 1***		***Model 2*** **(R^2 = 0.876)**		
	(*n* = 2997)	***n* (%)**	***n* (%)**	**COR (95%CI)**	***p***	***β***	**AOR (95%CI)**	***p***
Place of birth		***	0.679					
Home	1792	2 (0.11%)	11(0.61%)	0.02(0.01–0.06)	***	−6.95	0.02(0.01–0.05)	***
Institution (Ref)	1205	513(42.57%)	6 (0.49%)	1			1	
Maternal age (years)		***	-					
Young age (18–34.99) (Ref)	2119	420 (19.80%)	11 (0.51%)	1			1	
Advanced age (≥35)	878	95(10.80%%)	6 (0.68%)	0.49(0.39–0.62)	***	0.17	1.18(0.85–1.65)	0.313
Parity		***	*(0.037)					
Primipara (Ref)	1275	408 (32.00%)	3 (0.23%)	1			1	
Multiparous	1722	107 (6.20%)	14 (0.81%)	0.14(0.11–0.18)	***	−1.79	0.17(0.13–0.22)	***
History of abortion		0.825	-				-	-

No (Ref)	2541	435 (17.10%)	13 (0.51%)	1				
Yes	456	80 (17.50%)	4 (0.87%)	1.03(0.79–1.34)	0.825	−0.08	-	-
Mode of conception		***	-					
Spontaneous (Ref)	2654	505 (19.01%)	15 (0.56%)	1				
ART	343	10 (2.92%)	2 (0.58%)	0.13(0.07–0.24)	***	1.08	2.94(0.76–11.43)	0.119
Mode of birth		***	-			-	-	-
SVB (Ref)	2184	0 (0.00%)	16 (0.73%) *	1				
Operative birth (OB)	813	515 (63.35%)	1 (0.12%)	nie---	0.980	-	-	-
Rupture of membrane		***	* 0.046			-	-	-
SROM (Ref)	1281	0 (0.00%)	10 (0.78%)	1				
tPROM	892	0 (0.00%)	1(0.11%)	1.00(0.001–99)	1.000	-	-	-
AROM	824	515 (62.50%)	6 (0.72%)	nie---	0.985	-	-	-

Variable(s) entered in step 1: Maternal age, Parity, History of abortion, Mode of conception 2, Intervention, BIG2 Mortality, Place of birth, and pooled outcome measures (Intervention * mortality). R^2-Nagelkerke R-square, β- Regression coefficient, (-) indicates not fit for the model, (nie---) indicates not computed for the model, i.e., not indicated for enumeration (nie). Abbreviations and acronyms: AROM—Artificial rupture of membrane, ART—Assisted reproductive

technologies, OB—Operative birth, SGA—Small for gestational age, Ref—reference group, SROM—spontaneous rupture of membrane (at term), SVB—Spontaneous vaginal birth, and tPROM—At term pre-labour rupture of membrane. Variables at $p < 0.20$ fixed value threshold on binary logistic were fitted to the multivariable logistic regression model. Model 1: Crude odds ratio. Model 2: Adjusted for maternal and neonatal factors. * $p < 0.05$; *** $p < 0.001$.

3.4. Discussions

According to our study, home births have been a more common occurrence in Hungary over the past ten years. As a result, the average homebirth rate in Hungary is 0.22%, which is considerably low when compared with the Netherlands (17%), New Zealand (3.5%), Australia (0.3%), and the United Kingdom (2.4%) (2,91,164,165). Studies have indicated homebirth choice is controversial and enshrouded in debate. Generally, issues related to risk and safety in a well-integrated health care system, home birth is also deemed safe for healthy, low-risk women. (9,27)

In Hungary, very little research has been published regarding home births for a multitude of reasons, specifically, the lack of funding and institutional support. However, beyond Hungary, studies indicate women who plan home births experience a very low risk of instrumental vaginal birth and Caesarean section, therefore, a higher probability of spontaneous vaginal birth (18,28,82,119,124). Distinctly, our study has shown the majority (64.3%) of low-risk multiparous women experienced spontaneous deliveries at home *($p<.001$)*. A study originating from four Nordic countries in northern Europe have shown the majority of low-risk multiparous women who experienced spontaneous birth in their previous pregnancies were more likely to give birth at home (18), and low-risk pregnancies attended by qualified midwives ushered in positive results among both maternal and newborn health levels, including low rates of obstetric intervention (28,82,124), similar to the investigation by Galera-Barbero & Aguilera-Manrique (119).

Additionally, our study demonstrated how advanced age mothers (aged ≥35years) were more likely to experience home births than when compared with younger age mothers ($p<0.001$). Our finding is consistent with the comparative study by Beaujouan and Sobotka, from the Austrian Institute of Demography, aptly substantiated a general

indication in the increased number of late childbearing age to women aged 40 and above (166). The study by Landero et al (167) and Shan et al (87) also showed the mean maternal age experiencing their first delivery and over 35 years of age. Yet another study from Australia also showed an increased prevalence among older maternal age experiencing their first delivery (168). Today, it is becoming common for women in developed countries to delay their childbearing age. Older maternal age at first birth is now an ingrained demographic trend in higher-income countries. This phenomenon is due to multiple factors, yet effective birth control methods significantly contribute to postponing motherhood (166).

In our study, obstetrical conditions and complications related to mothers were prevalent among institutional births, while neonatal related pathologic conditions and complications were relatively more frequent among home birth cases ($p<0.05$). Interestingly, the systematic review from Denmark showed, low-risk mothers with no previous history of obstetric complications and outcome conditions were highly likely to experience planned home births than when compared with mothers with a previous history of either medical or obstetrical outcome conditions (169).

We found 1.5% of newborns from mothers who experienced home births had a relatively low Apgar score. Studies have shown, a newborn with a low Apgar score is relatively at a greater risk for obstetric and pregnancy-related complications (82,87,119,156). Additionally, our findings are consistent with a study by Chandra et.al regarding differences in maternal characteristics and pregnancy outcomes which has significantly shown an association between a low Apgar score at 5 minutes and poor pregnancy outcomes ($p<0.05$) (30).

In our study, a relatively higher number of women experienced prolonged second stage labour in which the hospital transfer rate was 11.77%. A systematic review of a large

number of studies have shown home birth with a transfer rate of 11.77% is considered reasonable, and an indication the system is well integrated and able to support an expectant mother's choice regarding the place of birth (170). A possible explanation implies women who planned home birth were considerably low risk throughout labour and less likely to be transferred to an institution for advanced obstetric care, which typically results in a prolonged duration in second stage labour (82). This condition again is associated with the use of episiotomy which also leads to perineal lacerations and intrapartum haemorrhage (87,169). Similarly, our study also showed primary uterine inertia, third stage haemorrhage, delayed and secondary postpartum haemorrhage which, was reported from women who experienced home births. The other possible reasons why the duration of second stage labour was shorter regarding institutional births may be due to improved intervention rates (option for Caesarean sections and/or instrumental births) (P<.001) supplemented with continuous monitoring of maternal and foetal conditions during and following delivery. Additionally, our study showed "Big 2" pregnancies at home exhibit a mortality disadvantage, suggesting comparatively lower intervention rates. The occurrence of overtreatment in the institution may be present in the "Big 2" women. However, the benefit of substantially fewer interventions among the home birth group seems to be counterbalanced by substantially increased rates of mortality. However, our findings were partially inconsistent regarding the study from the Netherlands, in which increased larger sample sizes (n=146,752) demonstrated planned home births attended by registered community midwives confirm the lower risk of medical intervention resulting in equal rates of mortality (91). Other possible explanations were due to increased chances for women who planned home birth to switch their birthplace to an institution due to a medical condition they recently experienced just before or during labour. Nonetheless, the safety

and risks related to home birth is not well expounded upon and is very much a topic of debate. Available published literature also substantiates regional variability (18,28,82,87,119,167,171).

Strength

- As far as we are aware, this is the first study of its sort to describe homebirth characteristics in Hungary.
- Notably, case-mix adjustment and intention-to-treat approach resulted in the most important aspect and strengthened our study. Without adjusting for this, one risks con-founding the issue by indication bias.

Limitations

- Tauffer database is a compulsory database, however, some outcome variables were missed (like estimated volume of blood loss and birth outcomes of transferred cases) and less likely to be compared.
- The NICU admission, maternal weight (BMI), reason(s) used to transfer cases, and one-minute Apgar scores were not recorded in the compulsory database regarding homebirth cases.
- Lack of detailed information regarding maternal dropout and transfer for obstetric care, homebirth assistant's level of experiences and training, and their practices implemented in monitoring and evaluating foeto–maternal conditions before and during birth.
- Despite baseline matching the potential confounders and restriction to low-risk women in our study, the possibility of residual confounding cannot be excluded given an observational study.

3.5. Conclusion

In careful consideration of our findings, both maternal and foetal–neonatal outcome conditions were relatively better among institutional cases when considering a comparatively lower perinatal mortality rate and fewer maternal complications. However, these slightly better results were associated with a high intervention rate. However, further research may be needed if this difference is being observed due to less detection of risk groups.

Midwives should be regularly trained regarding strict clinical guidelines to precisely identify danger signs of imminent complications and upon those conditions pursue immediate hospital transfer to avoid avoidable complications. More detailed statistical evidence will probably promote an exploration of the way to further improve the homebirth conditions in Hungary. Moreover, considering the experiences of countries with long-lasting practices of homebirth would support one in reaching the highest level of this significant human event at home.

Chapter 4: Sub-study 3: Maternal and foeto-neonatal characteristics of childbirth in Ethiopia: A multilevel mixed-effect analysis

4.1. Introduction

The place of birth is an important decision that expectant parents must make during pregnancy (3,40). While institutional births, such as hospital or birthing centre deliveries, are the most common choice for many families (50,101), there has been a growing interest in homebirth as a safe and empowering alternative. Proponents of homebirth argue that it can provide a more comfortable and personalized experience for mothers, with fewer interventions and a lower risk of medical complications (61,91). However, opponents cite concerns about the safety and readiness of homebirth

attendants, as well as the potential for delayed access to emergency medical care in the event of complications (94,102,103). Recent research has shed light on some of these issues, with studies showing that homebirth can be a safe and satisfying option for low-risk pregnancies, provided that appropriate precautions and guidelines are followed (9,15).

The number of women and girls who died each year from pregnancy and childbirth-related complications is declined from 451,000 in 2000 to 295,000 in 2017. These improvements are particularly incredible in light of rapid population growth in many of the countries with the highest maternal deaths (172). South Asian countries achieved the greatest overall per cent reduction in maternal mortality ratio (MMR) by 59% (from 395 to 163 maternal deaths per 100,000 live births) while Sub-Saharan Africa achieved a substantial reduction of 39% of maternal mortality on average during this period, but there is a wide disparity among countries. This translates into an average rate of reduction of 2.9 per cent per annum. While substantive, this is less than half of the 6.4 per cent annual rate needed to achieve the global Sustainable Development Goals (SDGs) of 70 maternal deaths per 100,000 live births (172–175). Despite a decrease in the global number of newborn deaths from 5 million in 1990 to 2.4 million in 2019, it remains true that infants are most vulnerable to mortality in the first 28 days of life (176).

Even though significant progress has been made in the last two decades, about 295,000 women died during pregnancy, childbirth, and post-childbirth in 2017 (172,173,177). As of today, around two-thirds (68%) of the world's maternal death is happening in Sub-Saharan Africa; with the highest maternal mortality ratio of 533 per 100,000 live births, or 196,000 maternal deaths (172,175). But, studies have shown that most

maternal deaths are preventable with timely management by skilled health personnel working in a compassionate environment (177).

According to the latest WHO Global Health Observatory Report, Ethiopia has a MMR of 401 per 100,000 live births, and births attended by skilled health personnel is only 49.8% (175,178). World Health Organization and its partner in collaboration with all other program efforts working tirelessly to make pregnancy safer. Many studies have characterized maternal mortality and its general causes in Ethiopia; however, very limited studies have characterized foetal-maternal conditions peculiar to their desperate place of birth. Thus, this study aspires to explore more characteristics and evidence related to maternal and newborn characteristics by birthplaces in Ethiopia. In the hope that it will support programs aimed at reducing the risk of childbirth, these findings are being made available.

Research question: Is there a correlation between birthplaces and foetal-maternal characteristics in Ethiopia?

4.2. Methods

4.2.1. Study design and setting

For this study, the most recent Ethiopian Demographic and Health Survey-2016 (2016 EDHS) data were utilized. The study involved analysing secondary data collected through a population-based cross-sectional survey design. The 2016 EDHS marks the fourth survey conducted in Ethiopia every five years; however, until this study was carried out, the anticipated 2021 EDHS dataset was not yet available. As a standard Demographic and Health Survey, it is a nationally representative household survey that provides data on key performance monitoring and impact evaluation indicators in population, health, and nutrition for both urban and rural areas separately (179).

Ethiopia was divided into nine geographical regions and two administrative cities for administrative purposes. These regions were grouped into three major categories according to the United Nation Development Program (UNDP) report of 2007 (180). The first category consisted of emerging regions including Afar, Somali, Benishangul-Gumuz, and Gambela. The second category comprised developed regions which were Oromia, Amhara, Tigray, Harari, and Southern Nation, Nationalities and People's Region (SNNP). The third category was comprised of two city administrations, namely Addis Ababa and Dire Dawa.

4.2.2. Data source and Sampling procedure

The data used for our study were retrieved from the official database of the "Measure DHS Program" data repository found at https://www.dhsprogram.com/ (181). Even though, the anticipated 2021 Ethiopian Demographic and Health Survey (2021 EDHS) dataset was not yet available until this analysis was done. This national survey was conducted using pretested validated standard tools and a well-designed methodological approach to generate nationally representative and up-to-date data on health and health-related indicators.

The study subjects in the EDHS were selected using a multi-stage stratified cluster sampling technique. In the first stage, a representative sample of 645 Enumeration Areas (EAs) across the country was selected. Then, in the second stage, systematic random sampling was used to select an average of 28 households per EA. This study focused on women who gave birth within the 5 years preceding the survey, and a total of 7590 women were included in the analysis. The complete details of the data collection and sampling methodology can be found in the full EDHS 2016 report (182).

4.2.3. Study Variables

4.2.3.1. Outcome variable

Place of birth: Place of birth as reported by the mother, and it was defined as the home or health institution (governmental, private or NGO') at which the mother gave birth to her last-born baby within five years preceding the survey. [0 - Homebirth, 1-Institutional birth].

4.2.3.2. Independent variables

Independent variables were from two levels i.e., at the individual level and community level. The individual-level factors considered were maternal age, educational status, religion, wealth quantiles, marital status, partner's education, occupation, media exposure, smoking status, husband/partner's educational status, parity, age at first birth, kind and mode of birth, skilled birth attendant, number of antenatal care (ANC) visit(s), postnatal care (PNC), and level of anaemia. The community-level factors included region/state, place of residence, education levels of women in the community, community poverty, community media exposure, and distance to healthcare facilities. The analysis utilized two types of community-level variables: direct community-level variables, which were used without modification, and aggregated community-level data, which were generated by consolidating individual-level information at the cluster level.

Three variables, namely reading the newspaper, listening to the radio, and watching television, were used to measure media exposure. These variables were combined and classified into two categories: "yes" indicating exposure to any of the three variables and "no" indicating no exposure to any of them. Parity is classified into two categories: primipara (giving a viable birth for the first time) and multipara (giving viable birth more than one time). The birth weight was classified into three categories: Birth weight

less than 2500 g was categorized as small size, and greater than 4000g was classified as large size. Otherwise, birthweight was determined as average. Anaemia in the 2016 EDHS was classified into three categories: mild with haemoglobin (Hb) concentration between 10.0 and 11.9 g/dL, moderate (7.0 < Hb < 9.9 g/dL), and severe (Hb < 7.0 g/dL), and A skilled birth attendant (SBA) is defined in 2016 EDHS as "a trained health professional, such as a doctor, nurse, or midwife, who has the skills to manage normal deliveries and to recognize, manage and refer complications in women and newborns." This definition is in line with the World Health Organization's definition of a skilled birth attendant (178,182).

4.2.4. Data collection procedure

The 2016 Ethiopian Demographic and Health Survey (2016-EDHS) data was accessed from the official database of the "Measure DHS Program" found at https://www.dhsprogram.com/ (181). For our study, we used the individual recode (IR) and 2016 GPS datasets.

4.2.5. Data management and analysis

4.2.5.1. Multilevel analysis

The variables were extracted and cleaned from the IR dataset using STATA version 15 statistical software. The data were weighted for design and representativeness using strata, weighting variables, and primary sampling units to obtain a reliable estimate. The weight data were used for analysis to adjust for the unbalanced probability of selection and non-response bias. A standard model like the logistic regression model is not proper, because these models are used for data having a flat structure, but DHS data has hierarchical nature (data collected at individual and community levels) of non-flat structure. Therefore, to draw a valid inference and conclusion from non-flat EDHS data, the advanced statistical model of hierarchical modelling which consider the intra-

cluster variability by using a multilevel binary and multivariable multilevel logistic regression analysis model were used for mixed-effect estimates. These models were used to estimate the effect size of the independent variables on the dependent variable (place of birth). Accordingly, four models were fitted for this study. The first model is a *Null model* (a model without an explanatory variable) is fitted to calculate the extent of the cluster variability on the dependent variable, birthplace. It was assessed using a Likelihood Ratio Test (LRT), Intraclass Correlation Coefficient (ICC), Median Odds Ratio (MOR) and Proportional Change in Variance (PCV).

ICC (Intra-cluster correlation coefficient) is a measure of the proportion of the total variance in a dependent variable that can be attributed to the variation between clusters (183). It is calculated using the formula:

$$ICC = \sigma^2 / (\sigma^2 + \pi^2/3)$$

Where σ^2 stands for the variance between clusters, and $\pi^2/3$ is a constant term.

MOR (Median Odds Ratio) is a measure of the variability by birthplace between clusters (184). It is calculated using the formula:

$$MOR = \exp (\sqrt{} (2\sigma^2) \times 0.6745)$$

$$= \exp (0.95\ \sigma)$$

Where σ^2 stands for the variance between clusters, σ is the standard deviation between clusters.

PCV (Proportional change in variance) is a measure of the variation of birthplace that can be attributed to the inclusion of individual and community-level variables in a model (184,185). It is calculated using the formula:

$$PCV = (Var\ (null\ model) - Var\ (full\ model)) / Var\ (null\ model)$$

The second model is *Model II (*a multilevel model with individual-level characteristic variables), the third model is *Model III* (a multilevel model with community-level characteristic variables), and the final model is *Model IV* (a multilevel model adjusted with individual and community-level characteristic variables) were fitted, and a model comparison was made based on deviance. The model with the lowest deviance is the chosen final model for this study. The bivariable two-level binary logistic regression analysis was conducted and variables with a fixed criterion threshold of P-value ≤ 0.2 were considered for multilevel multivariable analysis. The Adjusted Odds Ratio (AOR) with 95% CI in the multilevel multivariable logistic regression model was reported to declare statistical significance and strength of association between the dependent variable and independent variable. Both maternal and foetal-neonatal home and institutional birth characteristics and outcomes were compared. A pseudo-linear regression for the multi-collinearity test was checked for Variance Inflation Factor (VIF) at < 5 units, and Condition Index < 15 units and none of which was multicollinear.

4.2.5.2. Spatial analysis

The spatial distribution of homebirth practices across Ethiopian regions was speculated using ArcGIS version 10.6 statistical software. Based on the values noticed from sampled areas, the Gettis-OrdGi statistical analysis and the Kriging spatial interpolation technique were used to forecast the prevalence of institutional and home birth practices in unsampled/unmeasured areas, respectively. Different deterministic and geostatistical interpolation techniques exist, but due to its decreased residual and root mean square error, the Ordinary Kriging spatial interpolation and the Gettis-OrdGi statistical analysis methods were chosen for this study.

4.3. Results

4.3.1. Socio-demographic and Economic characteristics of women

This study analysed a total weighted sample of 7590 women who gave birth within five years preceding the survey. The majority of the women were aged between 20 and 34 years old and had institutional births (74.8%). Women who had home births tended to be less educated (74.0%), economically poor (47.9%), and married to partners who had no formal education (57.9%), while women who had institutionalized births had better education (23.1%), were in above-average wealth quantiles (46.6%) and had a partner with at least secondary education (29.7%). Almost all women in the sample did not smoke, and all variables have shown a statistically significant difference by birthplace ($p<0.001$) (Table 8).

Table 8: Socio-demographic and economic characteristics of women by place of birth (individual level) in Ethiopia

	Weighted	**Place of birth**		
	frequency	**Home**	**Institution**	***P***
Characteristics	**(n=7590)**	**(%)**	**(%)**	
Maternal Age (years)				
<20	339	3.9	5.7	***
20-34	5291	67.3	74.8	
35+	1959	28.7	19.5	
Educational status				
No education	4791	74.0	39.8	***
Primary education	2150	24.3	37.1	
Secondary and above	649	1.8	23.1	
Religion				

Orthodox	2882	32.9	48.8	***
Muslim	2824	40.3	30.5	
Protestant	1651	22.8	19.6	
Others	232	4.0	1.0	
Wealth quantile				
Poor	3208	47.9	30.1	***
Average	1603	20.1	23.3	
Above average	2779	32.0	46.6	
Marital status				
Never married	55	0.4	1.5	***
Married	7109	94.2	92.6	
Divorced/separated/widowed	426	5.4	6.0	
Occupational status				***
Not working	4193	57.1	51.3	
Working/employed	3397	42.9	48.7	
Media exposure				***
No	6125	88.7	63.5	
Yes	1465	11.3	36.5	
Smoking status				***
No	7535	99.2	99.5	
Yes	55	0.8	0.5	
Husband/Partner's education				
No education	3870	57.9	36.2	***
Primary	2731	36.9	34.1	
Secondary and above	988	5.3	29.7	

*** *p<0.001*

4.3.2. Obstetric and health service-related characteristics

Most of the women who had home birth were multiparous (87.6%) and gave birth to a single baby (98.7%), and all had a vaginal birth. Skilled birth attendants were present at 99.1% of institutional births, while unskilled birth attendants attended 97.3% of home births (*p<0.001*) (Table 9).

Most women who had home birth wanted their pregnancy (90.0%) but had no ANC visit (49.8%) and had their first child before the age of 20 (67.3%); while on the other hand, institutional birth was associated with higher rates of primiparity (32.9.1%), four or more antenatal care (ANC) visits (56.8%), and postnatal care (PNC) within two months after delivery (15.1%). Vaginal delivery was the most common mode of birth (92.4%), while only 7.6% had a Caesarean section (*p<0.001*).

The women who had undergone abortion/terminated pregnancies showed no significant difference by birthplace (9.1% vs 8.6%, *p>0.05*) (Table 6). More than two-thirds of women had a BMI within the normal range (18.5-24.9 kg/m2). One-fourth of the women who had home births had BMI less than 18 kg/m2 (23.5% vs 18.4%) while those with relatively greater BMI had institutionalized births (12.7% vs 3.9%, *p<0.001*).

The prevalence of anaemia among women was 29.0%, where most women who had home births reported having mild anaemia (21.7% vs 17.2%, *p<0.001*) (Table 6). Table 6 presents data on obstetric and health service-related characteristics of women by place of birth, 2016 and shows an observed significant difference (Table 9).

Table 9: Obstetric and health service-related characteristics of women (individual level) by birthplace in Ethiopia

Characteristics	Weighted frequency (N=7590)	Place of birth		*P*
		Home (%)	Institution (%)	
Parity				
Primipara	1434	12.4	32.9	***
Multipara	6155	87.6	67.1	
Age at first birth (years)				***
<20	4799	67.3	54.4	
20-34	2781	32.5	45.5	
35+	10	0.1	0.2	
Mode of birth				
Vaginal	7406	100.0	92.4	***
Caesarean section	183	0.0	7.6	
Kind of birth				
Single birth	7470	98.7	97.8	***
Multiple births	120	1.3	2.2	
Skilled birth attendant				
No	5065	97.3	0.9	***
yes	2524	2.7	99.1	
Pregnancy desire				
Unwanted	695	10.0	7.3	***

Wanted	6895	90.0	92.7	
Number of ANC Visit				
No ANC visit	2818	49.8	9.9	***
1-3 visit(s)	2342	29.7	33.3	
4+ visits	2430	20.5	56.8	
PNC (within 2 months)				***
No	6954	94.8	84.9	
Yes	632	5.2	15.1	
Abortion/terminated pregnancy				0.446
No	6910	90.9	91.4	
Yes	680	9.1	8.6	
Maternal BMI (kg/m2)				***
<18.5	1660	23.5	18.4	
18.5-24.9	5421	72.6	68.8	
>=25	509	3.9	12.7	
Anaemia level				
Severe	96	1.7	0.4	***
Moderate	464	7.0	5.0	
Mild	1484	21.7	17.2	
Not anaemic	5285	69.6	77.5	

****p<0.001*, ANC-Antenatal care, BMI-Body Mass Index, kg-Kilograms, m^2-Meter Square, PNC-Postnatal care.

4.3.3. Newborn related characteristics

The sex of the newborn has shown no significant difference by birthplace. The proportion of male and woman births at home and in healthcare institution did not vary significantly (*p>0.05*). However, newborns who were larger in size were more likely to be delivered in health care institution (34.2%), whereas newborns who had smaller sizes were more likely to be born at home (29.5%) (*p<0.001*). Institutional pregnancies were more likely resulted in twins than home births (2.2% vs 1.2%, *p<0.001*). Birth order also had an impact on the place of birth, with firstborns more likely born in the institution (32.9%), while later births were more likely to occur at home (41.1.%) (Table 10).

Neonatal mortality was higher among home births than institutional births (4.5% vs 2.8%). The majority of the newborn was alive (in their first month of life), with a higher percentage of children surviving among institutional births (97.2%) (Table 10).

Table 10: Child obstetric characteristics by place of birth in Ethiopia

	Weighted	**Place of birth**		
	frequency		**Institution**	***p***
Characteristics	**(N=7950)**	**Home (%)**	**(%)**	
Sex				
Male	3940	52.1	51.6	0.663
Female	3649	47.9	48.4	
Size of the newborn				
Larger than average	2399	30.4	34.2	***
Average	3081	40.1	41.7	
Smaller than average	2110	29.5	24.1	

Twin				
No	7470	98.7	97.8	***
Yes	120	1.3	2.2	
Birth order				
1	1434	12.4	32.9	***
2-4	3190	41.1	44.0	
>=5	2966	46.5	23.1	
The newborn is alive (first month of life)				***
No	304	4.5	2.8	
Yes	7286	95.5	97.2	

****p<0.001*

4.3.4. Community-level characteristics of women

In terms of region, Oromia had the highest percentage of home births (45.6%) while Harari has the lowest (0.1%) (Table 11 and Figure 7). Rural areas have a higher percentage of home births (97%) compared to urban areas (3%) while urban areas had a much higher percentage of institutionalized births (33.8% vs 66.2%, $p<0.001$). A higher percentage of home births were reported in areas where a distance to the health facilities was a big problem (40.9%). Overall, the differences in birthplace across community-level characteristics were significant ($p<0.001$) (Table 11).

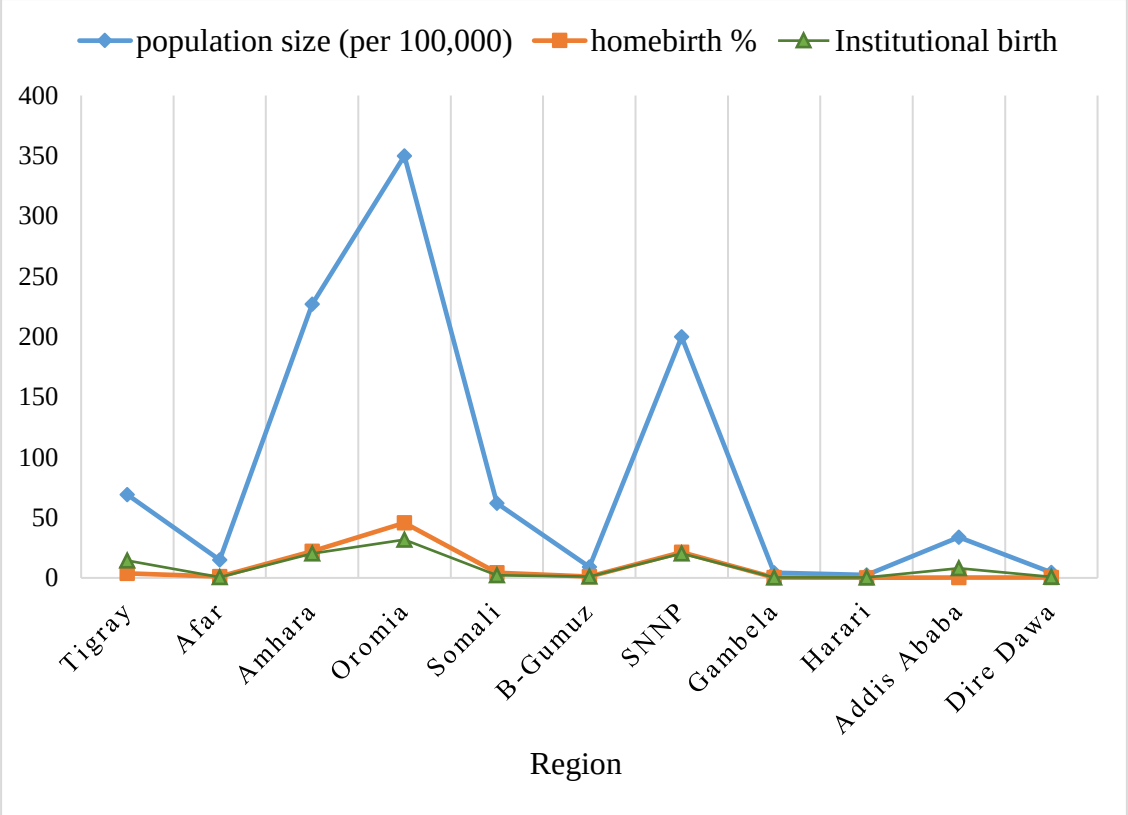
Table 11: Community-level characteristics of women by place of birth in Ethiopia

Community characteristics	Weighted frequency (N=7950)	Place of birth		*p*
		Home (%)	Institution (%)	
Region				
Tigray	537	3.7	14.3	***
Afar	71	1.1	0.6	
Amhara	1632	22.1	20.2	
Oromia	3129	45.6	31.7	
Somali	269	4.2	2.2	
Benishangul-Gumuz	81	1.1	1.1	
SNNPR	1601	21.4	20.3	
Gambela	21	0.2	0.4	
Harari	17	0.1	0.4	
Addis Ababa	198	0.2	7.9	
Dire Dawa	33	0.2	0.9	
Place of residence				
Urban	969	3.0	33.8	***
Rural	6621	97.0	66.2	
Community Education				
low	4744	74.3	37.1	***
high	2846	25.7	62.9	
Community Employment				
low	3764	56.8	34.1	***
high	3826	43.2	65.9	

Community media exposure				***
low	3668	55.9	32.1	
high	3922	44.1	67.9	
Community poverty				
low	3784	41.3	68.2	***
high	3806	58.7	31.8	
Distance to the health facility				***
big problem	2764	40.9	26.9	
not a big problem	4825	59.1	73.1	

*SNNP-Southern nation, nationalities, and people's region, ***p<0.001.*

The figure demonstrated that regions with bigger population size had higher proportions of home births than institutional births, while the two administrative cities (Addis Ababa and Dire Dawa) and Tigray region had more of institutionalized birth practices than home homebirth (Figure 7).

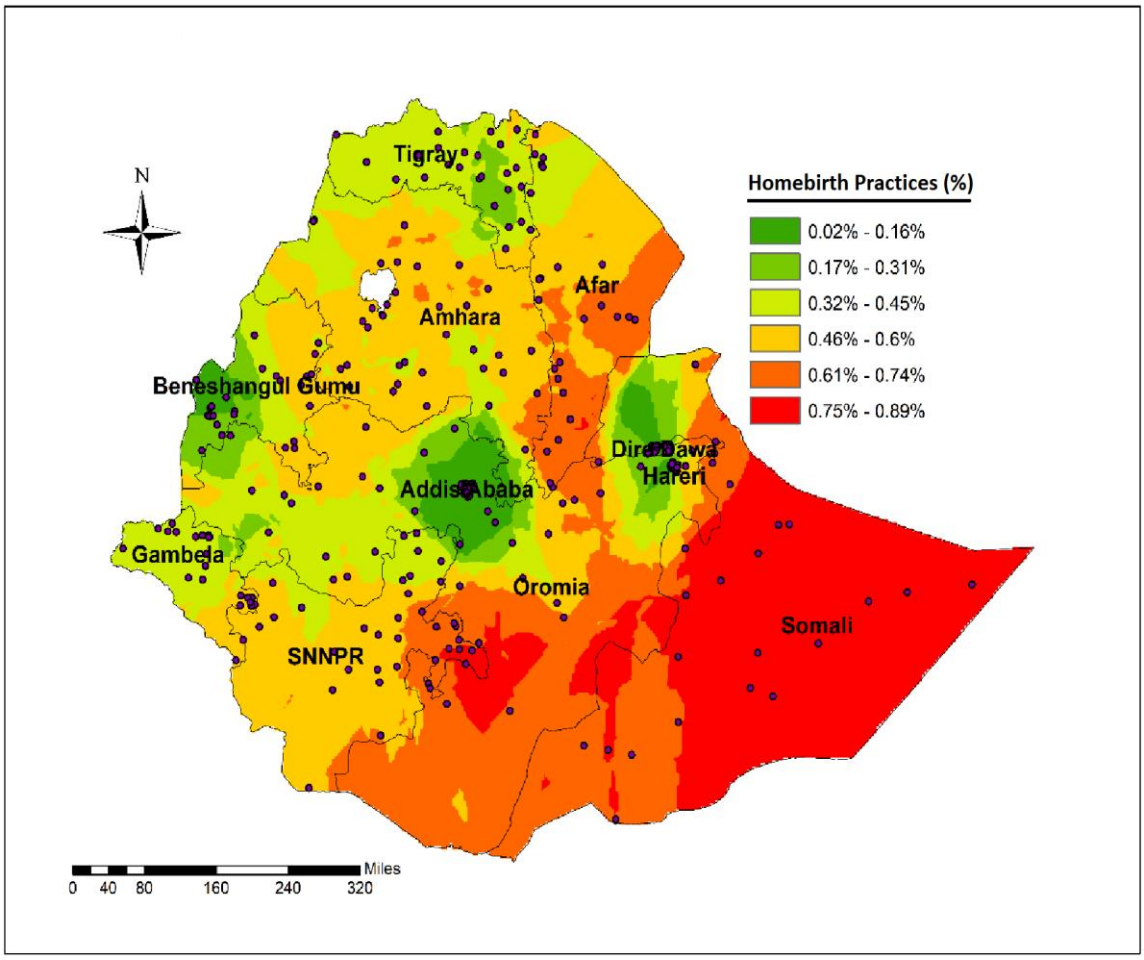


SNNP-Southern nation, nationalities, and people's region; (Source of the population size: http://www.csa.gov.et/ehioinfo-internal)

Figure 7: Proportions of home and institutional births by regions and population sizes in Ethiopia

4.3.5. Spatial analysis of homebirth practices

The Ordinary Kriging spatial interpolation showed that there was a high percentage of home birth practices along the borders of the SNNPR, Afar, southern Oromia, and Somali regions. On the other hand, only a small percentage of deliveries were made at homes in sections of Tigray, central Oromia, Benishangul-Gumuz, Dire Dawa and Addis Ababa (Figure 8).

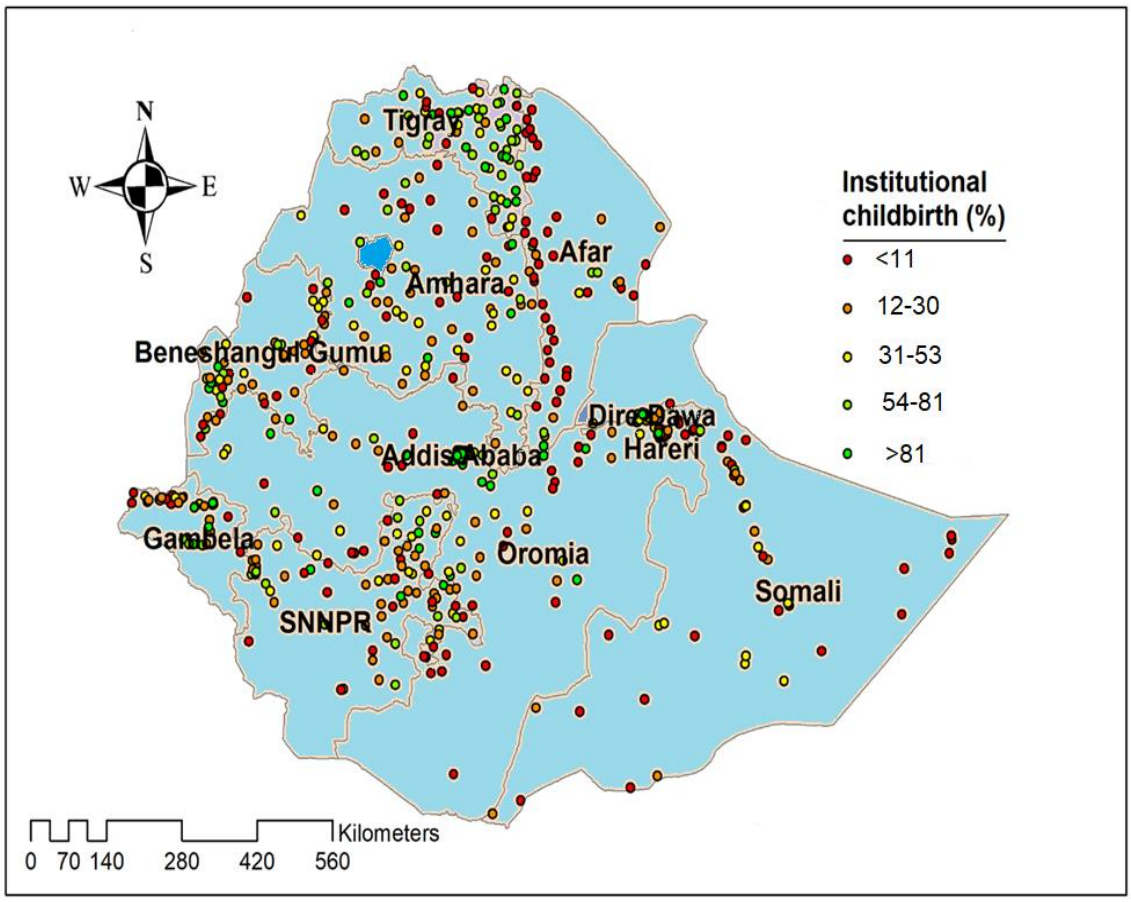


SNNPR-Southern nation, nationalities, and people's region; EDHS- Ethiopian Demographic Health Survey; (Source: Shape file from Central Statistical Agency (CSA) of Ethiopia, 2013)

Figure 8: Kriging interpolation analysis of homebirth practices in Ethiopia, EDHS 2016

4.3.6. Spatial analysis of institutional childbirths

The Gettis-OrdGi statistical analysis revealed that, in various regions of the nation, institutional delivery was geo-distributed in clusters. Addis Ababa city, Dire Dawa city, Hawassa town in SNNP, several sites in Benishangul-Gumuz, Gambella, and a small number of places in the Oromia region had the highest prevalence of institutional childbirths (Figure 9).



SNNPR-Southern nation, nationalities, and people's region; EDHS- Ethiopian Demographic Health Survey; (*Source: Shape file from Central Statistical Agency (CSA) of Ethiopia, 2013*)

Figure 9: Spatial distribution of Institutional childbirths in Ethiopia, EDHS 2016

The results of the multivariable multilevel mixed effect logistic regression analysis indicate that several factors significantly predict the birthplace. Among individual-level variables, the likelihood of women aged <20 and 20–35 years giving birth at home had declined by 77% (AOR = 0.33; 95% CI: 0.24-0.47, p<0.001) and 33% (AOR = 0.77; 95% CI: 0.65-0.90, p<0.01) respectively, compared to advanced age women aged 35 years and above. Women who had no formal education and attended only primary education were 5.57 times (AOR = 5.57; 95% CI: 4.02-7.75, p<0.001) and 3.13 times (AOR = 3.13; 95% CI: 2.28-4.30, p<0.001) more likely to give birth at home than

women who attended secondary education or higher, respectively. Women from poor households had 1.33 times (AOR = 1.33; 95% CI: 1.11-1.61, p<0.01) increased likelihood of experiencing home births compared to above-average wealth quantile households. Primiparous women were 0.79 times less likely to have home births (AOR = 0.79; 95% CI: 0.79, 0.92, p<0.001) than multiparous women. Women who had home births were 4.58 times (AOR = 4.58; 95% CI: 3.89–5.19, p<0.001) more likely to be attended by unskilled birth attendants.

Among community-level variables, the likelihood of giving birth at home was higher for women living in Oromia and Somali regions by 4.36 (AOR = 4.36; 95% CI: 1.64–11.58, p<0.01) and 3.96 (AOR = 3.96; 95% CI: 1.50–7.69, p<0.01) times, respectively, compared to women in Dire Dawa. The likelihood of women in the community with lower educational levels and media exposure were 1.95 times (AOR = 1.95; 95% CI: 1.34–2.84, p<0.001) and 1.53 times (AOR = 1.53; 95% CI: 1.06-2.19, p<0.05) higher than their opposite counterparts, respectively, whereas women who reported having a big problem reaching healthcare facilities had 1.66 times more likelihood of giving birth at home (AOR = 1.66; 95% CI: 1.08–3.37) than women who had less problem to access a healthcare facilities (Table 12).

Table 12: Multivariable multilevel mixed-effect logistic regression analysis of home birth characteristics in Ethiopia, 2016

Characteristics	Model-I (Null-model)	Model-II (Individual level)	Model-III (Community level)	Model-IV (Full model)
Maternal age				
<20	-	0.22 (0.16,0.30) ***	-	0.33 (0.24, 0.47) ***
20-34	-	0.58 (0.49,0.67) **	-	0.77 (0.65, 0.90) **
35+	-	1	-	1
Educational status				
No education	-	10.90 (8.09,14.70) ***	-	5.57 (4.02, 7.75) ***
Primary education	-	4.57 (3.39,6.16) ***	-	3.13 (2.28, 4.30) ***
Secondary and above	-	1	-	1
Religion				
Orthodox	-	0.47 (0.25,0.89) *	-	0.42 (0.21, 0.81) **
Muslim	-	0.69 (0.36,1.32)	-	0.53 (0.26, 1.04)
Protestant	-	0.51 (0.28,0.96) *	-	0.51 (0.266, 0.98) *
Others	-	1	-	1
Wealth quantiles				
Poor	-	1.93 (1.63,2.30) ***	-	1.33 (1.11, 1.61) **
Average	-	1.27 (1.07,1.52) **	-	1.03 (0.86, 1.24)
Above average	-	1	-	1
Marital status				

Never married	-	0.35 (0.17,0.73) **	-	0.49 (0.23, 1.07)
Married	-	0.75 (0.57,0.99) *	-	0.88 (0.66, 1.19)
Divorced/separated/widowed	-	1	-	1
Occupational status				
Not working	-	0.93 (0.81, 1.07)	-	0.99 (0.85, 1.14)
Working/employed	-	1	-	1
Media exposure				
No	-	2.09 (1.75,2.51) ***	-	1.30 (1.07, 1.58) **
Yes	-	1	-	1
Smoking status				
No	-	0.49 (0.19,1.19)	-	0.61 (0.24, 1.55)
Yes	-	1	-	1
Husband/Partner's educational status				
No education	-	5.25 (4.19,6.59) ***	-	2.48 (1.90, 3.22) ***
Primary	-	3.67 (2.93,4.59) ***	-	2.13 (1.66, 2.72) ***
Secondary and above	-	1	-	1
Parity				
Primipara	-	0.27 (0.23, 0.31) ***	-	0.79 (0.59, 0.92) ***
Multipara	-	1	-	1
Age at first birth				
`<20	-	0.72 (0.11, 4.73)	-	0.82 (0.03, 22.72)
20-34	-	0.54 (0.08, 3.57)	-	0.86 (0.03, 23.64)
35+	-	1	-	1
Kind of birth				
Single birth	-	1.64 (1.04, 2.59) *	-	0.65 (0.28, 1.49)
Multiple births	-	1	-	1
Skilled birth attendant				

No	-	4.87 (3.81, 6.15) *** ***	-	4.58 (3.89, 5.19) ***
Yes	-	1	-	1
Pregnancy desire				
Unwanted	-	1.82 (1.47, 2.31) ***	-	1.18 (0.78, 1.78)
Wanted	-	1	-	1
ANC visit(s)				
No ANC visit	-	7.78 (6.39, 9.46) ***	-	1.44 (1.05, 1.97) ***
1-3 visit(s)	-	1.73 (1.49, 2.01) ***	-	1.12 (0.85,1.48)
4+ visits	-	1	-	1
PNC (within 2 months)				
No	-	1.73 (1.39, 2.15) ***	-	0.76 (0.52, 1.12)
Yes	-	1	-	1
Abortion/terminated pregnancy				
No	-	1.06 (0.85, 1.32)	-	1.18 (0.79, 1.77)
Yes	-	1	-	1
Maternal BMI (kg/m2)				
<18.5	-	2.22 (1.62, 3.04)	-	1.10 (0.66, 1.85)
18.5-24.9	-	1.82 (1.36, 2.43)	-	1.13 (0.71, 1.79)
>=25	-	1	-	1
Anaemia level				
Severe	-	2.28 (1.04, 4.92) ***	-	1.38 (0.40, 4.74)
Moderate	-	0.91 (0.672, 1.22) ***	-	1.04 (0.62, 1.75)
Mild	-	1.16 (0.98, 1.37) ***	-	0.96 (0.71, 1.30)
Not anaemic	-	1	-	1
Region		-		
Tigray		-	11.39 (3.85, 33.65) ***	1.67 (1.24, 2.84) *
Amhara		-	66.65 (23.29, 190.73) ***	3.25 (1.23, 8.61) *

Oromia		-	94.25 (33.06, 268.68) ***	4.36 (1.64, 11.58) **
Somali		-	79.13 (15.96, 392.30) ***	3.96 (1.50, 7.69) **
SNNPR		-	55.02 (19.27, 157.16) ***	2.58 (1.73, 6.87) *
Dire Dawa		-	1	1
Place of residence		-		
rural		-	4.03 (3.02, 6.04) ***	3.12 (2.06, 4.21) ***
urban		-	1	1
Community Education		-		
low		-	10.13 (6.81, 15.08) ***	1.95 (1.34, 2.84) ***
high		-	1	1
Community Employment		-		
low		-	4.38 (2.79, 6.88) ***	1.21 (0.86, 1.72)
high		-	1	1
Community Media Exposure		-		
low		-	5.78 (3.74, 8.93) ***	1.53 (1.06, 2.19) *
high		-	1	1
Community Poverty		-		
low		-	5.67 (3.64, 8.85) ***	1.99 (1.39, 2.84) ***
high		-	1	1
Distance to a health facility		-		
Big problem		-	1.77 (1.07, 1.92) **	1.66 (1.08, 3.37) *
Not a big problem		-	1	1
Random effect				
Community level variance (SE)	5.73 (0.52)	1.23 (0.37)	1.63 (0.16)	1.15 (0.37)
MOR	16.12	3.63	4.41	3.48
ICC	0.64	0.27	0.33	0.26
PCV	1	0.07	0.42	0.06
Model fitness				
Loglikelihood	**-3603.11**	**-593.09**	**-3301.03**	**-576.82**
Deviance	**7,206.22**	**1186.18**	**6602.06**	**1153.64**

ANC-Antenatal care, BMI-Body mass index, PNC-Postnatal care, SNNP-Southern nation, nationalities, and people's region, SE- standard error, MOR-Median odds ratio, PCV-Proportional change in variance, ICC- Intra-class correlation.

1-reference group

***p<0.001

**p<0.01

*p<0.05

4.4. Discussions

Homebirth is a common practice, even nowadays, in many countries and regions across the globe. The reason to choose homebirth is mixed, and multifaceted and cannot be solely attributed to financial hardships or limited access to healthcare facilities. Despite the increasing global emphasis on institutional delivery, homebirths continue to persist (50,61).

The findings of our study reveal that women who gave birth at home were more likely had a lower level of education, economically poor, and had a limited access to media than women who had an institutionalized birth. These findings are consistent with the previous studies from Nigeria (186,187), Bangladesh (6,64), Indonesia (32), and Ghana (52,188). These highlight the need for targeted interventions that aim to improve access and utilization of maternal health services among disadvantaged groups such as women with low education, low income, and living in rural areas.

In our study as it was also illustrated in geospatial analysis, being located at the coastal regions, rural, distant to the healthcare facilities were also been identified as a significant predictor in influencing the place of birth than their urban counterparts were also consistent with other studies (16,67). Similarly, study from Zambia (73), Malawi (4), Uganda (189), Pakistan (65) and Nepal (49,190) evidenced that women who lived

further away from health facilities were less likely to seek institutional delivery and prone to deliver at home. This finding underscores the need to mobile maternity and newborn care services to address socio-economic and geographic barriers in accessing basic maternal and newborn services.

The study showed that the majority of the women who had home births were multiparous and had no antenatal care followup. The finding of this study is consistent with previous studies which have shown that lack of antenatal care is a significant predictor of home birth (4,67,191). Consistently, a study from rural Uganda (189) and Nigeria (67,191) found that women who gave birth in healthcare facilities were more likely to have received perinatal care services than those who gave birth at home.

The likelihood of skilled birth attendants attending births at home and in rural areas is trivial. This finding is consistent with other studies from Africa and other developing countries (3,4,6,67) explains that the majority of the home births were attended by untrained and non-professional personnel while the skilled birth attendants were present at a higher percentage of institutionalized births (74,192). This could possibly be due to limited access to healthcare facilities and lack of transportation services to healthcare facilities when they go into labour, and in some cultures, giving birth at home with the help of family members or traditional birth attendants is a common practice, and women may feel more comfortable and supported than in a hospital or health facility (70).

The likelihood of twins and larger newborns being delivered in health institutions is higher than in-home settings. This is consistent with the studies reported in Nigeria (67,193). A possible explanation could be institutional births were associated with better access to emergency obstetric care and neonatal intensive care units. However, the finding that smaller newborns were more likely to be born at home is not necessarily consistent with other findings, as smaller newborns may also require medical

interventions that may not be available for in-home birth (20,176,194,195). This could be due to the fact that larger babies may require more medical aid during birth, which is more likely to be available in a healthcare facility. This may include interventions such as C-sections or assisted vaginal deliveries, which are more commonly performed in healthcare facilities than in-home birth settings. Additionally, larger newborns may have a higher risk of complications during and after birth, and healthcare facilities may be better equipped to handle these complications. Smaller newborns may also require medical interventions such as resuscitation or specialized neonatal care, which may not be available in-home birth settings. But one possible explanation for this finding is that women who choose to give birth at home may have a lower risk of pregnancy complications or may have had uncomplicated previous births, which could make them feel more comfortable with home birth.

Overall, the study's findings emphasize the need to increase access to perinatal care services (antenatal, intrapartum, and postpartum care), especially for women who are less educated, economically disadvantaged, and reside in remote or rural areas, usually coastal regions of the countries, where pastoralists and nomadic residents are present and have limited access to obstetric services and healthcare facilities. To further improve maternal and newborn health outcomes, initiatives should be taken to guarantee the presence of trained birth attendants at all deliveries, regardless of location.

4.5. Strengths and limitations

This study's primary strength lies in utilizing a dataset that is nationally representative. With a vast amount of data available, it becomes possible to draw conclusions from the research findings. Nevertheless, a limitation associated with national surveys is the potential for recall bias, and poses a weakness that could influence causation, given that

cross-sectional nature of the survey's study design. Furthermore, this study relied on secondary data, and while the EDHS interviews concentrated on demographic and socioeconomic factors, other elements such as cultural norms and issues related to accessibility that could affect facility-based and home-based childbirth were not accounted for in the survey tool.

4.6. Conclusion

Our finding lends credence to the evidence that, in Ethiopia, most deliveries occurred at home, with significant regional variations. Through geospatial exploration, we have demonstrated that childbirth characteristics vary depending on the place of birth within Ethiopia. Notably, localized clusters with a low prevalence of institutionalized births have been identified in the southeastern sections of Oromia, Somalia, Afar, and coastal areas of the Southern Nation, Nationalities, and People's regions (SNNPR), where pastoralist and nomadic communities predominantly reside.

It is evident from our research that most births in these areas are attended by unskilled birth attendants, predominantly among women of low socioeconomic status and less educated rural residents. In light of these findings, enhancing perinatal care services, particularly through the implementation of mobile perinatal care services staffed with trained birth attendants, holds significant promise. This approach would not only improve birthing outcomes for those choosing to give birth at home but also present a more feasible and cost-effective solution compared to promoting institutional births. The fact that deliveries with an increased likelihood of complications tend to be managed at the facility level. Thus, policymakers should prioritize the establishment of mobile perinatal care services, especially in remote coastal regions, to ensure equitable access to quality care for women and newborn.

Chapter 5: Summary of the novel findings

1. Sub-study 1:

    1.1. We logically came to the conclusion that whether a birth is planned to take place at home or in a hospital in developed countries, the risk of stillbirth, neonatal mortality, or morbidity is almost the same among strictly identified low risk women. In line with this, a total of 2042 studies were initially screened in accordance with the PRISMA guidelines. Finally, our systematic review of 21 studies and meta-analysis of 20 studies in European countries involving approximately a million women samples supports the notion that planned home births, particularly in well-integrated settings, are associated with better obstetric and maternal outcomes. However, due to the heterogeneity across studies and the limited evidence for certain outcomes, interpretation must be exercised with caution.

2. Sub-study 2:

    A total of 2,997 cases were considered in support of our comparative retrospective cohort study. Data regarding home birth cases (n=1792) was sourced from Hungarian Tauffer databases and compared with its matched institutional birth data (n=1205) obtained from a university linked obstetrical departments. Both descriptive and inferential statistics were conducted.

    2.1. A total of 2997 cases were considered in support of our retrospective cohort study. In the examined period, there was a significant, continual rise in the number of homebirths from 0.04 (2012) to 0.48% (2020) in Hungary, which represent rate of 0.22% on average per year (95% CI, 0.02-0.25).

    2.2.. Advanced maternal age was reported from homebirth (33.16±4.71 vs 29.69±5.44 ($p<.001$); while significant number of women who choose

homebirth were multiparous and have experienced spontaneous mode of childbirth ($p<.001$). On the other hand, the rate of operative (vaginal or Caesarean) delivery was 26.31% among institutionalized births.

2.3. Aggregated maternal complications (primary uterine inertia, prolonged second stage labour, and third stage haemorrhage) were prevalent among homebirth cases (1.29% vs. 0.72%, $p < 0.05$) and were associated with an average of 11.77% rate of transfer to a health care institution with unknown outcome.

2.4. A slightly better Apgar score and relatively high rate (20%) of Caesarean deliveries were correlated with institutionalized births ($p < 0.05$), and evidently, the overall intervention rate was lower among homebirths (0.11% vs. 42.57%) than institutional birth cases ($p < 0.001$) (Intervention here is, AROM and Episiotomy).

2.5. Overall, homebirth is a reliable option for childbirth for healthy and low-risk mothers with uncomplicated pregnancies, which is reflected in the increasing number of deliveries at home in Hungary. Also, brooding of preliminary requirements and strict selection criteria for midwives of homebirth provide an acceptable alternative in support of safe home childbirth. Furthermore, utilizing the experiences of countries where homebirth is a long-established method may further improve the outcome of homebirths in Hungary.

3. Sub-study 3:

3.1. A mixed-method multilevel regression models were employed. Data from the only recent and available Ethiopian Demographic and Health Survey (EDHS-2106) were analysed using weighted sample of 7,590 women who

had birth within the five years preceding the survey., accounting for design and clustering effects. The Kriging spatial interpolation, and the Gettis-OrdGi geospatial analysis were used to visualize the prevalence of childbirth practices.

3.2. The weighted prevalence of home births in Ethiopia was 68.3%. Women who delivered at home were more likely to have lower education levels (AOR=5.57, 95%CI: 4.02-7.75, p<0.001), limited access to media (AOR=1.30, 95%CI: 1.07-1.58, p<0.01), experienced economic hardship (AOR=1.33, 95%CI: 1.11-1.61, p<0.01), and partnered with a husband who lacks formal education (AOR=2.48, 95%CI: 1.90-3.22, p<0.001).

3.3. Home births were more common among multiparous women residing in rural areas and experienced no antenatal care visits (p<0.05). Skilled birth attendants were present in most institutional births, while unskilled attendants were attended majority of home births (AOR=4.58, 95%CI: 3.89-5.19, p<0.001). Twins and larger newborns were more likely to be delivered in healthcare institutions (p<0.001), where C-section rate was about 7.60%.

3.4. The geospatial analysis revealed a widespread home birth practices in south-eastern costs of Oromia, Afar, and Somali regional states, where local clusters of areas with a low prevalence of institutionalized births were detected in south-eastern sections of Oromia, Somali and Afar regions. The likelihood of home births was considerably increased among women with low socioeconomic backgrounds and educational levels. Hence, improving perinatal care services would improve the outcome of childbirth at home and would be cheaper and easier to carry out instead of persuading women to give birth institutionally.

Thus, our studies unequivocally show that majority of births in areas attended by unregistered, unlicensed, and unskilled birth attendants, typically among rural residents with low socioeconomic status and less education, would significantly affect safety, satisfaction, and foeto-maternal homebirth outcomes. We highly recommend, the prospect of improving 'perinatal care services' regardless of the place of birth has a great potential and the least expensive alternative. This strategy would not only enhance safety of home births for those who choose to do so, mostly a low-risk women, but also offer a more workable and affordable alternative than relying only on institutional births. In the fact that, deliveries with a higher chance of complications must still handle at the facility level.

Chapter 6: Implementation suggestions and potential strategies to address homebirth-related challenges.

Addressing the challenges and ensuring the safety of homebirth involves implementing a comprehensive approach that includes the following strategies:

Standardized risk assessment and selection criteria: Developing standardized guidelines for assessing maternal and foetal risk factors can help identify women who are suitable candidates for homebirth. This involves establishing clear criteria based on evidence-based research and expert consensus to determine the eligibility of women for homebirth (37,42). When determining a woman's fitness for homebirth, a variety of criteria might be considered, including her age, health history, pregnancy problems, and previous number of deliveries. A hospital delivery may be more appropriate for women who have specific risk factors, such as diabetes, high blood pressure, or obesity. However, if they are closely supervised by a licensed midwife, many women with these risk factors can still give birth at home safely and healthily. The choice of having a homebirth or not is ultimately a personal one. However, women can choose the best

birthing choice for them if they are aware of the advantages and disadvantages of giving birth at home and consult with a licensed midwife (15,42).

Integration into the healthcare system: It is imperative that midwives, hospitals, and homebirth providers work together more closely and communicate more effectively. This entails creating precise guidelines for the handoff of medical care, guaranteeing prompt access to emergency treatment, and encouraging women and healthcare professionals to participate in decision-making together (43).

Skilled birth attendants and training: It is crucial to make sure that midwives and other homebirth attendants have the required knowledge, abilities, and continuous training. Their knowledge and skills should be regularly assessed, accredited, and provided with continuing education opportunities, therefore enhancing the standard and safety of homebirth procedures (13,178,196).

Informed decision-making and education: It is essential to give women and their families thorough and objective information on the advantages, disadvantages, and options for homebirth. Talks about possible issues, services that are accessible, and the significance of having a well-thought-out birth plan should all be part of this. By providing women with information about their alternatives, they may make choices that are in line with their tastes and are aware of any potential risks (38,40,65,197,198).

Access to emergency equipment and Supplies: It is essential to make sure that homebirth settings have access to the right supplies, medications, and emergency gear. A safer homebirth setting can be achieved by establishing clear rules for the maintenance and availability of emergency equipment, along with methods for treating probable difficulties (43,199).

Monitoring and Evaluation: Tracking results and identifying opportunities for improvement can be facilitated by putting in place strong monitoring and evaluation systems. Data on adverse events, safety indicators, and maternal and newborn outcomes in homebirth settings can be gathered and analysed to support continuous quality improvement initiatives and provide evidence-based practices (76,104,105,200).

Collaboration and support networks: Encouraging cooperation and support systems between hospitals, homebirth providers, and other medical professionals can improve homebirth's general safety and experience. This can entail creating official referral processes, cultivating civil relationships, and encouraging interdisciplinary communication to guarantee smooth treatment and, if required, the proper management of difficulties (27,28,44,48,200)

Regulatory frameworks and guidelines: Ensuring uniform standards of care can be facilitated by creating and executing homebirth-specific regulatory frameworks and guidelines. This entails setting standards for homebirth providers as well as oversight procedures and quality control techniques to maintain security and responsibility (27,44,69,101)

A safer and more encouraging homebirth experience for moms and their babies would result from the adoption of these practices. However, it is important to note that achieving safety in homebirth requires a collaborative effort among policymakers, healthcare providers, and women themselves (11,27,45). Furthermore, ongoing researches, evaluation, and open dialogue are essential to continually improve practices, minimize risks, and enhance the overall safety of homebirth (36,95).

Chapter 7: List of publications and scientific activities during Ph.D. course

7.1. Published full text articles:

Wami GA, Prémusz V, Csákány GM, Kálmán K, Vértes V, Tamás P. Characteristics of Homebirth in Hungary: A Retrospective Cohort Study. Int J Environ Res Public Health. 2022 Aug 22;19(16):10461. doi: 10.3390/ijerph191610461. PMID: 36012096; PMCID: PMC9407858.

Tamás P, Kovács K, Várnagy Á, Farkas B, **Wami GA**, Bódis J. Preeclampsia subtypes: Clinical aspects regarding pathogenesis, signs, and management with special attention to diuretic administration. Eur J Obstet Gynecol Reprod Biol. 2022 Jul 1; 274:175–81.

Tamás P, Betlehem J, Szekeres-Barthó J, Kovács K, **Wami GA**, Vértes V, Bódis J. A preeclampsia két arca [The two faces of preeclampsia]. Orv Hetil. 2022 Apr 24;163(17):663-669. Hungarian. doi: 10.1556/650.2022.32427. PMID: 35462351.

7.2. Articles related to dissertation currently under review.

Wami GA, Argefa TG, Prémusz V, Tamás P. *Maternal and foeto-neonatal characteristics of childbirth in Ethiopia: a multi-level mixed-effect analysis,* **under review** at Wiley, Journal of Obstetrics and Gynaecology International.

Wami G A, Kiptulon EK, Galgalo DA, Chauhan S, Prémusz V, Tamás P: *Effects of planned place of birth on obstetric interventions and feto-maternal birth outcomes in low-risk women: A systematic review and meta-analysis of European studies,* **under review** at BMC systematic review.

7.3. Additional articles currently under review

Kiptulon EK, **Wami GA**, Elmadani M, Klára S, Orsolya M, Adrienn US. The impact of organizational culture on work stress and career leaving among nurses: A systematic review, currently **under review** at BMC systematic review.

Galgalo D A, Mokaya P, Chauhan S, Kasmai EK, **Wami GA**, Ákos Várnagy, Viktória Prémusz: Utilization of maternal health care services among pastoralist community in Marsabit county, Kenya: a cross-sectional baseline survey, currently **under review** at BMC pregnancy and childbirth

7.4. Abstracts chapter in book (conference paper) in "Health sciences":

Wami GA, Argefa TG, Prémusz V, Tamás P. Maternal and foeto-neonatal characteristics of childbirth in Ethiopia: a multi-level mixed-effect analysis, Value in Health November 2023, ISPOREurope 2023, Copenhagen, Denmark. https://doi.org/10.1016/j.jval.2023.09.1620

Wami GA, Olayemi O, Akpa OM, Gudissa GG, Premusz V, Tamas P. Factors affecting provisions of Quality Emergency Obstetric and Newborn Care (EmONC) services in public health facilities in Dire Dawa, Ethiopia: a qualitative study. IX. Interdiszciplináris Doktorandusz Konferencia 2020 [9th Interdisciplinary Doctoral Conference 2020] 595 p. pp. 575-588., 14 p. Publication:32007934.

Tamás, P; **Wami GA**. Az anyai centrális hemodinamika hatása a magzat súlyfejlődésére. In: Betlehem, József; Karamánné, Pakai Annamária (eds.). A szombathelyi felsőfokú szülésznőképzés 20 éves jubileuma és konferenciája: absztrakt kötet, Szombathely, Hungary: Pécsi Tudományegyetem Egészségtudományi Kar (PTE ETK) (2021) 110 p. pp. 63-63., 1 p. Publication:32094760

Wami GA, Prémusz V, György MC, Kovács K, Vértes V, Tamás P. Janus-kináz. inhibitorok. gyulladáscsökkentő. https://dosz.hu/fil/480381b03c5b02c2f15acd218d190f9044f34f94f6d74c54dcdd7866762e19ed

7.5. Other ongoing research work in "Health sciences":

Wami GA, Kiptulon EK, Galgalo DA, Prémusz V, Tamás P. Impact of midwifery-led care on the safety and outcomes of home birth in developed countries: A systematic review and meta-analysis. PROSPERO 2023 CRD42023439428 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42023439428

Chauhan S, Muka T, Jaswal N, Al-Debes W, Korovljev D, **Wami GA**, Acs P, Karsai I, Premusz V. Effect of Yoga on Anti-mullerian hormone AMH level and androgen level in female with polycystic ovarian syndrome – A Systematic Review and Meta-analysis. PROSPERO 2022 CRD42022342913 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42022342913

Prémusz V, Muka T, Chauhan S, Várnagy A, Bódis J, Makai A, Hock M, **Wami GA**. Effects of melatonin supplementation on sleep patterns and psycho-social distress in women undergoing assisted reproductive treatment - A systematic review and meta-analysis. PROSPERO 2022 CRD42022349542 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42022349542

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Appendix

Ethical Clearance

KK/808-1/2021

10. sz. melléklet

PTE Klinikai Központ statisztikai és tudományos adatgyűjtési kérelem [46]

Az adatkérő adatai	***Név***	Gitka Hanna Wami
	Főállású munkahely*: (hallgatóknál: kar)	Egészségtud. kar
	Beosztás	Stipendiális hung. hallg.
	Elérhetőség (e-mail és tel.)	et2+hg@pte.hu
	Adatgyűjtéssel összefüggő PTE jogviszony jellege:	☐ ***PTE oktató, kutató*** ☒ ***PTE PhD hallgató*** ☐ ***PTE KK önkéntes segítő*** ☐ ***PTE hallgató (nappali, levelezős)*** ☐ ***egyéb:***

A kutatás (klinikai vizsgálat/ PhD téma/ pályázat/ projekt/ szakdolgozat stb.) címe, azonosító száma (ha már van), vezetője (principal investigator, témavezető, pályázat szakmai vezető, stb.):
Characteristics of home birth in Hungary – Dr. Tamás

Az adatgyűjtéssel érintett klinika / intézet:
Ált. é. Nőgy. Klin.

Az adatgyűjtési kérelem célja, rövid indoklása:
kutatócsoport kérése

A kért adatkör meghatározása (adatcsoport megnevezése, pl.: kórlap, ambuláns napló, járóbeteg karton):
2020. év születéseire a 37-40. hétre kiírt adatai (kutatás)

Adatterjedelem (vizsgált hónapok a kezdő és a záró időpont megjelölésével, nem összefüggő időszakok esetében a kezdő és a záró időpont megadása időszakonként):
2020. jan. 1 – dec. 31.

Adattgyűjtés tervezett kezdete: 2021. 06. 10.
Adatgyűjtés tervezett befejezése: 2021. 07. 10.

**Kérjük, a PTE-n kívüli, főállású munkahelyet is szíveskedjen megjelölni.*

[46] *A módosítást a Szenátus 2020. december 02-án lezárt elektronikus döntéshozatali eljárásában fogadta el. Hatályos: 2020. december 03. napjától.*

Büntetőjogi felelősségem tudatában kijelentem, hogy a rendelkezésemre bocsátott személyazonosító és egészségügyi adatokat GDPR, 2011. évi CXII., valamint az 1997. évi XLVII. törvény értelmében, továbbá az egészségügyi adatvédelmi tisztviselő tájékoztatásának megfelelően kezelem.

Adatkérő aláírása: _____ (Ivanics Péter)

Adatkérő munkahelyi (klinika/intézet/kar) vezetőjének neve, aláírása: Dr. Kovács Szilárd

Adatgyűjtéssel érintett klinika/intézet vezető neve, aláírása: _____ a. a.

Egészségügyi adatvédelmi tisztviselő neve, aláírása: _____

Az engedélyező, Klinikai Központ elnökének neve, aláírása: Dr. Sebestyén Andor elnök

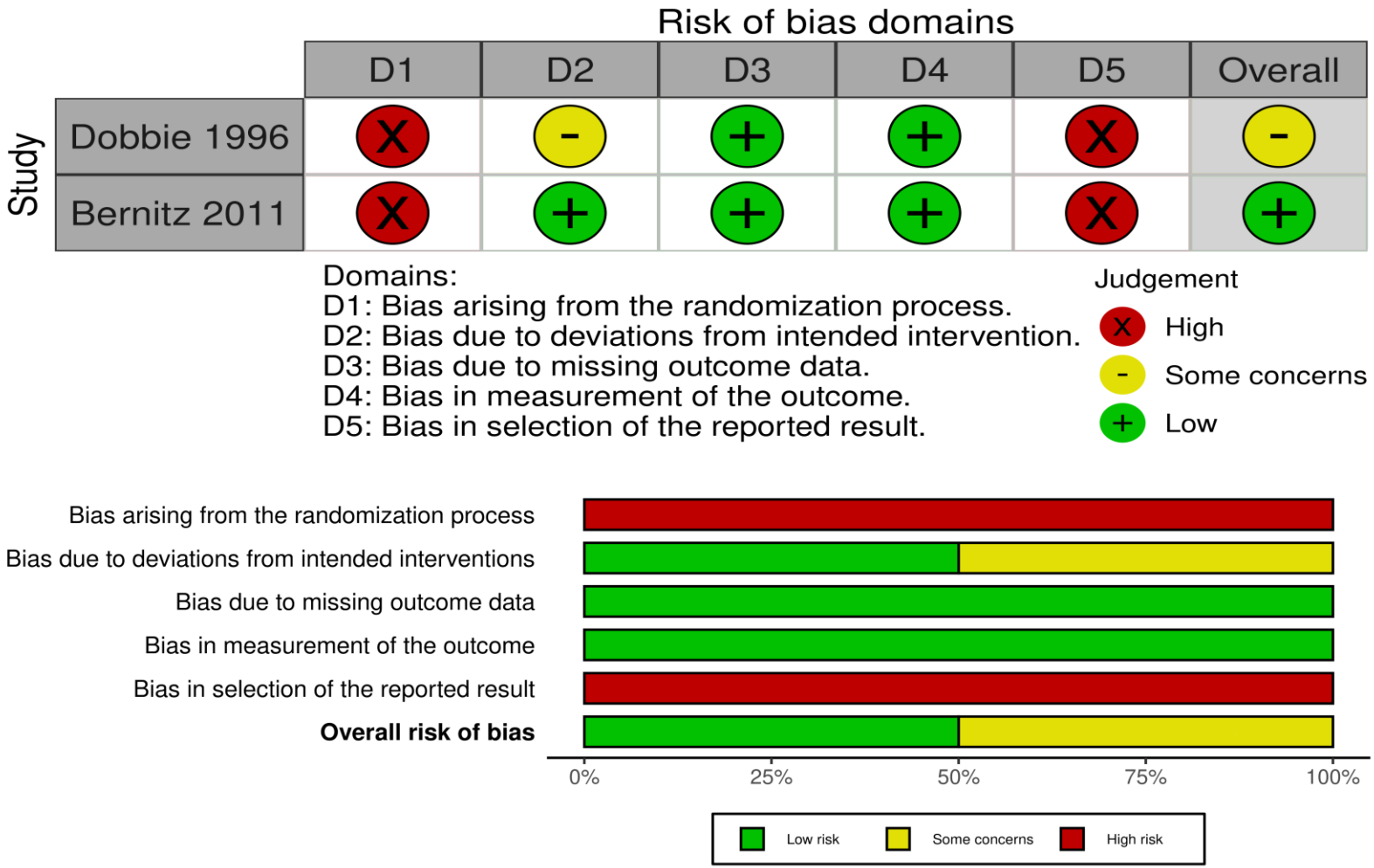
PÉCSI TUDOMÁNYEGYETEM 1. KLINIKAI KÖZPONT

2021 JÚN. 14

Dátum: 20 21. 06. 07.

[46] *A módosítást a Szenátus 2020. december 02-án lezárt elektronikus döntéshozatali eljárásában fogadta el. Hatályos: 2020. december 03. napjától.*

Cochrane risk of bias assessment for randomized trials (RoB 2)



Used tool: Robvis visualization tool available at https://www.riskofbias.info/welcome/robvis-visualization-tool

Search terms [including Mesh terms]

Title: Effects of planned place of birth on obstetric interventions and foeto-maternal birth outcomes in low-risk women in European countries: A systematic review and meta-analysis

Population (Participant)	Intervention (Exposure)	Comparison (Comparator)	Outcome
low-risk women low risk mothers uncomplicated pregnancy minimal-risk pregnancy safe pregnancy non-risky pregnancy non-complex pregnancy uncomplicated expectant mothers safe expectant mothers	planned place of birth birthplace birth place birth setting birth site site of birth out-of-hospital birth midwife-led setting midwife-led unskilled birth planned home birth homebirth home delivery home childbirth child birth childbirth at home domiciliary birth birth at home home-based childbirth natural birth at home non-institutional childbirth unassisted home birth unplanned home birth family-centered birth home parturition home birthing non-hospital childbirth	planned institutional birth institutional birth hospital birth hospital delivery facility birth facility delivery obstetric led setting obstetric-led physician-led birthing center birth center health facility birth healthcare facility birth facility parturition	perinatal death OR perinatal mortality neonatal death OR neonatal mortality foetal death OR foetal mortality maternal outcome adverse maternal outcomes maternal mortality maternal death PPH OR post-partum haemorrhage post-partum infection third /fourth degree tear foetal outcomes NICU admission neonatal resuscitation neonatal malformation Apgar score foetal-maternal outcomes foetal-neonatal outcomes pregnancy outcomes birth complications pregnancy complications obstetric interventions operative vaginal birth assisted vaginal birth vacuum delivery vacuum birth forceps delivery Caesarean section OR C-section delivery epidural analgesia episiotomy oxytocin administration

#1: Search strategy [PubMed]

Search number	Query	Results
1	low-risk women [Title/Abstract]	1,364
2	low risk mothers [Title/Abstract]	112
3	uncomplicated pregnancy [Title/Abstract]	1,289
4	minimal-risk pregnancy [Title/Abstract]	140
5	safe pregnancy [Title/Abstract]	140
6	non-risky pregnancy [Title/Abstract]	3
7	non-complex pregnancy [Title/Abstract]	1
8	uncomplicated expectant mothers [Title/Abstract]	3
9	Safe expectant mothers [Title/Abstract]	45
10	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9	3,082
12	planned place of birth [Title/Abstract]	51
13	birthplace [Title/Abstract]	1,688
14	birth place [Title/Abstract]	311
15	birth setting [Title/Abstract]	235
16	birth site [Title/Abstract]	59
17	site of birth [Title/Abstract]	673
18	out-of-hospital birth [Title/Abstract]	109
19	midwife-led setting [Title/Abstract]	118
20	unskilled birth [Title/Abstract]	54
21	midwife-led [Title/Abstract]	451
22	planned home birth [Title/Abstract]	176
23	homebirth [Title/Abstract]	322
24	(home delivery [Title/Abstract]) AND (home delivery [Title/Abstract])	1,119
25	home childbirth [Title/Abstract]	105
26	child birth [Title/Abstract]	1,012
27	childbirth at home [Title/Abstract]	29
28	domiciliary birth [Title/Abstract]	64
29	home-based childbirth [Title/Abstract]	53
30	natural birth at home [Title/Abstract]	220
31	non-institutional childbirth [Title/Abstract]	1
32	unassisted home birth [Title/Abstract]	1
33	unplanned home birth [Title/Abstract]	8
34	family-centered birth [Title/Abstract]	251
35	home parturition [Title/Abstract]	73
36	home birthing [Title/Abstract]	17
37	non-hospital childbirth [Title/Abstract]	7
38	#12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37	6,666
39	Planned institutional birth [Title/Abstract]	12

40	institutional birth [Title/Abstract]	73
41	hospital birth [Title/Abstract]	622
42	hospital delivery [Title/Abstract]	572
43	facility birth [Title/Abstract]	119
44	facility delivery [Title/Abstract]	609
45	obstetric led setting [Title/Abstract]	802
46	obstetric-led [Title/Abstract]	45
47	physician-led [Title/Abstract]	747
48	birthing center [Title/Abstract]	127
49	birth center [Title/Abstract]	353
50	health facility birth [Title/Abstract]	24
51	healthcare facility birth [Title/Abstract]	91
52	facility parturition [Title/Abstract]	92
53	#39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50 OR #51 OR #52	3,969
54	perinatal death [Title/Abstract]	3,469
55	perinatal mortality [Title/Abstract]	10,787
56	neonatal death [Title/Abstract]	5,835
57	neonatal mortality [Title/Abstract]	9,396
58	foetal death [Title/Abstract]	530
59	foetal mortality	31,482
60	Maternal outcome [Title/Abstract]	1,430
61	adverse maternal outcomes [Title/Abstract]	568
62	Maternal mortality [Title/Abstract]	13,745
63	maternal death [Title/Abstract]	4,595
64	PPH[Title/Abstract]	7,711
65	post-partum haemorrhage [Title/Abstract]	659
66	Post-partum infection [Title/Abstract]	20
67	third /fourth degree tear [Title/Abstract]	9
68	Foetal outcome [Title/Abstract]	341
69	foetal outcomes [Title/Abstract]	382
70	NICU admission [Title/Abstract]	1,381
71	Neonatal resuscitation [Title/Abstract]	2,240
72	Neonatal malformation [Title/Abstract]	39
73	Apgar score [Title/Abstract]	8,030
74	Foetal-maternal outcomes [Title/Abstract]	6
75	Foetal-neonatal outcomes [Title/Abstract]	14
76	Pregnancy outcomes [Title/Abstract]	21,842
77	birth complications [Title/Abstract]	659
78	Pregnancy complications [Title/Abstract]	20,175
79	Obstetric interventions [Title/Abstract]	502
80	operative vaginal birth [Title/Abstract]	99
81	assisted vaginal birth [Title/Abstract]	90
82	Vacuum delivery [Title/Abstract]	267
83	Vacuum birth [Title/Abstract]	5
84	forceps delivery [Title/Abstract]	958

85	Caesarean section [Title/Abstract]	19,790
86	C-section delivery [Title/Abstract]	131
87	epidural analgesia [Title/Abstract]	8,413
88	episiotomy [Title/Abstract]	3,158
89	oxytocin administration [Title/Abstract]	927
90	#54 OR #55 OR #56 OR #57 OR #58 OR #59 OR #60 OR #61 OR #62 OR #63 OR #64 OR #65 OR #66 OR #67 OR #68 OR #69 OR #70 OR #71 OR #72 OR #73 OR #74 OR #75 OR #76 OR #77 OR #78 OR #79 OR #80 OR #81 OR #82 OR #83 OR #84 OR #85 OR #86 OR #87 OR #88 OR #89	144,187
91	**#10 AND #38 AND #53 AND #90 [Title/Abstract]**	**382**

#2: Search strategy (Ovid MEDLINE)

#	Searches	Results
1	low-risk women.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	7133
2	low risk mothers.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	447
3	uncomplicated pregnancy.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	7462
4	minimal-risk pregnancy.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	30
5	safe pregnancy.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	5516
6	Safe expectant mothers.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	5
7	Pregnancy outcome.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	95799
8	1 or 2 or 3 or 4 or 5 or 6 or 7	114041
9	planned place of birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	197
10	birthplace.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	7675
11	birth setting.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1098
12	birth site.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	360
13	site of birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	377
14	out-of-hospital birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4138

15	midwife-led setting.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	5
16	midwife-led.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1564
17	unskilled birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	140
18	planned home birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	708
19	homebirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	660
20	home birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4055
21	home delivery.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4081
22	home childbirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3134
23	home childbirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3134
24	child birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	6272
25	childbirth at home.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	130
26	domiciliary birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	13
27	birth at home.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	2137
28	home-based childbirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	6
29	natural birth at home.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	10
30	non-institutional childbirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3
31	Unassisted home birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	13
32	Unplanned Home Birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	50
33	family-centered birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	40
34	home birthing.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	230
35	non-hospital childbirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	0

36	9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35	30467
37	Planned institutional birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1
38	institutional birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	184
39	hospital birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4664
40	hospital birthing.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	443
41	hospital birth center.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	296
42	hospital delivery.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3756
43	hospital childbirth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	285
44	facility birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	355
45	facility delivery.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1240
46	obstetric led setting.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3
47	obstetric-led.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	189
48	birthing center.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	932
49	birth center.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1911
50	health facility birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	65
51	healthcare facility birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	2
52	facility parturition.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3
53	37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52	12357
54	perinatal death.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	15404
55	perinatal mortality.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	31303
56	neonatal death.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	24554

57	neonatal mortality.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	26219
58	foetal death.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	51972
59	foetal mortality.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	7312
60	Maternal outcome.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4943
61	adverse maternal outcomes.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	2438
62	Maternal mortality.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	43639
63	maternal death.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	18539
64	(PPH or post-partum haemorrhage).mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	16551
65	Post-partum infection.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	98
66	(third or fourth degree tear).mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3052197
67	NICU admission.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	7391
68	Neonatal resuscitation.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	8568
69	Neonatal malformation.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	113
70	Apgar score.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	37100
71	Foetal-maternal outcomes.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	793
72	Foetal-neonatal outcomes.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1686
73	pregnancy outcomes.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	66848
74	birth complications.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4087
75	Pregnancy complications.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	205909
76	Obstetric interventions.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	2491

77	operative vaginal birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	607
78	assisted vaginal birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	402
79	Vacuum delivery.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	1433
80	Vacuum birth.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	62
81	forceps delivery.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	4725
82	(Caesarean section or C-section delivery).mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	54555
83	epidural analgesia.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	33950
84	episiotomy.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	12365
85	Oxytocin administration.mp. [mp=ab, bo, bt, ti, hw, tx, ct, ot, nm, fx, kf, ox, px, rx, ui, sy, ux, mx]	3355
86	54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 or 84 or 85	3475668
87	8 and 36 and 53 and 86	792
88	limit 87 to (english language and humans) [Limit not valid in Books@Ovid,Journals@Ovid,Your Journals@Ovid; records were retained]	**763**

DATA AVAILABLITY STATEMENT

All the datasets, all other search strategies, data extraction sheets and supportive documents used in this research are available from the author upon a reasonable request.

Submission of the doctoral dissertation and declaration of the originality of the dissertation

The undersigned,
Name: **Girma Alemu Wami**
Maiden name: -
Mother's maiden name: **Wakjira**
Place and time of birth: **Enchine, 06 July 1989**

on this day submitted my doctoral dissertation entitled:

Maternal and foeto-neonatal characteristics of home childbirth

to the

PR-5, Human Reproduction Programme

of the Doctoral School of Health Sciences, Faculty of Health Sciences, University of Pécs.

Names of the supervisor(s): **Prof. Dr. Tamás Péter**

At the same time, I declare that
- I have not submitted my doctoral dissertation to any other Doctoral School (neither in this country nor abroad),
- my application for degree earning has not been rejected in the past two years,
- in the past two years I have not had unsuccessful doctoral procedures,
- my doctoral degree has not been withdrawn in the past five years,
- my dissertation is independent work, I have not presented others' intellectual work as mine, the references are definite and full, on preparation of the dissertation I have not used false or falsified data.

Furthermore, I declare that I contribute to the request of DOI identification of my doctoral dissertation.

Dated: 26/03/2024

Girma Alemu Wami
Ph.D. Candidate

Prof. Dr. Tamás Péter
Supervisor