

Improving integrated antenatal screening for sexually transmitted diseases: identification of barriers and facilitators and cost-effectiveness analysis

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Thesis submitted in partial fulfilment of the requirements for the degree of

PhD in Economics

Institute for Global Health

University College London

11th September 2025

Declaration

I, Lucie Sabin, confirm that the work presented in my thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract [300 words]

The World Health Organisation (WHO) recommends integrated antenatal screening for HIV, syphilis, and hepatitis B to eliminate vertical transmission. This approach allows pregnant women to be screened for all three diseases with a single blood draw in one visit, potentially increasing uptake. However, more research is needed to determine its feasibility and acceptability. This thesis explores barriers and facilitators to integrated antenatal screening for HIV, syphilis, and hepatitis B and models its impact and cost-effectiveness in Nepal.

First, I investigated barriers and facilitators to antenatal screening for HIV, syphilis or hepatitis B in Asia using a systematic literature review. Evidence for syphilis and hepatitis B was limited, but several factors, including socio-demographic factors, husband and health workers' support and risk perception, influenced HIV antenatal screening. **Second**, I examined factors that influenced HIV antenatal screening by analysing the Nepal Demographic and Health Surveys 2016 and 2022. Women with higher education, later pregnancy desire, and four or more antenatal care visits were more likely to be screened for HIV, while poverty and limited knowledge of vertical transmission and prevention methods were barriers to uptake. **Third**, by undertaking semi-structured in-depth interviews, I explored the knowledge, attitude, and perceptions of pregnant women, their family members, health workers and healthcare decision-makers on integrated antenatal screening. Results showed screening involved many stakeholders and was influenced by various factors. Implementation issues were found regarding service delivery, health workforce and medical products. **Fourth**, using modelling techniques, I estimated the health impact and cost-effectiveness of integrated antenatal screening strategies. Results concluded that integrated triple screening was highly cost-effective.

Improving screening for HIV, syphilis and hepatitis B in Nepal requires a multi-sectoral approach, including strengthening healthcare systems, increasing investment in prevention programs and addressing stigma. In line with WHO recommendations, findings suggest that triple-integrated screening is a promising strategy for achieving the elimination of vertical transmission.

Content

Declaration	2
Abstract [300 words].....	3
Content	4
Impact Statement [500 words]	7
Research Paper Declaration Form.....	9
Acknowledgements	15
List of Figures	16
List of Tables	18
List of Abbreviations	20
1. Introduction	22
1.1. Overview	22
1.2. Rationale for integrated screening.....	24
1.3. Integrated antenatal screening interventions in Asia.....	24
1.4. Aim, objectives and research questions	25
1.5. Structure of the thesis	26
2. Literature review	27
2.1. Introduction	27
2.2. Factors influencing screening demand: the theoretical perspective.....	28
2.3. Methods	29
2.4. Results	31
2.5. Discussion and Conclusions	46
3. Empirical context of Nepal	48
3.1. Country context	48
3.2. Health context	50
3.3. Cultural context	59
3.4. Conclusion.....	63
4. Barriers and facilitators to HIV antenatal screening	64
4.1. Introduction	64
4.2. Method	65
4.3. Results	69
4.4. Complementary analysis	73
4.5. Discussion and Conclusions	81

5.	Knowledge, attitudes and perceptions regarding antenatal screening.....	86
5.1.	Introduction	86
5.2.	Method	86
5.3.	Results	94
5.4.	Discussion and Conclusions	107
6.	Cost-effectiveness of integrated screening.....	111
6.1.	Introduction	111
6.2.	Method	112
6.3.	Results	117
6.4.	Discussion and Conclusions	122
7.	General conclusions and implications.....	125
7.1.	Main results	125
7.2.	Strengths and limitations	126
7.3.	Research implications	127
7.4.	Policy implications.....	129
8.	References	132
1.	Literature review appendix.....	153
1.1.	Literature review reporting checklist	153
1.2.	Full search terms used on Scopus	154
1.3.	Quality appraisal checklists of the included studies.....	156
2.	DHS data appendix.....	157
2.1.	Results	157
2.2.	Quantitative analysis reporting checklist	160
2.3.	Complementary analysis	162
3.	Qualitative study appendix.....	163
3.1.	Vignette 1 - A pregnant friend heard about ANC visits.....	163
3.2.	Informed consent form	164
3.3.	Participants' information sheet	167
3.4.	Topic guide – husbands	167
3.5.	Topic guide – pregnant women	172
3.6.	Topic guide – mothers-in-law.....	177
3.7.	Topic guide – health workers	182
3.8.	Topic guide – decision-makers.....	185
3.9.	Qualitative research reporting checklist	188

4.	Cost-effectiveness appendix.....	190
4.1.	Model parameters.....	190
4.2.	Economic evaluation reporting checklist	192
4.3.	One-way sensitivity analysis.....	195

Impact Statement [500 words]

The main objective of my thesis was to explore barriers and facilitators to integrated antenatal screening for HIV, syphilis, and hepatitis B and model its impact and cost-effectiveness in Nepal. My results demonstrated that improving screening requires a multi-sectoral approach, including strengthening healthcare systems, increasing investment in prevention programs and addressing stigma. My results also demonstrated that triple-integrated screening is a promising strategy for achieving the elimination of vertical transmission.

The findings of this thesis made substantial contributions to multiple areas of the literature. I contributed to the literature on barriers and facilitators to antenatal screening for sexually transmitted infections in the region. The systematic review concluded on the limited evidence in the Asian context in this regard. This thesis also contributed to the literature on the potential acceptability and the cost-effectiveness of integrated screening for HIV, syphilis, and hepatitis B. Data on the subject were limited globally, particularly in Asia.

My thesis has built a solid foundation for future research, providing access to models and data that can be used by other researchers. Future research could apply the models developed to evaluate the cost-effectiveness of integrated screening in other settings. Moreover, the transcripts of the interviews conducted in Nepal have been shared on University College London (UCL) Discovery. Further research could expand my results by empirical studies evaluating the health impact and cost-effectiveness of triple-screening. Integrated antenatal screening for sexually transmitted infections can be an entry point for other blood tests. Further research could look at opportunities to develop integrated antenatal screening for other diseases such as anaemia.

My findings have significant implications for policymakers in Nepal and in other contexts where integrated screening could be implemented. Results inform the implementation of the WHO framework as part of the triple elimination initiative of vertical transmission of HIV, syphilis, and hepatitis B. Many Asian countries, including Nepal, are far from having achieved antenatal screening targets, potentially leading to an underestimation of the burden of these diseases. Understanding barriers and facilitators to screening may guide healthcare decision-makers regarding the design of targeted interventions to improve antenatal screening uptake and, as a result, contribute to global efforts to improve maternal and child health. This thesis also provides essential insights into how health systems can be strengthened by integrated screening programmes. By streamlining antenatal care services, health systems can make more efficient use of resources and increase access to screening.

I have already started disseminating the results of this research to a wider community through presentations and publications in peer-reviewed journals. I presented results from the Nepal Demographic and Health Surveys analysis at the 2023 International Health Economics Association (IHEA) Congress. Additionally, results from four of the analytical chapters have been published in peer-reviewed journals. I intend to continue these dissemination efforts by sharing my findings through workshops, international collaborations, and teaching materials.

In addition, the collection of primary data strengthened UCL's existing collaborations in Nepal with the Health Research and Social Development Forum (HERD) International, opening up the possibility of future collaborations.

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Factors affecting antenatal screening for HIV in Nepal: results from Nepal Demographic and Health Surveys 2016 and 2022.

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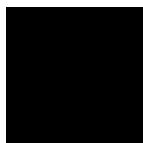
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Lucie Sabin, Naomi Saville and Hassan Haghparast-Bidgoli discussed the research and analysis strategy. Lucie Sabin conducted the analysis and submitted the paper. Lucie Sabin is responsible for the overall content as the guarantor. Naomi Saville and Hassan Haghparast-Bidgoli supported Lucie Sabin throughout the process. Naomi Saville, Madhu Dixit Devkota and Hassan Haghparast-Bidgoli proofread the final document.

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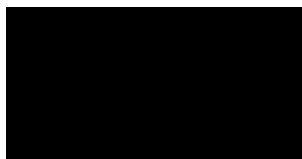
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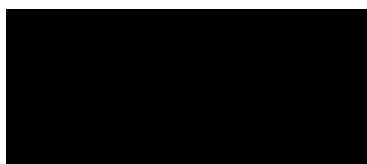
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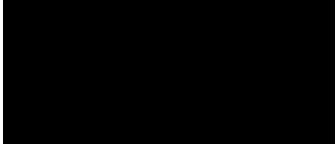
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List of Figures

Figure 1 - World Health Organisation framework for the triple elimination of vertical transmission for HIV, syphilis and hepatitis B in Asia and the Pacific	23
Figure 2 - PRISMA diagram of the research strategy	32
Figure 3 - Flowchart of factors influencing antenatal screening for HIV, syphilis and hepatitis B based on Andersen's conceptual model	37
Figure 4 - Structure of the public health system in Nepal.....	51
Figure 5 - Availability of basic health services, by province (2020).....	54
Figure 6 – Availability of basic health services, by type of health facilities (2020)	54
Figure 7 - Breakdown of current health expenditure by source (2017)	55
Figure 8 - Availability of basic laboratory tests among facilities providing antenatal care (ANC) services	58
Figure 9 - Flow chart of potential influencing factors based on Andersen's conceptual model	66
Figure 10 - Scree plot of eigenvalues after the principal components analysis	81
Figure 11 - Combination of the social-ecological model and the WHO building blocks	87
Figure 12 - Factors influencing access to and provision of antenatal screening for HIV, syphilis and hepatitis B in Nepal presented according to the social-ecological model and the WHO building blocks	95
Figure 13 - Schematic of the Markov cohort model for HIV	113
Figure 14 - Schematic of the Markov cohort model for syphilis	114
Figure 15 - Schematic of the Markov cohort model for hepatitis B.....	115
Figure 16 - Tornado diagrams of the percentage change in the incremental cost-effectiveness ratio (ICER) for dual-integrated screening for HIV compared with HIV screening only (status quo) and syphilis and triple integrated screening for HIV, syphilis and hepatitis B compared with dual-integrated screening produced from a deterministic one-way analysis of key parameters	119
Figure 17 - Cost-effectiveness plane showing the statistical uncertainty around estimates of incremental costs and incremental disability-adjusted life years (DALYs) averted for dual-integrated screening for HIV compared with HIV screening only and syphilis and triple-	

integrated screening for HIV, syphilis and hepatitis B compared with dual-integrated screening	120
Figure 18 - Cost-effectiveness acceptability curves, by intervention	121

List of Tables

Table 1 - Eligibility criteria for study inclusion	30
Table 2 - Characteristics of selected studies.....	34
Table 3 - Barriers and facilitators to antenatal screening for HIV, syphilis and hepatitis B identified in the selected studies based on Andersen's conceptual model	38
Table 4 - Description of the variables	66
Table 5 - Pregnant women counselled and tested for HIV in 2016 and 2022	69
Table 6 - HIV screening uptake among pregnant women by type of health facility attended during the last ANC visit.....	70
Table 7 – Odds ratios of the multilevel multivariable logistic regression of the potential factors associated with HIV screening during pregnancy and ANC visits in 2016 and 2022.....	72
Table 8 - Variables considered for the association between women's empowerment and antenatal screening	75
Table 9 - Correlation matrix of the empowerment variables.....	76
Table 10 - Descriptive statistics for different dimensions of empowerment conveyed by the empowerment variables.....	78
Table 11 – Univariate logistic regressions of the association between women's empowerment variables and HIV screening during pregnancy (odds ratio, 95% CI in parentheses)]	79
Table 12 – Mutually adjusted odds ratios for empowerment indices in multivariate logistic regression analysis of potential factors associated with HIV screening during pregnancy controlling for predisposing characteristics, enabling factors, and need factors (odds ratio, 95% CI in parentheses).....	80
Table 13 - Participants and required number of semi-structured interviews.....	89
Table 14 - Pregnant women, husbands and mother-in-law's characteristics.....	90
Table 15 - Health workers' characteristics.....	91
Table 16 - Decision makers' characteristics	92
Table 17 - HIV, syphilis and hepatitis B testing model interventions	115
Table 18 - Health effect, cost, and cost-effectiveness results of maternal HIV, syphilis and hepatitis B screening interventions	118

Table 19 - Characteristics of pregnant women tested and not tested for HIV in 2016 (n=1,070) and 2022 (n=2,007) presented in percentages	157
Table 20 – Odds ratios from multivariable logistic regression with fixed-effect at the cluster level on potential factors associated with HIV antenatal screening	159
Table 21 - Correlation matrix of the empowerment variables with predisposing characteristics, enabling factors and need factors	162
Table 22 - Model parameters	190
Table 23 - Unit time and cost for antenatal screening for health workers.....	194
Table 24 - One-way sensitivity analysis of ICER for dual-integrated screening for HIV and syphilis compared to HIV screening only (base case scenario) and for triple-integrated screening for HIV, syphilis and hepatitis B compared to dual-integrated screening	195

List of Abbreviations

AHWs	Auxiliary Health Workers
AIDS	Acquired Immunodeficiency Syndrome
ANC	Antenatal Care
ANMs	Auxiliary Nurse Midwives
ART	Antiretroviral Therapy
CI	Confidence Interval
DALYs	Disability-Adjusted Life Years
ELISA	Enzyme-Linked Immunosorbent Assays
FCHVs	Female Community Health Volunteers
HBsAg	Hepatitis B surface antigen
HIV	Human Immunodeficiency Virus
HPs	Health posts
ICC	Intraclass Correlation Coefficient
ICER	Incremental Cost-Effectiveness Ratio
IHMIS	Integrated Health Management Information System
GDP	Gross Domestic Product
LMICs	Low- and Middle-Income Countries
NDHS	Nepal Demographic Health Surveys
NGO	Non-Governmental Organisation
NHFS	Nepal Health Facility Survey
OR	Odds Ratios
PCA	Principal Components Analysis
PHCs	Primary Healthcare Centres

PMHW	Paropakar Maternity and Women's Hospital
PSA	Probabilistic Sensitivity Analysis
Rs	Nepalese Rupees
RDts	Rapid diagnostic tests
RPR	Rapid Plasma Reagin
STIs	Sexually Transmitted Infections
UCL	University College London
UNAIDS	Joint United Nations Programme on HIV/AIDS
US\$	United States Dollars
VDRL	Venereal Disease Research Laboratory
WHO	World Health Organisation

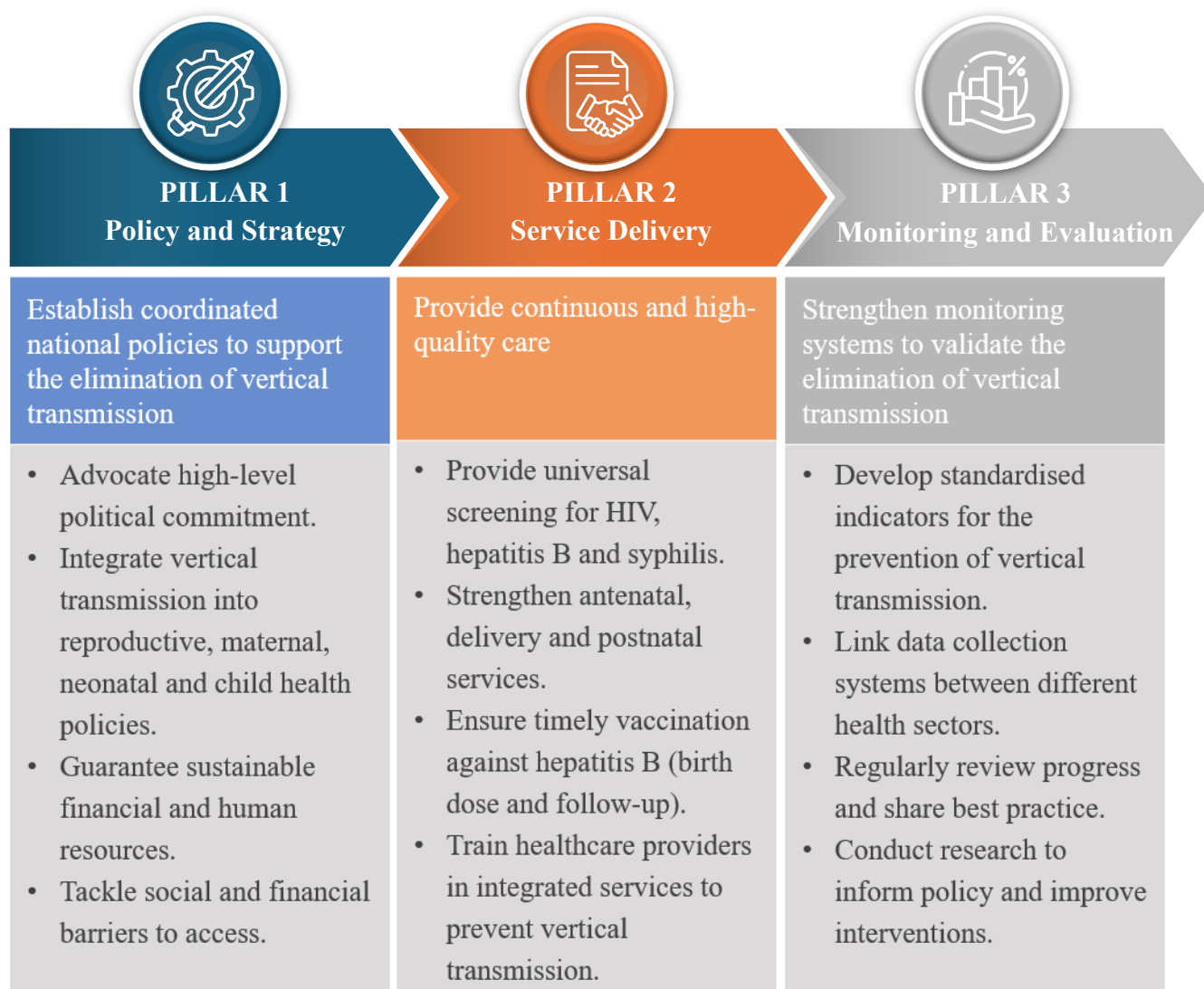
1. Introduction

1.1. Overview

Human immunodeficiency virus (HIV), syphilis and hepatitis B are sexually transmitted infections (STIs) that, if left undiagnosed and untreated, can lead to serious complications and death. Unknowingly, women living with these STIs risk transmitting diseases to their children during pregnancy, childbirth, or breastfeeding, a process known as vertical transmission. This transmission pathway occurs when the pathogen crosses from the mother to the child through the placenta, exposure to blood and body fluids during delivery, or through breast milk. Women who are unaware that they have these STIs may also miss timely treatment, leading to long-term health complications and increased healthcare costs. Vertical transmission can be prevented with simple and effective interventions, including prevention of male-to-female transmission during sexual intercourse and timely antenatal screening and treatment. Screening for HIV, syphilis and hepatitis B during antenatal care (ANC) is key to eliminating vertical transmission. Early detection and treatment of these diseases in pregnant women can significantly reduce the risk of vertical transmission [1–3]. Between 2010 and 2017, interventions targeting the reduction of vertical transmission of HIV reduced the number of new HIV infections in children by 33% [4].

To guide a path towards triple elimination of vertical transmission of HIV, syphilis, and hepatitis B in Asia and the Pacific, the World Health Organisation (WHO) developed a regional framework [4] that aligned with a key health target of the Sustainable Development Goals (SDGs), i.e., “end the epidemics of Acquired Immunodeficiency Syndrome (AIDS), tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases by 2030” [5]. This framework aims to eliminate these three infections in newborns and infants by 2030 in Asia (Figure 1). The key recommendations emphasise an integrated approach to triple elimination, recognising the interconnectedness of the three diseases and the potential for resource optimisation. It highlights the importance of strengthening health systems to effectively deliver comprehensive services and achieve universal health coverage. The framework focuses on building capacity, improving laboratory and diagnostic services, ensuring a reliable supply chain for medicines and commodities, and improving reporting systems. It recognises the need for collaboration between different sectors beyond the health sector and the importance of sustainable financing mechanisms to support the implementation of elimination programmes. Meanwhile, it encourages the participation of women living with HIV, women affected by syphilis, and mothers with hepatitis B, men and communities in the design, implementation, and evaluation of programmes and policies.

Figure 1 - World Health Organisation framework for the triple elimination of vertical transmission for HIV, syphilis and hepatitis B in Asia and the Pacific



Notes: Figure developed based on the World Health Organisation's framework for the triple elimination of vertical transmission of HIV, syphilis and hepatitis B in Asia and the Pacific [4].

Although these diseases are the subject of specific guidelines due to their high incidences and mortality rates [6–8], antenatal screening for STIs in Asia remains low [9], due to the limited availability and accessibility of interventions aimed at reducing vertical transmission [4]. Among 17 reporting countries in the Asia-Pacific region, including Nepal, only three met the global target of over 95% coverage for knowledge of HIV status among women receiving ANC in 2017, and six countries (Bangladesh, Timor-Leste, Papua New Guinea, Lao People's Democratic Republic, Indonesia, Singapore) reported coverage below 40% [9]. Only thirteen out of the 17 countries currently have a policy of screening for hepatitis B during pregnancy, and very little data on hepatitis B screening coverage is available in these settings [4]. Most Asian countries also have no data on syphilis screening for pregnant women. Of the 30 countries in the Asia-Pacific region (according to WHO definitions of regions) that reported antenatal screening coverage for syphilis between 2010 and 2017, six countries reported coverage below 5% (Afghanistan, Democratic People's Republic of Korea, Indonesia, Lao People's Democratic Republic, Nepal, Solomon Islands) [9].

It is essential to understand barriers to accessing screening and better design policies to increase antenatal screening uptake. This thesis aimed to understand the barriers to the national roll-out of integrated antenatal screening for HIV, syphilis, and hepatitis B in Nepal. In the following sections, I discussed the rationale for, and characteristics of, integrated antenatal screening and integrated antenatal screening strategies in Asia. I then presented the objectives and structure of my thesis.

1.2. Rationale for integrated screening

The last few decades have seen a growing trend towards integrating health services, justified by a search for efficiency and optimisation of resources. The integration of healthcare services involves the coordination of different healthcare providers and resources to ensure comprehensive and efficient delivery of health services to patients. In line with this trend, the integration of screening has evolved. Integrated antenatal screening for HIV, syphilis and hepatitis B allows pregnant women to be tested for these three diseases as well as perform the entire ANC panel (including anaemia and gestational diabetes) with a single blood sample during a single visit to a healthcare provider.

Several reasons justify the recommendation of integrated screening for HIV, syphilis, and hepatitis B. Prevention of vertical transmission of HIV has seen significant success in recent years, with approximately 82% of pregnant women living with HIV having access to antiretroviral medicines to prevent transmission of HIV to their child in 2022 [10]. This success is notably due to significant funding allocated to the fight against HIV on a global scale and the international organisations' reporting obligations. Key strategies and interventions, including the widespread availability of antiretroviral drugs, targeted counselling and support services, and the integration of services for the prevention of vertical transmission of HIV into ANC visits and community awareness programmes, have considerably improved access to and uptake of HIV screening by pregnant women. Although most women are offered HIV screening during ANC, this is not the case for hepatitis B and syphilis, for which screening coverage among pregnant women remains very low. The current success of interventions to prevent vertical transmission of HIV offers a unique opportunity to accelerate that of hepatitis B and syphilis simultaneously with minimal additional costs. Moreover, ANC services, which have increased widely over the last decade [4], provide a common entry point for antenatal screening. Secondly, these three diseases have synergistic effects. HIV interacts with both syphilis and hepatitis B and increases the risk of vertical transmission [11,12]. Furthermore, these diseases can be easily diagnosed using blood tests. Integrated rapid tests for HIV and syphilis, with a waiting time for results of 15 to 20 minutes, are available and recommended by the WHO. A few triple-integrated rapid tests for HIV, syphilis and hepatitis B are on the market but have not yet received WHO prequalification quality assurance [13].

1.3. Integrated antenatal screening interventions in Asia

Several countries in Asia and the Pacific have already achieved the WHO goal of double elimination of vertical transmission of HIV and syphilis, demonstrating the value of integrated approaches. In Thailand, where the target was reached in 2016, screening for HIV, syphilis and

hepatitis B is included in routine ANC and provided free of charge. Similarly, in Sri Lanka and Malaysia, which have achieved the WHO target of eliminating vertical transmission of syphilis and HIV, respectively, in 2019 [14] and 2018 [15], HIV and syphilis screening and management of infected women during pregnancy are fully integrated into maternal and child health services.

In Asia, two countries have piloted integrated antenatal screening for triple elimination interventions. A study conducted in Vietnam showed that integrated antenatal screening for HIV, syphilis and hepatitis B was feasible and effective in increasing antenatal screening uptake [16]. Similar results were found in a case study in Yunnan Province, China, between 2005 and 2012, where rapid HIV, hepatitis B and syphilis counselling and screening were integrated into maternal and child health services and provided free of charge to all pregnant women [17]. Although these studies were conclusive in terms of the feasibility and effectiveness of integrated screening, the evidence remains limited in the Asian context.

1.4. Aim, objectives and research questions

This thesis aimed to explore barriers and facilitators to integrated antenatal screening for HIV, syphilis, and hepatitis B and model its impact and cost-effectiveness in Nepal. This research was based on a combination of qualitative, quantitative, and modelling methods applied to primary and secondary data.

To achieve this aim, I set the following objectives:

Objectives	Research questions to meet the objectives
1. Literature review: summarise evidence on barriers and facilitators to antenatal screening for HIV, syphilis, or hepatitis B for women in Asia and identify knowledge gaps.	- What are the documented barriers and facilitators to antenatal screening for HIV, syphilis, and hepatitis B in Asia? - What are the evidence gaps regarding barriers and facilitators?
2. Barriers and facilitators to HIV antenatal screening: investigate barriers and facilitators to HIV antenatal screening in Nepal using 2016 and 2022 Nepal Demographic Health Surveys (NDHS) data.	- Who has access to HIV antenatal screening in Nepal and who does not? - What are the effects of individual- and district-level factors on the uptake of antenatal screening for HIV in Nepal? - How did barriers and facilitators to antenatal HIV screening evolve between 2016 and 2022?
3. Knowledge, attitudes, and perceptions regarding integrated antenatal screening: explore knowledge, attitudes, and perceptions of pregnant women, their husbands, mothers-in-law, health workers	- What are the factors influencing the acceptance and potential implementation of integrated antenatal screening of HIV, syphilis, and hepatitis B in Nepal? - What is the level of knowledge among pregnant women and other stakeholders

and healthcare decision-makers regarding integrated antenatal screening for STIs.

regarding integrated antenatal screening for HIV, syphilis, and hepatitis B?

- What are the attitudes and perceptions of pregnant women and other stakeholders towards integrated antenatal screening for STIs?
4. Cost-effectiveness of integrated screening: estimate the predicted health impact and the cost-effectiveness of integrated antenatal screening interventions.
- Is integrated antenatal screening for HIV, syphilis and hepatitis B an appropriate intervention to minimise costs while maximising the number of infections prevented?
5. Implications and recommendations: discuss the research and policy implications of the findings from this research.
- What are the research and policy implications of the findings of this thesis in general and in the Nepalese context?
-

1.5. Methodological contribution

This thesis makes a distinct methodological contribution by integrating multiple methodological approaches into a single coherent framework. Through the complementary and coherent nature of its chapters, it demonstrates the value of a mixed approach in generating holistic conclusions and concrete recommendations and highlights the potential for applying mixed methods in larger research projects. The mixed-methods design allowed for triangulation of behavioural, epidemiological, and economic evidence and provided a comprehensive understanding of the barriers, facilitators, and potential impact of integrated prenatal screening for HIV, syphilis, and hepatitis B.

An innovative aspect of this research is the use of NDHS data in a novel way to analyse HIV antenatal screening. Multi-level modelling was applied to the NDHS datasets to identify determinants of HIV antenatal screening in Nepal, with comparisons across survey years to capture changes over time.

Unlike many previous studies that focus exclusively on pregnant women, this research included pregnant women, family members, health workers, and healthcare decision-makers, providing a multi-level perspective on acceptability and implementation challenges. The findings highlight the value of engaging multiple stakeholder groups in qualitative research to generate richer and more nuanced insights.

The economic evaluation adapted and combined existing Markov models to the Nepalese context, integrating all three infections into antenatal screening scenarios using locally relevant epidemiological and cost data. The model can be readily adapted to other settings and incorporates policy-relevant scenarios informed by WHO recommendations and national priorities.

1.6. Structure of the thesis

The thesis is divided into seven chapters, including three analytical chapters:

In Chapter 1, I introduced the topic, objectives and structure of this thesis. In Chapter 2, I conducted a systematic literature review on barriers and facilitators to antenatal screening for HIV, syphilis, or hepatitis B for women in Asia. In Chapter 3, I presented the empirical context, including key features of the Nepalese health system, epidemiologic situation and cultural background. In Chapter 4, I analysed the 2016 and 2022 NDHS data using multilevel multivariable logistic models to investigate barriers and facilitators to HIV antenatal screening in Nepal. In Chapter 5, I investigated the knowledge, attitudes, and perceptions of pregnant women, their husbands, other family members, health workers and healthcare decision-makers regarding antenatal screening for HIV, syphilis, and hepatitis B in the Nepalese context. In Chapter 6, I conducted cost-effectiveness modelling of dual- and triple-integrated antenatal screening interventions. Finally, in Chapter 7, I provided a summary of the thesis and discussed the overall results and their implications. I have also proposed policy recommendations arising from the findings, both in general and for the Nepalese context.

2. Literature review

2.1. Introduction

Understanding barriers and facilitators influencing antenatal screening for STIs is essential to designing effective screening interventions. A systematic review conducted by Blackstone et al. [18] investigated the barriers and facilitators to routine antenatal HIV screening in sub-Saharan Africa, using literature published between 2000 and 2015. They identified the fear of the screening results, perceived stigma towards HIV-positive people, fear of the partner's reaction in case of a positive test result, and perceived partner disapproval of the test as barriers to antenatal HIV screening. A high level of education, good knowledge of HIV and its vertical transmission, and partner involvement in ANC were favourable factors for screening. Health system and provider issues affected the acceptance of antenatal screening. Good patient-provider communication, counselling to improve knowledge of pregnant women of the benefits of screening through counselling, and the perception that HIV screening is mandatory were facilitators of screening. However, factors affecting screening in Asia are likely to differ from those in the African context due to cultural and contextual differences. Barriers are likely to change over time, as societies evolve, beliefs change, or targeted interventions are implemented.

There is no literature review summarising the evidence on barriers and facilitators to antenatal screening for HIV, syphilis, and hepatitis B in the Asian context. Barriers preventing vulnerable communities from accessing screening are not known, which may contribute to disparities in health outcomes, with potentially negative impacts on maternal and child health. This hinders the development of targeted strategies and interventions to overcome barriers and improve the effectiveness of antenatal screening programmes. It also limits the application of the WHO framework towards the triple elimination of vertical transmission of HIV, syphilis and hepatitis B.

To fill this evidence gap, this review aimed to investigate the barriers and facilitators to antenatal screening for HIV, syphilis, or hepatitis B for women in Asia. Its specific objectives were to identify available evidence and underline possible gaps in the research knowledge base surrounding this subject.

This literature review has been published in PLOS One after three rounds of revisions based on comments from two reviewers [19].

2.2. Factors influencing screening demand: the theoretical perspective

Theoretical models have been developed to explore the various demand- and supply-side factors that influence the use of healthcare, including screening services.

Grossman (1972) [20] theorised the factors influencing the demand for healthcare, including health capital, costs, perceived benefits and risks, access to information and services, and social and cultural influences, presenting an overview of individuals' decisions regarding healthcare-seeking behaviours. According to his model, individuals invest in their health capital, viewing healthcare as an investment in maintaining and improving well-being. This investment decision involves a rational assessment of costs and benefits associated with healthcare utilisation, including preventive measures such as screening.

Samuelson's price theory, rooted in the concepts of income and price elasticity of demand developed by Marshall [21], emphasises the role of health service costs in shaping demand [22]. Higher costs discourage use, while subsidies stimulate it. Empirical evidence shows that financial incentives significantly increase ANC visits [23]. Moreover, research highlights how out-of-pocket expenses can substantially hinder HIV management and screening [24,25], and money was identified as a barrier to antenatal screening in many settings [26].

The social determinants of health, as described by Marmot [27], highlighted the cultural and social barriers that influence access to healthcare. Gender norms and stigma surrounding STIs have emerged as important barriers to screening for HIV in a variety of settings, with cultural beliefs and stigma influencing pregnant women's willingness to be screened [28]. Community beliefs and misinformation also contribute to reduced demand, highlighting the importance of addressing societal factors to promote screening uptake [29,30].

Psychological theories also theorise factors influencing individual health behaviours and decision-making processes. The health belief model explained and predicted these behaviours based on beliefs about health conditions [31]. Key factors included cues to action, self-efficacy and perceived severity, benefits and barriers. This model has been applied to various health-related areas, including HIV risk behaviour changes [32]. Similarly, the theory of planned behaviour suggests that attitudes, subjective norms and perceived behavioural control predict intention, which, together with perceived behavioural control, predict actual behaviour, including health behaviours [33]. This theory has been widely applied to health contexts, including screening programmes [34].

In their paper, Goddard and Smith (2001) [35] theorised the equity of access to healthcare services and the impact on demand. An empirical study conducted in the United States showed that women in urban areas have higher access to antenatal screening due to better healthcare infrastructure compared to those in rural settings [36]. In line with the theory, the shortage of screening kits and equipment was found to be a major issue in screening uptake in low- and middle-income countries (LMICs) [28].

Quality of service is an intrinsic element of access that can complicate access to healthcare services [35]. Donabedian (1980) identified three quality categories: structure, process, and outcome [37]. Variations in each can affect patients' health-related demands. Lancaster's consumer theory [38], although not specific to healthcare, suggested that consumers derive utility from the attributes of goods, which may explain how perceived quality affects demand for healthcare. Arrow highlighted the unique aspects of the healthcare market, such as uncertainty and the importance of trust and perceived quality in decision-making [39]. The theory postulated that higher perceived quality leads to increased demand for healthcare services. Similarly, Linder-Pelz examined how patients' perceptions of healthcare quality and their experiences influence overall satisfaction and subsequent demand, encompassing factors such as staff training, equipment availability and patient satisfaction [40]. Empirical evidence confirmed that perceived quality has an impact on demand for ANC. A study conducted in Nepal found that well-trained staff and better health facility capacity increased access and utilisation of ANC services, reflecting the positive association between perceived quality and service utilisation [41]. Similarly, a study conducted in Kenya highlighted the fact that staff attitudes significantly influence demand for ANC, underlining the importance of high-quality care in meeting patient expectations and building confidence in healthcare services [42].

These factors influencing screening demand might vary depending on the context and diseases screened. I conducted a systematic literature review, presented in the following sections, to summarise evidence of factors influencing antenatal screening for HIV, syphilis, and hepatitis B in Asia.

2.3. Methods

2.3.1. Search strategy

The review and its reporting complied with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [43] (Appendix 1.1). I conducted a comprehensive search of electronic databases, including Ovid (MEDLINE, Embase, PsycINFO), Scopus, Global Index Medicus, and Web of Science, to identify relevant studies published between 2000 and June 2023. I divided the keyword search into five main groups: “barriers or facilitators”, “antenatal screening”, “HIV or syphilis or hepatitis B”, and “Asian countries”. I developed the finalised search terms through a trial-and-error process for use on Scopus and adapted them to the different databases. The full keywords used are shown in Appendix 1.2.

I used forward and backwards citation searching to capture resources either citing or being cited by the included literature, and searched the websites of the WHO, the World Bank and the Joint United Nations Programme on HIV/AIDS (UNAIDS) for reports.

2.3.2. Inclusion criteria

I developed the eligibility criteria for study inclusion using the acronym SPIDER: S sample; P phenomenon of interest; D design; E evaluation; R research type [44] (Table 1).

Table 1 - Eligibility criteria for study inclusion

Category	Description
Sample	Pregnant women or women of childbearing age in Asian countries (as defined by the United Nations), their family members, health workers and healthcare decision-makers.
Phenomenon of Interest	Barriers and facilitators to antenatal screening and factors influencing screening uptake. Barriers were defined as factors discouraging or impeding screening uptake. Facilitators were defined as factors or resources enhancing screening uptake. Factors may also relate to the implementation and effectiveness of antenatal screening.
Design	Primary or secondary research studies, including quantitative, qualitative, and mixed-methods studies.
Evaluation	Antenatal screening programs or interventions related to the screening of HIV, syphilis, or hepatitis B during pregnancy.
Research type	Peer-reviewed journal articles and grey literature in English published between 2000 and June 2023.

Notes: HIV = Human Immunodeficiency Virus.

2.3.3. Study selection

Following the initial search, I collated records and uploaded them into Rayyan [45] to facilitate screening. After the removal of duplicates, I screened titles and abstracts for relevance and assessed the full text of potentially relevant studies using the inclusion criteria. Those meeting the inclusion criteria at the full-text screen were included in the results.

2.3.4. Data extraction

I used a standard form to extract key information, including study characteristics (author, year, country, urban/rural setting, diseases considered), study design, sample, and aim, and identified significant barriers and facilitators to screening (e.g. $p\text{-value} < 0.05$). I thematically analysed qualitative studies through an iterative process of reading and coding them using Andersen's framework [46]. This theoretical framework, widely used in literature reviews on healthcare utilisation [47], provides an understanding of how individuals and environmental factors influence health behaviours. The framework categorises predictors of health service use as i) Predisposing characteristics, including demographic factors that influence health service use. ii) Enabling factors, such as wealth, place of residence and social and cultural norms, allow the

individual to seek health services if needed. iii) Need factors, including the perceived needs of healthcare service use.

2.3.5. Quality assessment

I assessed the quality of the included studies using tools appropriate to the study design. The quality of the studies included was evaluated based on Von Elm et al's checklist for observational studies [48] and O'Brien et al's checklist for qualitative studies [49]. A table containing the quality appraisal checklists for the considered studies is presented in Appendix 1.3. I scored each study based on how many checklist items were met. Overall, studies that met over 75% of the checklist items were considered to be of high quality, those meeting 50% to 75% of the checklist were regarded as moderate quality, and those meeting less than 50% poor quality. Because the aim was to describe and synthesise a body of literature and not determine an effect size, studies were not excluded based on quality.

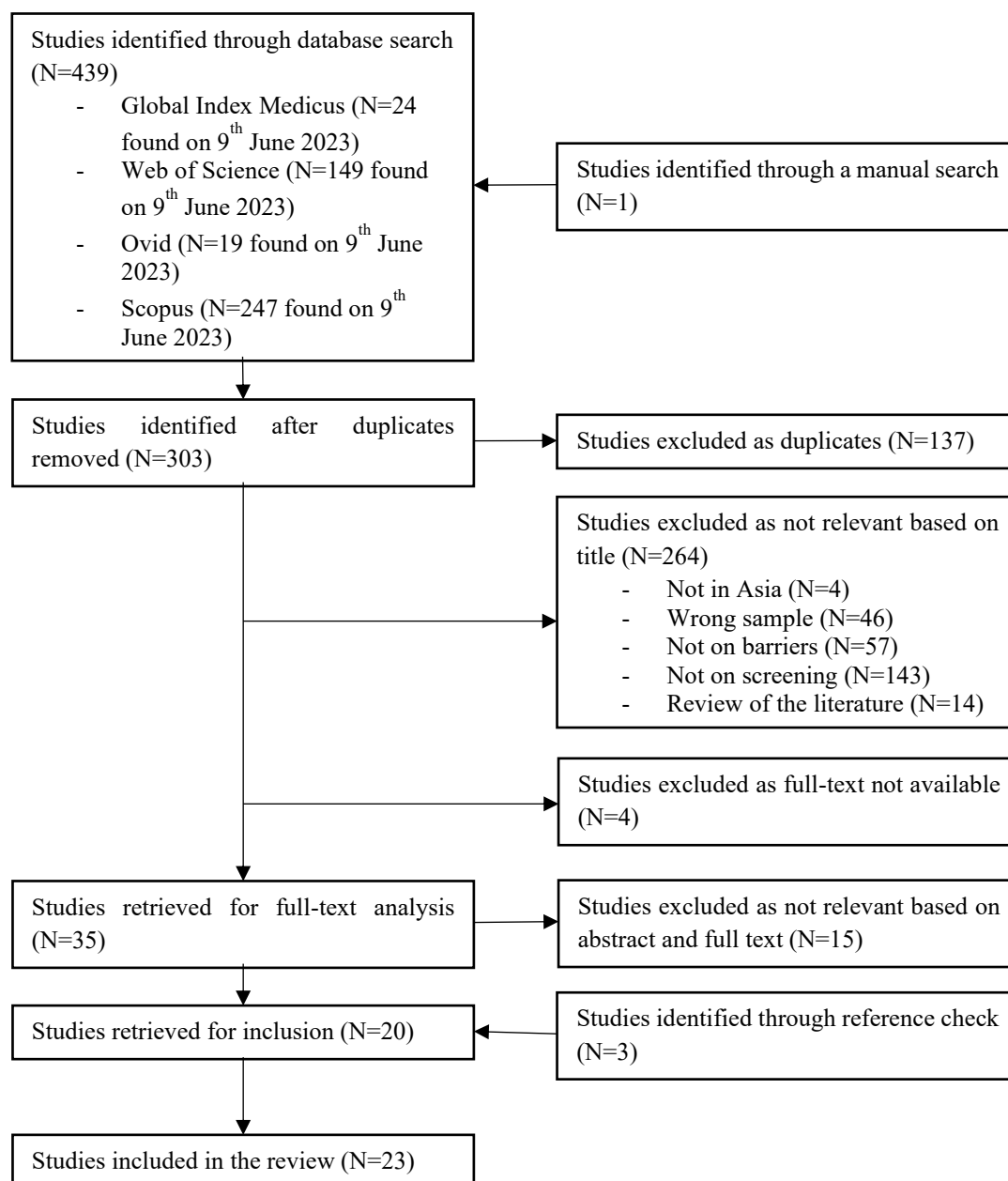
2.3.6. Data analysis and presentation

I reported the descriptive characteristics of research studies. I conducted a narrative synthesis [50] to summarise the findings of the included studies. I did not combine quantitative estimates because of the heterogeneity of approaches and findings. I identified and analysed themes and patterns related to factors influencing screening uptake and categorised the final set of barriers and facilitators according to Andersen's conceptual model [46].

2.4. Results

After the selection process, 23 studies met the eligibility criteria and were included in the review. The PRISMA diagram provides an overview of the selection process (Figure 2).

Figure 2 - PRISMA diagram of the research strategy



Notes: N = Number of studies.

2.4.1. General study characteristics

Details about the studies included are presented in Table 2. Most included studies were on HIV screening, one was on syphilis screening [51], one on HIV and syphilis [52] and one on HIV, syphilis and hepatitis B [53]. Eight out of the 23 studies used data collected after 2015 [52,54–60]. Six of the studies were conducted in Vietnam, five in India, three in Indonesia, two in Cambodia, and one each in Hong Kong, Mongolia, China, Afghanistan and Thailand. Nineteen of the studies (83%) used quantitative methods, three (15%) used qualitative methods, and one (2%) used mixed methods.

In the four studies that used qualitative methods, pregnant women were interviewed as well as other individuals such as health providers, district managers, husbands, and mothers-in-law. Sample sizes in quantitative studies ranged from 114 to 122,351 pregnant women, most often recruited during ANC visits. The quantitative studies were all cross-sectional except for a longitudinal one from Indonesia [57]. Most quantitative studies used logistic regression models to determine the association between potential barriers and the outcome of interest.

Table 2 - Characteristics of selected studies

Citation	Date	Country	Urban/rural	Disease	Sample	Study type	Aim
Dinh	2005	Vietnam	Urban	HIV	500 pregnant women who were first-time ANC visitors and had never been tested	Quantitative	Identify the factors associated with declining HIV antenatal screening and the failure to return for results
Nguyen	2010	Vietnam	Urban	HIV	300 women who had recently delivered	Quantitative	Describe the uptake of antenatal HIV screening
Hanh	2011	Vietnam	Urban/ rural	HIV	1108 nursing mothers	Quantitative	Assess early uptake of HIV screening and the provision of HIV counselling among pregnant women
Pharris	2011	Vietnam	Urban	HIV	1108 pregnant women who attend ANC	Quantitative	Assess early uptake of HIV testing and the provision of HIV counselling among pregnant women
Khuu	2018	Vietnam	Urban	HIV	320 women who were tested during ANC	Quantitative	Identify reasons for late HIV screening among pregnant women
Chu	2019	Vietnam	Urban/rural	HIV	1484 women having a live birth within the last 2 years	Quantitative	Assess the socioeconomic inequalities in HIV screening during ANC
Bharucha	2005	India	Urban	HIV	6,702 pregnant women presenting in labour	Quantitative	Explore factors affecting the eligibility and acceptability of voluntary counselling and rapid HIV testing
Rogers	2006	India	Rural	HIV	202 pregnant women attending a rural ANC clinic	Quantitative	Investigate HIV-related knowledge, attitudes toward infant feeding practices, and perceived benefits and risks of HIV screening
Sinha	2008	India	Rural	HIV	400 women that gave birth in the previous 12 months	Quantitative	Investigate HIV screening among rural women during pregnancy
Sarin	2013	India	Rural	HIV	357 women who had given birth in the last two years	Quantitative	Examine the prevalence and the barriers to HIV screening among pregnant women vulnerable to HIV due to their spouses' risky behaviours

Sharma	2022	India	Urban/ rural	HIV	122,351 women aged 15–49	Quantitative	Determine the factor associated with HIV screening during ANC
Lubis	2019	Indonesia	Urban/ rural	HIV	20 private midwives	Qualitative	Examine midwives' perceptions of barriers and enabling factors about referring pregnant women for HIV screening
Wulandari	2019	Indonesia	Urban/ rural	HIV	619 women to voluntary HIV counselling and screening clinics	Quantitative	Examine the rates of HIV screening uptake among pregnant women attending private midwife clinics
Baker	2020	Indonesia	Rural	HIV, syphilis	3382 pregnant women and 40 health workers involved in screening	Mixed method	Explore current practices, barriers and facilitators in the delivery of antenatal testing for anaemia, HIV and syphilis
Pakki	2020	Indonesia	Rural	HIV	42 health worker managers	Quantitative	Investigate the influence of training given to health workers on HIV testing uptake by pregnant women
Setiyawati	2021	Indonesia	Urban	HIV	350 housewives in districts that implemented the prevention of vertical transmission program	Quantitative	Assess the factors that influence the housewife's attitude toward HIV testing
Kakimoto	2007	Cambodia	Urban	HIV	315 mothers who came to a childhood immunisation with their child	Quantitative	Assess predictive determinants for HIV testing
Sasaki	2010	Cambodia	Urban	HIV	600 eligible mothers who were admitted to the hospital after delivery	Quantitative	Assess the prevalence of and barriers to HIV screening
Lee	2005	Hong Kong	Urban	HIV	3,500 pregnant women attending their first ANC visit	Quantitative	Investigate acceptance of universal HIV antibody screening programme
Munkhuu	2006	Mongolia	Urban	Syphilis	150 ANC providers and 27 senior doctors	Qualitative	Assess ANC providers' practices and opinions toward antenatal screening
Todd	2008	Afghanistan	Urban	HIV, syphilis, hepatitis B	114 doctors and midwives	Quantitative	Determine attitudes toward and utilisation of testing for HIV, syphilis, and hepatitis B among care providers

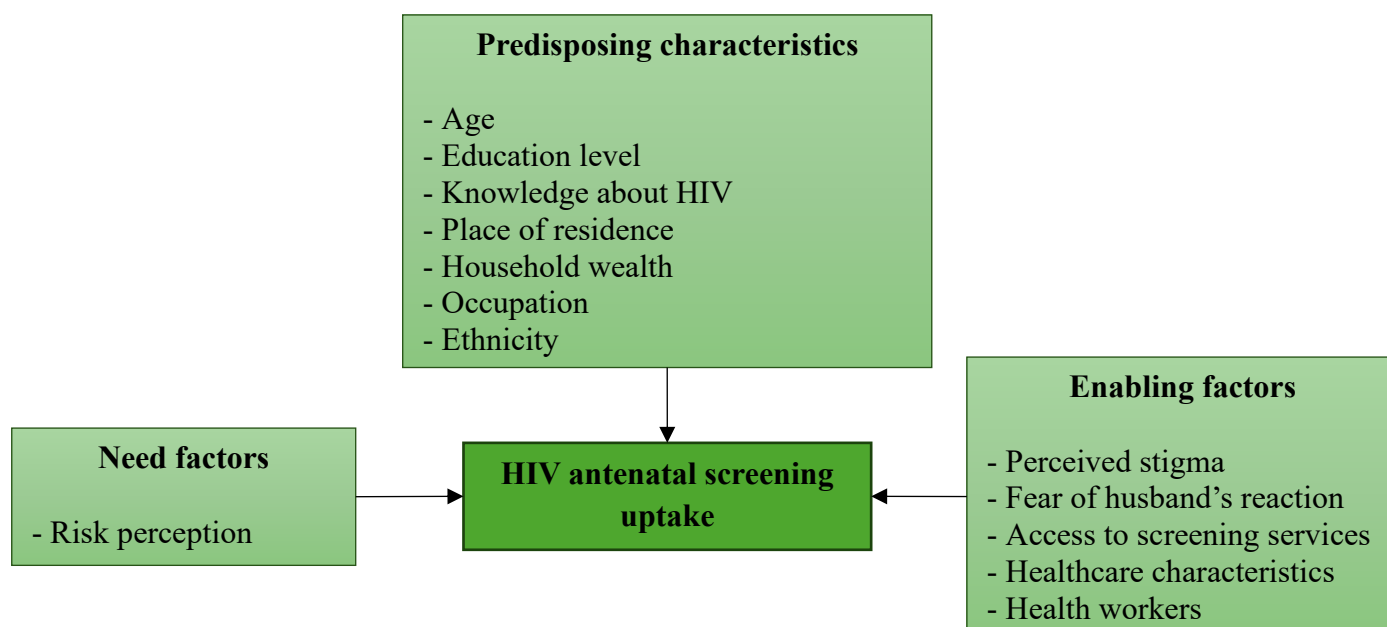
Crozier	2013	Thailand	Urban	HIV	38 migrant pregnant women who had been through the HIV screening process 2013 and 26 health personnel	Qualitative	Explore factors that relate to HIV screening decisions for migrant women
Li	2014	China	Urban	HIV	500 pregnant women recruited during their antenatal visit	Quantitative	Assess the prevalence of the willingness for HIV testing among pregnant women and cognitive factors associated with it

Notes: HIV = Human Immunodeficiency Virus. ANC = Antenatal care.

2.4.2. Overviews of the barriers and the facilitators identified

The barriers and facilitators identified in the included studies are presented in Figure 3 and Table 3, based on the categories of Andersen's conceptual model.

Figure 3 - Flowchart of factors influencing antenatal screening for HIV, syphilis and hepatitis B based on Andersen's conceptual model



Notes: HIV = Human Immunodeficiency Virus.

Table 3 - Barriers and facilitators to antenatal screening for HIV, syphilis and hepatitis B identified in the selected studies based on Andersen's conceptual model

Citation	Date	Country	Diseases	Predisposing characteristics	Enabling factors	Need factors
Bharucha	2005	India	HIV	Facilitators: - Being older - Living closer to the hospital	Barriers: - Being too far along in the birth delivery process when the opportunity to test arises Facilitators: - Having had antenatal care in the hospital rather than in other health facilities	
Dinh	2005	Vietnam	HIV	Barriers: - Being a housewife - Low level of education	Barriers: - Fear of husband's disapproval - Perception of poor healthcare availability	<u>Barriers:</u> - Low-risk perception
Lee	2005	Hong Kong	HIV	Facilitators: - High level of education - Good HIV knowledge - Access to HIV information by means of posters, pamphlets, videos and group talks	Facilitators: - Health workers' recommendations to be screened	<u>Barriers:</u> - No or low-risk perception <u>Facilitators:</u> - Good perceived benefits of screening
Rogers	2006	India	HIV	Barriers: - Low knowledge of HIV	Barriers: - Fear of negative reactions from husbands, parents, and community - Fear of stigma and discrimination	
Munkhuu	2006	Mongolia	Syphilis	<u>Barriers:</u> - Low knowledge of syphilis - Being poor - Long travel distance to get tested	<u>Barriers:</u> - Limited time for screening due to antenatal visits starting late in pregnancy - Complexity of testing service system - Undersupplied screening materials - Health workers not in favour of screening	<u>Barriers:</u> - Reporting previous sexually transmitted infections

Kakimoto	2007	Cambodia	HIV	<u>Facilitators:</u> - Basic knowledge of HIV transmission - High partner education level	<u>Barriers:</u> - Need to obtain husband's approval to be tested
Sinha	2008	India	HIV	<u>Barriers:</u> - Low awareness of existing HIV testing facilities	<u>Barriers:</u> - Never received HIV counselling before
Todd	2008	Afghanistan	HIV, syphilis, hepatitis B		<u>Facilitators:</u> - High acceptance of screening by providers <u>Barriers:</u> - Providers' perceptions that infections were rare - Provider's low perceived likelihood of infection based on healthy appearance - Stigma toward infected individuals - Need to obtain husband's approval to be tested
Nguyen	2010	Vietnam	HIV	<u>Barriers:</u> - High distance to the hospital	
Sasaki	2010	Cambodia	HIV	<u>Barriers:</u> - Low knowledge of HIV	<u>Barriers:</u> - Lack of access to antenatal care services - Need to obtain husband's approval to be tested
Hanh	2011	Vietnam	HIV		<u>Facilitators:</u> - First antenatal check-up at primary health facilities rather than at district and provincial health facilities
Pharris	2011	Vietnam	HIV	<u>Facilitators:</u> - Younger age - Residence in a semi-urban area	<u>Barriers:</u> - Low perception of risk

				- Higher economic status			
Crozier	2013	Thailand	HIV	<u>Barriers:</u> - Low knowledge of HIV and mother-to-child transmission	<u>Barriers:</u> - Language differences between health worker and pregnant women - Concern about the reactions of health workers - Financial barriers - Costs and time of transportation - Provider's lack of time to inform women properly - Having only one antenatal check-up - Lack of support from husband	<u>Barriers:</u> - Low perception of risk	
Sarin	2013	India	HIV	<u>Facilitators:</u> - More than six years of education - Good knowledge of HIV	<u>Facilitators:</u> - Discussions with husband about HIV - Seeking antenatal care in government district hospitals and private clinics as opposed to community health centres (not equipped with either HIV counselling or testing facilities)		
Li	2014	China	HIV	<u>Facilitators:</u> - Good knowledge of HIV	<u>Facilitators:</u> - Less perception of social stigma	<u>Facilitators:</u> - High perception of risk	
Khuu	2018	Vietnam	HIV	<u>Barriers:</u> - Younger than 30 years old - Nine or fewer years of education - Working as a homemaker or worker/farmer - Living 20km or more from the hospital	<u>Barriers:</u> - Having received antenatal care at private clinic/hospital only	<u>Barriers:</u> - Low perceived benefits of screening	
Chu	2019	Vietnam	HIV	<u>Barriers:</u> - Belonging to ethnic minorities - Having primary or less education			

				- Being poor - Living in rural areas		
Lubis	2019	Indonesia	HIV		<u>Facilitators:</u> - Free HIV screening - Reward and punishment system to motivate providers - Training for health workers <u>Barriers:</u> - Fear of stigma - Limited voluntary counselling and testing opening hours do not cater for those in employment - Not a one-roof for ANC and VCT services - Providers disguising or not revealing purpose of the blood testing for fear of causing offense	
Wulandari	2019	Indonesia	HIV	<u>Facilitators:</u> - Living in urban area		
Baker	2020	Indonesia	HIV, syphilis		<u>Barriers:</u> - National policy on testing not widely disseminated - Testing not seen as a priority intervention - Multiple small-scale funding sources - Tests seen as expensive by pregnant women - Lack of knowledge and training of providers - Shortage of laboratory personnel - Shortage of tests and laboratory resources - Stigma amongst providers and community - Lack of time for pregnant women - Fear of the results	<u>Barriers:</u> - Perceived low prevalence
Pakki	2020	Indonesia	HIV		<u>Facilitators:</u>	

					- Health workers training on predisposing factors of provider-initiated testing and counselling of HIV	
Setiyawati	2021	Indonesia	HIV		<u>Barriers:</u> - Pregnant women's beliefs that their husbands have a bad attitude towards HIV testing	<u>Barriers:</u> - Low perceived benefits of screening
Sharma	2022	India	HIV	<u>Barriers:</u> - Low educational level - Low knowledge of HIV - Being poor - Living in rural area - Low exposure to mass media		

Notes: HIV = Human Immunodeficiency Virus.

2.4.3. Predisposing characteristics

Several predisposing characteristics were reported as either barriers or facilitators to antenatal screening for HIV and syphilis. In three studies conducted in Vietnam and India, age was associated with antenatal screening of HIV [54,61,62]. Pharris et al. [61] found that younger Vietnamese women were more likely to be screened, while Bharucha et al. [62] found the opposite result in India. Khuu et al. [54] identified being younger than 30 years old as a barrier to antenatal screening.

The low education status of pregnant women was a barrier to antenatal screening in three studies conducted in Vietnam [54,63,64] and one in India [60]. Similarly, one study conducted in Hong Kong [65] and one in India [66] identified higher education as a facilitator of antenatal screening. However, the level of education associated with a positive likelihood of being screened varied between studies. For example, Khuu et al. [54] showed that nine or more years of education was associated with more acceptance of screening in Vietnam, whereas Sarin et al. [66] showed that this was true at more than six years of education in rural India.

Pregnant women's knowledge about HIV and prevention of vertical transmission was associated with antenatal screening decisions. Lack of knowledge about HIV [60,66–68], about vertical transmission services [67], and about the availability of HIV screening facilities [69] were identified as barriers to screening in four studies in India, one in Cambodia and one in Thailand. Similarly, three studies conducted in Cambodia, Hong Kong and China found that a better knowledge of HIV amongst pregnant women was associated with a higher screening uptake [65,70,71]. Moreover, Munkhuu et al. [51] found similar results for syphilis in their study conducted in Mongolia. Lack of knowledge about syphilis amongst pregnant women was associated with lower screening uptake. A study conducted in India [60] found that low exposure to mass media was associated with lower HIV screening uptake. Similarly, in Hong Kong, Lee et al. [65] identified access to HIV information through posters, pamphlets, videos, and group talks as a facilitator to screening.

2.4.4. Enabling factors

The role of enabling factors such as wealth, place of residence, husbands and health workers' roles, social and cultural norms or screening costs has been discussed in several studies.

Low household wealth or socio-economic status was a barrier even in countries where antenatal screening was free of charge. Three studies conducted in Mongolia, Vietnam, and India found low socioeconomic status to be a barrier to antenatal screening for HIV [51,60,64]. Pharris et al. [61] identified higher economic status as a facilitator of antenatal screening for HIV in Vietnam.

Various studies have shown that the place of residence was associated with antenatal screening for HIV [54,57,60–62,64,72] and syphilis [51]. A study conducted in Vietnam [64] and another conducted in India [60] identified living in a rural area as a barrier to antenatal screening for HIV. Similarly, Wulandari et al. [57] and Pharris et al. [61] found that living in an urban area and a semi-urban area were facilitators of antenatal screening of HIV in Vietnam and Indonesia,

respectively. Proximity to the hospital is also a factor influencing antenatal screening uptake. Khuu et al. [54] and Nguyen, Christoffersen, and Rasch [72] found that living further away from the hospital (over 20km in the case of Khuu et al. [54]) was a barrier to antenatal screening for HIV. Similar results were found by Munkhuu et al. [51] in Mongolia for the antenatal screening of syphilis. Meanwhile, Bharucha et al. [62] identified living closer to the hospital as a facilitator for antenatal screening of HIV in India.

Two studies conducted in Vietnam found a significant association between occupation and the decision to be tested. For example, housewives or labourers/farmers were less likely to be tested for HIV [54,63]. Kakimoto et al. [70] identified high partner education level as a facilitator of antenatal screening in Cambodia. Meanwhile, Chu, Vo et al. [64] found a negative association between belonging to ethnic minorities and being tested during pregnancy.

Several studies identified that husbands play a key role in women's decision to be screened. Fear of negative reactions from their husbands [67], husbands' disapproval [63] and lack of support [73], and beliefs that husbands have a bad attitude towards HIV screening [59] were identified as barriers to screening in India, Thailand, Indonesia and Vietnam. Two studies conducted in Cambodia [68,70] found that the perceived need to obtain a partner's authorisation was a barrier to screening for HIV. The need to obtain a partner's authorisation was also identified as a barrier to syphilis and hepatitis B antenatal screening in Afghanistan [53]. Similarly, Sarin et al. [66] reported that having discussions with spouses about HIV in India encouraged women's screening for HIV.

Various studies have shown that social and cultural factors were key barriers to antenatal screening for HIV, syphilis or hepatitis B. Todd et al. [53] identified stigma toward infected people as a barrier to antenatal screening for HIV, syphilis, and hepatitis B in Afghanistan. Similar results were found by Baker et al. [52] in Indonesia for the screening of HIV and syphilis, and Lubis et al. [56] and Rogers et al. [67] for the screening of HIV. This last study also identified the fear of negative reactions from parents and the community as a barrier. Similarly, Li et al. [71] found that a lower perception of social stigma was associated with higher screening uptake in China.

Time was also associated with antenatal screening decisions for HIV and syphilis. It was a barrier both from the supply and the demand side. Working pregnant women reported that limited opening hours of screening centres were a major health-facility-related barrier to antenatal screening for HIV in Indonesia [56]. Limited time to inform women properly about HIV during pregnancy and antenatal screening [73], as well as limited time to perform screening for syphilis [51], were barriers to antenatal screening in Thailand and Mongolia. From the demand side, long travel time to access antenatal screening services was associated with lower HIV screening uptake in Thailand [73]. Similarly, lack of time was identified as a barrier to screening for HIV and syphilis in Indonesia by Baker et al. [52]. Meanwhile, Bharucha et al. [62] found that being offered screening too late in pregnancy is associated with lower screening uptake for HIV in India.

The type of screening provider was a factor associated with screening in various studies. H  nh, Gammeltoft, and Rasch [74] showed that, in Vietnam, having the first ANC visit at a commune health station was a factor associated with an increased probability of being tested, compared with district and provincial health facilities. Similarly, in the same country, having received ANC only at a private clinic/hospital was found to be a barrier [54]. However, in India, Sarin et al. [66] found that seeking ANC at government district hospitals and private clinics, as opposed to community health centres not equipped with either HIV counselling or screening facilities, was positively associated with the probability of receiving HIV screening. Similar results were found by Bharuch et al. [62] in India. Some facilities lack screening materials, and this was associated with lower screening of syphilis in Mongolia [51] and lower screening of HIV and syphilis in Indonesia [52]. In addition, a study carried out in Indonesia [56] revealed that the lack of ANC and screening services in the same building was a barrier to HIV screening. In Cambodia, the lack of access to ANC services outside the capital city was a barrier to screening for HIV [68].

Health workers play a key role in screening decisions. In Vietnam, Dinh, Detels and Nguyen [63] found that poor perception of health workers' availability was negatively associated with screening for HIV. Fear that health workers would become impatient with them or that their questions would not be considered important was a barrier in Thailand [73], and concern that health workers were opposed to antenatal screening for syphilis impeded screening in Mongolia [51]. Similarly, Lee et al. [65] identified health workers recommending HIV screening as a facilitator of screening. A study conducted in Vietnam [61] identified never having received antenatal HIV counselling as a barrier to screening, and another identified differences in languages between health workers and women as a barrier [73]. High acceptance of screening for HIV, syphilis and hepatitis B by health workers was also a factor in increasing screening uptake in Afghanistan [53]. Pakki et al. [58] and Lubis et al. [56] found that, in Indonesia, health worker training as well as a reward and punishment system to motivate them was associated with higher antenatal HIV screening. This is consistent with findings reported in Indonesia for HIV and syphilis screening [52]. Todd et al. [53] found that provider perceptions of low infection rates and assumptions on a person's likelihood of infection based on a healthy appearance were associated with lower screening uptake of HIV, syphilis and hepatitis B in Afghanistan. Baker et al. [52] also identified the shortage of laboratory workers as a barrier to HIV and syphilis antenatal screening in Indonesia.

Costs of screening were also identified as a factor associated with HIV and syphilis screening uptake. Tests being seen as expensive by pregnant women were identified as a barrier to HIV and syphilis screening in Indonesia [52]. Similarly, Crozier et al. [73] found that the costs of screening and transportation represented barriers to screening for HIV and syphilis in Thailand.

At the national level, enabling factors were identified by two studies in Mongolia and Indonesia [51,52]. Munkhuu et al. [51] identified the complexity of the syphilis screening service system, with poor coordination between ANC visits and STI services, as a barrier to antenatal screening. Similarly, Baker et al. [52] found that poor dissemination of national policy on screening, not seeing screening as a priority intervention, and fragmented and insufficient funding from multiple sources were barriers to HIV and syphilis screening in Indonesia.

Meanwhile, Crozier, Chotiga, et Pfeil [73] showed that having only one ANC visit was associated with low screening uptake.

2.4.5. Need factors

Four studies conducted in Hong Kong, Vietnam and Thailand found that low perceived risk of HIV was associated with low screening [61,63,65,73]. Similarly, Lee, Yang, and Kong [65] found that, in China, a high perceived risk of HIV was associated with high screening. In a study investigating barriers and facilitators in the delivery of antenatal screening for HIV and syphilis, Baker et al. [52] identified the perceived low prevalence of HIV and syphilis as barriers to antenatal screening in Indonesia. Two studies found that believing that HIV screening was not important during pregnancy was associated with a lower screening uptake in Indonesia and Vietnam [54,59]. Similarly, Lee et al. [65] identified the perception of the benefits of HIV screening as a factor facilitating it. Meanwhile, Munkhuu et al. [51] found that women who previously reported STIs were less likely to be screened in Mongolia.

2.5. Discussion and Conclusions

2.5.1. Discussion

This systematic review of qualitative, quantitative, and mixed-methods studies showed that there are research gaps in the factors influencing screening for syphilis and hepatitis B, with most of the studies reviewed focusing on HIV. This review, therefore, effectively allowed conclusions to be drawn about HIV alone.

Antenatal screening for HIV in Asia is influenced by a range of factors, including predisposing characteristics (age, education level, wealth, place of residence, knowledge about HIV), enabling factors (husband support, health facilities characteristics, health workers' support and training) and need factors (risk perception, perceived benefits of screening). These factors are similar to those identified in a review conducted by Blackstone et al. in sub-Saharan Africa [18]. In this literature review, as in the sub-Saharan African context, being better off and highly educated were identified as facilitators. In both contexts, pregnant women's lack of knowledge about HIV appeared to be a significant barrier to antenatal HIV screening. These results suggest that antenatal screening could be improved by facilitating access to information for women, their husbands and health workers. Most studies have emphasised the importance of improving the dissemination of information about HIV and HIV screening to improve the uptake of antenatal screening. Unlike Blackstone et al.'s review of the literature in the sub-Saharan African context [18], I did not identify fear of results as such a barrier to screening, but more broadly fear of partner reactions and potential violence in the event of a positive result. I did not find cultural gender norms to be a barrier, such as "screening is a woman's business", as found by Blackstone et al. [18]. However, in this review, women mentioned the need to obtain a husband's approval to undergo screening [53,68,70]. In both African and Asian contexts, societal stigma towards HIV-positive people proved to be a major barrier to HIV screening. These findings, and those of Blackstone et al. [18], suggest that antenatal screening could be improved by strengthening the healthcare system. Both reviews highlighted the role of

healthcare and communication professionals in increasing antenatal screening rates. In the sub-Saharan African context, the perception of screening being mandatory was a barrier to screening, but this did not emerge in this literature review.

Although the studies I reviewed were all conducted in Asia, they spanned very different contexts. It is reasonable to assume that the barriers to antenatal screening differ between Hong Kong and India, for instance. Guidelines about screening and adherence to guidelines differ between countries. A review of maternal health care policies in eight countries in the Western Pacific region found that WHO recommendations on antenatal HIV screening were not included in ANC guidelines in two countries [75]. In 2018, 37 countries in the Asia Pacific region promoted antiretroviral therapy for all pregnant and breastfeeding women living with HIV, but in six of these countries, the policy was implemented in less than 50% of all maternal and child health sites [76]. Reported barriers in the Hong Kong study were mainly focused on the demand side [65], whereas the Mongolia study identified many supply-side barriers [51]. This highlights the need for qualitative studies in Asian contexts to investigate context-dependent factors that may be missed in quantitative studies.

As stigmatisation of people with STIs is one of the main factors preventing pregnant women from being screened, interventions should provide information and counselling to pregnant women and their husbands, tailored to low-literacy populations, to help reduce stigma and increase uptake [65,66,68]. Raising awareness within communities of the importance of male partner involvement, the benefits of screening and adherence to treatment could increase demand for antenatal screening services. However, studies on awareness campaigns about HIV in Vietnam [77] and Thailand [78] showed that the stigma attached to social judgment is difficult to reduce. Various studies recommended the integration of HIV screening into community-level ANC services [57,64,65,72,74] and the development of opt-out approaches for those who prefer not to test [63,69], as recommended in sub-Saharan Africa by Blackstone et al. [18]. I found that husbands play a key role in encouraging pregnant women to undergo screening. Interventions to improve husbands' knowledge and involvement in maternal and newborn health had a positive impact on maternal health behaviour in Bangladesh [79] and Nepal [80]. To reduce financial barriers to antenatal screening, screening should be offered to pregnant women universally free of cost [61,65]. Currently, national budgets do not cover all the costs associated with antenatal screening in all Asian countries. In the 17 Asian countries for which data on the cost of screening pregnant women for HIV, syphilis and hepatitis B were available in 2017, HIV screening of pregnant women was free in all of these countries, syphilis screening in 14 countries and hepatitis B screening was free in eight countries [9]. Meanwhile, the quality of services depends on the availability and capacity of health workers. To reduce the persistence of inappropriate healthcare practices in pregnancy, interventions need to develop health worker training programmes on STIs and pregnancy screening. A successful initiative in Cambodia to decrease risky sexual intercourse and improve access to sexual and reproductive health care services has focused on training community health workers in sexual and reproductive, maternal, neonatal, child and adolescent health [81].

2.5.2. Strengths and limitations

This systematic literature review has a number of strengths. It included multiple databases and grey literature to ensure a comprehensive exploration of the evidence, minimising the risk of publication bias. The review followed a rigorous methodology aligned with the PRISMA guidelines, enhancing its reliability and reproducibility. Included studies were assessed for quality and risk of bias, ensuring that conclusions were based on robust evidence. In addition, the results were synthesised systematically in a table.

However, several limitations to this chapter should be noted. Firstly, most studies sampled pregnant women through ANC services. However, women who have not sought ANC may face the greatest barriers to screening. Due to resource constraints, only studies reporting in English were reviewed, which may limit access to the grey literature and studies published in other languages. Meanwhile, different studies were undertaken in different contexts and using different methods. This heterogeneity limited my ability to compare between studies.

2.5.3. Conclusion

Understanding barriers and facilitators is essential to improving screening uptake. By following a rigorous method of study selection and analysis, this systematic literature review complemented existing literature reviews on barriers to antenatal screening, particularly in sub-Saharan Africa [18,82]. The main barriers to antenatal screening identified in this systematic review were stigmatisation of infected individuals, lack of involvement of husbands and health system factors. However, studies to examine the barriers and facilitators to antenatal screening for syphilis and hepatitis B and to examine the behavioural determinants of antenatal screening in Asia are still needed. Moreover, factors influencing integrated antenatal screening remain unexplored.

To fill these gaps in the existing literature, this thesis investigated factors influencing integrated antenatal screening for HIV, syphilis and hepatitis B in Nepal and explored its effectiveness in addressing barriers to screening. This provided a basis for discussion on how to improve maternal screening and its integration.

3. Empirical context of Nepal

This chapter aimed to justify the choice of Nepal as a case study for this thesis and to provide context for this research. I outlined characteristics of the Nepalese context which were relevant to my research, including the health and cultural contexts.

3.1. Country context

Nepal is a landlocked country in South Asia with a population of more than 30 million in 2023 [83], of which the majority (66%) reside in urban municipalities or metropolitan / sub-metropolitan cities [84]. In 2021, 7% of the total population resided in Kathmandu district, which had the highest population [84]. The combined population of the metropolitan cities of

Kathmandu and Lalitpur exceeds 1.15 million. Kaski district, home to Pokhara, the second largest city in the country, accounted for 2% of the total population [84].

Since 2006, the signing of the Comprehensive Peace Agreement ended a decade of conflict, and Nepal has gone through a long and complex transition to a new constitution in 2015 that established a federal structure. This federalisation has changed how the country is governed, with decision-making power being transferred to the local level. This decentralisation means that decision-making power is now devolved to the municipalities, which now play a key role in managing local services, including healthcare. The country is now divided into 7 provinces, each with its own provincial government, 77 districts and 753 local governments. These local governments include 460 rural municipalities, also known as “Gaunpalikas”, 276 municipalities with a population of over 10,000, 11 sub-metropolitan cities with a population of over 200,000, and 6 metropolitan cities with a population of over 500,000, including Kathmandu, Bharatpur, Biratnagar, Pokhara, Lalitpur, and Birganj. Nepal is geographically divided into three regions: the mountains ("Parbat") with the high Himalayas, the hills ("Pahad") and the plains ("Terai").

According to the 2021 census in Nepal, 81.2 % of the population practices Hinduism, 8.2% adheres to Buddhism, followed by Islam, Kirat, Christianity and others [84]. Almost all Nepalese, independently of their religion, universally identify with a caste. The caste system is an ancient social system that continues to influence social dynamics in Nepalese society. It is an important aspect of cultural identity, with many people defining themselves and their communities in terms of caste. Even if the Bill on Caste-based Discrimination and Untouchability [85] prohibited caste discrimination in 2011, the caste system remains a defining element of Nepalese society, and members of lower castes still face discrimination and unequal economic opportunities. Brahmins hold the highest status, followed by Chhetris. In contrast, Dalits, people from plains ethnicities, Muslims and certain mountain ‘Janajati’ ethnic groups face discrimination and exclusion [86,87].

In 2023, Nepal’s gross domestic product (GDP) per capita was 1,324 United States Dollars (US\$) (constant 2015 US\$), compared to an average of US\$2,308.7 in South Asia overall [88]. The country's economy has been severely affected by some major events, including the civil war from 1996 to 2006, the 2015 earthquakes, which killed more than 9,000 people, and the COVID-19 pandemic. In addition, the border blockade between India and Nepal in 2015-2016, a major political crisis, exacerbated the economic impact of the earthquake by disrupting the flow of essential goods and services. These difficulties have been compounded by structural problems such as slow job creation at the national level, high vulnerability to natural disasters and inadequate infrastructure. The country had a 2.1% contraction in the Nepalese economy in 2020. Additionally, Nepal is heavily dependent on remittances, which represent nearly a quarter of its GDP [89]. The mass migration of men seeking employment abroad has reshaped household dynamics, increasing the burden of labour and caregiving responsibilities on women and altering traditional family structures (developed in Section 3.3.1).

I have chosen Nepal for my case study as the country is part of the WHO regional framework for the triple elimination of vertical transmission in Asia and the Pacific [4]. Little information is available on the prevalence of syphilis and hepatitis B due to low screening coverage, which

leads to an underestimation of their burden. However, prevalence could increase over the next few years, particularly as a result of growing foreign labour migration to India, the Middle East and East Asian countries [90]. Moreover, this thesis represents a good opportunity to address the large research gap on antenatal screening for STIs in Nepal and South Asia more widely.

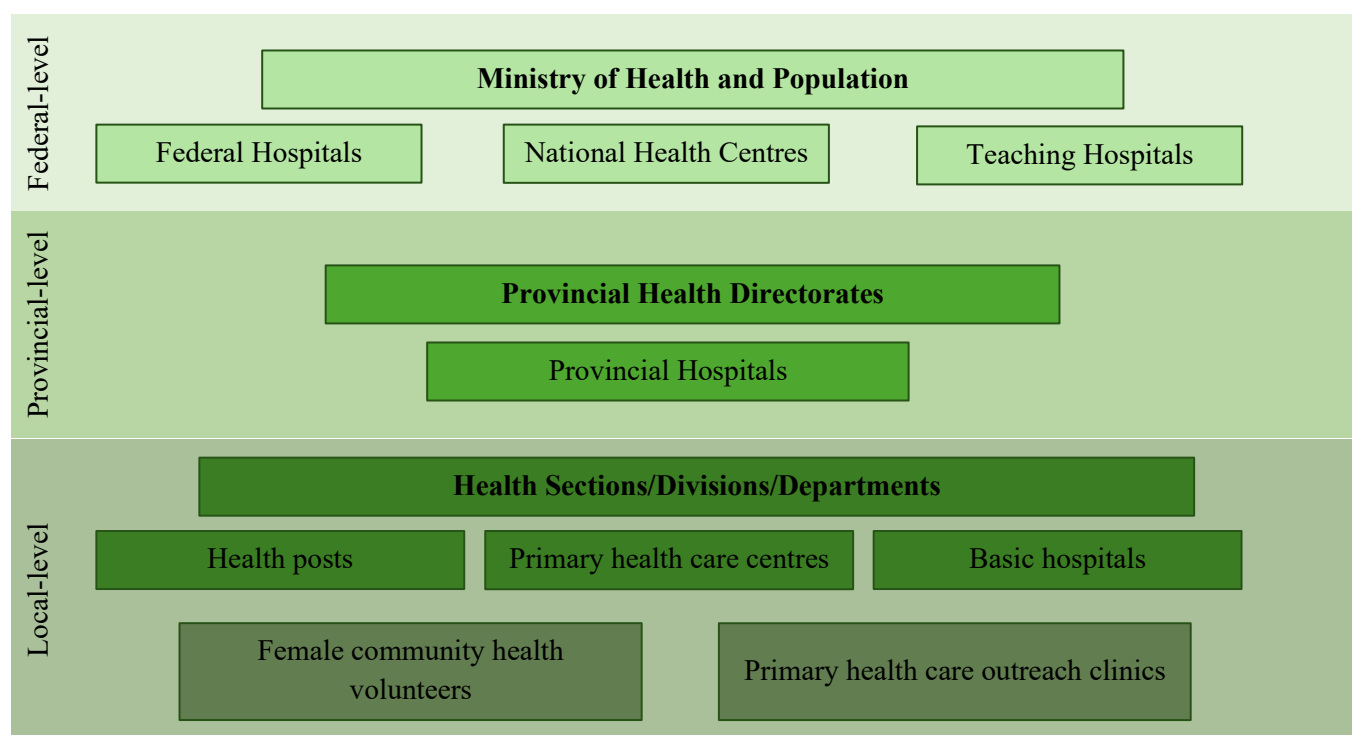
3.2. Health context

3.2.1. Health system structure

Since 2017, after the promulgation of the Constitution of Nepal in 2015 and the establishment of the federal state, the health system in Nepal has been decentralised, transferring responsibility for health services delivery from the district to the municipality level [91]. Previously, decisions concerning Nepal's health system were taken by district public health and district health offices at the district level, but these decisions have now been entrusted to health coordinators at the municipality level in coordination with the elected municipality-level officials, who are usually not trained in public health. This transition has led to substantial changes in managing and delivering health services, creating both opportunities and challenges. While decentralisation aims to make health services more responsive to local needs, it has also created confusion during the transition period. Many municipalities have struggled to develop the necessary administrative capacity, and the lack of clarity of roles and responsibilities between the district and municipality has sometimes led to delays and inefficiencies in health service delivery [92].

Health care in Nepal is provided by public health facilities, private health facilities and health facilities run by non-governmental organisations (NGOs). The structure of the public health system is presented in Figure 4. The public health system operates at several levels, with differences in the availability of health workers and services offered from basic to specialist care. Female Community Health Volunteers (FCHVs) are the only community cadre in practice, providing essential basic services such as health education, distribution of contraceptives and patient referrals [93]. They help to raise awareness about the importance of ANC, encourage early and regular visits and promote health-seeking behaviour among pregnant women. In addition, FCHVs promote health awareness among communities about maternal health issues, including HIV risks and the importance of screening. They also support pregnant women through home visits during pregnancy and the neonatal period, and the organisation of monthly mothers' group meetings [93]. Although these groups are supposed to focus on the needs of pregnant and breastfeeding women, they are open to everyone and, in practice, few pregnant and breastfeeding women attend them regularly. Primary health care outreach clinics provide basic services at the community level, often in temporary facilities such as a volunteer's home. These clinics are important for antenatal care but are limited to basic physical examinations because they lack diagnostic equipment and qualified staff.

Figure 4 - Structure of the public health system in Nepal



At the next level are health posts (HPs) and Primary Health care Centres (PHCs), the first points of contact for basic outpatient health services such as vaccinations, antenatal care and minor treatments. Health posts are usually staffed by auxiliary health workers (AHWs) and auxiliary nurse midwives (ANMs), while PHCs are better equipped. They usually have at least one doctor and a few nurses, and they offer a wider range of services, including basic diagnostics and more comprehensive care. However, many health posts and PHCs have limited laboratory facilities, often only able to carry out basic tests such as blood glucose, malaria screening and sometimes haemoglobin. In recent years, sub-health posts were all ‘upgraded’ into health posts, but many of them have yet to catch up in terms of infrastructure and services offered. Basic hospitals are 5 to 15-bed hospitals that provide more advanced services, including limited inpatient care as well as outpatient and emergency care. They usually have qualified doctors and staff nurses, and their laboratories can carry out a wider range of diagnostic tests, such as complete blood counts and tests for infectious diseases. Referral mechanisms are in place to direct patients requiring more specialised care to basic hospitals, which have more comprehensive laboratory capabilities and a wider range of specialists, including general practitioners and surgeons.

At the top of the public health hierarchy are the federal, provincial and teaching hospitals, which serve as referral centres for complex cases. These hospitals are equipped with specialised diagnostic and therapeutic services, such as imaging, advanced laboratory tests and surgical facilities, and are staffed by specialists. Referrals from lower levels to these hospitals often depend on the severity of the patient's condition and the availability of diagnostic and treatment services at lower levels. The structure of the healthcare system is reflected in the availability of

the necessary equipment¹ in health facilities to deliver basic services². Indeed, hospitals are the most equipped to provide these services, with 70% having the required equipment, compared to only 28% of the health posts [95].

The private sector accounts for more than two-thirds of hospital beds [96] despite only 19.6% of private health facilities offering basic health services [95]. The use of the private sector is high in Nepal; for example, 63.3% of fever treatments for children were sought in private health facilities in 2020 [95]. However, there is little information on this sector as there is no routine monitoring. In addition, there is a large informal healthcare system, in which many people seek treatment for minor ailments in medical shops or from untrained village practitioners who often prescribe and sell medicines [97].

NGOs and international organisations also play an important role in the Nepalese healthcare system, particularly in the context of HIV screening, treatment and care. The main players are NGOs such as Save the Children, the Nepal Youth Foundation and the Blue Diamond Society, among others, as well as the Global Fund and United Nations agencies. These NGOs and international organisations work with the government to fill gaps in service provision, focusing on at-risk populations. Their role includes targeted HIV screening, counselling and facilitating access to care for positive cases. NGOs often run mobile clinics or community screening centres, making services accessible in areas where health infrastructure is limited [98,99].

Reflecting the federal system in Nepal, the health system is managed at three levels: federal, provincial and local. At the federal level, the Ministry of Health and Population (MoHP) formulates policy, oversees planning, manages health-related NGOs and coordinates, regulates and implements the health sector. The MoHP also directly manages federal hospitals.

There are five semi-autonomous centres within the MoHP:

- The National Health Education, Information and Communication Centre (NHEICC) coordinates information, education and communication activities on behaviour changes.
- The National Health Training Centre (NHTC) organises and implements training programmes for healthcare providers.
- The National Centre for AIDS and STD Control (NCASC), the National Tuberculosis Control Centre (NTCC) and the National Public Health Laboratory (NPHL) support the delivery of essential health services in coordination with other divisions. The NCASC plays a key role, as it is dedicated exclusively to the fight against AIDS and STIs, demonstrating the commitment of the country to the elimination of these diseases.

¹ The World Health Organisation (WHO) and the United States Agency for International Development (USAID) recommend seven essential items of equipment for a health facility to ensure the availability of basic services: a scale for adults, children and infants, a thermometer, a stethoscope, a blood pressure meter and a light source [94].

² The World Health Organisation (WHO) defines basic health services as essential health services that meet the primary health needs of a population. These services focus on the prevention, treatment and management of common health problems.

There are three departments within the MoHP:

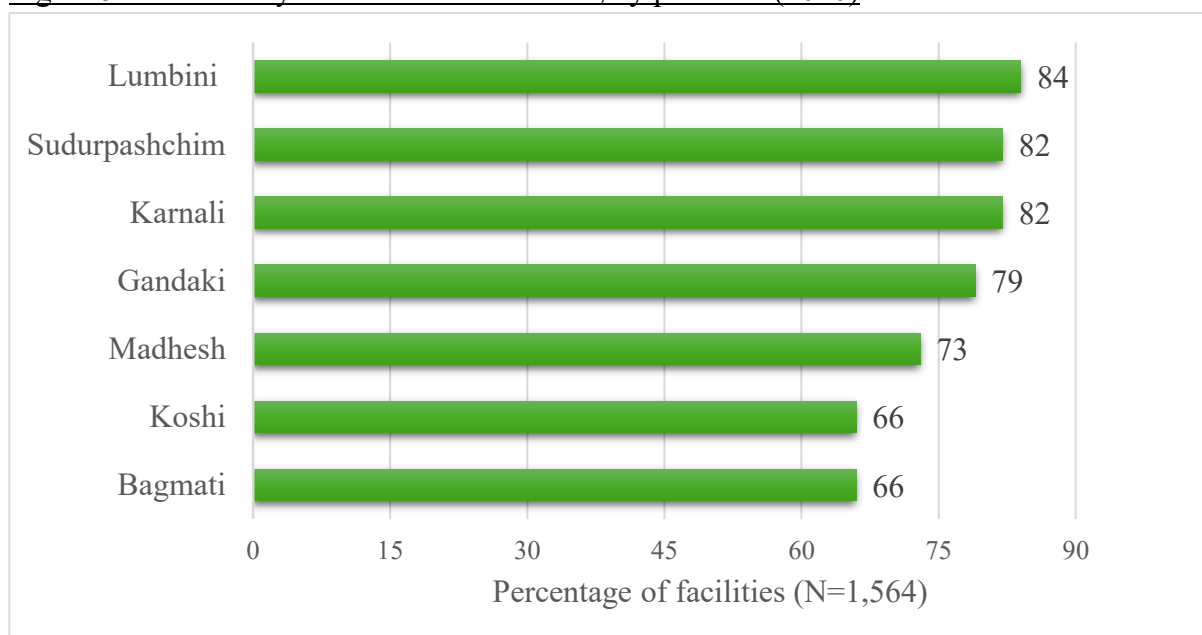
- The Department of Health Services (DoHS) deals with human resource requirements, procurement of drugs and supplies, resource mobilisation, programme planning, monitoring and evaluation. It also facilitates international cooperation and manages health information systems.
- The Department of Ayurveda and Alternative Medicine (DoAA) oversees alternative medicine programmes.
- The Department of Drug Administration (DDA) regulates the quality, import, export, production and distribution of medicines.

Below the federal level, under the MoHP, provincial health directorates have the responsibility to manage the delivery of health services at the provincial level. They provide technical assistance and program monitoring to district health offices. At the local level, local governments oversee basic health services, including the management of health facilities and outreach workers, as well as the procurement of essential drugs and supplies.

3.2.2. Access to healthcare service

Significant disparities exist in the provision of health services in Nepal. While most women (77%) reported travelling less than 30 minutes to reach the nearest health facility, 9% had to travel over an hour, a burden that disproportionately impacts women in remote areas [100]. This is reflected in the uneven availability of basic health services across provinces (Figure 5). WHO defines basic health services as essential health services that meet the primary health needs of a population. These services focus on the prevention, treatment and management of common health problems, and they do not include care or diagnosis for STIs. Nationally, three-quarters of health facilities are reported to provide a full package of basic services, but this varies widely, from 84% in Lumbini to 66% in Bagmati and Koshi [95]. Additionally, rural facilities (44%) are slightly better equipped than urban facilities (39%) to provide these basic services [95].

Figure 5 - Availability of basic health services, by province (2020)

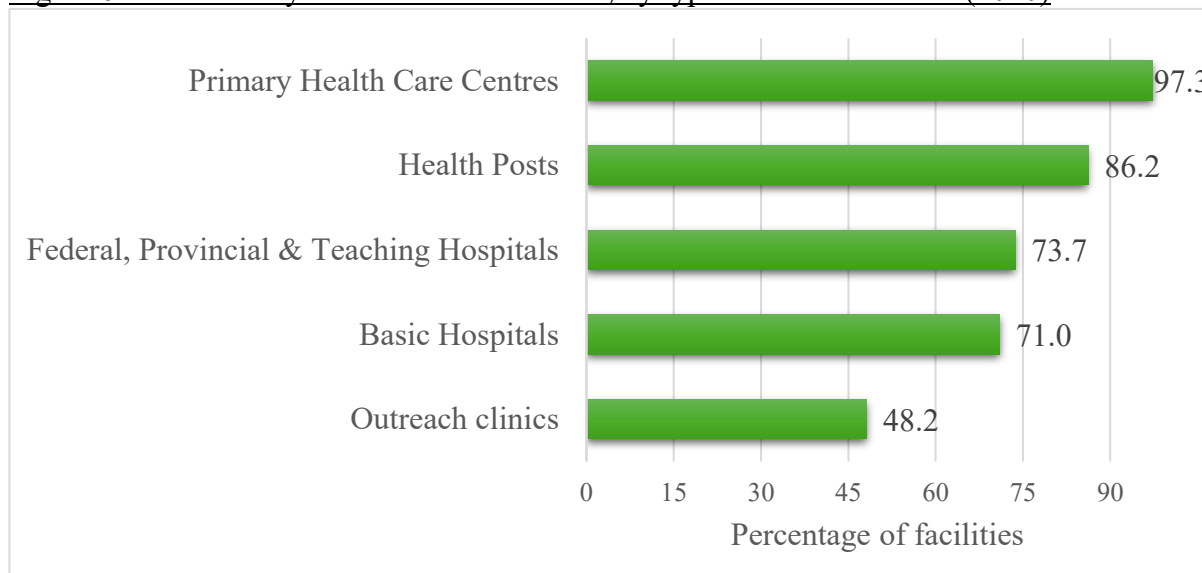


Source of the data: [95]

Notes: The World Health Organisation (WHO) defines basic health services as essential health services that meet the primary health needs of a population. These services focus on the prevention, treatment and management of common health problems, and they do not include care or diagnosis for sexually transmitted infections.

The provision of health services varies significantly across different types of health facilities. In line with the structure of Nepal's health system, hospitals, which are designed to deliver more specialised services, are less likely to offer basic health services compared to primary health care centres and health posts (Figure 6).

Figure 6 – Availability of basic health services, by type of health facilities (2020)



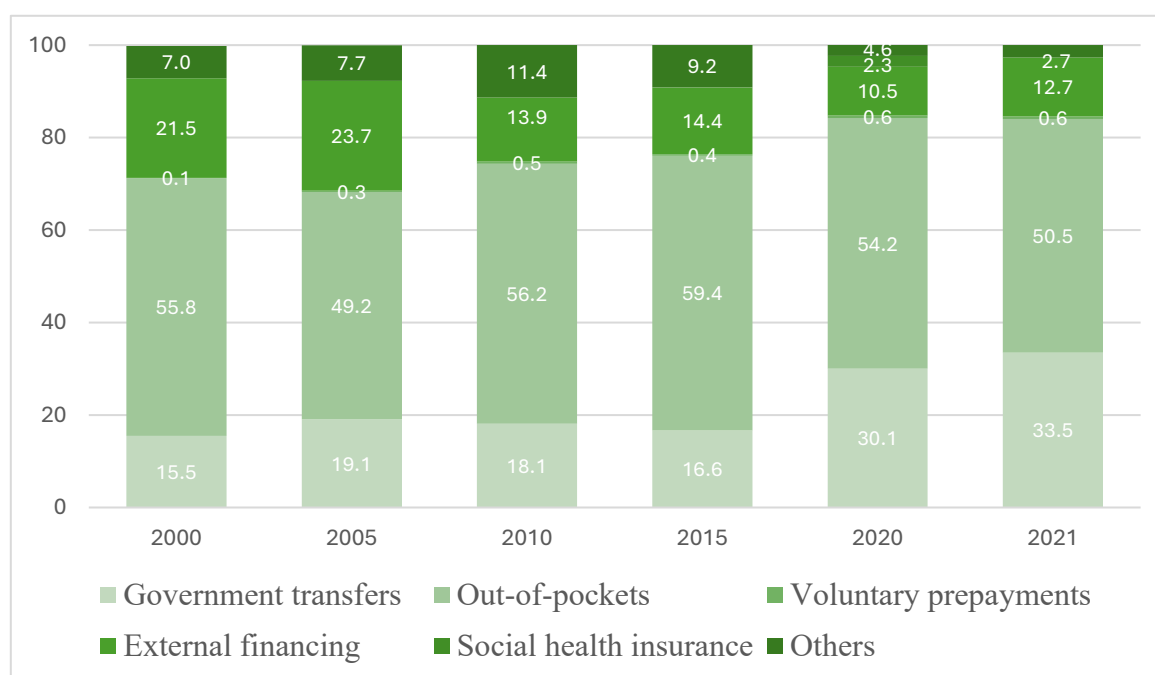
Source of the data: [95]

Notes: The World Health Organisation (WHO) defines basic health services as essential health services that meet the primary health needs of a population. These services focus on the prevention, treatment and management of common health problems, and they do not include care or diagnosis for sexually transmitted infections.

3.2.3. Healthcare financing

Current expenditures on health per capita in current US\$ each year in Nepal have increased from US\$8.34 in 2000 to US\$58.31 in 2020, an increase of about 9.9% per year [101]. Figure 7 presents the breakdown of current health expenditure by source [102]. Private spending, mainly out-of-pocket (55% on average), dominates healthcare funding, at 3% of GDP per capita. External financing contributed 17% in 2017, while government contributions amounted to 18%. The importance of private funding probably contributes to inequalities in access to health services.

Figure 7 - Breakdown of current health expenditure by source (2017)



Notes: Figure adapted from [103]. For zeros in the above figure, no contribution from these sources in the given years.

The Social Health Security Program (SHSP) in Nepal is a voluntary family-based health insurance program aimed at equitable healthcare access and financial protection. Families with fewer than five members pay an annual premium of 3,500 Nepalese rupees (Rs) for healthcare services, including free medicines. Additional members cost Rs 700 each per year. In 2022, the programme covered 22.5% of the population across the 77 districts [103]. Despite its success [104], barriers like lack of information and fear of stigma limit its access [105]. Moreover, aligned with the National Strategic Plan on HIV, Nepal's social protection program for children with AIDS provides over 1,360 children with a monthly stipend of Rs 1,000 in their bank accounts [105].

3.2.4. Antenatal care

Access to ANC services is the first step to accessing antenatal screening. ANC services are available in different types of health facilities, from primary health care centres and health posts to district and zonal hospitals and private clinics [106]. However, health posts generally do not have laboratory services and are limited to basic ANC services such as physical examinations

and health education. On the other hand, hospitals are equipped with laboratory facilities, allowing basic tests such as urine analysis and checking haemoglobin levels as well as blood tests for syphilis, HIV and hepatitis B. Since 1997, the National Safe Motherhood Programme [107] has promoted maternal and child health in Nepal through ANC services and institutional deliveries. As part of this strategy, the Aama and Newborn programme, introduced in 2005, aims to reduce financial barriers to maternal care by offering incentives to health workers for institutional deliveries, free delivery services in health facilities and transport incentives for women who complete four ANC visits and deliver in a health facility. Transport incentives vary by region: 400 Rs (US\$2.96) in the Terai, 1,000 Rs (US\$7.39) in the hills and 1,500 Rs (US\$11.08) in the mountains. These services are available to all Nepalese in public health facilities with delivery rooms. The maternal incentive coverage was 96.5% among 21,697 women admitted for delivery between 2017 and 2018 [108], and the program was associated with an improvement in maternal outcomes [109] with a decrease in maternal mortality rate from 361 per 100,000 live births in 2006 to 174 in 2020 [110].

The proportion of women receiving at least one ANC visit from a skilled provider rose from 25% in 1996 to 86% in 2016 and 94% in 2022 [100]. However, only 81% of pregnant women received the four recommended ANC visits in 2022. The definition of a visit varies widely and can be as simple as checking the mother's blood pressure, weight and baby's heartbeat, and asking a few questions [111]. An ANC visit does not necessarily mean access to screening. Moreover, significant barriers and inequalities in access persist, especially between rural and urban areas [112]. The barriers include poverty, ethnicity, low women's autonomy, limited knowledge of maternal health services, low media exposure, and a high number of pregnancies [113,114]. Additionally, many women still give birth at home, with 21% of women aged 15-49 who did not deliver their last child in a health facility in the 2022 NDHS survey [100].

3.2.5. Sexually transmitted infections

In 2020, HIV prevalence among adults aged 15-49 in Nepal was estimated at 0.12%, or 39,397 individuals [105]. In 2019, hepatitis B prevalence was estimated at 0.5% among pregnant women [115]. There are no official data on the national prevalence of syphilis. Syphilis prevalence estimates vary, with rates of 1.5% among a group of 3,570 women screened in 2017 [116] and 0.2% among 1,362 women screened in 2013 [117].

Blood tests remain the norm for screening for HIV, syphilis and hepatitis B, and oral tests are not widely available in Nepal. However, oral HIV tests are increasingly available in some urban areas for non-invasive testing. The most used HIV tests in Nepal are rapid diagnostic tests (RDTs), which can be used in the field and offer rapid results in a matter of minutes. These tests require a blood sample, a test strip or cassette and the reagents included in the RDT kits. Enzyme-linked immunosorbent assays (ELISA) tests are also used for confirmation, particularly in hospitals and clinics, and require additional equipment such as microplates, reagents and a spectrophotometer. In Nepal, screening for syphilis is generally carried out using blood tests such as the Rapid Plasma Reagin (RPR) test and the Venereal Disease Research Laboratory (VDRL) test, as is common practice worldwide. These tests detect antibodies produced by the body in response to syphilis infection. The equipment required includes sterile

syringes or lancets for blood sampling, reagents and, in some cases, equipment such as a rotator for mixing samples during the RPR test. Screening for hepatitis B is generally performed by blood tests that detect hepatitis B surface antigen (HBsAg). These tests require a blood sample, sterile collection tubes and specific HBsAg test kits containing reagents to identify the antigen. In some contexts, centrifuges may be used to separate serum if this is necessary for test accuracy.

Coverage of antenatal screening for HIV, syphilis and hepatitis B varies, with significantly higher rates for HIV, mainly due to mandatory WHO monitoring of HIV and interest from external donors. The National HIV Strategic Plan 2021-2026 outlines the actions in the fight against HIV in Nepal [118]. A community programme to prevent vertical transmission covers 77 districts and offers free HIV screening during ANC visits following an opt-out approach. In addition, according to the Nepal Safe Motherhood and Newborn Health Roadmap 2030 [119], systematic screening for HIV and syphilis should be offered to all pregnant women during the first ANC visit. However, as the data on screening coverage below shows, there is still an important gap between policy and practice. Although 82% of women underwent screening for HIV during pregnancy in 2022 [120], only 65% of pregnant women had a known HIV status mainly because the results were not communicated afterwards [121], and only 40% of pregnant women living with HIV were receiving antiretroviral treatment to reduce the risk of vertical transmission, compared with the target of 95%.

Syphilis is also included in the National Medical Standard for Maternal and Newborn Care [122], which requires screening for all pregnant women at their first ANC visit. Coverage of syphilis screening among women receiving ANC in 2018 was very far below the 95% target at 0.03% indicating an almost complete failure in the provision of syphilis screening [123]. However, the few ANC attendees who tested positive for syphilis received appropriate treatment [123]. Only around one-fifth of facilities offering ANC services were able to screen for syphilis in 2019 [124].

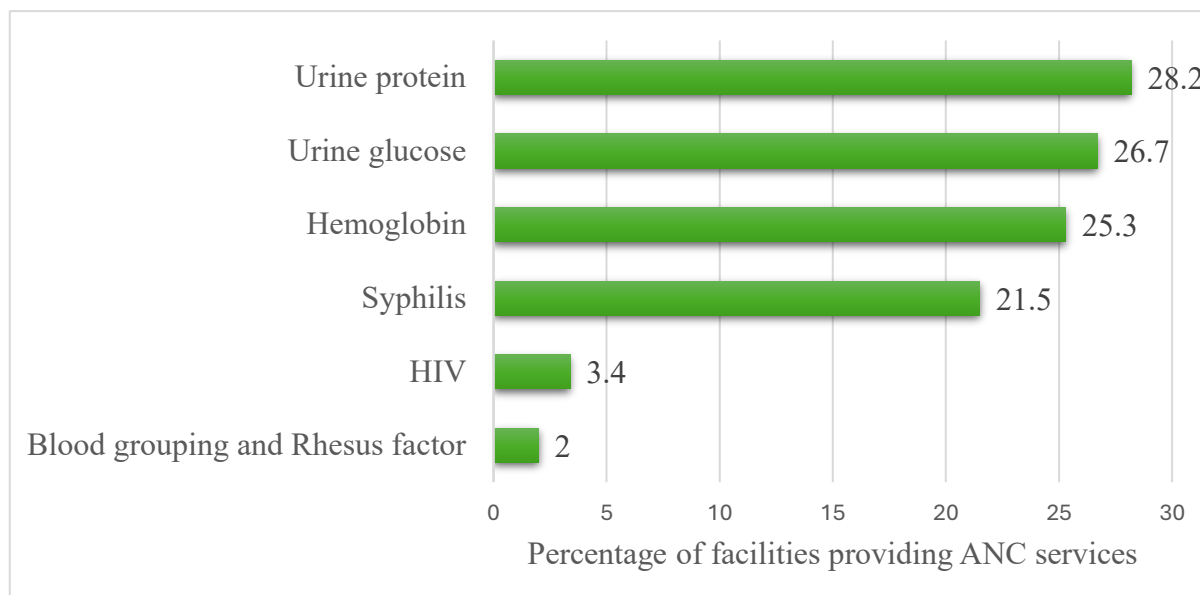
Among facilities offering ANC services, the availability of laboratory tests varies significantly by test type (Figure 8). HIV screening capacity among facilities providing ANC services remains notably low, at just 3.4% compared with 21.5% for syphilis [95]. This is counterintuitive, given that the coverage of antenatal HIV screening is much higher than that of syphilis screening. However, this may be explained by the stricter criteria for defining HIV screening capability, which require several unexpired rapid test kits or advanced diagnostic equipment³. In contrast, the requirements are simpler for a health facility to be considered having the capacity to screen for syphilis⁴. Less than 40% of facilities offering prevention of

³ For a facility to be considered as having HIV screening capacity, it must report performing HIV screening and have, as a minimum, one unexpired Determine test, one unexpired Uni-Gold test and one unexpired Stat Pak HIV rapid diagnostic test kit on-site at the time of the survey. Alternatively, the health facility must have the capacity to carry out enzyme-linked immunosorbent assay (ELISA) tests at the time of the survey.

⁴ For a facility to be considered as having syphilis screening capacity, it must have a rapid test for syphilis, a Venereal Disease Research Laboratory test, polymerase chain reaction (PCR), or a rapid plasma reagin (RPR) at the time of the survey.

vertical transmission services have staff with recent training on the prevention of vertical transmission [124].

Figure 8 - Availability of basic laboratory tests among facilities providing antenatal care (ANC) services



Source of the data: [95]

Notes: ANC = Antenatal care. HIV = Human Immunodeficiency Virus.

Notes on the definition of 'availability' in the Demographic Health Survey data: For haemoglobin: capacity to conduct any haemoglobin test in the facility. For urine protein: available dipsticks for urine protein. For urine glucose: available dipsticks for urine glucose. For blood grouping and rhesus factor: available anti-A, anti-B, and anti-D reagents, plus an incubator, Coomb's reagent, and glass slides, all present. The availability of syphilis screening is defined as having any one of the following diagnostic options: rapid test for syphilis, Venereal Disease Research Laboratory test, polymerase chain reaction (PCR), or rapid plasma reagin (RPR). For HIV: facility reports conducting HIV testing at the facility and that it had at least one unexpired Determine test, at least one unexpired Uni-Gold test, and at least one unexpired Stat Pak HIV rapid diagnostic test kit available somewhere in the facility on the day of the survey, or else facility had ELISA (enzymelike immunosorbent assay) testing capacity or other HIV testing capacity observed in the facility on the day of the survey.

The availability of laboratory tests for STIs also varies significantly across health facilities and provinces. Hospitals offering ANC services, particularly federal and provincial hospitals, are much better equipped to provide basic diagnostic tests (64.9%), including HIV screening, than other health facilities offering ANC services [95]. In contrast, only 9.8% of basic hospitals and 1.1% of health posts offering ANC services can perform HIV diagnostic tests [95]. The situation varies considerably by location, with 5.8% of health facilities in urban areas offering HIV testing, compared with only 0.8% in rural areas. There are also provincial disparities, with 4.7% of facilities providing ANC services in Province 1 that can provide HIV screening, compared with only 0.7% in the province of Karnali [95].

There is limited information on current guidelines and practices for antenatal screening for hepatitis B in Nepal. Hepatitis B screening is not mentioned in the National Medical Standard for Maternal and Newborn Care [122], and no information on coverage is available. Hence, despite the efforts made, the country is still far from achieving the triple elimination targets set by the WHO [125]. These targets include at least 95% coverage of HIV and syphilis screening and at least 90% coverage of hepatitis B screening for pregnant women.

3.3. Cultural context

3.3.1. Gender

Although Nepal's 2015 Constitution adopted Article 38 on women's rights, which states “Women shall have the right to obtain special opportunity in education, health, employment and social security, based on positive discrimination.” [91], gender, familial, societal and religious discrimination challenge its implementation [126]. Nepal remains a patriarchal society where women are largely considered subordinate to men. Caste and ethnic identity reinforce these norms, affecting work, marriage and inheritance [86]. As a result, Nepal ranks 106th out of 156 countries in the Global Gender Gap Index 2021 [127]. The Nepal Human Development Report 2021 showed that women's participation in politics and the economy remains lower than that of men [128]. Gender disparities in access to resources, including limited women's access to education and health services [129], translate into health inequalities [130]. This is reflected in significant gender gaps in literacy and education rates, with 89% of men literate compared to only 74% of women, and 39% of women and 46% of men having at least some secondary education [100]. These disparities also extend to access to vaccination, with 55% of male children and 49% of female children aged between 12 and 23 months fully vaccinated following the national schedule [100]. In addition, 16% of women reported difficulties in obtaining authorisation for medical treatment, highlighting problems of access to healthcare [100]. Poor women's health indicators stem from their subordinate status, early marriage and pregnancy, and their heavy workload [131,132], with reproductive health often seen as their sole responsibility [133,134].

Migration has a significant impact on gender norms and roles in Nepal, reshaping traditional dynamics within households and communities. Men's migration, which affects more than 25% of households nationwide [90], often results in increased responsibilities for women, who are required to take on both traditional men's and women's roles [135]. Studies highlighted mixed outcomes: while some women gain decision-making power and authority within the household in the absence of men [136,137], others face a heavier workload, emotional burden and limited recognition as *de facto* heads of household [136,138–140]. Remittances may improve household food security in the short term, but they often reinforce women's financial dependence and pose sustainability challenges for long-term self-sufficiency [141,142]. In nuclear families, women's power may increase, but in extended families, older household members may restrict women's mobility and decision-making. In addition, the feminisation of agriculture due to male migration has reduced productivity, increasing economic dependence on remittances [143,144]. These dynamics highlight the complex interplay between migration, gender equality and socio-economic stability.

3.3.2. Family context

Despite recent changes, particularly in urban areas [100], Nepalese women generally settle in their husband's households after marriage [145,146], where their decision-making power is often limited [147,148] and strongly influenced by their social position within the household

[149,150]. In this context, decisions about ANC and sexual health are strongly influenced by extended family [151,152].

In joint households in Nepal, mothers-in-law hold a higher position than their daughters-in-law in the family hierarchy and act as "guardians" over daughters-in-law, exercising authority and decision-making power. They often take on the role of financial decision-makers [153]. A study in rural Nepal explored the effects of antenatal food and cash transfers with women's groups on household allocative behaviour and whether these effects are explained by intergenerational bargaining among women [154]. The study highlighted that young pregnant women often have lower dietary adequacy than men and older women. The study suggested that intergenerational negotiations between women within households play a key role in the effectiveness of cash transfers but have less influence on the results of food transfers. Mothers-in-law are frequently involved in decisions concerning young couples' pregnancies and maternal and reproductive health, even if they do not make the decisions directly [155,156]. The opinions of mothers-in-law are often at odds with the views of daughters-in-law [146,155,157]. For example, a qualitative study carried out in urban and rural communities in Nepal among antenatal and postnatal mothers, husbands, and mothers-in-law revealed that although some pregnant women were in favour of ANC visits, their mothers-in-law did not always see the need and did not allow their daughters-in-law to attend them [156]. Diamond-Smith et al. (2020) [158] found that many newly married women wanted to delay their first birth but felt unable to do so because of perceived pressure from their husbands and in-laws. In a recent qualitative study, the family was found to influence women's decision-making regarding the timing of ANC [159].

3.3.3. Husbands' involvement

Although antenatal screening is primarily a matter for women, husbands' involvement is essential [160]. As shown in Chapter 2, lack of support and low partner/husband involvement were identified as barriers to antenatal screening for pregnant women in Asia. Women whose husbands work abroad or who have not discussed family planning with their husbands were more likely to have an unmet need for family planning in Nepal [161]. Women, as well as their husbands and mothers-in-law, perceived the husband as the most influential person in the woman's decision to use ANC and delivery care in Nepal [162], and the partner's involvement during pregnancy was reported to be high at a tertiary level hospital [163].

Gender-based violence is the leading cause of violence-related deaths in Nepal [164]. A study conducted in 2021 found that 70.5% out of 105 women interviewed in Kathmandu were exposed to physical, sexual or psychological violence [165]. In this sample, about one-third of respondents considered patriarchal norms as a leading cause of violence against women. Despite the legal marriage age of 20, over one-third of women aged 20-24 were married before 18, and more than 10% before 15 in 2016 [166], increasing their isolation and dependence on husbands [167]. A qualitative study of 41 men and 76 women, conducted in 2015 in a municipality of Kavre district in Bagmati Province, revealed that violence during pregnancy threatens women's health and hinders access to ANC [168].

3.3.4. Peer pressure

Several studies examined how peer pressure influences individual decisions, including women's health in Nepal [169–173]. Peer dynamics were found to play an important role in health-related behaviours, such as contraceptive use and maternal health practices. For example, a qualitative study conducted among post-partum mothers in Nepal (2018) examined factors influencing the adoption and continued use of an intrauterine device after childbirth [151]. It found that negative subjective norms, including family, peer and societal opposition, hindered women's intention and behaviour towards intrauterine device use. Conversely, positive influences from healthcare providers encouraged intrauterine device adoption.

Studies conducted in Nepal showed the effectiveness of peer interventions in improving women's health. For example, a study conducted in Kathmandu demonstrated the benefits of peer interventions in enhancing the psychosocial health and empowerment of female sex workers [174]. Similarly, Singh et al. (2018) [175] found that peer interventions, in rural Nepal, effectively improved women's health and nutrition knowledge and behaviours. In 2021, a pilot study in rural Nepal tested the Sumadhur intervention, a four-month weekly group programme for women, their husbands and mothers-in-law on nutrition, antenatal care, gender norms and family planning [176]. The study revealed significant improvements in pregnancy-related norms, knowledge of family planning and the legality of abortion. Family planning intentions increased among newly married women, and qualitative results revealed an improvement in family dynamics and gender equity.

Several studies explored the potential of participatory learning and action (PLA) interventions and other community group engagement approaches in Nepal. A study evaluated the effectiveness of the Suaahara nutrition program in Nepal, a large-scale, multi-sectoral intervention to improve nutrition-related knowledge and practices among mothers and young children [177]. The intervention combined healthy mothers' groups with several channels of social and behavioural change, including a radio programme, push messages by mobile phone, groups and individual counselling and peer mobilisation. Over 10 years, the program significantly reduced maternal underweight and improved infant length [177]. Additional improvements were observed in complementary feeding practices, including dietary diversity, meal frequency, and care during illness. A study examining the impact of a PLA intervention on birth outcomes was carried out in the Makwanpur district of Nepal [178]. The intervention involved monthly women's groups discussing pregnancy, childbirth, and newborn health and was effective at reducing neonatal mortality. The results suggested that women's groups could be a low-cost, potentially sustainable and scalable approach to improving delivery outcomes in poor rural communities [178]. A subsequent follow-up study conducted 11.5 years later, which assessed the long-term impact of the community-based PLA women's group intervention implemented in rural Nepal on women's agency in the household, found a limited association between the PLA intervention and women's agency [179]. An evaluation of the impact of the Low Birth Weight South Asia Trial (LBWSAT)'s PLA intervention on women's agency in pregnancy found an increase only in the area of empowerment related to group participation, with no significant changes observed in other areas [180]. LBWSAT demonstrated that food

supplements in pregnancy, combined with PLA women's groups, can increase birth weight [181].

3.3.5. Knowledge about sexually transmitted infections

Good knowledge of STIs has a positive influence on safer sex practices and encourages screening [182,183]. In 2021, 80% of women and 96% of men aged between 15 and 49 in Nepal had heard of HIV/AIDS, and 37% of women and 33% of men knew that the risk of vertical transmission can be reduced if the infected mother takes medication [100]. Although knowing where to get tested is the first condition for an individual to get tested, only 34% of women and 58% of men knew where to get tested for HIV in 2016 [184].

Data on knowledge of STIs other than HIV/AIDS in Nepal is limited, but it is probably safe to assume that knowledge is lower than that of HIV due to less media attention and coverage. A survey of adolescents in Kapilvastu and Arghakhanchi found that they learnt about STIs, including HIV, syphilis and gonorrhoea, mainly through school, media and peers, with little communication from parents [185]. A few adolescents interviewed also mentioned FCHVs as the source of such information in their community [185]. A survey of 680 young men and 720 young women aged 15-24 in Kathmandu Valley found that syphilis was the most well-known STI, followed by HIV, hepatitis B and gonorrhoea [186]. The few studies on syphilis and hepatitis B awareness focused only on young populations, highlighting the need for more research in Nepal [185,186].

Several studies have examined the knowledge and attitudes of Nepalese medical students regarding STIs. A study of 181 medical students conducted in Kathmandu in 2020 found that while more than 90% of participants knew that hepatitis B is caused by a virus and understood its routes of transmission, there were some misconceptions and negative attitudes towards people infected with hepatitis B [187]. A significant number of students thought that hepatitis B could be transmitted through casual contact, coughing/sneezing, or contaminated food or water. In addition, only 43.7% of participants said they felt comfortable sitting next to someone with hepatitis B, and 56.3% did not hesitate to shake hands or hug an infected person. Another study of 313 students at Chitwan Medical College conducted in 2015 found that 87% had correct knowledge about hepatitis B [188], and similar results were obtained by Paudel et al. in 2011 [189]. Regarding HIV, a cross-sectional study of 200 first- and second-year Bachelor of Medicine and Surgery students at Universal College of Medical Sciences Teaching Hospital in 2019 found that knowledge of HIV was high overall [190]. However, gaps remained in knowledge about routes of transmission. Although respondents generally had positive attitudes, stigmatising beliefs, such as support for isolation or banning HIV-positive people from entering the country, were notable. Similarly, a cross-sectional study carried out in 2023 at Dhading Hospital in Bagmati province revealed that most health workers had sufficient knowledge about the transmission of HIV. However, only 75.8% were aware of voluntary counselling and testing services, and 73.27% still considered HIV to be a taboo subject in Nepal [191]. Most of the investigations in Nepal to date have focused on medical students, and there is a need to study STI knowledge among health workers in the profession as well as in the broader community.

3.3.6. Discrimination and stigma related to sexually transmitted infections

A study carried out in Pokhara in 2018 revealed that people living with HIV/AIDS were highly stigmatised, which encouraged them not to reveal their status [192]. Similar findings were found by a global study that showed that stigma and fear of violence were obstacles to STI screening for pregnant women [193]. A review of studies on the impact of HIV-related stigma on the uptake of prevention of vertical transmission services in LMICs highlighted that tackling HIV-related stigma is critical to the success of maternal health services [194]. In line with these findings, the WHO, in its recommendations on integrated antenatal screening, advocates for additional measures to reduce health inequities and ensure that people can access health services without stigma and discrimination [195].

In 2021, 51% of women and 42% of men held discriminatory views about HIV-positive people, for example, believing that HIV-positive children should not attend the same school as others or avoiding buying from HIV-positive shopkeepers [100]. These attitudes were more widespread among people living in rural areas, the uneducated and the less wealthy.

Providers' discriminatory behaviours are a major barrier to STI screening in LMICs [196–201]. A qualitative study conducted in 2016 in two rural districts of the western region of Nepal, which interviewed young women aged between 15 and 19, identified service quality and provider behaviour as key reasons for not using STI screening services [185]. Studies conducted in Malawi, Brazil and Sub-Saharan African countries showed that these issues hinder husbands' involvement in reproductive health and STI screening [202–205]. This is confirmed in Nepal by a qualitative study conducted in 2017 on factors affecting men's participation in reproductive health [206]. Similarly, providers' discriminatory behaviours were recently reported as barriers by young Nepalese to accessing reproductive health services, including STI screening [207–209].

3.4. Conclusion

The unique geographical, socio-cultural and health system characteristics of Nepal make a case for integrating HIV, syphilis and hepatitis B screening and treatment services. The recent decentralisation of the health system with federalisation, economic challenges, disparities in health infrastructure and deep-rooted social and cultural norms significantly influence access to care. Persistent caste-based discrimination, gender inequalities, gender-based violence and family dynamics complicate access to maternal care in Nepal.

Existing gaps in screening for STIs, particularly syphilis, hepatitis B and HIV, underline the need to address these issues to improve maternal and child health outcomes. This thesis aimed to fill research gaps by providing a comprehensive analysis of antenatal screening for STIs in Nepal. The next chapters investigated factors influencing antenatal screening for HIV, syphilis and hepatitis B and their integration.

4. Barriers and facilitators to HIV antenatal screening

4.1. Introduction

Chapter 2 showed that factors affecting antenatal screening for HIV remain unexplored in Asia. However, understanding the barriers and facilitators to antenatal HIV screening is essential for developing targeted interventions to ensure early diagnosis and prevent vertical transmission of HIV. Moreover, given the uneven availability of screening services [124] and the unique geographical challenges in Nepal, understanding the impact of geographical factors on screening access is essential to improving screening uptake. Understanding these barriers may also inform screening for other blood-tested STIs, such as hepatitis B and syphilis, for which there is insufficient data to conduct this type of study.

Extensive literature has explored the role of women's empowerment in improving maternal health outcomes [210–212]. As presented in Chapter 3, Section 3.3, gender and family dynamics influence access to maternal care in Nepal. Considering the multidimensionality of empowerment and the lack of direct indicators [210], I conducted an exploratory analysis to examine how different dimensions of women's empowerment are associated with HIV antenatal screening decisions in Nepal.

To the best of my knowledge, this chapter represented the first national investigation of individual and district-level factors influencing antenatal HIV screening in Nepal, including geographical factors and women's empowerment. It was also the first study to apply multilevel models to explore HIV screening in the country, thus providing valuable insights into the field. Therefore, by investigating barriers and facilitators to HIV antenatal screening and addressing objective 2, as detailed in section 1.4, this chapter added to the literature on factors influencing antenatal screening for HIV. The main analysis of this chapter has been published in *BMJ Open* after a round of revisions based on comments from three reviewers [213].

In this chapter, I tested the following hypotheses:

- Hypothesis 1: Predisposing characteristics, enabling factors and need factors are associated with antenatal screening for HIV. These factors are different from those associated with ANC visits.
- Hypothesis 2: Women who were not screened despite attending an ANC visit were not screened because of supply-side barriers such as the health facility not having the necessary equipment or the ANC health worker not being sufficiently qualified to do so, rather than because they refused screening.
- Hypothesis 3: Given the geographical constraints and unequal provision of antenatal screening across Nepal, the cluster and the district of residence play a key role in whether or not women receive HIV screening during pregnancy. Women living in districts where more ANC services offer antenatal screening are more likely to be tested. Living in the hills is positively associated with HIV screening during pregnancy because it is in this region where the capital, Kathmandu, is located. The opposite effect is expected for the plains and mountains.

- Hypothesis 4: Factors associated with the utilisation of antenatal screening for HIV changed between 2016 and 2022.

In a complementary analysis, I also tested the following hypothesis:

- Hypothesis 5: Empowered women are more likely to make decisions about their health and therefore be screened for HIV during pregnancy.

In the next sections, I present the data and the empirical strategy, followed by the results from the various models. Finally, I discussed how this evidence fits within the existing literature.

4.2. Method

4.2.1. Data sources and samples considered

I used publicly available cross-sectional data from the Nepal Demographic and Health Survey collected between June 2016 and January 2017 (subsequently named NDHS 2016) [214] and between January and June 2022 [100] (subsequently named NDHS 2022). Sample design has been detailed elsewhere [184]. Stratified, multi-stage, random sampling was used to collect data. Nepal was divided into different strata based on geographical regions and other relevant factors, such as urban and rural areas. Within each stratum, clusters defined as neighbourhoods were randomly selected. In the second stage, households to be interviewed were randomly selected from these clusters, ensuring the national representativeness of the survey. For NDHS 2016 and NDHS 2022, respectively, the total sample was a representative cohort of the total prenatal population, including 1,978 and 2,007 women aged 15–49 years who gave birth in the two years preceding the survey and with information on antenatal screening for HIV during ANC.

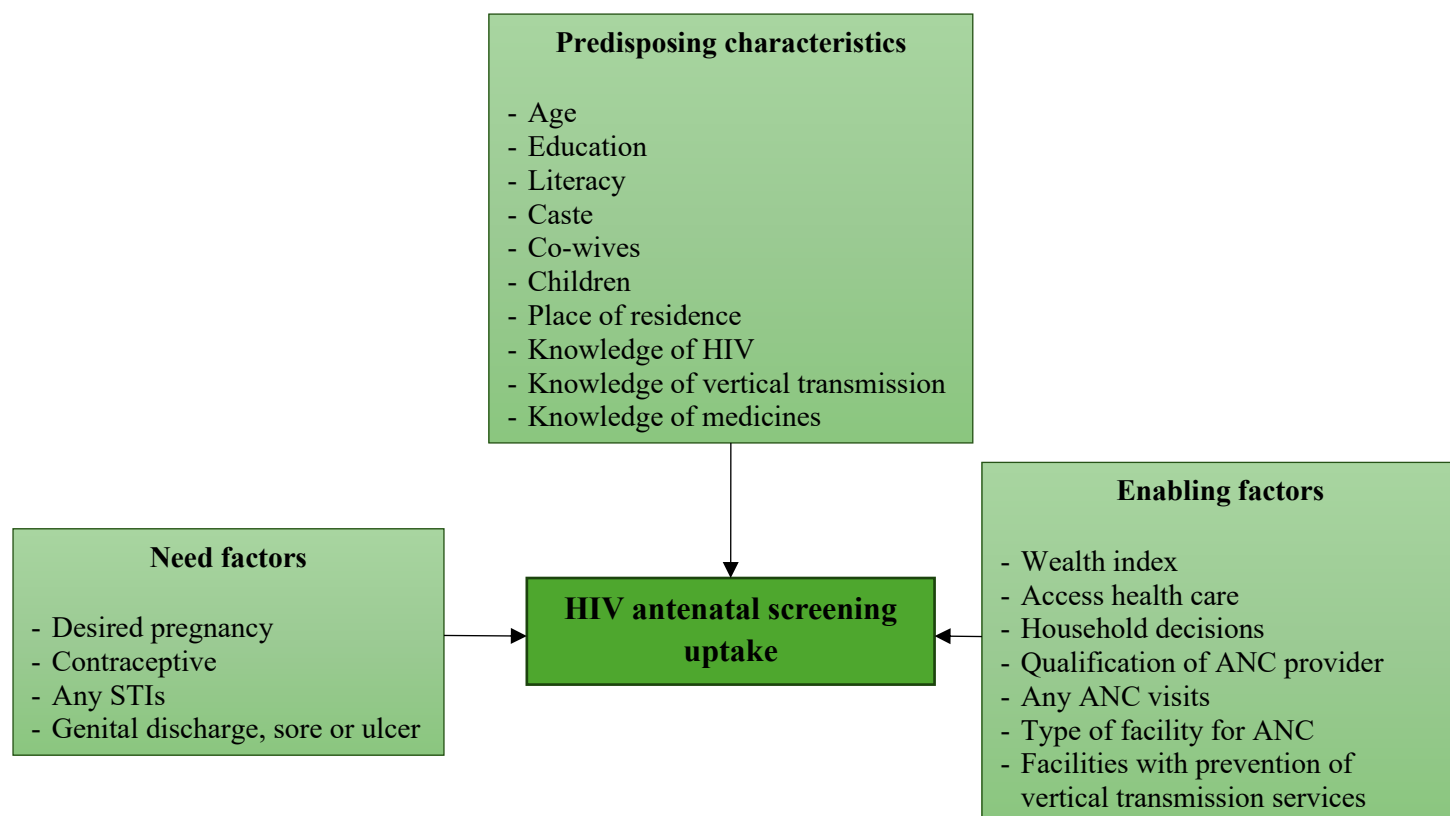
4.2.2. Outcome variable

The main outcome variable was a variable coded “1” if a woman was tested for HIV and got the results as part of an antenatal visit and “0” otherwise.

4.2.3. Exposure variables

I identified potential factors influencing antenatal screening for HIV based on the systematic literature review presented in Chapter 2 and organised potential factors using Andersen’s conceptual model (Figure 9) [215]. This theoretical framework for understanding how individual and environmental factors influence health behaviours identified three categories of predictors: i) Predisposing characteristics, including demographic factors, social structure, and health beliefs that influence health services use. ii) Enabling factors allowing the individual to seek health services if needed. iii) Need factors, including perceived needs of healthcare services use (Figure 9).

Figure 9 - Flow chart of potential influencing factors based on Andersen's conceptual model



Notes: HIV = Human Immunodeficiency Virus. STIs = Sexually transmitted infections. ANC = antenatal care

Table 4 describes the variables used in the analysis. I conducted multicollinearity tests between these potential variables using Cramer's V and the variance inflation factor. Subsequently, women's literacy was not included in the econometric analysis. Due to missing values, I did not include variables on discriminatory behaviour (465 missing observations), occupation (708 missing observations) and husband's education (708 missing observations).

Table 4 - Description of the variables

Name	Type	Description	Reference category
Dependent variables			
HIV screening	Binary	Coded "1" if the woman was tested for HIV and got the results	-
Any ANC visits	Binary	Coded "1" if the woman attended at least one antenatal (ANC) visit	-
Predisposing characteristics			
Age	Continuous	Grand-mean-centred woman's age	-
Education	Categorical	Highest level of schooling attended or completed	No education
Caste	Categorical	Ethnic and caste groups	Chhetri
Co-wives	Binary	At least one co-wife	No co-wives
Children	Discrete	Number of living children	-
Knowledge of HIV	Binary	Comprehensive knowledge of HIV, including knowing that consistent condom use and having a single sex	Do not have comprehensive knowledge

Knowledge of vertical transmission	Binary	partner reduce HIV risk, a healthy-looking person can have HIV, and mosquito bites do not transmit the virus. Knowledge of the risks of vertical transmission of HIV during pregnancy, childbirth and breastfeeding	Do not have comprehensive knowledge
Knowledge of medicines	Binary	Knowledge of the existence of drugs to reduce the risk of vertical transmission of HIV	Do not have comprehensive knowledge
Enabling factors			
Access health care	Binary	At least reported one problem accessing healthcare	No problem accessing
Household decisions	Binary	Decisions on health, spending and visits, alone or jointly with the partner	Not involved in decision-making
Qualification of ANC provider	Binary	Qualification of the person providing ANC	Unskilled healthcare provider
Facilities with prevention of vertical transmission services	Discrete	Number of facilities with prevention of vertical transmission services in the district of residence	-
Place of residence	Categorical	Agro-ecological zone of residence	Hill
Type of facility for ANC	Categorical	Type of facility where the last antenatal care visit took place	Home
Number of ANC visits	Categorical	Had the 4 ANC visits recommended by the World Health Organisation	Less than 4 ANC visits
Wealth Index	Categorical	Composite measure of household's cumulative living standard calculated based on ownership of assets, materials used for housing construction and types of water access and sanitation facilities	Poorest household
Need factors			
Contraceptive	Categorical	Current contraceptive use	No contraceptive method
Desired pregnancy	Categorical	Whether the pregnancy was wanted then, later, or not at all	Pregnancy wanted then
Any STIs	Binary	Had any sexually transmitted infections (STIs) in the last 12 months	No STIs
Genital discharge, sore or ulcer	Binary	Had genital discharge, sore or ulcer in the last 12 months	No genital discharge, sore or ulcer

Notes: STIs = Sexually transmitted infections. ANC = Antenatal care. HIV = Human Immunodeficiency Virus.

4.2.4. Descriptive analyses

I conducted descriptive analyses to investigate the completeness of key variables and to describe characteristics of women tested and untested for HIV during pregnancy using proportions and their confidence intervals (Appendix 2.1, Table 19).

4.2.5. Econometric analyses

Taking into account the possible correlation that may exist within and between clusters and districts, the hierarchical structure of the data with women (level 1) nested within clusters (level 2) nested within districts (level 3) and given that the dependent variable is binary, I used a two-level random intercept multinomial logistic regression model. I chose the 75 districts as level-2 units of analysis for NDHS 2016 and the 77 districts as level-2 units of analysis for NDHS 2022.

I estimated a series of multilevel multivariable logistic models with potential associated factors mutually adjusted to test the hypotheses and answer the research question [216,217] using NDHS data 2022 and 2016 in separate models. To test hypothesis 1 and determine factors associated with antenatal screening, I performed mutually adjusted multivariable analyses containing potential predisposing characteristics, enabling factors and need factors (model 1, Table 7). I hypothesised that these elements could be combined using the Andersen framework, which postulates that multiple interdependent factors jointly influence health behaviours. The framework supports the inclusion of all relevant factors, regardless of their independent significance, to account for complex interrelationships. I therefore decided a priori to test them simultaneously and adjust them mutually. To investigate the first hypothesis and distinguish barriers to HIV testing from barriers to accessing ANC services, I performed the same analyses using NDHS 2022 and 2016 data, with the dependent variable being a dummy variable indicating whether women attended at least one ANC visit (model 2, Table 7). I compared the results of model 1 and model 2. To test hypothesis 4, I compared the factors associated with the utilisation of antenatal screening for HIV between 2016 and 2022.

I tested the second hypothesis, ie. women were not screened despite attending an ANC visit because of supply-side barriers, by running the same multivariable multilevel logistic models as those used to test hypothesis 1 but on a sample composed only of women who attended at least one ANC visit (model 3, Table 7).

To explore the association between location in terms of district and cluster (and all the associated issues of road access and health service quality/availability) and women's access to HIV testing, independently of individual and household characteristics (hypothesis 3), I included districts and clusters in the model. To determine whether the fixed-effects model or the random-effects model at the cluster and district levels was more appropriate, I performed separate Hausman tests for both NDHS 2016 and NDHS 2022 data. The Hausman test tests the null hypothesis that the difference in coefficients between the two models is not systematic, implying that unobserved heterogeneity is uncorrelated with independent variables. Under this null hypothesis, the random effects model at the cluster and district level is preferred because it is more efficient and considers both within-group and between-group variability. Conversely, if the null hypothesis is rejected, this suggests that the fixed-effects model is more appropriate because it considers the presence of systematic differences caused by unobserved factors correlated with the independent variables. To test hypothesis 3, a logistic multilevel model without any explanatory variables was estimated to determine the existence of variability by clusters and districts.

To test hypothesis 5 and investigate the impact of women's empowerment on screening uptake, I estimated a multilevel multivariable logistic model containing proxy variables of women's empowerment as well as predisposing characteristics, enabling factors and need factors.

Given the oversampling of certain populations and as recommended to make data more nationally representative, I used individual weights [218]. I approximated level-1 weights using the method recommended by NDHS [219]. Given the method used to sample the NDHS data, districts have a chance of being included in the sample that is proportional to the size of their population. I estimated the level 2 weights by aggregating the individual weights at the district level and normalising them [219]. I used the *svy* command in STATA for all econometric analyses. I conducted all analyses using STATA 18 and the package *melogit*. Results were reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [48] (Appendix 2.2).

4.3. Results

4.3.1. Descriptive analyses

Table 5 reports on HIV counselling and screening during pregnancy. 20% of women who gave birth in the last two years reported being tested for HIV during ANC and receiving the results. This percentage did not change between 2016 and 2022.

Table 5 - Pregnant women counselled and tested for HIV in 2016 and 2022

	Were tested for HIV during antenatal care and who:	
	Received the results	Did not receive the results
2022		
Frequency	401	15
Percentage	20.27	0.75
Total sample	1,978	1,978
2016		
Frequency	383	9
Percentage	19.81	0.49
Total sample	1,933	1,933

Notes: HIV = Human Immunodeficiency Virus.

The characteristics of the study participants are presented in Appendix 2.1, Table 19. Samples were similar between the NDHS 2016 and NDHS 2022. The majority of the participants were between 15 and 30 years old and were literate, although they had not necessarily completed their education. Among women with a high level of education, the proportions of those who had undergone antenatal HIV screening and those who had not were equal. Among pregnant women from wealthy households, almost 80% did not get tested. More than 86% of women did not have comprehensive knowledge about HIV. The vast majority of women in the sample had at least one problem accessing health services. Among pregnant women who attended at least one ANC visit, most of them attended more than 4 visits with a skilled ANC provider. Most of the women tested attended an ANC visit at a public health facility.

Table 6 shows the HIV screening uptake rates among pregnant women according to the type of health facility where the last ANC visit took place. Screening uptake rates varied by type of facility, with federal and provincial hospitals and PHCs showing the highest rates, followed by private health facilities, outreach clinics and health posts/sub-health posts.

Table 6 - HIV screening uptake among pregnant women by type of health facility attended during the last ANC visit

	Screening uptake rate (%)
Federal and provincial hospitals	24.7
Primary health care centre (PHC)	24.3
Private health facility	21.1
Outreach clinic	20.4
Health/sub-health post	16.5

4.3.2. Econometric analyses

The results of the Hausman test for the 2016 and 2022 datasets failed to reject the null hypothesis (2016: $\chi^2(30) = 37.61$, $p = 0.16$; 2022: $\chi^2(30) = 34.83$, $p = 0.25$). These results suggested that there was no significant systematic difference between the coefficients estimated by the fixed- and random-effect models at the cluster and district levels. Thus, the random effects model at the cluster and district levels was considered appropriate for both datasets, indicating that clustering at the district level did not introduce significant bias in the estimated coefficients. This allowed the random effects model to better account for individual- and district-level variability while maintaining the efficiency of the estimates. The direction of the coefficients in the fixed-effects models was consistent with that observed in the random-effects models for both datasets, confirming the robustness of the random-effects approach in this analysis. Detailed results for the fixed-effect models are presented in Appendix 2.1, Table 20.

The estimated odds ratios (OR) of the potential factors influencing HIV screening during pregnancy for the random-effect models at the cluster and district levels are presented in Table 7. Hypothesis 1 was partially supported by the results. Only certain predisposing characteristics, enabling and need factors were significantly associated with HIV screening. Model 1 (Table 7), which contains variables at the individual and district level, showed that women with incomplete secondary, complete secondary or higher education were respectively 2.6, 4.5 and 4.7 times more likely to be tested during pregnancy than women with no education. Women with knowledge of vertical transmission and knowledge of the availability of medicines to avoid it had a significantly higher likelihood of being tested during pregnancy. Among the enabling factors, all had a significant impact on the likelihood of being tested, except the variable indicating barriers to accessing health care services and the variable about access to health care. Pregnant women who had 4 or more ANC visits were more likely to be tested than women who had fewer visits. Pregnant women from wealthier households were more likely to be tested for HIV than women from poor households. Meanwhile, among the need factors, women wanting the pregnancy later had a significantly higher likelihood of being tested.

Factors significantly associated with ANC visits and antenatal screening differed (Model 2, Table 7). Factors associated with having any ANC visits were the caste, the presence of co-wives, the number of children, the agroecological zone of residence and the participation in decision-making within the household. Factors associated with antenatal screening for HIV included the education level of the mother, the number of ANC visits, the wealth, whether the pregnancy was desired later and knowledge of vertical transmission and the availability of medicines to avoid it. None of these factors overlapped.

Contrary to hypothesis 2, assuming that women were not screened despite attending an ANC visit because of supply-side barriers, when considering only those women who attended at least one ANC visit (Model 3, Table 7), having a qualified health professional and the type of facility when attending ANC visits were not significantly associated with antenatal screening.

The intraclass correlation coefficient (ICC) represents the proportion of the variation between districts and clusters in the total variation. In the empty model, the ICC indicated that 24.6% of the chance of being tested for HIV during pregnancy was explained by differences between districts and 75.4% by differences within the district. The ICC indicated that 27.0% of the chance of being tested for HIV during pregnancy was explained by differences between clusters. The cluster and the district of residence are partially associated with antenatal screening. Hypothesis 3 also assumed that living in hilly areas positively influenced antenatal screening and that women living in districts where such antenatal screening was more available in ANC services were more likely to be tested. This was not verified in the data. The environment of residence and the number of facilities offering prevention of vertical transmission services in the district of residence did not have a statistically significant association with the probability of women being screened (Model 1, Table 7).

When comparing Model 1 (Table 7) for 2016 and 2022 to investigate hypothesis 4, the factors associated with HIV screening during pregnancy have slightly changed between 2016 and 2022. The association between education, wealth, knowledge of medicines and the number of ANC visits on HIV antenatal screening remained positive and significant in both years. However, participation in household decisions and having genital discharge, sore or ulcer were significantly associated with HIV screening in NDHS 2016 but not in 2022. Moreover, knowledge of vertical transmission and the pregnancy being desired were not significant in NDHS 2016 but were in 2022. In 2016, 34.8% of the chance of being tested for HIV during pregnancy was explained by differences between districts and 43.8% by differences between clusters, whereas in 2022, districts explained 24.6% and clusters 27.0%.

Table 7 – Odds ratios of the multilevel multivariable logistic regression of the potential factors associated with HIV screening during pregnancy and ANC visits in 2016 and 2022

	Model 1		Model 2		Model 3	
	HIV screening		Any ANC visits		HIV screening conditioned on ANC visit	
	2022	2016	2022	2016	2022	2016
n_i	1,995	1,966	1,778	1,969	1,866	1,884
n_j	74	73	74	73	74	73
Predisposing characteristics						
Age	1.0 (1.0, 1.1)	1.0 (1.0, 1.1)	1.1 (1.1, 1.3)	1.0 (1.0, 1.1)	1.0 (1.0, 1.1)	1.0 (1.0, 1.1)
Education						
Incomplete primary	1.3 (0.7, 2.4)	1.6 (0.8, 3.1)	2.0 (0.7, 5.8)	2.4 (0.8, 7.3)	1.3 (0.7, 2.5)	1.4 (0.7, 2.8)
Complete primary	1.6 (0.7, 3.6)	1.1 (0.5, 2.4)	0.5 (0.0, 3.1)	1.6 (0.4, 5.7)	1.7 (0.7, 3.9)	1.0 (0.5, 2.4)
Incomplete secondary	2.6** (1.3, 5.1)	2.7*** (1.5, 4.5)	1.5 (0.4, 5.5)	3.4* (1.1, 11.1)	2.7** (1.4, 5.4)	2.5*** (1.5, 4.3)
Complete secondary	4.5*** (2.0, 9.8)	3.1* (1.2, 7.8)	0.8 (0.1, 5.6)	7.2* (1.0, 50.8)	4.1*** (1.8, 10.9)	2.7** (1.1, 6.7)
Higher	4.7*** (1.9, 11.2)	5.6*** (3.0, 10.7)	-	32.4** (2.4, 429.0)	4.5*** (1.8, 10.9)	5.1*** (2.7, 9.7)
Caste						
Brahmin	1.5 (0.8, 2.9)	1.7 (0.9, 3.2)	-	6.8 (0.6, 73.1)	1.7 (0.8, 3.4)	1.8 (0.9, 3.4)
Other	1.0 (0.4, 2.1)	0.6 (0.3, 1.3)	11.9** (2.0, 70.0)	0.2* (0.1, 0.9)	0.9 (0.4, 2.1)	0.6 (0.3, 1.2)
Dalit	1.0 (0.6, 1.6)	1.2 (0.6, 2.4)	2.9 (0.7, 12.0)	0.6 (0.2, 1.7)	0.9 (0.5, 1.6)	1.3 (0.7, 2.4)
Newar	1.1 (0.5, 2.3)	1.1 (0.4, 3.3)	-	0.0*** (0.0, 0.2)	1.0 (0.5, 2.2)	1.1 (0.4, 3.5)
Janajati	1.0 (0.7, 1.6)	0.8 (0.5, 1.4)	1.5 (0.3, 6.8)	0.3** (0.1, 0.8)	1.1 (0.7, 1.6)	0.8 (0.5, 1.4)
Muslim	0.6 (0.1, 2.0)	0.9 (0.4, 2.4)	7.3** (1.6, 33.9)	2.6 (0.4, 18.2)	0.5 (0.1, 1.9)	0.9 (0.4, 2.3)
Co-wives	1.4 (0.6, 3.5)	0.6 (0.2, 2.1)	51.5*** (8.0, 333.1)	0.3 (0.1, 1.6)	1.5 (0.6, 4.0)	0.5 (0.2, 1.8)
Children	0.9 (0.7, 1.1)	0.8 (0.7, 1.0)	0.3*** (0.2, 0.6)	0.7* (0.6, 0.9)	0.9 (0.7, 1.1)	0.8 (0.7, 1.0)
Environment of residence						
Mountain	0.6 (0.3, 1.4)	0.4 (0.2, 1.1)	12.1* (1.2, 119.8)	7.3 (0.7, 78.3)	0.7 (0.3, 1.5)	1.4 (0.1, 1.1)
Terai	0.7 (0.4, 1.4)	0.8 (0.0, 0.1)	0.1** (0.0, 0.6)	1.3 (0.3, 4.5)	0.8 (0.4, 1.4)	0.9 (0.5, 1.0)
Knowledge of HIV	1.5 (0.9, 2.5)	1.2 (0.8, 1.8)	2.3 (0.2, 28.8)	1.8 (0.6, 5.8)	1.3 (0.8, 2.3)	1.2 (0.8, 1.7)
Knowledge of vertical transmission	1.9** (1.2, 2.9)	1.2 (0.9, 1.8)	0.6 (0.3, 1.3)	1.1 (0.5, 2.3)	1.9** (1.2, 3.1)	1.3 (0.9, 1.8)
Knowledge of medicines	1.5* (1.0, 2.1)	2.2*** (1.5, 3.2)	1.0 (0.4, 2.4)	1.0 (0.5, 1.8)	1.5* (1.0, 2.1)	2.1*** (1.5, 3.1)
Enabling factors						
Access health care	0.8 (0.6, 1.1)	0.8 (0.5, 1.2)	0.4 (0.1, 1.1)	0.5 (0.1, 2.3)	0.7* (0.6, 1.0)	0.8 (0.5, 1.3)
Household decisions	1.0 (0.8, 1.4)	2.1*** (1.4, 3.3)	2.7* (1.1, 6.4)	1.3 (0.5, 3.3)	1.0 (0.8, 1.4)	2.2*** (1.4, 3.4)
Facilities with prevention of vertical transmission services	1.0 (1.0, 1.0)	1.0 (0.9, 1.0)	1.0 (0.9, 1.1)	0.9 (0.9, 1.0)	1.0 (1.0, 1.0)	1.0 (0.9, 1.0)
Health worker skills	-	-	-	-	5.0 (0.7, 34.1)	2.1* (1.0, 4.2)

Facility type						
Federal and provincial hospitals	-	-	-	-	0.3 (0.3, 2.0)	1.6 (0.7, 3.5)
PHC center	-	-	-	-	0.3 (0.0, 2.5)	1.1 (0.4, 3.4)
Health post	-	-	-	-	0.2 (0.0, 1.8)	0.8 (0.4, 1.6)
PHC outreach clinic	-	-	-	-	0.4 (0.0, 3.0)	0.9 (0.3, 2.7)
Other public facilities	-	-	-	-	0.0* (0.0, 0.5)	1.2 (0.6, 2.6)
Private facilities	-	-	-	-	0.3 (0.0, 2.2)	0.9 (0.5, 1.8)
Other	-	-	-	-	0.4 (0.0, 4.5)	0.4 (0.1, 1.9)
Number of ANC visits	2.2** (1.3, 3.7)	3.0*** (2.0, 4.7)	-	-	1.7** (0.9, 2.9)	2.8** (1.8, 4.3)
Wealth Index						
Poorer	0.8 (0.5, 1.6)	1.6** (1.1, 2.3)	2.4 (0.8, 7.1)	2.9* (1.0, 8.4)	0.9 (0.5, 1.6)	1.5* (1.1, 2.2)
Middle	1.1 (0.6, 2.1)	1.7* (2.0, 2.9)	5.6* (1.3, 23.7)	5.1** (1.8, 13.9)	1.1 (0.6, 2.1)	1.5 (0.9, 2.6)
Richer	1.7 (0.9, 3.1)	1.7* (1.0, 2.8)	1.7 (0.4, 7.8)	7.5*** (2.2, 25.0)	1.7 (0.9, 3.3)	1.4 (0.8, 2.4)
Richest	2.8** (1.3, 5.8)	2.5** (1.3, 4.9)	7.5 (0.6, 100.5)	1.3 (0.3, 6.5)	2.7** (1.3, 5.9)	2.0* (1.0, 4.0)
Need factors						
Contraceptive						
Traditional method	0.9 (0.6, 1.4)	0.7 (0.4, 1.2)	6.3 (0.6, 69.2)	0.2** (0.1, 0.7)	0.9 (0.5, 1.4)	0.7 (0.4, 1.2)
Modern method	1.0 (0.7, 1.5)	0.8 (0.5, 1.2)	1.8 (0.7, 450.0)	1.0 (0.5, 1.9)	1.2 (0.8, 1.7)	0.8 (0.5, 1.2)
Desired pregnancy						
Wanted later	1.6* (1.1, 2.3)	0.8 (0.4, 1.5)	1.8 (0.6, 5.3)	0.9 (0.4, 2.2)	1.7** (1.2, 2.4)	0.8 (0.4, 1.5)
Wanted no more	1.0 (0.4, 2.5)	0.8 (0.4, 1.5)	2.2 (0.5, 9.6)	0.3** (0.2, 0.6)	1.1 (0.4, 2.5)	0.8 (0.4, 1.4)
Any STIs	4.5 (0.3, 65.4)	3.2 (0.4, 22.8)	-	-	-	2.8 (0.5, 14.4)
Genital discharge, sore or ulcer	1.1 (0.8, 1.6)	1.9** (1.2, 3.0)	0.5 (0.2, 1.1)	1.3 (0.3, 5.4)	1.1 (0.8, 1.7)	2.0** (1.2, 3.2)
Variance at the district level	0.9 (0.6, 1.4)	1.1 (0.6, 1.8)	14.5 (6.0, 35.1)	5.7 (2.8, 11.4)	0.9 (0.6, 1.5)	1.0 (0.6, 1.7)
Variance at the cluster level	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	1.0 (0.3, 3.2)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
Intraclass correlation at the district level	0.2 (0.1, 0.3)	0.2 (0.2, 0.3)	0.8 (0.6, 0.9)	0.6 (0.5, 0.8)	0.2 (0.2, 0.3)	0.2 (0.2, 0.3)
Intraclass correlation at the cluster level	0.2 (0.1, 0.3)	0.2 (0.2, 0.3)	0.8 (0.7, 0.9)	0.6 (0.5, 0.8)	0.2 (0.2, 0.3)	0.2 (0.2, 0.3)

Notes: ni: number of women in the sample; nj: number of districts; *p≤0.05; **p≤0.01; ***p≤0.001. 95% confidence intervals in parentheses. STIs = Sexually transmitted infections. HIV = Human Immunodeficiency Virus. PHC = Primary health care. ANC = Antenatal care.

4.4. Complementary analysis

Women's empowerment is increasingly recognised as a key determinant of maternal and child health outcomes, including the use of antenatal care services [220,221]. Empowered women, who are characterised by greater autonomy in decision-making, greater freedom of movement and better control over resources, are generally more likely to seek and access essential health

services, thereby improving their own health and that of their children. This relationship can be explained by the increased ability of empowered women to navigate health systems [210], negotiate with their partners and family members [222], and prioritise their own health needs [223].

However, evidence on the impact of women's empowerment on ANC uptake remains mixed and context-specific. For instance, a multi-country analysis across 33 Sub-Saharan African countries found no significant association between women's empowerment and ANC uptake [224]. Moreover, findings are mixed regarding which specific empowerment dimension exerts the greatest influence. A study conducted in Afghanistan identified women's decision-making power within the household as a key factor influencing ANC uptake [225], whereas research in Sub-Saharan African countries highlighted economic empowerment as having a stronger effect [226,227].

To date, there are no data on the specific impact of women's empowerment on the use of antenatal HIV screening. While empowerment has been associated with general use of ANC, its role in HIV screening during pregnancy has not been studied, particularly in Asia, where cultural, social, and structural barriers may influence women's ability to access and consent to these services.

4.4.1. Method

I carried out this additional analysis after the publication of the main analysis. This decision was motivated by the results of the qualitative study (Chapter 5), which highlighted that women's empowerment, and in particular their autonomy in decision-making, was crucial in influencing their access to antenatal screening services. Given that empowerment directly influences the ability to overcome family and systemic barriers, further investigation was required to quantify its impact on antenatal screening uptake. I only used data from the NDHS 2022, as the dynamics of empowerment and access to HIV screening change over time. Focusing on the most recent data allowed me to explore current trends and behaviours.

The main outcome variable was the same as in the main analysis: a variable coded “1” if a woman was tested for HIV and got the results as part of an antenatal visit and “0” otherwise. Based on the variables commonly used in the literature as a proxy of women's empowerment [210] and their availability in the NDHS database, I considered the exposure variables presented in Table 8. I recoded the answers to the selected questions so that a higher value (1) was given to categories considered to indicate greater empowerment, and the reference category was coded 0. The data do not cover psychological, legal, or political aspects of empowerment. I performed univariate logistic regression analyses for each empowerment variable. I included them in the multivariate logistic model of the main analysis. None remained significant in the multivariate analysis, suggesting a multicollinearity issue between the empowerment variables.

Table 8 - Variables considered for the association between women's empowerment and antenatal screening

Name	Type	Description: the female respondent	Reference category
<i>Health empowerment dimension</i>			
Permission needed	Binary	Sees permission requirements as a major obstacle in accessing healthcare	Yes
Contraception decisions	Binary	Decides on the use of contraception	No
Health care decisions	Binary	Has final say on her healthcare	No
<i>Mobility empowerment dimension</i>			
Family visits decisions	Binary	Participates in the decisions about her visits to family or relatives	No
<i>Violence dimension</i>			
Emotional violence	Binary	Experienced emotional violence from husband	Yes
Less severe violence	Binary	Experienced less severe violence from husband	Yes
Severe violence	Binary	Experienced severe violence from husband	Yes
Sexual violence	Binary	Experienced sexual violence from husband	Yes
<i>Economic empowerment dimension</i>			
Large purchase decisions	Binary	Participates in decisions about large household purchases	No
Owns assets	Binary	Owns land or property	No

No important correlation was found between empowerment-related variables and predisposing characteristics, enabling factors and need factors (Appendix 1.1, Table 21). The correlation matrix (Table 9) indicated a correlation between some of the empowerment-related variables. To address this problem, I created an empowerment index [228]. I created the index using principal components analysis (PCA). I analysed scree plots to define the number of components to be retained and applied orthogonal varimax rotation to the retained components. The variable about the knowledge of assets was excluded from the empowerment index due to its weak and negative correlations with other empowerment variables.

Table 9 - Correlation matrix of the empowerment variables

	Permission needed	Contraception decisions	Health care decisions	Family visits decisions	Emotional violence	Less severe violence	Severe violence	Sexual violence	Large purchase decisions	Knowledge of assets
Permission needed	1.00									
Contraception decisions	0.06	1.00								
Health care decisions	0.07	0.20	1.00							
Family visits decisions	0.05	0.17	0.46	1.00						
Emotional violence	0.06	0.15	0.11	0.10	1.00					
Less severe violence	0.02	0.10	0.06	0.11	0.46	1.00				
Severe violence	0.04	0.12	0.00	0.10	0.42	0.59	1.00			
Sexual violence	0.05	0.15	0.05	0.10	0.48	0.42	0.46	1.00		
Large purchase decisions	0.06	0.12	0.42	0.60	0.07	0.05	0.02	0.03	1.00	
Owns assets	0.01	-0.01	-0.01	0.06	-0.02	0.07	0.05	0.02	0.07	1.00

The empowerment index was included in the multilevel multivariable logistic model estimated in the main analysis that included predisposing characteristics, enabling factors and need factors to assess their association with HIV antenatal screening.

More empowered women are generally more likely to use health services [210,229,230]. To evaluate the validity of the empowerment index, I examined its association with two binary variables: whether the woman gave birth in a health facility and whether she received at least four ANC visits. Logistic regression models were used to estimate these associations, taking household wealth into account. As wealth was strongly correlated with outcomes, this adjustment aimed to determine whether empowerment was independently associated with these health outcomes.

As an alternative to the analyses using the empowerment index derived using the PCA, to quantify women's empowerment across various dimensions, I constructed indices for health, mobility, violence, and economic empowerment. Given the low number of variables within each dimension (Table 8) and their limited correlation (Table 9), I used a straightforward additive approach by summing the relevant variables for each dimension. This method provides an interpretable measure, where each index reflects a specific dimension of empowerment. To facilitate interpretation, I applied binary categorisation for each index with 1 indicating higher empowerment and 0 indicating lower empowerment. The indices, as well as the predisposing characteristics, enabling factors, and need factors, were included in the multilevel multivariable logistic model estimated in the main analysis to assess their association with HIV antenatal screening.

4.4.2. Results

Table 10 presents descriptive statistics for the empowerment variables. The majority of the women in the sample did not need permission to access healthcare (76%), and 89% were involved in contraception decisions. Moreover, 64% declared having the last say in the decision regarding their health care. Women who did not require permission for healthcare access, women involved in contraception decisions and those participating in healthcare decisions had higher testing rates compared to their counterparts. Regarding the social dimension, 3% of the women were reported experiencing violence from their husbands. Women who experienced emotional, physical, or sexual violence had lower screening rates than those who had not. A small proportion of women own assets (5%). A slightly larger proportion of women were excluded from large purchase decisions (58%). Women who can decide on large purchases and women owning assets had a higher testing rate than their less-empowered counterparts.

Table 10 - Descriptive statistics for different dimensions of empowerment conveyed by the empowerment variables

	Not tested Freq (%)	Tested Freq (%)
<i>Health empowerment dimension</i>		
Needs permission to go to health facilities		
Yes (0)	410 (24.0)	63 (17.0)
No (1)	1,226 (76.0)	308 (83.0)
Can make decisions about contraception		
Yes (1)	1,438 (87.9)	343 (92.5)
No (0)	198 (12.1)	28 (7.5)
Can make decisions about her health care		
Yes (1)	989 (60.5)	278 (74.9)
No (0)	647 (39.5)	93 (25.1)
<i>Mobility empowerment dimension</i>		
Can decide when to visit family in parental home		
Yes (1)	829 (50.7)	238 (64.2)
No (0)	807 (49.3)	133 (35.8)
<i>Violence dimension</i>		
Experienced emotional violence		
Yes (0)	72 (11.9)	11 (8.3)
No (1)	531 (88.1)	121 (91.7)
Experienced less severe violence		
Yes (0)	117 (19.4)	15 (11.3)
No (1)	485 (80.6)	118 (88.7)
Experienced severe violence		
Yes (0)	54 (9.0)	7 (5.3)
No (1)	549 (91.0)	125 (94.7)
Experienced sexual violence		
Yes (0)	44 (7.3)	5 (3.8)
No (1)	559 (92.7)	127 (96.2)
<i>Economic empowerment dimension</i>		
Can make decisions about household's large purchases		
Yes (1)	658 (41.7)	185 (49.8)
No (0)	978 (58.3)	186 (50.2)
Owns assets		
Yes (1)	79 (4.8)	31 (8.2)
No (0)	1,557 (95.2)	340 (91.8)

Notes: Percentages presented in parentheses. Freq = Frequencies

Table 11 presents the estimated univariate odds ratio of the association between individual women's empowerment variables and HIV screening during pregnancy. All variables were significantly associated with HIV antenatal screening, except the variable on severe violence. Higher empowerment was associated with higher odds of HIV screening during pregnancy.

Table 11 – Univariate logistic regressions of the association between women's empowerment variables and HIV screening during pregnancy (odds ratio, 95% CI in parentheses)]

	Odds ratios
<i>Health empowerment dimension</i>	
Does not need permission to go to health facilities (n = 2,007)	1.6** (1.1, 2.4)
Can make decisions about contraception (n = 1,995)	1.7* (1.1, 2.8)
Can make decisions about her health care (n = 1,995)	2.0*** (1.1, 0.3)
<i>Mobility empowerment dimension</i>	
Can decide when to visit family in parental home (n = 1,995)	1.8*** (1.4, 2.5)
<i>Violence dimension</i>	
Did not experience emotional violence (n = 735)	2.2** (1.2, 3.8)
Did not experience less severe violence (n = 735)	3.1** (1.4, 7.0)
Did not experience severe violence (n = 735)	2.1 (0.8, 5.8)
Did not experience sexual violence (n = 735)	3.2* (1.1, 9.2)
<i>Economic empowerment dimension</i>	
Can make decisions about household's large purchases (n = 2,007)	1.5* (1.1, 2.0)
Owens assets (n = 2,007)	2.2** (1.3, 3.5)

Notes: Confidence intervals presented in parentheses. *p-value≤0.05; **p-value≤0.01; ***p-value≤0.001. n = Total sample.

As the odds ratios for the variables included in the main analysis were in the same direction as those for the primary analysis, only the odds ratios for the empowerment indices are presented in Table 12. Although higher scores on the mobility empowerment index, economic empowerment index, and violence index were associated with slightly increased odds of HIV screening during pregnancy in the multivariate model after adjusting for predisposing characteristics, enabling factors, and need factors, none of these associations were statistically significant.

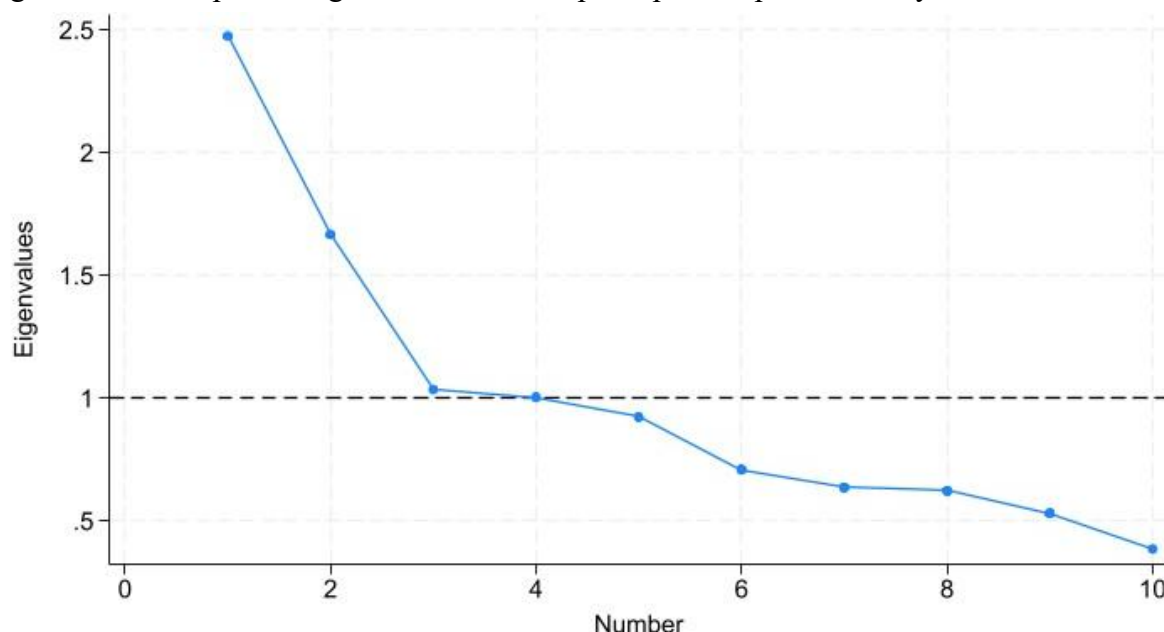
Table 12 – Mutually adjusted odds ratios for empowerment indices in multivariate logistic regression analysis of potential factors associated with HIV screening during pregnancy, controlling for predisposing characteristics, enabling factors, and need factors (odds ratio, 95% CI in parentheses)

n = 731	Odds ratios
Health empowerment index (1=more empowered)	1.0 (0.4, 2.6)
Mobility empowerment index (1=more empowered)	1.3 (0.6, 2.5)
Violence index (1=more empowered)	1.6 (0.7, 4.0)
Economic empowerment index (1=more empowered)	1.2 (0.6, 2.4)

Notes: Confidence intervals presented in parentheses. *p-value≤0.05; **p-value≤0.01; ***p-value≤0.001. No asterisks in this table as none of the variables were statistically significant. n = Total sample. Other explanatory variables included in the model: any sexually transmitted infections, genital discharge, sore or ulcer, wealth index, contraceptive, desired pregnancy, number of antenatal care visits, co-wives, children, environment of residence, knowledge of HIV, knowledge of vertical transmission, knowledge of medicines, access health care, facilities with prevention of vertical transmission services, health worker skills, age, education, caste.

Regarding constructing the global empowerment index using the PCA, scree plots (Figure 10) showed an abrupt flattening of the curve (ie. slower reduction in the eigenvalues) after the third component. Based on this observation, I retained the first three components and applied varimax rotation to identify which variables strongly contribute to each component by maximising the variance of squared loadings across each variable within the components. These three components were combined into a single global empowerment index by weighing each variable according to its loading across the three components. I assessed the validity of the global empowerment index through its association with place of delivery and the number of ANC visits. Compared with their less-empowered counterparts, I found that more-empowered women were significantly more likely to deliver in a health facility (OR: 1.2, 95% CI: [1.0, 1.4]). They were also slightly more likely to attend at least 4 ANC visits (OR: 1.1, 95% CI: [0.9, 1.3]), but this association was not statistically significant at the 5% threshold.

Figure 10 - Scree plot of eigenvalues after the principal components analysis



The global empowerment index (coded with a higher score, the more empowered the woman is) was slightly positively but not significantly associated with HIV antenatal screening in the multivariate model after adjusting for predisposing characteristics, enabling factors and need factors (OR: 1.12, 95% CI: [0.8, 1.5]). The odds ratios for the predisposing characteristics, enabling factors, and need factors were in the same direction as in the main analysis.

4.5. Discussion and Conclusions

4.5.1. Discussion

This chapter contributed to understanding the effects of individual- and district-level factors on the utilisation of antenatal screening. I found that HIV screening uptake and the factors associated with antenatal screening remained largely unchanged between 2016 and 2022. This suggests that the barriers to the use of antenatal screening have not changed and that the Nepalese health system and policymakers continue to face difficulties in addressing them effectively. I found higher uptake of HIV screening among women with higher education, whose pregnancy was desired later and women who had four or more ANC visits. Being from a poorer family and having low knowledge of vertical transmission and of the medicines to prevent transmission were associated with lower uptake. Although supply-side factors are not well represented in the individual-level DHS dataset, no factors from the supply side were significantly associated with antenatal screening. Similarly, none of the empowerment indices were significantly associated with antenatal screening.

Only 20% of women who gave birth in the last two years reported being tested for HIV and receiving the results. This is much lower than the 82% of women in Nepal tested for HIV during pregnancy reported by UNAIDS in 2022 [120]. This may be explained by the fact that UNAIDS data are collected from facilities, so the denominator is women attending ANC in a facility,

whereas NDHS data are reported by women, who may be unaware that they have been tested for HIV as part of their antenatal blood tests.

As found in other studies [55,200,231–235], I have shown that the more educated a woman was, the more likely she was to be screened for HIV during pregnancy. My results are consistent with other studies conducted in South- [236], East- [237–239] and sub-Saharan- Africa [196,200] which showed that knowledge of vertical transmission and the drugs to prevent it were significantly associated with antenatal screening. While educational programmes and awareness campaigns are essential to encourage screening and reduce stigmatisation, they must be designed with particular care. Community involvement in the design and implementation of these interventions is essential to ensure that they are culturally and contextually sensitive [240,241]. Despite decades of global efforts to raise awareness of HIV and its prevention, limited progress has been made, with persistent discrimination and gaps in knowledge and risk perception underlining the need for more innovative and inclusive strategies [242].

I found that women of wealthier households were more likely to be tested for HIV during pregnancy. Studies conducted in Tanzania by Westheimer, Urassa [243] and by Thierman et al. [244] in Zambia showed an opposite association between wealth and HIV screening. These contradictory results might be explained by the fact that the two studies were carried out in urban areas, where the financial barriers to screening, linked, for example, to the journey required to access screening services, are likely to be lower. However, studies conducted in Vietnam [64], sub-Saharan- [245] and East Africa [238] also found that wealthier pregnant women were more likely to be tested for HIV. To reduce financial barriers in contexts where screening is widely available, antenatal screening could become a prerequisite for obtaining the cash transfers already implemented in Nepal for completing four ANC visits [246] (see Chapter 3, Section 3.2.4). However, this can only be done once the supply-side issues have been addressed. Indeed, given the current lack of availability of screening services in many facilities, this could unfairly penalise women who do not have access to screening. Efforts must first address supply-side barriers to ensure equitable access to screening in all settings.

Among the need factors, only wanting a later pregnancy is significantly associated with antenatal screening. This may be explained by the fact that women do not always have the necessary information to consider risk factors as an indicator of the need for screening, and the fact that the prevalence of HIV in Nepal is relatively low [247]. A study conducted in Ethiopia showed that the lack of HIV risk perception was a major self-reported barrier to HIV screening [233]. Similarly, Katamba et al. (2019) showed that perceived risk was associated with higher hepatitis B antenatal screening in Uganda [248].

Attending ANC services, being a first step to accessing screening services, I found that pregnant women who attended four or more ANC visits were more likely to be tested. Attending fewer than six antenatal visits has been identified as a barrier in the literature [249], and women who had more than one antenatal visit were more likely to have been screened [250]. However, this chapter showed that the barriers to antenatal screening were different from those to ANC visits. Addressing the barriers to antenatal visits is not sufficient to improve access to screening.

In the Nepalese context, the shortage of equipment [251] and health workers [252] suggests that the supply-side barriers are significant. According to the Nepal Health Facility Survey (NHFS) 2021, only 7% of facilities offering ANC had staff with up-to-date training in infection control guidelines, and screening capacities were limited, with less than 3% of the facilities offering ANC care able to conduct HIV screening [124]. No factors on the supply side, such as the type of health facility or the health workers' qualification, were significantly associated with antenatal screening. Rather than a real absence of barriers on the supply side, this may be explained by the nature of the data. The NDHS data, while comprehensive, do not capture the variation and complexity of supply-side factors such as the knowledge and behaviour of health professionals and the quality of services, for example. In-depth qualitative studies should be conducted to better capture and understand these barriers.

None of the empowerment variables available in the NDHS datasets were found to be significantly associated with HIV antenatal screening after adjusting for predisposing characteristics, enabling factors and need factors. This conclusion contrasts with several previous studies that have shown that women's empowerment is positively associated with the use of ANC in Asia [220,221,225,253], although no study has examined the direct association with HIV testing.

However, the multidimensional nature of women's empowerment makes it difficult to capture its full impact on health outcomes [254]. Women's empowerment encompasses health [210], psychological [255], social [256], economic [257], legal [256], and political dimensions [258]. Many of these dimensions are context-specific and difficult to capture fully with standard survey instruments [259]. The NDHS data used in this analysis were not specifically designed to capture women's empowerment. Although they provide some proxies, these variables cannot fully reflect empowerment's complex and context-specific nature.

In addition, the adjusted model took into account several other factors, such as education and knowledge of medication to prevent vertical transmission, which are strongly and directly associated with HIV screening. This adjustment may have reduced the apparent effect of the empowerment variables, as these factors may mediate or moderate the association between empowerment and HIV antenatal screening uptake.

To the best of my knowledge, no quantitative study has specifically examined the impact of women's empowerment on antenatal HIV screening uptake. However, a study conducted in Peru examined the impact of four dimensions of women's empowerment on their likelihood of being tested for HIV: economic empowerment, freedom of movement, respect for women's opinions and rights within the couple and autonomy in health decision-making [260]. The study found that greater freedom of movement increased the likelihood of HIV testing. The study also found that autonomy in decision-making significantly increased the likelihood of seeking sexual and reproductive health services, including consultations for STI symptoms. Studies have also examined the impact of women's empowerment on ANC visit attendance in Bangladesh and sub-Saharan African countries [253,261]. They found that greater empowerment of women is associated with higher ANC attendance, with empowered women more likely to start ANC early and attend the recommended number of visits.

Access to screening services is another factor associated with the decision to undergo antenatal screening identified in the literature [200,201,262,263]. Given the geographical constraints in Nepal and the uneven provision of antenatal screening across the country, I initially assumed that place of residence would play an important role in screening uptake. However, I found that the district and cluster of residences were only partially associated with antenatal screening for HIV. Given the multi-level nature of the models used, this result could reflect the dominant association of individual factors, such as education, knowledge about HIV or number of ANC visits, which may overshadow variations at the district and cluster level. In addition, significant variability within districts, between urban centres and remote areas, could dilute any measurable effect at the district level.

Although I found that HIV screening uptake and the factors associated with antenatal screening remained mostly unchanged between 2016 and 2022, participation in household decisions and having genital discharge, sore or ulcer were significantly associated with HIV screening in NDHS 2016 but not in 2022. This could be attributed to changing public health priorities and societal norms over time, which may have reduced the emphasis on symptoms or women's decision-making role as factors associated with screening. Similarly, knowledge of vertical transmission and desired pregnancy were not significantly associated with HIV antenatal screening in the NDHS 2016, but were in 2022. This could be explained by the intensification of educational initiatives focusing on vertical transmission of HIV and the improvements in family planning services, which may have reinforced the importance of knowledge as a determinant of uptake of testing in recent years. However, despite the six-year gap between the two studies, the evolution of these social norms and issues is often slow. Further research, in particular qualitative studies, is needed to confirm this hypothesis, as the NDHS data do not allow for such in-depth analysis.

4.5.2. Strengths and limitations

This chapter has some notable strengths. It was based on nationally representative data from the NDHS, which provided robust information on the availability of services and uptake of antenatal HIV screening in the country. The use of NDHS data ensured a large sample size and a standardised methodology, which facilitated generalisation and comparability with studies conducted in other LMICs. The study applied a multi-level approach that allowed the impact of different levels -individual, cluster and district-level factors- to be disentangled. The integration of district-level data on the availability of services, although limited in terms of granularity, enabled a preliminary exploration of supply-side factors. This dual approach to individual and systemic determinants provided a better understanding of the factors associated with antenatal HIV screening.

Some limitations of this chapter need to be acknowledged. First, the NDHS data used in this study did not adequately capture the variation and complexity of supply-side factors related to the prevention of vertical transmission services. While the NDHS provided information on service availability, it lacked detailed insights into the quality of these services and the knowledge and behaviour of health workers. This may affect the interpretation of how effectively these services were distributed and used across different districts. Additionally, the

number of services for prevention of vertical transmission reported for each district did not necessarily reflect the accessibility for women. The data did not account for the proximity of a woman's residence to the nearest service facility. A woman may be in a district with a low number of services for the prevention of vertical transmission, but be close to one. Finally, the nature of the NDHS data did not allow for an in-depth analysis of the geographic barriers. Similarly, despite significant associations between domains of empowerment and screening uptake, the causal impact of women's empowerment on antenatal HIV screening could not be inferred from the data. In addition, although the presence of husbands during interviews with women was reported in less than 1% of cases, there remained a risk of social desirability bias, particularly when dealing with sensitive subjects such as violence or gender issues. This could lead to women's empowerment variables being less reported than what they actually are.

4.5.3. Conclusion

In this chapter, I used an econometric procedure which allowed me to isolate and clarify the distinct contributions of individual and district-level factors to HIV screening in Nepal. Factors associated with antenatal screening have broadly not changed between 2016 and 2022. Higher uptake of HIV screening was found amongst women from wealthier families, women who desired pregnancy later and women with good knowledge of vertical transmission and the drugs available to prevent transmission. Lower education and having fewer than 4 ANC visits were associated with lower uptake. No supply-side factors, including the qualification of health workers and the availability of prevention of vertical transmission services, were significantly associated with antenatal screening. These findings informed the need for a comprehensive strategy targeting women with a higher risk of not receiving HIV screening during pregnancy and the implementation of national guidelines for the effective provision of antenatal screening services. The difference in the factors associated with screening and those associated with antenatal visits suggested that encouraging antenatal visits is not sufficient. Specific interventions should be implemented, such as educational programs involving communities or, once supply-side availability of tests has been optimised, the inclusion of antenatal screening in the cash transfers already implemented in Nepal for 4 ANC visits. My results advanced the empirical literature on factors associated with antenatal screening for STIs. A qualitative study conducted in Nepal, presented in the next chapter, further explained these results and highlighted the contextual elements.

5. Knowledge, attitudes and perceptions regarding antenatal screening

5.1. Introduction

Over the last decade, the number of studies using qualitative methods has increased, often alongside quantitative methods. These qualitative methods are used either to develop questionnaires adapted to the context or to improve the results of quantitative analyses by incorporating contextual elements. Following this strategy of mixed-methods studies, this chapter further explored factors affecting antenatal screening for HIV that emerged from Chapter 4. Indeed, by addressing objective 3, as detailed in section 1.4 and interviewing pregnant women, their family members, health workers and decision-makers, this chapter aimed to explore factors influencing the implementation and the acceptance of integrated antenatal screening of HIV, syphilis, and hepatitis B in Nepal.

Few studies investigated the demand side [264,265] and supply side [266] factors affecting the implementation of antenatal screening of HIV in Nepal. Thapa et al. (2019) [265] examined the association between women's empowerment and HIV screening among Nepalese women using data from the 2012 NDHS. They found that women with a positive attitude towards negotiating safer sex and those with a high level of sexual autonomy were more likely to be screened for HIV [265]. Pokharel, Abbas, et Ghimire (2011) [264] studied the implementation of the prevention of HIV vertical transmission programme and found that the acceptability of HIV tests after counselling was satisfactory. They stressed the need for greater men's involvement. Only one study conducted in Nepal examined supply-side barriers. Using the 2015 NHFS, Acharya et al. (2020) [266] showed that the readiness of facilities for HIV counselling and screening services was higher than for other STI services. They found persistent gaps in staffing, guidelines, drugs, and commodities in HIV counselling and screening services. However, to the best of my knowledge, this chapter represented the first national investigation of knowledge, attitudes and perceptions regarding integrated antenatal screening for syphilis and hepatitis B. This chapter has been published in PLOS Global Public Health after two rounds of revisions based on comments from three reviewers [267].

5.2. Method

5.2.1. Setting

It is important to understand the differences between the Kathmandu Valley and Kapilvastu districts, where this study took place.

The Kathmandu Valley, with Kathmandu, the federal capital city of Nepal, is the most developed urban area of Nepal, with more than 1.5 million people [268]. Located in the hills of Bagmati province, the agglomeration attracts migrants from all over the country. The Kathmandu Valley houses many of the health facilities in the country, with 30 public hospitals

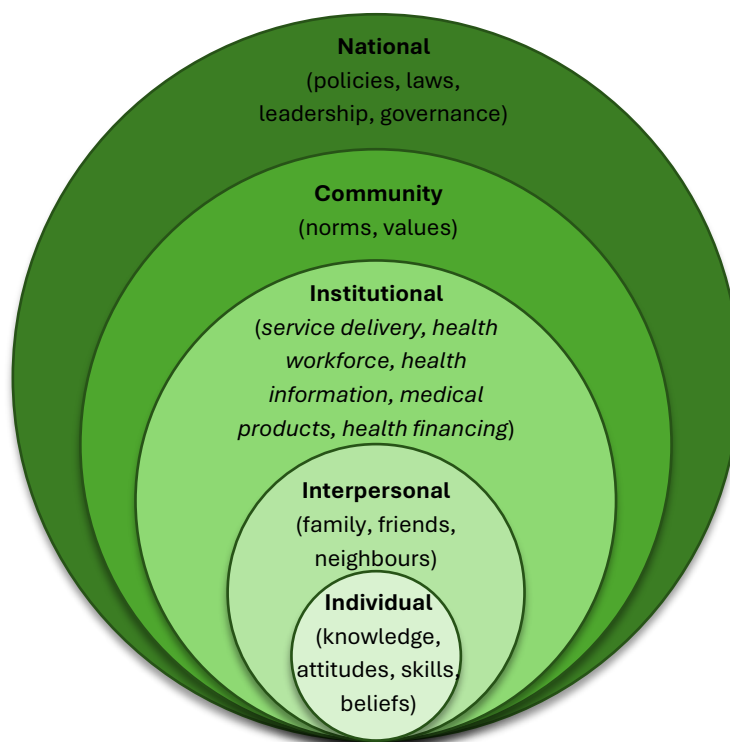
including the Paropakar Maternity and Women's Hospital (PMWH) (the federal referral centre for obstetrics), numerous provincial hospitals and 82 health posts [269].

Kapilvastu is a *Terai* (plains) district, which has a 55-bed government district hospital and 12 health posts. Bordering India, its population comprises largely Madhesi ethnic groups, including a high proportion of Muslims and Dalits, who are often marginalised and face discrimination [270]. Male foreign labour migration to India, the Middle East and East Asian countries (especially Malaysia) [90] is widespread in this district, which increases vulnerability to STIs. Most of the population are Awadhi-speaking rural farmers [271]. The Terai area of Nepal has a low Human Development Index (HDI) score, largely driven by poor education indicators [272] and the highest levels of gender disparity in Nepal [270].

5.2.2. Theoretical framework

I used a theoretical framework (Figure 11), combining the social-ecological model [273] and the WHO building blocks [274], to develop the topic guides (Section 5.2.3) and interpret the data (Section 5.2.6).

Figure 11 - Combination of the social-ecological model and the WHO building blocks



Note: The text in italics under the institutional level represents the components of the World Health Organisation (WHO) building blocks system integrated into the socio-ecological model.

The social-ecological model proposes a holistic approach and considers the relationship between individuals and their environment to understand health-related behaviours [273]. The model acknowledges that an individual's behaviour is shaped through complex and interrelated factors. In this chapter, as well as in the social-ecological model [273], I considered five levels that influence behaviour. The first level of influence is the individual level. This level refers to the personal characteristics of an individual that influence their behaviour, such as age, gender,

ethnicity, knowledge, attitudes, skills, and beliefs. The second is the interpersonal level, which describes the relationships between individuals and the social networks they belong to, such as family, friends, and neighbours. The third is the institutional level, which includes formal and informal health structures. The fourth is the community level, which refers to established norms and values, standards, and social networks. The higher level of influence is the national level, which describes how the laws, regulations, and policies affect behaviour by creating or limiting opportunities and resources, shaping social norms, and changing the physical and social environment.

I integrated the WHO building blocks [274] into the social-ecological framework to create a unified framework. The WHO building blocks provide a framework to improve the performance of health systems by considering six constituent elements: service delivery, health workforce, health information, medical products, health financing, and leadership and governance. I include these components within the institutional level of the socio-ecological framework.

5.2.3. Topic guides

We interviewed pregnant women and their families about their experience of ANC visits, blood tests, knowledge of and behaviours toward STIs and antenatal screening for STIs during pregnancy. We also interviewed health workers and decision-makers on the implementation, challenges and feasibility of integrated antenatal screening for STIs. The topic guides were initially designed based on the research questions and the theoretical framework presented in section 5.2.2. The topic guides evolved based on feedback received during funding applications and discussions with the entire research team and, in particular, with a trained and experienced qualitative researcher, Bibhu Thapaliya (BT), who was also my Nepalese counterpart throughout the study process. We also modified the topic guides after the pilot phase and during the data collection to explore emergent themes.

The pilot phase consisted of interviews with three pregnant women, a husband and a mother-in-law in Kapilvastu, and with a husband and a pregnant woman in Kathmandu, to identify any misunderstandings or difficulties related to the questions. The pilot interviews conducted in Kapilvastu were also used to train the data collectors and allow them to practise the topic guides. I did not include these interviews in the analyses. We used vignettes to interview pregnant women and mothers-in-law, which allowed for less personal exploration of sensitive topics that participants might otherwise find difficult to discuss [275–277]. In the vignette, participants were presented with a hypothetical situation in which they were discussing ANC visits and blood tests with a friend. In this hypothetical situation, the friend was also asking for advice about a genital discharge and the possibility of an STI. They aimed to reveal people's beliefs and potential behaviours without being too intrusive. I designed the vignettes according to the local context and on the advice of local researchers. They are presented in the topic guides in Appendix 1.1.

5.2.4. Participants recruitment and data collection

Participants were recruited between 10 January 2023 and 7 April 2023. On the demand side, we conducted a total of 14 semi-structured in-depth interviews in Kapilvastu and 12 in Kathmandu with pregnant women and their household members (i.e. husbands and mothers-in-law). We interviewed 12 currently pregnant women (6 in Kapilvastu and 6 in Kathmandu) and, since joint households are widespread in Kapilvastu, we also interviewed 4 mothers-in-law (Table 13). To explore male spouses' perspectives on maternal health and antenatal screening for STIs, we interviewed 10 husbands (4 in Kapilvastu and 6 in Kathmandu), among them, five were husbands of pregnant women who had been interviewed. Characteristics of participants are presented in Table 14.

Table 13 - Participants and required number of semi-structured interviews

Table 15: Participants and required number of semi-structured interviews				
	Activity	Criteria of selection	Kathmandu	Kapilvastu
Demand-side				
Pregnant women	12 SSIs	Woman from disadvantaged caste.	3	3
		Woman from high caste.	3	3
Husbands	10 SSIs	Husband from disadvantaged caste.	3	2
		Husband from high caste.	3	2
Mothers-in-law	4 SSIs	Mother-in-law from disadvantaged caste.	-	2
		Mother-in-law from high caste.	-	2
Total			12	14
Supply-side				
Health workers	7 SSIs	Health worker from public hospital	1	1
		Health worker from a stand-alone HIV testing site.	1	1
		Health worker from a health post.	1	1
		Health worker from a private hospital.	1	-
Decision-makers	4 SSIs	Rep' from the Ministry of Health.	1	-
		Rep' from the health division of the Municipality.	-	1
		Rep' from the Nepal Health Sector Support Program.	1	-
		A person implementing programs for the Global Fund.	1	-
Total			7	4

Notes: Disadvantaged castes included Dalit, Tharu and Muslim. High castes included Baniya, Brahmin, Chhetri. SSIs = Semi-structured interviews. Rep' = Representant. HIV = Human Immunodeficiency Virus.

I determined the sample size based on the concept of saturation, according to which data collection continues until no new themes emerge [278]. A suggested sample size was set at the beginning of the study based on the time and resources available and to provide staff with an idea of the scale of the data collection required. Data collection lasted three months, and the interviews were not conducted consecutively, which allowed time for ongoing analysis and to check for the emergence of new themes as data collection proceeded. Saturation was reached by the end of the data collection, and new analytical insights from additional interviews became rare.

Table 14 - Pregnant women, husbands and mother-in-laws' characteristics

Household characteristics			Pregnant woman characteristics					Husband characteristics				Mother-in-law characteristics			
District	Type	Husband abroad?	N°	Age	Education	Occupation	Gestational age	N°	Age	Education	Occupation	N°	Age	Education	Occupation
Kapilvastu	Joint	Yes	1	21	7	Housewife	9	1	23	9	Seller	1	45	0	Housewife
Kapilvastu	Joint	No	2	22	9	Housewife	2	-	-	-	-	-	-	-	-
Kapilvastu	Joint	No	3	27	12	Housewife	2	-	-	-	-	2	59	0	Housewife
Kapilvastu	Joint	Yes	4	38	10	Housewife	1	2	28	10	Unemployed	-	-	-	-
Kapilvastu	Joint	No	5	23	7	Housewife	5	-	-	-	-	3	52	0	Housewife
Kapilvastu	Nuclear	No	6	24	0	Housewife	9	3	42	0	Daily wage worker	-	-	-	-
Kapilvastu	Joint	Yes	-	-	-	-	8	4	45	8	Real Estate Broker	-	-	-	-
Kapilvastu	Joint	Yes	-	-	-	-	9	-	-	-	-	4	55	0	Housewife
Kathmandu	Nuclear	No	7	33	2	Housewife	7	5	39	SLC	Insurance Broker	-	-	-	-
Kathmandu	Nuclear	No	8	24	12	Lab Assistant	9	-	-	-	-	-	-	-	-
Kathmandu	Nuclear	No	9	28	SLC	Beautician	6	-	-	-	-	-	-	-	-
Kathmandu	Joint	No	10	26	SLC	Housewife	8	-	-	-	-	-	-	-	-
Kathmandu	Nuclear	No	11	33	Master	Teacher	9	-	-	-	-	-	-	-	-
Kathmandu	Nuclear	No	12	26	5	Housewife	6	6	38	8	Seller	-	-	-	-
Kathmandu	Joint	No	-	-	-	-	6	7	21	12	Student	-	-	-	-
Kathmandu	Nuclear	No	-	-	-	-	9	8	24	10	Daily wage worker	-	-	-	-
Kathmandu	Joint	No	-	-	-	-	3	9	30	SLC	Pathao (taxi) driver	-	-	-	-
Kathmandu	Nuclear	No	-	-	-	-	7	10	28	8	Construction worker	-	-	-	-

Notes: Joint household is a family structure in which several generations live together under the same roof. In Nepal, newly-married women often move in with their in-laws' family. In contrast to joint households, nuclear households consist solely of parents and their children.

In Kapilvastu, we contacted pregnant women through the FCHVs purposively approached in one semi-urban municipality (Kapilvastu) and two rural municipalities (Shuddhodhan and Maya Devi). We recruited pregnant women based on the selection criteria presented in Table 13 and defined before recruitment, ensuring they met the inclusion criteria. BT worked with five females and a male local interviewer to locate and interview pregnant women and their family members. They interviewed people of the same gender. Local interviewers were recruited as part of the wider project through which this study was funded and had previously worked with HERD International. We trained them based on recommendations from the existing literature on how to conduct interviews on sensitive topics [279,280]. We conducted nine interviews in the local language, Awadhi, and five in Nepali. A previous study in a similar context overcame the reluctance of mothers-in-law to let their daughters-in-law be interviewed in private by implementing a parallel interview strategy [153]. We applied a similar strategy by conducting concurrent but separate interviews in two different locations of the household with pregnant women and their mothers-in-law. We interviewed all the husbands alone around the household.

In Kathmandu, we identified and approached participants during their visits to the ANC unit of the PMWH. A gynaecologist from the hospital introduced us and the study to the participants in the ANC unit. Pregnant women and husbands were interviewed in a café nearby, where we could ensure privacy with pregnant women interviewed by BT and husbands by Obindra Chand (OC). Participants gave their written consent to participate. They were not reimbursed for their time. Pregnant women and husbands were relatively reluctant to participate in the study, as we met them in the hospital setting, they were often rushing to go home after their check-ups. 2 pregnant women and 4 husbands refused consent. We audio-recorded all interviews, which lasted 30 minutes to 2 hours.

On the supply side, we interviewed health workers involved in antenatal screening and local and national healthcare decision-makers. We recruited health workers and decision-makers based on their roles and ability to answer specific questions regarding antenatal screening for STIs. We conducted 4 interviews in Kapilvastu and 7 in Kathmandu. Most of the supply-side interviews were conducted after the demand-side data had been collected, which enabled us to use the demand-side insights to inform supply-side interviews and provide health workers and decision-makers with arguments and perspectives raised by pregnant women, their husbands and mothers-in-law. Interviews with decision-makers were conducted in English. Participant characteristics are presented in Tables 15 and 16.

Table 15 - Health workers' characteristics

Nº	Organisation	Municipality	Occupation	Years of experience	Gender
1	Health post	Kapilvastu	Auxiliary Nurse Midwife	6	Woman
2	NGO	Kapilvastu	Counsellor at ART Centre	5	Woman
3	Public hospital	Kapilvastu	Nursing Officer	7	Woman
4	Health post	Kathmandu	Auxiliary Nurse Midwife	23	Woman
5	Public hospital	Kathmandu	Doctor	7	Man

6	Public hospital	Kathmandu	Auxiliary Nurse Midwife	38	Woman
7	Private hospital	Kathmandu	Registrar in Obstetrics and Gynaecology	3	Woman

Notes: NGO = Non-governmental Organisation. ART = Antiretroviral Therapy.

Table 16 - Decision makers' characteristics

Nº	Organisation	Occupation	Years in current job
1	Kapilvastu Municipality Office, Health Branch	Health coordinator	7
2	Ministry of Health and Population, Family Welfare Division	Official	3 months
3	Recovering Nepal	Technical advisor	15
4	Nepal Health Sector Support Programme	Former technical advisor	10

We interviewed consenting mothers-in-law and husbands of the sampled pregnant women. In Kapilvastu, the strategy of interviewing pregnant women, husbands and mothers-in-law from the same family was prioritised to allow triangulation, resulting in one household with all three household members interviewed, three with mother-in-law and pregnant women only interviewed and three with husband and pregnant women interviewed. Since not all women's husbands and mothers-in-law were available at the time of interviews, husbands and mothers-in-law of pregnant women from different families were contacted. This strategy of interviewing people from the same household was not appropriate in the Kathmandu urban context, as pregnant women were reluctant to talk, knowing that their partner would also be interviewed. Although pregnant women were usually accompanied by their husbands, the latter were in a hurry to get back to work. In Kathmandu, we were unable to interview mothers-in-law because they did not accompany pregnant women on ANC visits.

5.2.5. Transcription and translation process

Transcription and translation were carried out throughout the data collection process. The transcription and translation process varied slightly between Kapilvastu and Kathmandu. In Kapilvastu, the data collectors simultaneously transcribed and translated the recordings of interviews in Awadhi into Nepali. After transcription, BT proofread the Nepali transcripts to ensure their quality and remove any ambiguity in the terms used. When unclear terms or phrases were identified, she discussed them with the interviewers to clarify their meaning and context and to ensure that the transcripts accurately reflected the participants' responses. This was an important step as, despite Awadhi being an important language of oral communication for the interviewers, it is not a language in which they read or write, which makes it challenging to undertake transcription into Awadhi before translation into Nepali. Once the Nepali transcripts were finalised, they were sent to HERD International's main office, where a translator translated them from Nepali into English. In Kathmandu, interviews were conducted in either Nepali or English. Interviews conducted in Nepali were transcribed verbatim from the recording into Nepali text and then translated into English. To ensure the accuracy of the translations, we reviewed the English translations to clarify imprecise sentences and check the intended meaning. Where problems of clarity or ambiguity arose, we checked the translations by reviewing the original audio recordings.

5.2.6. Data analysis

I analysed data using NVivo to undertake thematic content analysis [281], with support from two Nepalese researchers (BT and OC). After a step of familiarisation with the data, I read transcripts and carried out a line-by-line analysis. Each code identified was then classified on Nvivo according to the framework detailed in section 5.2.2, a combination of the socio-ecological framework [273] and the WHO building blocks [274]. To limit cultural bias and ensure rigour, ten of the transcripts were double-coded by my Nepalese counterpart (BT) before finalising the main thematic framework and coding transcripts in NVivo. The codes identified in the thematic analysis were discussed and established with BT and OC. In a process of back and forth, I then applied the themes to the whole data in a systematic way.

The themes were compared across the transcripts and specifically the different groups, to establish the range and similarities of the participants' perceptions, experiences and views. To triangulate the data, I tabulated quotes from the transcripts using a matrix that organised the data by themes and participant groups. In this matrix, rows represented themes while columns corresponded to different participant groups, and verbatim quotes from the data were inserted into the cells. This matrix helped identify patterns and outliers by enabling comparisons both within and across groups. I reported results following qualitative research guidelines [49,282].

5.2.7. Ethical approval

This study has been conducted under an extension of the UCL Global Engagement funding for the Comprehensive Anaemia Programme of Preventive Therapies (CAPPT) project. Ethical approval was received for this study from the Nepal Health Research Council (523/2022 P) and University College London Ethics Committee (14301/001).

Written consent was obtained at the beginning of each interview, and participants were informed of the content of the interview. Throughout the interview, respondents were reminded that they could end the interview at any time. To take into account the potential distress caused by sensitive subjects such as pregnancy and STIs, we used vignettes that allowed for less personal and less intrusive discussions. Data collectors were trained to report any problems that arose during data collection. In addition, the FCHVs involved in recruiting pregnant women and their family members in Kapilvastu were available during the interviews and could be contacted in the event of distress or other problems.

5.2.8. Quality of the research

The research was conducted rigorously to ensure the quality of data collection and analysis. The topic guides were designed using a theoretical framework that combines the socio-ecological framework [273] and the WHO building blocks [274], providing a comprehensive exploration of the context and ensuring that no critical aspects were overlooked. The topic guides evolved throughout the data collection process to incorporate emerging themes and to ensure that the research was flexible and adapted to participants' perspectives. Triangulation was used throughout the study, particularly to gather the views of different family members and

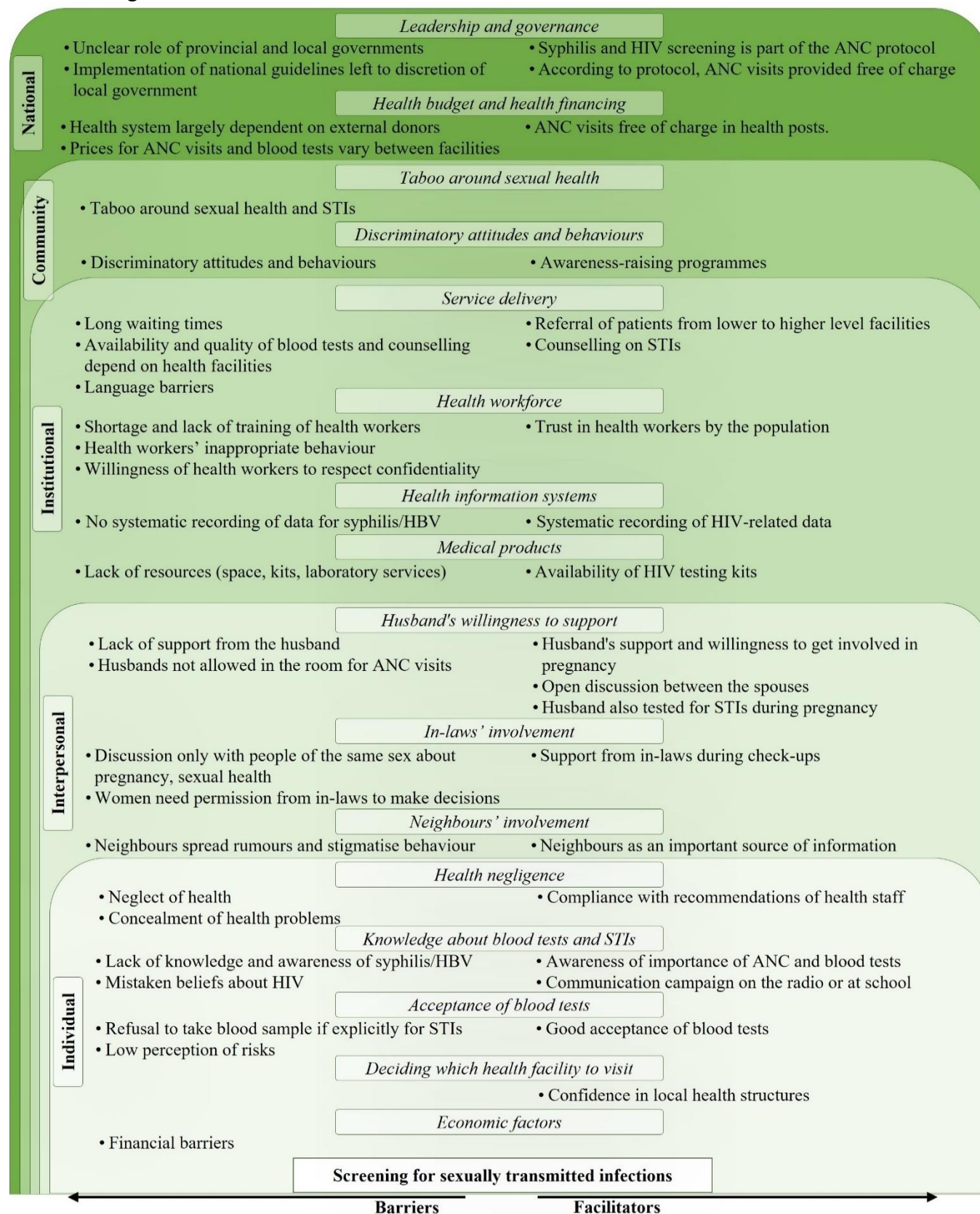
to compare findings in different contexts. Ongoing communication with my Nepalese colleagues, particularly during the study design phase and the data collection and analysis process, helped to refine the approach and ensure that the research was contextually appropriate. Rigour was also maintained throughout the transcription and translation process, with multiple rounds of revision and feedback between the data collectors, my Nepalese counterpart (BT) and the translation team, to ensure the accuracy and quality of the final transcriptions. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [282] is available in Appendix 3.9, ensuring transparency and consistency in the reporting of the research process.

Reflexivity in qualitative research was a key element of this study, particularly given my position as a researcher from a high-income country conducting research in a low-income setting [283]. Reflexivity involves critical reflection on how a researcher's background, beliefs and position may influence the research process, including the data collection and the interpretation of findings [284]. Aware of these challenges, I kept in mind the potential influence of my understanding of the context and my perceptions throughout the study. To mitigate these potential issues, I worked closely with my Nepalese counterpart (BT) throughout the study, who played a crucial role in helping to bridge cultural and contextual gaps and ensure the local relevance of the research. Although BT is Nepali, she comes from the Kathmandu Valley and does not share the Awadhi-speaking origins of respondents in the Kapilvastu area, which forced her to think critically about how her own position, including education, privilege and ethnicity, might influence her interpretation of the results. I also benefited from the advice of my supervisor, Naomi Saville, who has lived in Nepal for 30 years and has extensive experience in research in this context. Regular consultations with her, as well as engagement with specialists from the partner Nepalese organisation, HERD International, such as Obindra Chand, Abriti Thapa and Sanju Bhattarai, strengthened the reflexive research process. These collaborations enabled critical reflection on my hypotheses, adaptation of study design to the local context and ongoing validation and interpretation of the findings in response to local insights. By adhering to recommended reflexive practices, such as building strong local partnerships, collaborative interpretation and openness to contextual feedback, I sought to preserve cultural sensitivity and enhance the reliability of research findings [285].

5.3. Results

I present the perspectives of the different participants together by comparing similarities and differences according to their localities and their characteristics. I presented the results according to the categories of the social-ecological model [273] and the WHO building blocks [274] (Figure 12).

Figure 12 - Factors influencing access to and provision of antenatal screening for HIV, syphilis and hepatitis B in Nepal presented according to the social-ecological model and the WHO building blocks



Notes: HIV = Human Immunodeficiency Virus. HBV = Hepatitis B. ANC = Antenatal Care. STIs = Sexually Transmitted Infections.

5.3.1. National level

The WHO building block [274] on leadership and governance considers the policies, regulations and institutions that oversee and guide the health system and ensure the efficient and equitable provision of health services.

5.3.1.1. National guidelines

Syphilis, HIV, and hepatitis B screening are part of the ANC protocol in Nepal. However, in practice, STI screening is not available in all facilities, particularly rural health posts. This is despite claims to the contrary by the decision-maker interviewed from the Family Welfare Division of the Ministry of Health. *[PM2: HIV screening is conducted as a routine practice in Nepal. I remember it being implemented for a very long time, for more than 20 years, I think. Hepatitis B and syphilis are also routinely conducted in every health facility in Nepal.]* The implementation of elements included in the national guidelines is left to the discretion of the local government. They have to convince their elected representatives to give them a budget for it. The services included in the ANC package and the charges are decided by hospital management committees and by the municipality in the case of health posts. In the context of Nepal's federalisation introduced in 2015, the role of provincial and local governments is still unclear. *[PM3: For a long time, it was not clear whether the central or the federal government should oversee the health office of the districts. Finally, the Sthaniya Ain [Local Law] has been introduced. It clarifies the services that fall under the local government. However, it's still confusing whose responsibility it is to procure materials for the provincial level.]*

5.3.1.2. Health budget and health financing

The financing building block [274] is concerned with raising adequate funds for the healthcare system, allocation of resources, and protecting people from the high costs of care seeking.

The Nepalese health system is largely dependent on external donors. *[PM3: The revenue collected by the Government of Nepal is not sufficient to run all the health programs. From what I know, the Government of Nepal has enough money for regular salaries, management and running some programs, but the rest of the money is given by donors.]* Based on consultation with its various bodies, diplomatic and policy sectors, the Ministry of Health and Population (MoHP) decides on health priorities. It discusses at the national level how health projects can be financed and whether it will be necessary to seek external funding to meet the needs.

The ANC protocol also states that any ANC-related examination should be provided free of charge. However, STI screening is not always available for free. *[HW7: When I was working in the maternity ward, there was a minimum charge. It was lower than in other hospitals, but it was not free.]* At the level of health facilities, municipalities make decisions for health posts regarding the budget allocated, the purchase of equipment such as test kits and the services to be provided free of charge. *[PM4: If it is a protocol guideline which is not mandated by the Constitution, then it is the discretion of the local government or the health coordinator to*

implement it. First, they need to be convinced that it is important. Then, they need to convince their elected members to give them a budget for implementation. They can ignore it and not implement it because they can choose to do something much more appealing. Building a facility might be more appealing than just adding a small service which no one really knows.] Public hospitals are funded by provincial governments. The management committee of each hospital has the power to decide and prioritise which services to include in the ANC package and which services to provide free of charge, based on the recommendations in the government protocols. It must coordinate with municipal public health officials and doctors to make the service mandatory.

ANC visits are free of charge at health posts. In public hospitals, the price varies from one institution to another and depends on the content of the examinations. *[HW7: Costs in public hospitals are low, but they depend on the programs that the government is running.]* Participants complained about the price of ANC visits in private hospitals. *[PW4: In private health facilities, they take a lot of money, so it is better to go to health posts or government hospitals.]* This difference in cost justifies participants' preference for public health facilities over private ones. *[PW8: I did everything in a private hospital. I only came here [PMWH] three months ago because of monetary issues. It was too costly in the private hospital.]*

As with ANC visits, the price of blood tests varies from one public hospital to another. Blood tests are more expensive in private facilities, and patients complain about this to doctors. *[HW7: In private hospitals, serology for hepatitis B is considered to be very expensive in comparison to HIV because it requires more equipment. Patients come and tell us: "These three tests are expensive, doctor".]* It is common for patients to go to private facilities for ANC visits, but to go to public facilities for blood tests because they are cheaper. *[PW8: I was advised by the doctor that it's costly in the private hospital, so I went to a laboratory in Baneshwor.]* When available at health posts, blood tests are provided free of charge. Participants cited money as a reason for refusing blood screening during pregnancy. *[PW6: I have not done blood tests because I don't have money. If I had money, then I would surely do the test.]*

Overall, healthcare professionals do not have a clear idea of the cost of the services they provide. *[I: What is the cost of a blood test for haemoglobin, HIV, syphilis and hepatitis B? Can you tell us the exact cost? HW6: No, I have no idea.]*

5.3.2. Community-level

5.3.2.1. Taboo around sexual health

Most pregnant women, husbands and mothers-in-law were reluctant to talk about STIs. They laughed nervously, cut the discussion short or refused to answer questions. Also, the topics discussed were one of the main reasons why people refused to participate in the interview. This attitude of people not being ready to open up about the subject was also found in the interviews with health professionals.

Many interviewees pointed out that women may feel embarrassed to talk about sexual health, even with doctors. *[HW1: Even patients who come here cannot talk openly about their reproductive health problems. Sometimes, they come to us and secretly tell us their problems.]* Especially if the doctor is a male. *[PW2: If there is a female doctor, then we can talk openly about our problems. Even if there is no female doctor, we should not feel shy with the male doctor, because if we feel shy, then we cannot survive. But it would be better if there were a female doctor instead of a male doctor.]* This was often a reason given by participants for the need for the husband or someone to accompany the woman. *[H7: If there is a male doctor, then it can be difficult for the woman. The husband should go to make the situation easier.]*

5.3.2.2. Discriminatory attitudes and behaviours

Discriminatory behaviours regarding hepatitis B and syphilis were difficult to capture, as people were generally unaware of these particular diseases. However, the interviews revealed strong community stigma and peer pressure on HIV-positive people. *[H9: Some might feel the fear of embarrassment in society if the result comes positive because there is a practice of showing negative attitudes and discriminatory behaviour towards infected people in our society. Pregnant women might not agree to do the test due to the fear of being mistreated if they get diagnosed with STIs.]* HIV-positive people are often discriminated against and even excluded from society. *[HW2: The stigma here is that if you have contracted HIV, your life is over. How will I show my face? How am I going to get around?]* Thus, several participants emphasised the importance of awareness-raising programmes at the community level. *[PM1: Providing drugs is not enough. The main thing is to raise awareness. If people are aware, they can take care of themselves during pregnancy.]*

5.3.3. Institutional level

5.3.3.1. Service delivery

The service delivery building block [274] focuses on providing equitable access to essential health services that meet the needs of the population by guaranteeing the availability of resources and the quality of the services provided.

5.3.3.1.1. Availability of services

The availability of blood tests depends on health facilities. Blood tests are done at the first ANC visit, usually after the third month of pregnancy. STIs are tested during pregnancy with other tests, such as blood group or haemoglobin, using the same blood sample. The content of the blood tests depends on the healthcare facility. *[HW3: The test for HIV was considered important, but not the tests for syphilis and hepatitis B. With time, the demand for other tests also gradually increased. Now, the ANC check-up package includes haematology, biochemistry, and serology tests.]*

Participants reported long waiting times in some cases, but this did not seem to discourage them from accessing ANC services. *[I: Sometimes it takes 2 or 3 hours to meet the doctor, and*

sometimes even a whole day without eating any food.] Waiting times for ANC visits, blood tests and results vary from one health facility to another. According to interviews, waiting times for the test can range from zero in some health posts to several hours in public hospitals for ANC visits, and from one hour in health posts or some provincial hospitals to several days in the PMWH to receive blood test results. Distance to health facilities did not appear to be an issue for blood testing. Participants interviewed in the PMWH sometimes reported coming from far away to access that particular hospital. *[H9: I came with my wife on a motorbike. If I am alone, it takes about 1.5 hours. But I had to ride slowly with her as she is pregnant and sick, so it took around 2.5 hours.]*

Many interviewees referred, directly or indirectly, to the referral of patients from lower- to higher-level facilities. One example that emerged repeatedly in the interviews was the referral of patients from health posts that do not have laboratory or ultrasound facilities, or in case of complications during pregnancy, to public hospitals. *[HW4: We don't have ultrasound facilities. If an anomaly is detected in time, we are obliged to refer them elsewhere. They are referred to other services depending on their needs.]* Patients are also referred from one department to another within the same hospital. Several problems with the referral system emerged from the interviews. It sometimes makes it difficult for people to access care, creates confusion and leads to loss of follow-up during pregnancy. *[HW4: They find it complicated when we refer them to the hospital.]* This also sometimes leads to the saturation of the largest public hospitals. *[HW4: Everyone knows PMWH, but it is crowded most of the time.]* This referral system is sometimes used as an excuse for not taking care of HIV-positive patients. *[HW2: They would not admit an HIV-positive patient. They would still refer him to another health facility.]*

5.3.3.1.2. Quality of care

Overall, participants reported a high level of overcrowding in public hospitals that influences the quality of the services provided. *[PW12: There is so much crowd that patients enter the room for their turn before the previous one has completed the check-up. We can't ask for anything, and doctors don't have time to explain things.]*

Even when blood tests are carried out, the quality of services is not always good. Some participants reported errors, receiving other people's results or unreadable reports. *[PW11: When I had a miscarriage, I did a blood test in a polyclinic nearby, and my blood group was different. Since then, I don't want to do any tests there again because the report might have been exchanged with someone else.]* Others complained that the results of the blood tests were not explained to them by health workers. *[PW12: I came back after three days to get the report, but they did not tell me anything about it. I asked them whether I should go to ask about the report. Nobody told me anything about that, so I did not go anywhere.]*

Most of the participants said that they had not been counselled about blood tests and STIs. *[PW2: Health workers didn't tell me anything. They just took the blood sample. It was very crowded.]* When counselling is provided, it is for HIV, but not for hepatitis B or syphilis. *[HW6: The counselling is about the prevention of HIV transmission from mother to child. I do not need*

to tell them about hepatitis B and syphilis.] According to health workers, this depends on the health facility. For example, Tribhuvan University Teaching Hospital has a nurse who specialises in counselling, while health workers at other health facilities involved in ANC visits reported not doing counselling at all. Health workers justified not counselling pregnant women by the lack of time or space to do so, but also by the lack of interest or capacity to understand from the patients. *[HW7: In most health facilities, there is limited time for counselling. We cannot give half an hour or an hour to a patient when we have to deal with 100 or 150 patients. Sometimes, when people hear about HIV, they become reluctant, so we have to explain it to them. For hepatitis B, if patients understand and are willing to listen, then we explain to them too. Counselling is not done uniformly between patients; sometimes the explanations are done correctly, but sometimes they are not.]* Some health workers also felt that it was easier not to mention STIs, as this would lead women to refuse blood tests. *[HW1: The easiest way to counsel them about blood screening is to tell them that the test should be done to see if there is a problem in the blood. If we explain each test to them, they may not be able to understand it. Also, mentioning STIs may make them angry because they may feel insulted. They don't readily accept such tests.]* However, most health workers who report not counselling patients also say that they are happy to answer women's specific questions about blood tests. *[HW4: We tell them that we will do a blood test. If they ask, we tell them that we will do these and these tests and tell them everything, but they never ask this kind of question.]*

Two health workers in the rural area cited language as a barrier to providing services to individuals, primarily counselling. *[HW1: At first, I was confronted with the problem of the Awadhi language, but little by little, I managed and adapted to it. I'm still struggling to make sentences, but I can speak well enough to communicate.]*

5.3.3.2. Health workforce

The building block [274] that considers the health workforce addresses the availability, distribution, and capacity of health workers.

Training and shortage of health workers

Most interviews revealed a shortage of health workers, especially skilled workers. Many participants pointed to the large number of patients that need to be cared for by a limited number of health workers. *[H1: Thousands of people go to hospitals every day, so they are quite quick and give you information on the subject very quickly.]* This shortage results in a lack of time to provide health services and threatens their quality. *[PM4: Most of the ANC rooms are really busy. There will be women inside the room, and the process of ANC is less than 5 minutes.]* Participants also complained about the lack of follow-up by doctors. *[PW9: You want to show your report to the same doctor, but it doesn't happen that way. Even if it's the same day, the doctor changes from time to time.]*

Training of health workers is usually provided by the health facilities themselves or by the municipality. NGOs are also sometimes responsible for training health workers on specific topics. Some health workers reported that they had not received training for decades. *[HW6: After 2015, we did not receive any training. I had a 7-day training on the prevention of mother-*

to-child transmission of HIV and a 10-day training on breastfeeding, but it was about 8-9 years ago.] Almost all complained about the lack of regular training. [HW4: Nowadays, the municipality provides the training, but it is not enough to improve the skills like it used to be, before, even if routine training is provided to health workers.]

Attitudes of health workers

Regarding the attitude of the health workers, most pregnant women and their relatives said that the health workers had the right attitude, often described as kind. *[PW7: They are always cheerful and behave decently with me.]* Some participants reported inappropriate behaviour by health workers, such as rudeness or hostility toward pregnant women. *[PW12: Sometimes, when we ask them about anything, they scold us so badly for not knowing it. Once, I asked them about where I could get the blood test reports from. They shouted at me so badly, asking why I don't read myself and whether I have eyes or not. I felt very bad. Some are good, but some of them are very aggressive.]* Also, some participants complained about the lack of listening by health workers. *[I: Have you ever experienced someone who behaved badly with you? PW5: Yes, sometimes they do not listen to you at all.]* With respect to STIs, health professionals were generally reluctant to talk about discriminatory behaviour in their profession. However, some decision-makers and health workers revealed that this type of behaviour is quite common. *[HW2: Health workers still act rudely sometimes. Sometimes clients even refuse to enter health facilities. Even HIV-positive people with health insurance are reluctant to come because the health staff do not treat them properly and send them from one place to another.]* They also indicated that the situation had improved. All health workers reported that they strive to maintain confidentiality, but face difficulties in practice, mainly due to a lack of space.

The interviews revealed that, overall, people trust health workers. They often indicated that they gave them good suggestions. *[ML3: Health workers in the health post will give her good suggestions. If we take suggestions, we can get good treatment and the right medicines.]* Participants said they were willing to listen to them and do what they recommended because they had better knowledge. *[ML2: We are uneducated, and we do not understand anything. If it affects the health of a pregnant woman as well as the child, then we will follow the doctor's suggestion. We will try to follow whatever they tell us.]* However, some people suggested that people sometimes did not trust them and preferred to seek confirmation at different health facilities. *[PW2: The doctor said that there was no heartbeat. I did not believe it. The next day, I went to Bhairahawa for an ultrasound. They said the same thing there, too.]*

5.3.3.3. Health information systems

The health information building block [274] involves the collection, analysis and dissemination of data and information relating to health in order to facilitate decision-making and monitor the health of populations.

In Nepal, women's maternity data are only reported after three months of pregnancy. Any event or illness occurring before the third month of pregnancy is not recorded in the Integrated Health Management Information System (IHMIS). The recording of STI data is done manually by health workers in all health facilities. While HIV data seem to be systematically recorded, this

is not the case for syphilis and hepatitis B. According to some health workers, the lack of available information on syphilis and hepatitis B is due to the lack of available test kits and the lack of staff and time to record the data. *[HW7: In all facilities, data are reported manually. Patient loads are high, outpatient departments are busy with sometimes 200 to 300 patients coming, and manpower is limited. We try to record data as much as possible, but we do not write the data on both the patients' cards and in our data.]*

5.3.3.4. Medical products

The building block [274] that considers access to essential medicines addresses the availability and appropriate use of medicines, vaccines, and medical equipment, with a focus on quality, safety, and affordability.

Interviews revealed a general lack of resources. *[PW9: They told me there was no heartbeat. They advised me to get admitted, but due to a lack of beds at the emergency service, they could not admit me.]* While HIV testing kits are generally available in health facilities, syphilis and hepatitis B testing kits are often not available due to shortages. *[HW3: HIV test kits are usually available, but not kits to test hepatitis B and syphilis. They are not funded by any program, and we cannot afford them. HIV kits are available through external funding.]* Laboratory services are often not available at health posts. *[PM4: We have ANC all over Nepal, but screening for STIs is available only wherever there are laboratory facilities. That will be fewer than 200 government health facilities, hospitals, and a few Primary Health Care centres. The availability of ANC is very good in Nepal, but when you go deep into the service and look at the quality and the components. Then what we call availability becomes poor.]* Many health workers also complained about the lack of appropriate counselling spaces. *[PM2: There are counselling rooms in the hospitals, but not in small health posts.]*

5.3.4. Interpersonal level

5.3.4.1. Husband's willingness to support

Overall, the husbands interviewed expressed a willingness to be involved in their wives' pregnancies and often attested to supporting their wives with daily tasks. *[I: Do you support your wife during her pregnancy? H4: Yes, I support her 100%. I do not let her carry heavy objects or wash clothes. I encourage her to rest properly and follow the doctor's advice.]* However, some husbands reported not having any information about their wife's pregnancy other than that the baby is doing well. *[H2: She said that the baby is normal and healthy, so I didn't ask her about anything else. We were more concerned about the baby, so I didn't think it was important to ask about anything else.]* While some couples discuss the pregnancy openly, others do not discuss it at all with each other. *[H4: We spontaneously exchange health-related information, such as what we should do, whether we should go for a walk, etc.]*

In urban settings, some husbands reported accompanying their wives on ANC visits. However, in large urban hospitals, they are sometimes not allowed to enter the room for check-ups, even if they want to *[H6: Health workers should welcome both the husband and his wife. They should*

tell me about the problems of my wife and that I should not worry.] Husbands often expressed their inability to be there as much as they would like to be for their wives because of their work and the pressure to bring money into the household. *[H6: Sometimes, when I did not have time to go with her due to office obligations, she went alone. Otherwise, we always go together.]*

In the migratory context of Nepal, among the eighteen families interviewed, four husbands, living in Kapilvastu, were reported not living with their wives now or in the previous months but abroad or in another city. Communication difficulties within the couple are sometimes reinforced by the lack of proximity when the husband has to migrate. In this situation, communication sometimes takes place through the pregnant woman's in-laws. *[PW1: I told my sister-in-law first, then she shared it with everyone else. I: Didn't you share the news with others? PW1: No, because I was feeling shy.]*

For STIs in particular, in response to the hypothetical scenario presented, most husbands expressed that they would support their wives if they had symptoms of an STI. *[H7: If women get infected with STIs, they need full support from their husbands. Husbands should go with their wives as they could have problems like difficulty walking and dizziness.]* Mainly, if she needs their help in discussing her situation with health professionals. *[H3: Some women might feel shy. I will tell my wife that I will come with her. She should not be scared.]* However, several women and health professionals interviewed pointed out that in practice, some husbands are not as supportive and understanding. *[PW11: Although my husband is understanding, many pregnant women have husbands who do not understand or care about them.]* Most interviewees said that the husband should be the first to know about his wife's sexual health problems and that husbands should also be tested as part of antenatal screening for STIs. *[PW3: It is important and necessary that the husband take a blood test too. It will help to identify who is infected and how we can prevent it.]*

5.3.4.2. In-laws' involvement

In joint households, which are very common in rural areas, the parents-in-law are involved in the pregnant woman's health, mainly the mothers-in-law or sisters-in-law. Indeed, the topics of pregnancy, sexual health or STIs are more easily discussed with people of the same sex. *[I: Do you think she should tell her husband? PW1: Yes, and her mother-in-law or sister-in-law, but not her father-in-law.]* The involvement of in-laws may take the form of advice, pressure, or accompaniment during check-ups. *[HW3: If they are having repeated infections or lower abdominal pain during intercourse, they can't share such things in front of their mother-in-law. The mother-in-law may try to normalise the problems and demoralise the patients by not giving importance to their problems.]* In contrast, some mothers-in-law support their daughters-in-law. *[ML1: It is normal to help my daughter-in-law like this. She left her father and mother and came to live with us as if we were her parents. We must help her and understand her pain.]* Pregnant women generally need the permission of their in-laws before making decisions about their health. *[I: If the doctor says that they need to take your blood for STI tests, what would you do? PW3: I will say that I will decide after consulting with my family. I will ask my relatives if they want it or not. I will do as per their wish. I can't just do whatever I want.]* In the context

of migration, the husband often entrusts his wife to his family. *[H1: Our family lives together, so even if I can't help and support her, my family supports her when I'm not there.]*

5.3.4.3. Neighbours' involvement

In rural settings, neighbours are also an important source of information about health in general, the availability of health services and pregnancy in particular. *[PW5: My neighbour told me to go for a check-up if I had any health problems.]* In the case of STIs, participants shared that they learned a person's STI status from neighbours. *[I: Have you ever heard of anyone infected with HIV, syphilis, or hepatitis B? PW12: My neighbours said that someone has such a disease, so we should not visit him, otherwise we would get infected too.]* They play an important role in spreading rumours about the health of individuals and stigmatising behaviour. *[H2: There was a rumour in the village that he had HIV. We cannot go to visit him after knowing this about him.]* This type of behaviour seemed to be more present in rural areas and was not reported by participants in the Kathmandu Valley. *[H1: In urban areas like Pokhara, everyone is busy with their own work. Why should I interfere in other people's lives?]*

5.3.5. Individual-level

5.3.5.1. Health negligence

Some participants reported that they follow health workers' recommendations carefully, go for regular check-ups, and comply with treatments. *[PW1: I usually go for ultrasounds when they call me. I've never missed an appointment.]* On the contrary, some participants, through the description of certain situations or more directly the health workers interviewed, revealed the negligence of individuals in health-related matters. *[PW4: The doctor told me to visit again, but I did not.]* In the case of family members, and given their involvement in the pregnancies described above in rural settings, their neglect has direct consequences since women's health and consultations depend on them. *[PW2: I asked my in-laws to go for another check-up because it might be a problem with medication, but they did not take me for the check-up, and then I stopped the medicines.]*

Another established norm in Nepal that emerged from the interviews is that if there are no significant symptoms, people believe that there is no disease or that it will heal on its own or with home remedies. *[HW3: They first follow all the possible home remedies they can. If nothing works, then only they come to the hospital for help.]* Thus, people only go to the hospital if the illness and symptoms are severe. *[HW2: Here we have a scenario where patients only go to the hospital when their condition is really serious. For example, with STIs, if patients have severe back pain or abnormal discharge or something serious, then only they feel the need to go to the hospital.]* People also tend to hide their health problems in general, and especially when it comes to sexual health. *[PW11: Usually, people keep their disease secret, mostly in the village areas. It is similar in the case of miscarriage. For example, I did not reveal mine.]*

5.3.5.2. Knowledge about blood tests and STIs

When asked about their knowledge of ANC check-ups and blood tests, most participants were aware of their importance, although they did not know what was diagnosed by blood tests. When asked about their knowledge of STIs, most participants said they had heard of HIV and had some vague knowledge of the mode of transmission or symptoms. A limited number of educated participants have a good knowledge of the subject, mostly in urban settings. *[H9: HIV is a disease which gets transmitted through blood and sexual activities. It can get transmitted through blood by the use of needles, razors and sharp instruments if they are not sterilised.]* However, there is generally some confusion and misconception. *[H2: HIV can be transmitted by sitting and talking together. It can also be transmitted through sex or by living and sleeping together. If someone has this disease, we should not sit or live with them. We should keep our distance from such people.]* Participants reported hearing about it in the media, primarily on the radio, or during their studies. Most participants had never heard of syphilis and hepatitis B and had very low knowledge and awareness of their symptoms and mode of transmission.

5.3.5.3. Acceptance of blood tests

Consent for blood screening during pregnancy is given verbally by pregnant women. Health workers reported that blood tests were generally well accepted. This was confirmed by the pregnant women, husbands and mothers-in-law interviewed. The main reason given for the acceptance of blood tests was their importance to the health of the child and the mother. *[ML2: I would strongly advise pregnant women to take a blood test timely as it helps to know if the health of the baby and mother is going well.]* Most of the people interviewed said they would accept the blood test, regardless of its purpose. This view was not shared by health professionals, who felt that most people would refuse it if it was explicitly explained to them that it was to test for STIs. *[HW2: If you organise a campaign to test blood for dengue, diabetes and malaria, they will readily agree to take the blood test. However, they will hardly agree to the same blood test for STIs. They would rather run away or scold you. They will certainly not agree to take the blood test.]* Potential reasons for reluctance to accept blood tests that emerged from the interviews were financial constraints, but also the fact that people do not consider them necessary because they are healthy, or, conversely, they fear the results. *[H1: There are many reasons for not agreeing to have a blood test: for fear of what people might say, for fear of the disease, and in some cases, some people may feel that it is not necessary.]*

5.3.5.4. Deciding which health facility to visit

People reported preferring to receive all their care in a single establishment. *[HW4: Patients feel that they would feel more comfortable if all services were provided in this health facility, including ultrasound, instead of having to go to hospitals.]* However, the decision to change health facilities during pregnancy sometimes comes from the individuals themselves. In rural areas, people sometimes come to the health post with reports of test results from private or public hospitals to confirm interpretations. This shows people's trust in local health structures. *[H9: We took with us the report of the blood test we did at Binayak Hospital two or three days ago at the health post. Based on that report, they gave us some suggestions.]* In the Kathmandu

Valley, people sometimes choose health facilities where to access ANC services, knowing that they will eventually be referred by health professionals. *[PW9: We thought that even if I go to a private hospital, they will refer me to this place if any complication arises, so why not come here directly?]* Participants also indicated that they went to larger public facilities, believing that the services provided would be of better quality, or to private clinics to avoid the crowds in public hospitals. *[HW6: People from elsewhere think that they have to come to this hospital to deliver properly and avoid complications during operations. They may think that there are few or fewer qualified doctors in their area.]* In the latter case, people usually come for a few ANC visits but cannot afford to do them all. *[HW7: Per visit, it costs 500 rupees, so they do one visit here and then we lose the follow-up. They think something like: let's pay for once to deviate from the government hospital line.]*

5.3.6. Differences and similarities in perceptions between respondents in Kapilvastu (rural plains) and Kathmandu (urban)

Rural and urban settings differed in terms of respondents' perceptions and the barriers and facilitators to antenatal screening identified. While, on the whole, the lack of resources in the health system emerged as one of the main barriers to antenatal screening in both urban and rural areas, the lack of STI screening services was reported more by participants in Kapilvastu, mainly at health posts. Similarly, referral of patients from health posts to public hospitals with laboratories was more common in rural areas. All health workers said that they tried to maintain confidentiality, but health workers working in Kathmandu said that they encountered difficulties in doing so, mainly due to a lack of space. In Kathmandu, many health workers also complained about the lack of appropriate counselling facilities. This issue did not come up in the Kapilvastu interviews. In urban areas, participants highlighted the large number of patients who have to be cared for by a limited number of health workers, mainly in large urban hospitals, and participants complained about waiting times and husbands not being allowed to enter the room with their wives for examinations, even if they wanted to.

While husbands in both rural and urban areas expressed their inability to be as present as they would like for their wives, the reasons cited differed between the two settings. In Kathmandu, the main reason was work. In rural areas, husbands often lived abroad or in another town. In rural areas, joint households are more common than in Kathmandu, which makes the involvement of in-laws in the pregnant woman's health more important there. Similarly, the involvement of neighbours as a source of information, the spreading of rumours about people's health and stigmatising behaviour were not reported in the Kathmandu valley, whereas they were by several participants in Kapilvastu. While the attitude of people not being ready to open up on the subject of STIs was found in both rural and urban areas, this finding was exacerbated among participants in Kapilvastu. Some health workers in Kapilvastu were not even ready to say the words "sexually transmitted diseases".

5.3.7. Differences and similarities in perceptions between different household members

In interviews with the members of the same households, some interesting similarities and differences between household members' perceptions emerged. Husbands and mothers-in-law were generally less reluctant to talk about pregnancy and their knowledge of STIs than pregnant women. Pregnant women were particularly reluctant to talk about the subject, even though the interviewer was of the same sex. In the joint households interviewed in Kapilvastu, most of the pregnant women were embarrassed to talk about their mother-in-law's involvement in their pregnancy, even if she was not in the room, whereas the mother-in-law was not embarrassed to talk about their daughter-in-law.

Husbands expressed support for their wives if they had STI symptoms, while pregnant women and mothers-in-law tended to perceive husbands' support as weak in some cases, as husbands were not as understanding as they might say. The main reason given by husbands for accepting blood tests was their importance for the child's health, while the health of both mother and child was mentioned by mothers-in-law and pregnant women. Husbands and pregnant women agreed that they wanted the husbands to be involved in their wives' pregnancies, but tended to differ in their perceptions of in-laws' involvement. Some pregnant women complained about the involvement of their mothers-in-law and sisters-in-law in their pregnancy, particularly in Kapilvastu, while husbands and mothers-in-law were quite satisfied with it.

5.4. Discussion and Conclusions

5.4.1. Discussion

This qualitative chapter showed that antenatal screening for HIV, syphilis and hepatitis B in Nepal involved many stakeholders and was influenced by factors at different levels of the socioecological model and across the different WHO building blocks. I identified implementation gaps in service delivery, health workforce, health information system, medical products, health financing and governance and leadership. Interpersonal and individual factors, such as the involvement of husbands and in-laws in health decisions and people's knowledge of STIs, play a key role in the uptake of antenatal screening.

At the national level, different points need to be discussed regarding the leadership and governance and health financing building blocks. Syphilis and HIV screening are part of the ANC protocol in Nepal [119] and is implemented by the Ministry of Health and Population with support from various international organisations, including United Nations International Children's Emergency Fund (UNICEF), WHO, and the United States Agency for International Development (USAID). Nepal has adopted an opt-out screening strategy, similar to that of Thailand [286] and Sri Lanka [287], which have eliminated vertical transmission. However, in practice, I found that women were not really offered the choice to opt out as they were unaware of the purpose of the blood test. On the other hand, hepatitis B screening is not covered by national guidelines or in antenatal care procedures.

Despite an overall lack of clarity in roles and responsibilities between different government levels since the federalisation in 2017 [288], local authorities play a key role in implementing health protocols and allocating funding for antenatal screening. Yet the elected officials often lack the technical training or experience needed to make informed decisions [92] and antenatal screening for STIs is often not a priority [92,266]. Meanwhile, federalisation has added layers of decision-making, increasing administrative burdens and causing delays in bringing about change [92]. In addition, local priorities have shifted from social sectors, including health, to visible projects such as road and building construction, which are seen as beneficial for re-election [92,289]. Political instability also makes it difficult to implement long-term decisions [290].

At the community level, a lack of knowledge and misconceptions about HIV transmission result in a high level of stigmatisation of HIV-positive people. Consistent with other studies [291,292], I found a significant taboo surrounding sexual health and HIV, leading to discriminatory behaviour. Although the questions addressed the stigma attached to STIs, discussions predominantly focused on HIV, thus limiting information on the stigma associated with syphilis and hepatitis B. I found that Nepalese people often delay seeking care, especially for STIs, due to shame and fear of judgment.

At the institutional level, different WHO building blocks were investigated. Implementation of HIV screening is limited and uneven across regions, with 25% of pregnant women in Gandaki Province receiving an HIV test during ANC compared to only 7% in Karnali Province [293]. Facilities are less well equipped to provide syphilis screening than HIV, with only 22% of facilities having the equipment to screen for syphilis [95], despite national recommendations, indicating incomplete integration of these services [266]. WHO recommends the dual HIV/syphilis test in ANC settings for its cost-effectiveness, reduced loss to follow-up, and increased syphilis testing coverage [294]. These tests are available for less than US\$1 each and require minimal training and lab infrastructure [295]. Similar rapid tests are available for hepatitis B. Based on integrated rapid-test approaches, Thailand's model has been recognised by WHO as having reached the elimination targets for the vertical transmission of HIV and syphilis [286]. A similar rapid-test approach should be prioritised in Nepal to facilitate the availability of antenatal screening in health facilities and increase screening uptake [13].

HIV counselling reduces stigma and improves community knowledge [77]. In Nepal, however, counselling is not uniform, and women are often not informed of the purpose of their blood tests. Reducing stigma requires community awareness campaigns and a culture of transparency on the part of health professionals regarding the objectives of screening and the sharing of results. Lack of communication by health workers can perpetuate stigma. The more health workers contribute to stigma by avoiding discussions about diseases, the slower the resolution of stigmatisation will be.

I found that referrals for ANC and antenatal blood tests are common in Nepal, particularly in rural areas where access to screening services is limited [95]. Although referrals are intended to provide timely care, they can overload hospitals with cases that do not require specialist attention. The high level of trust in local health facilities suggests that there is scope to improve

screening and counselling at health posts, reducing the need for referrals. Significant investment in lower-level public health laboratories is required for effective triple screening.

Regarding the health workforce building block, the shortage of qualified healthcare staff lengthens waiting times and threatens the quality of services. In addition, healthcare staff often lack adequate training on STIs, which is essential for reducing stigmatising behaviour [296,297]. These problems have also been identified in studies elsewhere in Nepal, such as the mountain area of Jumla [298] and the southern plains [299].

Of the three diseases considered, HIV has benefited from more screening resources, awareness campaigns and media coverage, due to the global interest and the substantial international financial support it receives [300]. On the other hand, syphilis and hepatitis B, which are more prevalent in Nepal, lack resources and systematic data. Hepatitis B screening and prevalence are excluded from IHMIS and national surveys [301], while syphilis, although included, is not systematically reported. This hampers monitoring [302], leading to neglect of these diseases and their vertical transmission. A robust national monitoring and evaluation system, which uses data to improve programmes at national and sub-national levels, has played a crucial role in Thailand's success in eliminating vertical transmission of HIV and syphilis [286].

At the interpersonal level, I found that the husband's lack of involvement or support for antenatal screening and pregnancy in general is often due to a lack of time, caused by the pressure to earn money, rather than an intention to withhold support. Husbands' lack of engagement is reinforced by migration, especially in rural areas [90]. In Nepal, women usually move into their husband's households after marriage [145,158], where their decision-making power is often weak [147,148]. This is changing over recent years, with people no longer living in joint families, especially in urban contexts. However, social position within the household remains an important determinant of decision-making capacity in Nepal [149,150]. The migration of husbands often complicates the communication between spouses and increases the involvement of in-laws in women's pregnancies. I found that women in joint households generally need the approval of their in-laws before making decisions about their health, which has also been found by others [303,304].

Husbands expressed that they would provide support to their wives in the hypothetical scenario of positive STI test results, but this was not always confirmed in interviews with women and health workers. This discrepancy might indicate underlying issues such as potential interpersonal violence, which may prevent women from expressing themselves openly or asking for help. Although not raised in interviews, similar concerns have been raised in other countries in the region, such as India [305] or Vietnam [306].

At the individual level, the priority given to HIV over other diseases is reflected in people's knowledge. I found relatively good knowledge about HIV, but very little about syphilis and hepatitis B. These findings underscore the importance of awareness programs at the community level, coupled with increased resources for individual counselling by health workers.

Financial barriers in households hinder access to and acceptance of antenatal screening, a problem identified in Thailand and Indonesia [52,73]. People move from one facility to another to save money, as well as to get blood test screening and ultrasound services, leading to long waits and overcrowding in public hospitals, disrupting the continuity of care. The choice of healthcare facility is influenced by price disparities, perceived differences in quality between public and private facilities [307,308], recommendations from neighbours or family members [309,310] and availability of services such as blood tests and ultrasound.

5.4.2. Strengths and limitations

This study has several strengths that contribute to its robustness and relevance. The in-depth qualitative approach enabled a nuanced understanding of the perspectives of pregnant women, their families and health workers and decision-makers regarding antenatal STI screening. The use of vignettes in the interviews allowed personal topics to be explored in a sensitive and less intrusive way, while the involvement of local researchers ensured cultural relevance and contextual accuracy. In addition, collaboration with experienced Nepalese counterparts and continuous feedback throughout the data collection and analysis process strengthened the validity and reliability of the results.

However, this chapter has several limitations. Firstly, in Kathmandu, participants were recruited through the PMWH, which meant that all the women interviewed had already attended at least one ANC visit, and I was not able to access women who had not received ANC. Secondly, given the sensitivity of the subject, people were sometimes reluctant to answer questions about STIs. When people said they did not know about HIV or how it was transmitted, it was almost impossible to determine whether this was a real lack of knowledge or shyness about discussing the subject. The local word for syphilis was not always used by the data collectors during interviews in Kapilvastu, which caused confusion and limited how much I could infer about syphilis from these interviews. However, even in interviews where the local terms were used, knowledge of syphilis was minimal. Although I planned to interview husbands, mothers-in-law, and pregnant women from the same households, this was only possible in a subset of households in Kapilvastu and not at all in Kathmandu. This limited my capacity to triangulate and compare perceptions of different members within households.

5.4.3. Conclusion

This chapter highlighted the multi-level challenges of integrating antenatal screening for HIV, syphilis and hepatitis B in Nepal. I identified gaps in different WHO building blocks. I also found that interconnected factors played an important role at different levels of the socio-ecological model. Local authorities play a key role but often lack technical expertise, and community stigma remains a significant barrier.

Improving the availability of screening by using rapid tests, investing in strengthening health systems and implementing an opt-out approach to hepatitis B screening, similar to that for HIV and syphilis, are crucial steps. Effective community engagement through awareness campaigns

to reduce stigmatisation and investment in lower-level public health facilities is essential to improve the uptake of screening and reduce vertical transmission of these infections.

6. Cost-effectiveness of integrated screening

6.1. Introduction

As detailed in Chapter 1, section 1.2, the triple-integrated antenatal screening of HIV, syphilis, and hepatitis B recommended by the WHO [311] has the potential not only to improve adherence to screening but also to optimise the use of resources within healthcare systems. Indeed, given that all three infections can be detected by blood tests, integrating their screening into a single protocol may reduce demand and supply-side barriers to antenatal screening, including the logistical, time and financial barriers associated with multiple screening for women and health workers [19]. These STIs are prioritised for antenatal screening because they present a significant risk of vertical transmission, which can lead to serious complications for newborns if they are not treated in time.

However, as Chapter 3, section 3.2.5 highlights, the disparities in screening coverage for these diseases in Nepal reveal the difficulties in implementing these integrated strategies. These disparities reflect decades of focus on HIV, often to the detriment of other diseases and integrated health strategies. Disease-specific funding mechanisms, while enabling significant progress to be made in targeted areas, tend to discourage planners from seeking opportunities for integration, as their mandate is narrowly focused on preventing their specific disease rather than addressing broader public health needs. The narrow focus of these funding mechanisms is often poorly aligned with the multifaceted health needs of populations, particularly in LMICs such as Nepal, where coordinated strategies could offer better value for money. Overcoming these systemic barriers requires a paradigm shift in health planning, prioritising integrated approaches that tackle the interrelated problems of maternal and child health. This change requires data-driven evidence to convince decision-makers of the benefits and cost-effectiveness of integrated strategies.

Given the constraints of limited resources and the need for prioritisation, health economic evidence becomes crucial in determining the most cost-effective strategies for integrated antenatal screening. Cost-effectiveness analysis provides a systematic approach to assessing the trade-offs between health costs and health outcomes, enabling policymakers to allocate resources efficiently and maximise health benefits within budgetary constraints. However, only a few studies investigated the cost-effectiveness of simple HIV, syphilis or hepatitis B antenatal screening in LMICs [312–315]. Moreover, although positively conclusive on the cost-effectiveness of dual-integrated screening, only a few studies investigated dual-integrated antenatal screening for HIV and syphilis in LMICs [316–319]. A modelling economic evaluation conducted in Malawi concluded that dual-integrated rapid HIV and syphilis screening was cost-saving compared with HIV rapid screening only, single rapid screening for HIV and syphilis and HIV rapid screening with syphilis laboratory tests [319]. Similarly, a cost-effectiveness analysis conducted in China concluded the cost-effectiveness of dual-integrated

screening for HIV and syphilis compared to HIV only [318]. As far as I know, only one study conducted in Cambodia investigated the cost-effectiveness of a triple screening strategy [320]. The study concluded that triple-integrated screening is highly cost-effective, but its findings are context-specific and cannot be directly applied to other settings without adaptation. Moreover, cost-effectiveness analyses on dual-integrated screening conclude on the sensitivity of results to the context and mostly the sensitivity to disease prevalence [317,318].

Yet, gaps remain in understanding the cost-effectiveness of integrated screening strategies, and no study has been previously conducted to determine the optimal approaches tailored to the Nepalese context. In this chapter, I aimed to model the cost-effectiveness of triple screening during antenatal care in Nepal. This chapter has been published in *The Lancet Regional Health – Southeast Asia* after two rounds of revisions based on comments from three reviewers [321].

6.2. Method

6.2.1. Models structure, parameterisation, and assumptions

Maternal HIV, hepatitis B and syphilis cascade of care and their corresponding disease states were modelled using disease-specific Markov models adapted from previous studies [318,320,322]. Although the models were constructed separately for each condition (see next subsections), they shared common parameters including disease prevalences, incidence, test coverage, maternal and infant mortality rates, and probability of infant infection. Key parameters of these disease models, including disease prevalences and screening coverage, were adjusted based on the most recent data available to reflect the Nepalese context. I employed a cycle length of a year and evaluated models over 20 years, projecting outcomes and costs starting from childbirth for the infant model and from the time of screening (average age at pregnancy [100]) for the women's model. I considered the following adverse pregnancy outcomes: stillbirth, neonatal death, congenital syphilis in live-born infants, perinatal HIV infection, and perinatal hepatitis B infection. Foetal losses due to syphilis were considered, but foetal losses due to HIV and hepatitis B were not considered. This decision was taken because of the relatively lower incidence of foetal loss directly attributable to HIV and hepatitis B compared with syphilis. Co-infections/reinfections were not incorporated into the model, and risks of vertical transmission of HIV, syphilis and hepatitis B, and associated infant health outcomes were independent of one another. This simplification made it possible to model the transmission and results of each infection independently, to better understand the impact of each disease.

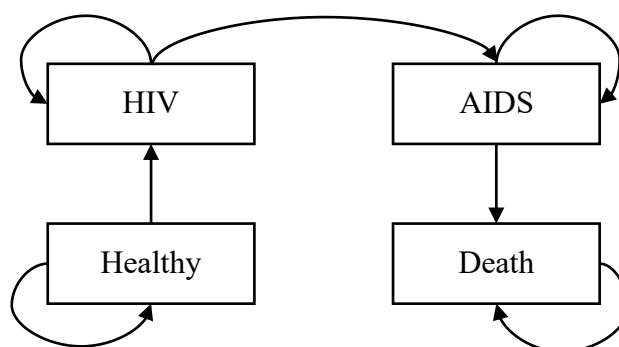
I assumed that screening is carried out once during pregnancy at the first ANC visit following an opt-out strategy. The sensitivity and specificity of the tests were considered in the models. Treatment for HIV, syphilis and hepatitis B should be initiated as early as possible in positive pregnant women. I thus assumed that women diagnosed as infected were given treatment from the first ANC visit (week 12) [119], which corresponds to time zero ($t=0$) in my models. As the retention of antiretroviral therapy (ART) in women was 99% in 2021 in Nepal [323], I assumed no discontinuity once the treatment had begun, and that visits as part of the pregnancy were the only means of access to treatment and screening for infected women and children. Treatment

could not be started later in life. Pre-exposure prophylaxis (PreP) uptake is particularly low in Nepal and was not considered in my model [323]. I excluded from my model pregnant women who were already diagnosed and on ART before their pregnancy [324]. Infant infections and deaths were estimated based on exposure to diseases in utero, with a probability dependent on the status of the mother during pregnancy. Based on Nepal's protocol [325], I assumed that all children from positive mothers with known status were screened, regardless of the treatment status of the mothers, and adherence to children's treatment was independent of the mother's adherence.

6.2.1.1. Markov model for HIV

Figure 13 presents a schematic of the Markov progression states for HIV, adapted from Owusu-Edusei et al [318]. Four disease states were considered for HIV: uninfected, HIV, AIDS and death [318]. The screening sequence considered in the model was the one recommended in the national guidelines, namely a rapid test confirmed by a second one if positive [325]. Regarding the ART treatment for HIV-positive pregnant women, it consisted of a once-daily fixed-dose combination of Tenofovir Disoproxil Fumarate (TDF), Lamivudine (3TC) and Efavirenz (EFV). ART should be continued lifelong [325], so I assumed that pregnant women treated took the treatment for 20 years. According to the national guidelines [325], the treatment of babies at risk of transmission was dual prophylaxis and Nevirapine (NVP) for 12 weeks.

Figure 13 - Schematic of the Markov cohort model for HIV



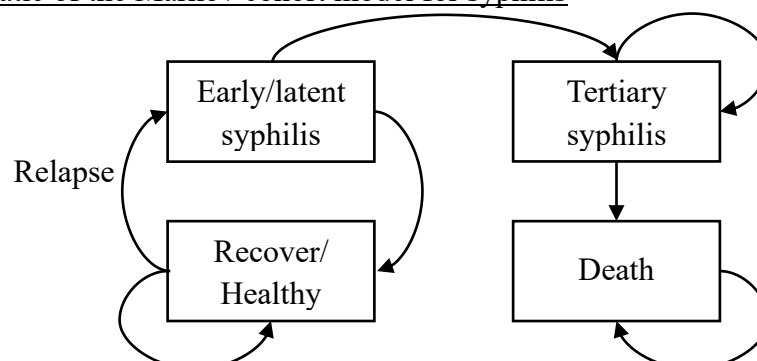
Notes: State transition probabilities were obtained from the literature (see Appendix 4.1). We assumed that patients can only remain in the same state or progress; it is not feasible for them to move back to a less severe state. HIV = Human Immunodeficiency Virus. AIDS = Acquired Immunodeficiency Syndrome.

6.2.1.2. Markov model for syphilis

Figure 14 presents a schematic of the Markov progression states for syphilis, adopted from Owusu-Edusei et al [318]. Four disease states were considered for syphilis: uninfected, early (primary/secondary) or latent syphilis, tertiary syphilis, and death [318]. In the case of syphilis transmission, three adverse outcomes were considered: stillbirth, congenital syphilis, and neonatal death. The screening sequence considered in the model was the one recommended in the National Guidelines on Management of Sexually Transmitted Infections in Nepal [325], which involves a rapid test confirmed by a Treponema pallidum particle agglutination assay (TPPA) if positive. If tested positive, the recommendations differentiated treatment based on the stage of the syphilis: late (more than two years) or early (less than two years). This

distinction was not made in my model, and I considered that when tested positive, women would be offered benzathine penicillin intramuscular in a single dose [317]. In the case of congenital syphilis, the children would be treated with the same process.

Figure 14 - Schematic of the Markov cohort model for syphilis

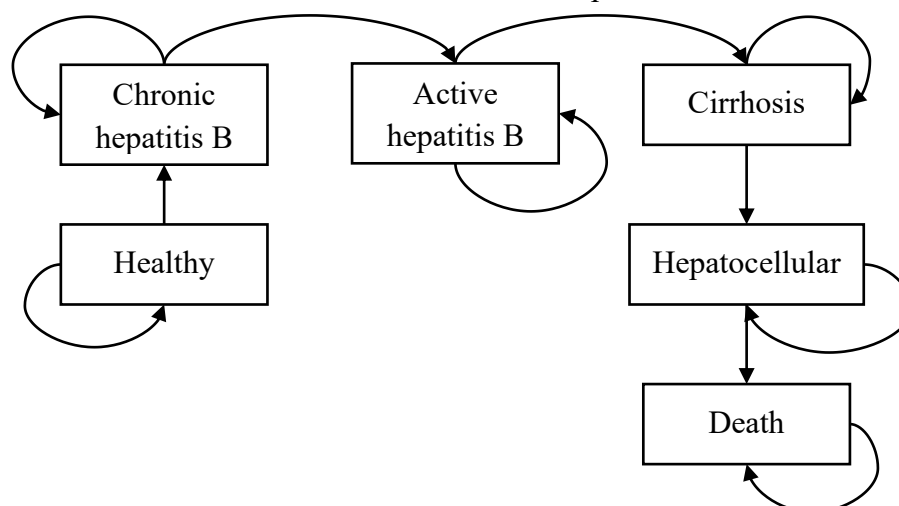


Notes: State transition probabilities were obtained from the literature (see Appendix 4.1). For treated women, there is a possibility of syphilis relapse at $t=1$. We assumed no relapse possible for children. For untreated infants with congenital syphilis, the disability weight was applied to the first three years of life, after which the children will move into the early/secondary syphilis stage and then follow the transitions from one state to the other in the mother's model.

6.2.1.3. Markov model for hepatitis B

Figure 15 illustrates a schematic of the Markov progression states for hepatitis B, adopted from Su et al. [322]. Six disease states were considered for hepatitis B [322]: uninfected, chronic hepatitis B, active hepatitis B, cirrhosis, including compensated and decompensated, hepatocellular, and death. The costs of vaccination for hepatitis B were not considered in my analysis, as the focus was on integrated screening and treatment approaches rather than vaccination strategies. Moreover, hepatitis B vaccination is implemented as a routine practice in Nepal, and its costs are already accounted for in public health budgets. In 2016, the Immunisation Act 2072 BS recognised hepatitis B vaccination as the right of all Nepalese children below 15 months. I, therefore, assumed that none of the women of childbearing age had been immunised by vaccination. The screening sequence recommended in the national guidelines is a rapid test confirmed by an enzyme-linked immunosorbent assay (ELISA) test for hepatitis B surface antigen (HBsAg) [115]. If tested positive, the recommended treatment for the mother is Tenofovir Disoproxil Fumarate (TDF) [115]. I assumed a lifetime treatment for treated women. In the case of children with hepatitis B, they will be treated with Hepatitis B Immunoglobulin (HBIG).

Figure 15 - Schematic of the Markov cohort model for hepatitis B



Notes: State transition probabilities were obtained from the literature (see Appendix 4.1). We assumed that patients can only remain in the same state or progress; it is not feasible for them to move back to a less severe state. We assumed that treated women stayed in state B all their lives.

6.2.2. Data collection

Antenatal care-related data, including the number of pregnant women per year, screening and treatment coverage, as well as epidemiological data, including the prevalence of HIV, syphilis, and hepatitis B among pregnant women, were taken from the 2022 NDHS, 2021 NHFS and governmental reports. Cost data, including screening and drug costs, were obtained from the Global Fund's pooled procurement mechanism reference prices, on which the Nepalese government bases its negotiations for the purchase of supplies. Health worker time costs were calculated based on the public sector scale [326]. See Appendix 4.1 for parameter details.

6.2.3. Screening interventions

I compared three interventions with different screening interventions (Table 17): HIV screening only (status quo), HIV and syphilis integration (intervention 2) and HIV, syphilis and hepatitis B integration (intervention 3).

Table 17 - HIV, syphilis and hepatitis B testing model interventions

Intervention	Description
Status quo HIV screening only	Integration of ANC and screening only for HIV, with HIV screening being offered at the first ANC visit.
Intervention 2 Integrated screening of HIV and syphilis	Integration of HIV and syphilis activities into ANC routine visits, with the activities taking place in the same health facility.
Intervention 3 Integrated screening of HIV, syphilis and hepatitis B	Integration of HIV, syphilis and hepatitis B activities into ANC routine visits, with the activities taking place in the same health facility.

Notes: ANC = Antenatal care. HIV = Human immunodeficiency virus. Integration= Conducting screening for several diseases into a single blood draw.

6.2.4. Cost-effectiveness analyses

6.2.4.1. Outcomes

To assess the economic benefits of HIV, hepatitis B and syphilis integrated screening and treatment, I analysed the investment costs and the impact on the population's health for each intervention. Key indicators for effectiveness included the number of new infections, the number of disease-related adverse events, the number of person-years living with the disease and the number of disease-related deaths. Investment costs included labour costs and the purchase of screening kits and treatments.

For each infection, disability-adjusted life years (DALYs) were calculated as the sum of years of life lost and years lived with a disability. Disability weights for the different health states were obtained from the Global Burden of Disease study [327]. DALYs for each stillbirth and neonatal death were equal to the years of life lost due to the death of the newborn, taking into account the local potential life expectancy if the child had survived. I assumed a 3% discount rate for DALYs.

6.2.4.2. Costs

Costs consisted of direct medical costs for screening and treatment, including the cost of screening kits, treatment and labour costs for screening, data entry, counselling, training, and the supply of drugs. See Appendix 4.1 for parameter details. I excluded from the analysis the costs related to the infrastructure of health facilities, as well as distribution costs. I assumed that treatments were given during routine ANC visits and that no further visits were needed. Costs of stillbirths and neonatal deaths related to syphilis were considered the same and equal to the costs of delivery with complications. The costs of vertical transmission of HIV and hepatitis B, taken into account, are the costs of treating infected infants and mothers. When collected in 2024's local currency (Nepalese rupees), I converted costs to US\$ using the 2024 exchange rate [328]. I applied a 3% annual discount rate for costs [329].

6.2.4.3. Analysis

A cost-effectiveness analysis was conducted from a healthcare provider's perspective. Interventions 2 and 3 were compared with the status quo, and the impact of integrative approaches on differences in life quality indicators was assessed. I calculated the incremental cost-effectiveness ratio (ICER) as the ratio of the incremental investment cost associated with implementing interventions 2 and 3 compared with the status quo, divided by the expected benefits to the population resulting from the improved screening coverage in these interventions. The incremental investment cost included the additional expenditure incurred in moving from the status quo to integrated approaches, while the expected population benefits included the DALYs. The determination of cost-effectiveness depended on whether the ICERs were below the country-specific cost-effectiveness threshold, otherwise understood as the country's willingness to pay. Cost-effectiveness was determined by comparing ICERs to the country-specific cost-effectiveness threshold, which reflects the country's willingness to pay.

Different thresholds were considered, ranging from 50% of GDP per capita (US\$662) [330], as estimated by Wood et al. [331], to three times GDP per capita (US\$3,972) based on WHO guidelines [332].

Analyses were conducted in Microsoft Excel 2023, and results were reported according to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement [329] (Appendix 4.2).

6.2.4.4. Sensitivity analysis

I conducted one-way sensitivity analyses to assess the effect of changing models' parameters, including disease prevalence, test and treatment costs, discount rates and costs. These parameters were chosen based on their potentially significant influence on the results, as identified in the existing literature, or their inherent uncertainty, which could lead to highly volatile results. I used low and high parameter values from confidence interval bounds when available, $\pm 10\%$ relative changes for cost parameters and $\pm 20\%$ relative changes for all other parameters.

In addition, I conducted a probabilistic sensitivity analysis (PSA) to allow several parameters to be varied simultaneously according to their probability distributions. Upper and lower bounds of parameters are presented in Appendix 4.1. Probability distributions were assigned to each parameter based on available data and expert opinion. I assumed that probabilities follow a beta distribution and continuous variables a gamma distribution. I used Monte Carlo simulation techniques to generate 1,000 iterations of the model and quantify the impact on the outcomes of interest.

6.3. Results

I modelled populations of 752,506 pregnant women in Nepal [115]. In my models, routinely offering HIV, syphilis and hepatitis B rapid screening at the first ANC visit (intervention 3) was more effective compared with rapid dual screening for HIV and syphilis (intervention 2) or HIV screening only (status quo); it was also costlier (Table 18). Dual rapid diagnostic tests at the first antenatal care visit averted 470 congenital syphilis cases more than the status quo and reduced DALYs by 28,516 (16.12% reduction) compared to the status quo. Triple-integrated screening strategy averted 479 vertical transmissions of hepatitis B more than for dual-integrated screening strategy and reduced DALYs by 8,166 (5.50% reduction compared to dual-integrated screening). Dual integrated screening for HIV and syphilis and triple integrated screening cost, respectively, US\$18 and US\$40 more per DALY averted than HIV screening only. Triple-integrated screening costs US\$114 more per DALY averted than dual-integrated screening for HIV and syphilis. Dual-integrated screening was highly cost-effective compared to HIV screening only, and triple-integrated screening was highly cost-effective compared to dual-integrated screening.

Table 18 - Health effect, cost, and cost-effectiveness results of maternal HIV, syphilis and hepatitis B screening interventions

	Total cost (US\$)	Total vertical transmission			Total DALYs	Increment al costs (US\$)	Incremental DALYs averted	ICER (US\$/ DALY averted)
		HIV	Syphilis	Hepatitis B				
Status quo <i>HIV screening only</i>	1,782,350.19	83	783	941	176,920	Reference	Reference	Reference
Intervention 2 <i>HIV and syphilis screening</i>	2,307,840.25	83	313	941	148,403	525,490	28,516	18
Intervention 3 <i>HIV, syphilis and hepatitis B screening</i>	3,237,353.89	83	313	462	140,237	929,514	8,166	114

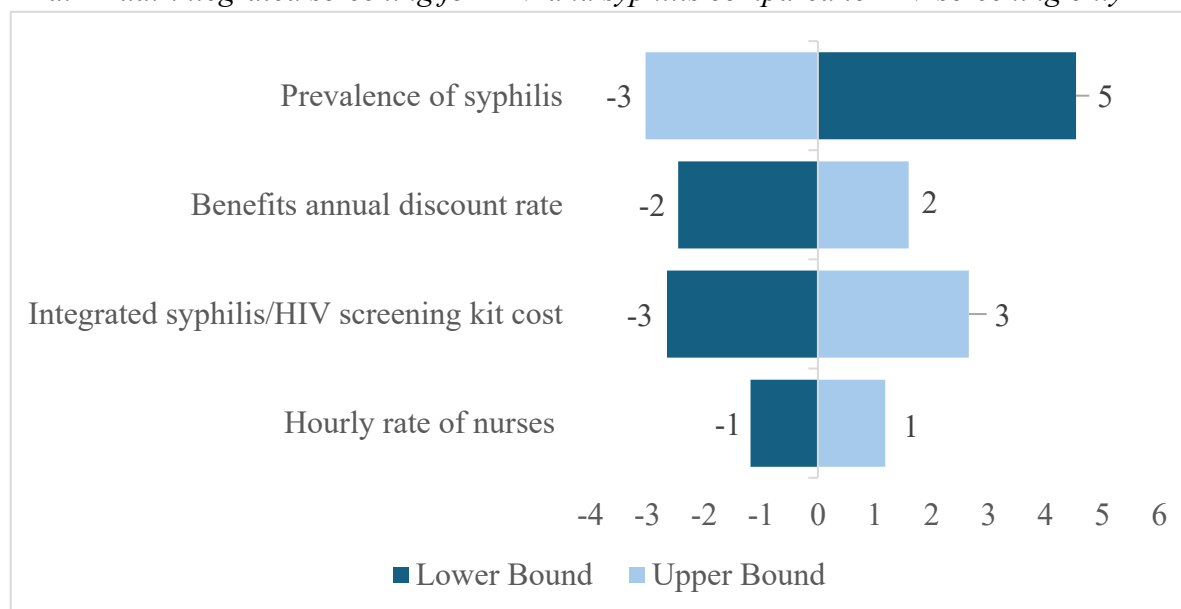
Notes: ICER= Incremental cost-effectiveness ratio. HIV= Human immunodeficiency virus. DALYs= Disability-adjusted life years. US\$= United States Dollars. Incremental costs, incremental DALYs averted, and ICER for intervention 2 were obtained by comparing dual-integrated screening with HIV screening only. Incremental costs, incremental DALYs averted, and ICER for intervention 3 were obtained by comparing triple-integrated screening with dual-integrated screening.

Figure 16 identifies the main factors influencing the ICER of dual screening for HIV and syphilis (intervention 2) and triple integrated screening (intervention 3). Detailed results of the one-way sensitivity analysis are presented in Appendix 4.3. HIV and syphilis drug costs had a minimal impact on ICER (<1%, compared to status quo results). The ICER for dual integrated screening (intervention 2) was sensitive to the price of the integrated syphilis/HIV test kit, syphilis prevalence and hourly rate of nurses, with maximum 14%, 25% and 6% variations, respectively, compared to the status quo scenario. The ICER for triple integrated screening (intervention 3) fluctuated between -5% and 5%, compared to the status quo scenario, due to the cost of the hepatitis B test kit and maternal drugs. Both scenarios were highly sensitive to the annual discount rate of benefits. In addition, the ICER for triple integrated screening (intervention 3) was highly sensitive to the prevalence of hepatitis B (-15% and 21% variations from the status quo scenario).

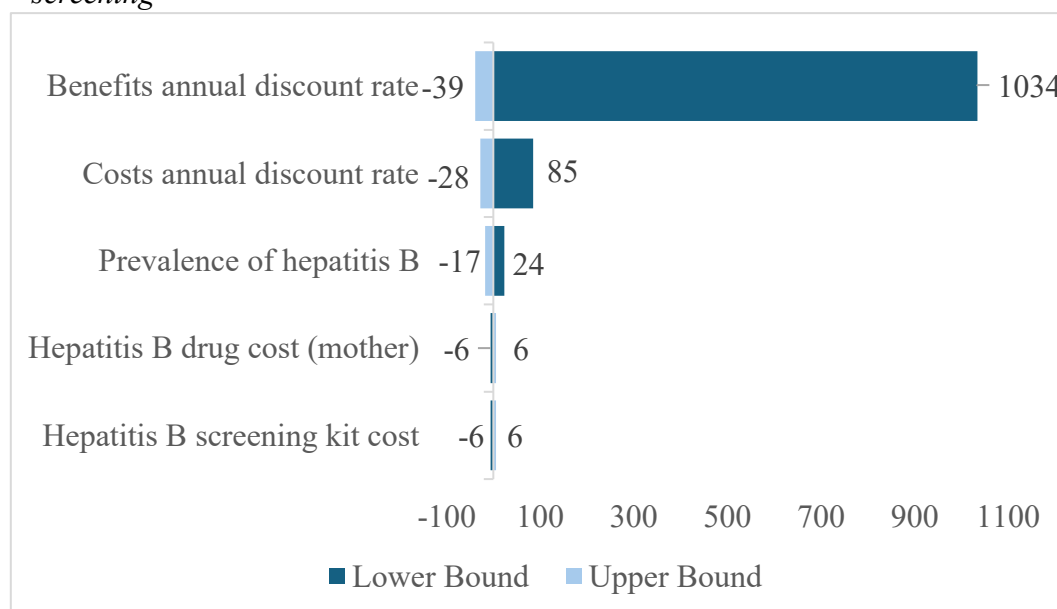
In PSA (Figure 17), the mean incremental cost per DALY averted was respectively US\$19 and US\$118 for dual and triple integrated screening (95% CI 18 to 20 for intervention 2 and -91 to 326 for intervention 3). Figure 18 presents the cost-effectiveness acceptability curves of the interventions. At a willingness-to-pay of US\$662 [331], 100% and 98% of the PSA estimates for dual and triple-integrated screening, respectively, remained cost-effective. With a willingness to pay equal to three times Nepal's GDP per capita (US\$3,972) [332], 100% of the PSA estimates for both dual- and triple-integrated screening remained cost-effective.

Figure 16 - Tornado diagrams of the percentage change in the incremental cost-effectiveness ratio (ICER) for dual-integrated screening for HIV compared with HIV screening only (status quo) and syphilis and triple integrated screening for HIV, syphilis and hepatitis B compared with dual-integrated screening produced from a deterministic one-way analysis of key parameters

a. Dual-integrated screening for HIV and syphilis compared to HIV screening only



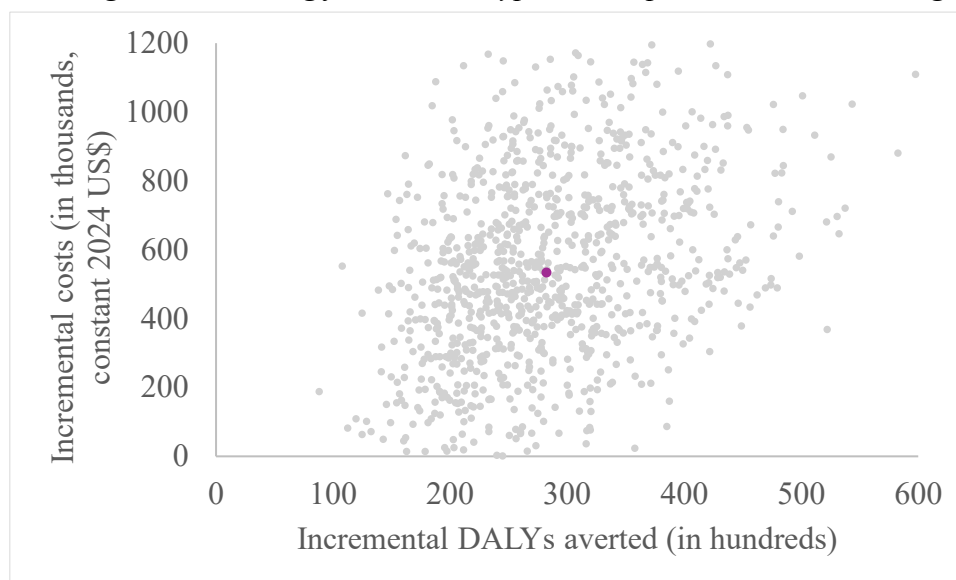
b. Triple-integrated screening for HIV, syphilis and hepatitis compared to dual-integrated screening



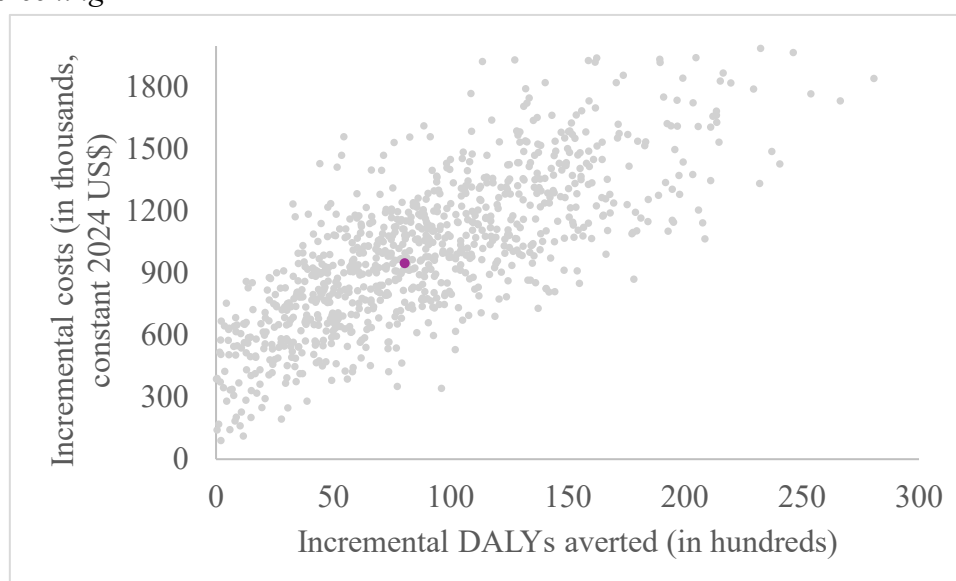
Notes: Dark blue bars indicate the absolute change in the ICER when the given parameter is at its minimum plausible value, whereas light blue bars indicate the absolute change in the ICER when the same parameter is at its maximum plausible value. Parameters listed towards the top of the diagram contribute more to the overall uncertainty in the cost-effectiveness ratio than do those towards the bottom, which contribute relatively little to the uncertainty in the cost-effectiveness ratio. Parameters that do not contribute at all were not presented in these diagrams. These included HIV drug cost (mother), HIV drug cost (child), syphilis drug cost (mother), syphilis drug cost (child), hepatitis B drug cost (child), prevalence of HIV, and hourly rate of doctors.

Figure 17 - Cost-effectiveness plane showing the statistical uncertainty around estimates of incremental costs and incremental disability-adjusted life years (DALYs) averted for dual-integrated screening for HIV compared with HIV screening only and syphilis and triple-integrated screening for HIV, syphilis and hepatitis B compared with dual-integrated screening

a. Dual-integrated screening for HIV and syphilis compared to HIV screening only



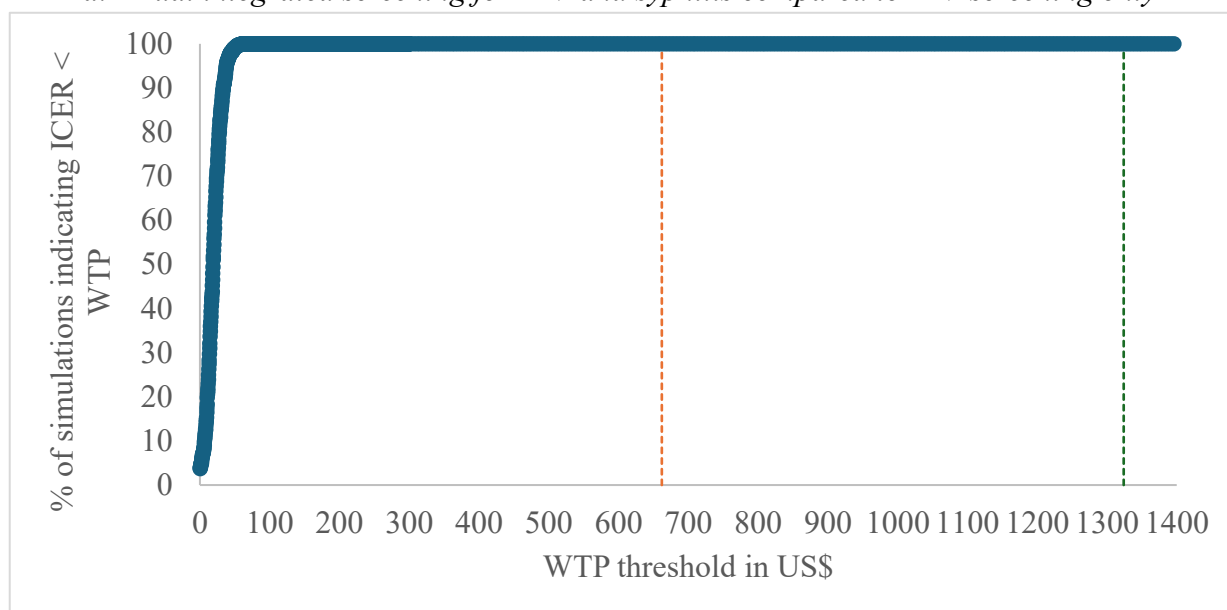
b. Triple-integrated screening for HIV, syphilis and hepatitis compared to dual-integrated screening



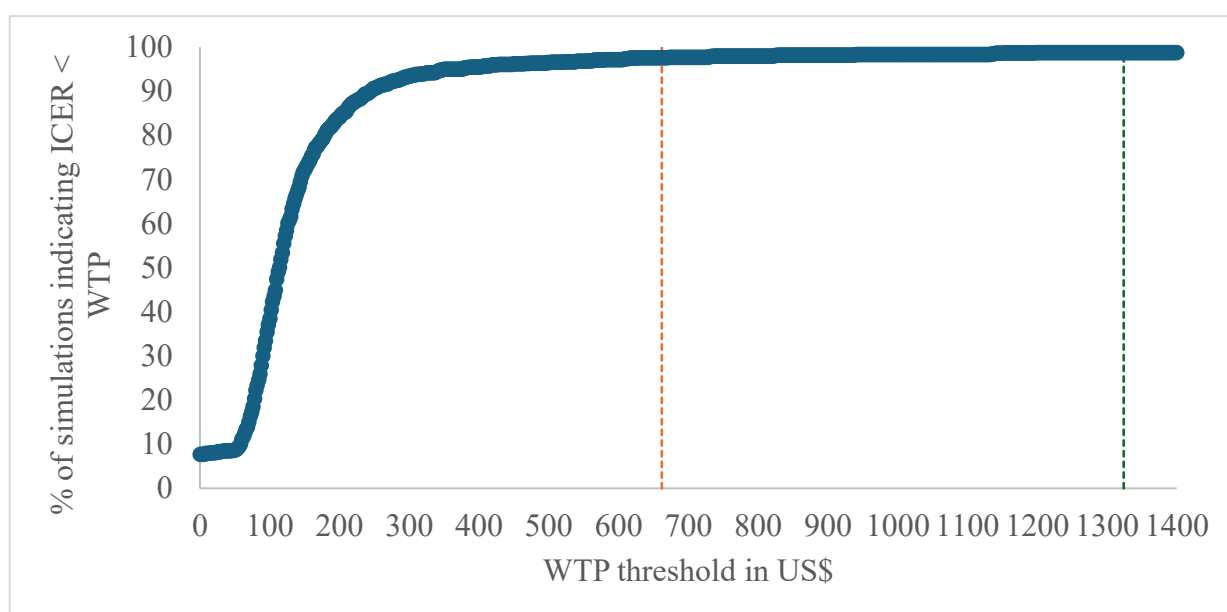
Notes: Each grey dot represents the results of one of the 1,000 simulations. The incremental cost-effectiveness ratio (ICER) for each simulation is defined as the slope of the line from the origin to that data point. The pink dot represents the mean incremental costs for the 1,000 simulations of US\$532,608 [95% CI: 514,418; 550,734] and US\$946,744 [95% CI: 919,960; 973,528] and a mean of 28,249 [95% CI: 27,725; 28,773] and 8,053 [95% CI: 7,665; 8,441] DALYs averted for Intervention 2 and 3 respectively, giving ICER mean ratios of US\$19 [95% CI: 18; 20] and US\$118 [95% CI: -91; 326]. Of the 1,000 estimates for integrated double screening, 96.3% were in the right upper quadrant and 3.7% in the right lower quadrant. For triple-integrated screening, out of 1,000 simulations, 91.1% were in the upper right quadrant, 1.2% were in the lower left quadrant, 7.6% were in the upper left quadrant, and 1.0% were in the lower right quadrant.

Figure 18 - Cost-effectiveness acceptability curves, by intervention

a. Dual integrated screening for HIV and syphilis compared to HIV screening only



b. Triple-integrated screening for HIV, syphilis and hepatitis compared to dual-integrated screening



Notes: Dashed vertical lines represent different acceptability thresholds. The orange one is equal to 50% of the Nepalese gross domestic product (GDP) per capita (US\$662), and the green one is equal to one time the Nepalese GDP per capita (US\$1324). ICER = incremental cost-effectiveness ratio. WTP threshold = country-specific cost-effectiveness threshold, otherwise understood as the country's willingness to pay.

6.4. Discussion and Conclusions

6.4.1. Discussion

Although Nepal has a concentrated epidemic, the country is still far from achieving the triple elimination targets set by the WHO [125]. In 2020, only 65% of pregnant women had a known HIV status, and coverage of syphilis and hepatitis B screening among women receiving antenatal care was 0% in 2018, well below the 95% target. This highlights the importance of promoting an integrated opt-out strategy for HIV, syphilis and hepatitis B screening during pregnancy to achieve universal screening as part of routine antenatal care practice. My modelling analysis demonstrated the high cost-effectiveness of integrated antenatal dual screening for HIV and syphilis compared with the HIV-only screening strategy currently implemented in Nepal. It also demonstrated the high cost-effectiveness of triple-integrated screening for pregnant women and children compared with the dual-integrated strategy.

This study indicated that triple screening was cost-effective compared with dual testing for HIV and syphilis, and its implementation seems relevant in the Nepalese context. The ICER was found to be highly sensitive to disease prevalence, with a 20% increase in syphilis prevalence leading to a 16% decrease in the ICER for dual-integrated screening and a 20% increase in hepatitis B prevalence leading to a 15% decrease in the ICER for triple-integrated screening. While these variations highlight the importance of accounting for global spatial disparities in the prevalence of diseases such as HIV, syphilis and hepatitis B, the PSA analyses, including these parameters, indicated that at a willingness-to-pay threshold of US\$662, dual- and triple-integrated screening remained cost-effective in 100% and 98% of simulations, respectively.

The ICER for triple-integrated screening was found to be highly sensitive to the coverage of hepatitis B screening and treatment, suggesting a potential reduction in costs with increased coverage. This suggests that increased coverage could enable fixed costs to be spread more effectively, thereby reducing the cost per DALY averted. These results, together with the important role of health workers in antenatal screening in Nepal shown in Chapter 5, highlight the importance of improving screening coverage. More specifically, a 10% reduction in the cost of hepatitis B screening kits led to a 5% reduction in ICERs for triple-integrated screening. Integrated rapid screening kits would allow costs to be shared between the three diseases. Assuming that costs for triple screening kits are similar to those of current dual screening kits for HIV and syphilis, costs per disease for hepatitis B could potentially be reduced by 47%, leading to a potential reduction in triple-integrated screening ICER of over 27%.

Integration offers significant potential for time savings for health workers. This time saving could enable health workers to devote their time to other interventions. However, it is essential to ensure that the quality of services is maintained through appropriate supervision and training of health workers. In this chapter, the benefits of integration may be underestimated since I did not consider the time saved by pregnant women. This time saved could increase the acceptability of the test and improve their access to antenatal care services, given that long waiting times are frequently reported in Nepal (Chapter 5).

As shown in Chapter 5, the availability of blood tests for STI screening is limited in some health facilities. In addition, only 22% are equipped for syphilis screening [95]. Promoting the use of integrated rapid tests in Nepal could alleviate this problem. Rapid tests require minimal training and laboratory infrastructure [295]. Based on integrated rapid-test approaches, Thailand's and Sri Lanka's models have been recognised by WHO as having reached the elimination targets for the vertical transmission of HIV and syphilis [286,287]. To ensure ethical implementation, treatment must be integrated into this approach, and a positive test must automatically be accompanied by care and treatment. This is particularly important for hepatitis B, as treatment is lifelong, expensive and should be provided free of charge to women who test positive.

I compared my findings with other economic evaluations evaluating dual- and triple-integrated antenatal screening. By supporting antenatal dual- and triple-integrated screening, my results are in line with other studies that have attempted to assess the cost-effectiveness of universal screening strategies for pregnant women [317,318,320]. A cost-effectiveness analysis of maternal dual rapid diagnostic tests at the first antenatal care visit compared with individual HIV and syphilis tests, using modelling methods for four countries (Kenya, Colombia, South Africa and Ukraine), found that incorporating dual rapid diagnostic tests into antenatal care can be cost-effective in countries with varying HIV prevalence [317]. Similarly, a modelling-based cost-effectiveness analysis in China compared four screening strategies: no screening, HIV screening only, syphilis screening only, and HIV and syphilis screening, and concluded that antenatal HIV screening programmes that include syphilis screening are likely to be significantly more cost-effective than HIV screening alone and to prevent significantly more adverse pregnancy outcomes [318]. In Cambodia, a cost-effectiveness evaluation of integrated triple testing concluded that integration of screening for HIV, syphilis and hepatitis B into antenatal, perinatal and postnatal care is highly cost-effective and efficient [320].

Although disease-specific funding allows considerable progress to be made, as was the case with HIV, for example,[333] it often limits the ability of programmes to tackle several diseases simultaneously, which is a source of inefficiency. This narrow focus can lead to inefficient use of resources, redundant efforts, and the loss of economies of scale that integrated approaches can achieve. In the case of antenatal screening, focusing on screening for specific diseases can lead to missed opportunities to address other co-existing conditions, particularly in settings where resources are limited and several diseases may have overlapping risk factors and target populations. Integrated screening also enables a patient-centred approach that many health systems and ministries of health are striving to implement [334]. Integrated approaches may also offer a more sustainable and effective public health model, and the extension of screening efforts within maternal and child health programmes could potentially include other conditions as testing, laboratory and treatment capacity improves. Our results encourage a gradual extension of Nepal's newborn screening programme to multiple other conditions as health infrastructure and economic viability improve.

6.4.2. Strengths and limitations

This study has several strengths which contribute to its reliability. Firstly, by integrating data on the prevalence of the diseases and existing national guidelines, the study provided

conclusions tailored to the local context. The modelling approach made it possible to estimate the health and economic impacts of integrated screening, providing policymakers with valuable information to guide the allocation of resources and the design of interventions. In addition, standard cost-effectiveness analysis methods have been used, ensuring that the results are in line with established best practices in health economics and can be compared with similar studies in other settings. Sensitivity analyses further enhanced the robustness of the results, helping to identify key variables that influence outcomes.

This study has some limitations which must be considered when interpreting the results. Firstly, I did not take into account foetal losses due to HIV and hepatitis B. In addition, I did not include co-infections or reinfections in my models, and the risks of vertical transmission of HIV, syphilis and hepatitis B, as well as associated infant health outcomes, were treated independently. This could potentially lead to an underestimation of the true health impact. Given the low number of reported cases in Nepal, I did not consider follow-up losses. Variations in disease prevalence and testing coverage in different subsets of the population were not considered. Screening and treatment protocols were assumed to be based on national guidelines, without considering variations in clinical practices between healthcare facilities. Furthermore, my analysis is sensitive to disease prevalence. Given the limited availability of regional prevalence data in Nepal, this study aimed to provide a generalisable assessment of integrated antenatal screening on a national scale. However, my results should be interpreted with caution in contexts where prevalence rates differ considerably. The study assumed immediate initiation of treatment at the first ANC visit, which may not reflect actual delays in diagnosis and initiation of treatment. Screening and treatment of children were assumed to be independent of their mothers' adherence to treatment, which may not accurately reflect real-world scenarios. Limited access to cost data at the national level forced me to make assumptions based on international costs. Finally, the simplified cost calculations excluded certain costs, such as infrastructure and supply costs, which could lead to an underestimation of total costs. In addition, the impact of screening was considered only for women and children, rather than for the population as a whole, to limit the assumptions and reduce the uncertainty of my modelling.

6.4.3. Conclusion

In conclusion, I found the high cost-effectiveness of the implementation of integrated HIV, hepatitis B and syphilis screening into routine ANC services for pregnant women and children in Nepal compared with the current dual-integrated approach for HIV and syphilis. The current development of integrated rapid screening kits for HIV, syphilis and hepatitis B will reinforce the feasibility and practicality of adopting this integrated approach. Successful integration requires effective and high-quality ANC services, supported by necessary human resources, facilities and supplies. Given the heavy long-life treatments necessary for hepatitis B and HIV-positive individuals, early diagnosis and prevention are essential to ensure timely treatment and eliminate vertical transmission. My results support WHO recommendations for the implementation of integrated triple antenatal screening in Asia, highlighting the need for further economic analyses of integrated screening pilots to inform decision-making. Moreover, a pilot economic evaluation conducted in Nepal would enable us to test effectiveness, determine costs

and eliminate assumptions from my model. It is essential to design the pilot project carefully to adapt to the context and to exploit its full potential.

7. General conclusions and implications

In this chapter, after summarising the main results of this thesis, I discussed its strengths and limitations. Then I discussed the research implications and avenues for further research. Finally, I discussed policy implications and recommendations for Nepal and similar contexts based on the results found in the analytical chapters.

7.1. Main results

In Nepal, national guidelines recommend free HIV and syphilis screening for pregnant women at their first antenatal visit, using an opt-out approach. However, screening uptake remains low, and the guidelines currently do not include hepatitis B screening. This thesis aligned with the WHO recommendations advocating for integrated screening for HIV, syphilis, and hepatitis B to prevent vertical transmission. By using mixed methods, this thesis investigated factors affecting antenatal screening for HIV, syphilis and hepatitis B in Nepal. It also explored the acceptability, feasibility, potential impact and cost-effectiveness of integrated antenatal screening for HIV, syphilis, and hepatitis B in addressing barriers to accessing screening for STIs during pregnancy.

The results of this thesis contribute to the literature in various novel ways. First, I conducted the first systematic literature review focused on barriers and facilitators to antenatal screening for HIV, syphilis, and hepatitis B in Asia. The review, presented in Chapter 2, highlighted the predominant focus on HIV in existing research and identified a significant gap in the literature regarding antenatal screening for hepatitis B and syphilis in the Asian context.

Secondly, in Chapter 4, I used multilevel models to investigate the effects of individual- and district-level characteristics on the utilisation of antenatal screening for HIV in Nepal and how these effects changed between 2016 and 2022. I found that factors associated with antenatal screening have not changed significantly between 2016 and 2022. Higher uptake of HIV screening was found amongst women with higher education, the pregnancy being desired later, and women who had 4 or more ANC visits. Being from a poorer family and having low knowledge of vertical transmission and the medicines to prevent transmission were associated with lower uptake. From the supply side, no factors had a significant effect on antenatal screening. I also distinguished barriers to HIV screening from barriers to accessing ANC services. The results also showed the partial importance of geographical factors on screening uptake.

Then, in Chapter 5, I conducted in-depth interviews to explore the knowledge, attitudes, and perceptions of pregnant women, their families, healthcare providers and policymakers on integrated antenatal screening. By using an original theoretical framework by integrating the social-ecological model with the WHO building blocks, the analysis showed that antenatal screening in Nepal involved many stakeholders and was influenced by various factors.

Implementation issues were found in the building blocks of service delivery, the health workforce and medical products. Husbands and in-laws play an important role in the acceptance of screening by pregnant women, especially in rural areas. High levels of stigma and discrimination against people with STIs were reported, and knowledge of hepatitis B and syphilis was low.

Finally, in Chapter 6, I investigated the cost-effectiveness of triple-integrated antenatal screening using modelling techniques. The results showed that the implementation of dual-integrated screening for HIV and syphilis and triple-integrated HIV, hepatitis B and syphilis screening into routine ANC services for pregnant women in Nepal are highly cost-effective.

In addition to these conclusions, this thesis also makes important methodological contributions, which are detailed in Section 1.5. By integrating quantitative, qualitative and modelling approaches into a single coherent framework, it demonstrates the value of mixed methods in the study of complex health interventions. More specifically, it introduced an innovative use of NDHS data and multilevel modelling to analyse the factors associated with antenatal HIV screening, developed an original analytical framework by combining the socio-ecological model with the WHO building blocks to guide qualitative analysis, and adapted and extended Markov models to evaluate the cost-effectiveness of triple-integrated antenatal screening in Nepal. These innovative approaches not only strengthened the robustness and policy relevance of the results but also provided transferable tools for future research in other low- and middle-income countries.

7.2. Strengths and limitations

This thesis demonstrated several strengths, each contributing to its methodological rigour and relevance to the Nepalese healthcare context. One of the key strengths was the adoption of a mixed-methods approach. Combining quantitative and qualitative methods allowed me to understand the context holistically, enabling a detailed interpretation of the results. This approach facilitated the triangulation of results between different environments and individuals, reinforcing the robustness of the conclusions. I used advanced econometric modelling, tailored to the specific context of Nepal. To inform the development of the model, I conducted a systematic literature review, which identified several potential variables to be included in the model. In addition to its quantitative depth, the thesis incorporates primary qualitative data collection that I analysed by combining two conceptual frameworks. This qualitative dimension provided contextual insights that complement the quantitative findings. Furthermore, I used complex modelling techniques, including cost-effectiveness models, strengthened by sensitivity analyses, allowing me to test the robustness and validity of the results across different scenarios. These strengths allow this thesis to have important research and policy implications.

Despite its contributions, this thesis has several limitations. I have discussed the limitations in detail in individual chapters, but I summarised them here to provide a comprehensive overview.

The analyses using NDHS data faced limitations in capturing the complexity of supply-side factors and geographic accessibility of prevention services for vertical transmission. The data

lacked granularity in terms of the quality of services, health worker knowledge, and behaviour. Furthermore, given the nature of the data, only associations could be explored with the available data, and no causal analyses could be undertaken.

The qualitative component of this thesis was constrained by sampling and contextual challenges. In Kathmandu, we recruited participants through a health facility only, which excluded perspectives from women who had not attended ANC. Moreover, sensitivity around discussing STIs sometimes hindered accurate data collection. The resources needed to undertake follow-up qualitative research were not available, and I was therefore unable to formulate and explore new questions.

The cost-effectiveness modelling also had certain limitations due to the limited national data on test kit costs and the assumptions I formulated to make the modelling exercise possible. These simplified assumptions, such as adherence to national guidelines and immediate initiation of treatment, may not fully align with real-world practices.

While the thesis aimed to provide generalisable conclusions, findings should be interpreted cautiously in settings with high prevalence rates or healthcare contexts that differ substantially from Nepal. These limitations underline the need for further research to address these gaps.

7.3. Research implications

The results of this thesis not only contribute to the literature on antenatal screening for HIV, syphilis and hepatitis B but also raise avenues for future research. Several gaps remain in my understanding of antenatal STI screening, particularly in the Asian context, and need further investigation to support the design and implementation of more effective screening interventions.

The factors affecting antenatal screening in Nepal are multiple and involve a complex interplay of individual, social and health system factors. Future research should use mixed methods to further explore the factors influencing the uptake of antenatal STI screening in the Asian context. While considerable progress has been made in the area of HIV, syphilis and hepatitis B remain under-researched, particularly in the context of integrated antenatal care.

As geographical factors emerged as significant in this thesis, where data allow, future research should consider using multilevel models in other contexts, particularly in Asian countries, where evidence on the uptake of antenatal screening for STIs is lacking. Such studies could explore how factors at the district and regional level influence the uptake of screening. Future qualitative research could apply the framework developed in this thesis to other countries to better understand the perceptions, knowledge and attitudes of key stakeholders towards integrated antenatal screening, providing information for developing tailored interventions.

In this thesis, the role of stigma and lack of knowledge emerged as a major barrier to antenatal STI screening. Given the central role played by health workers in the delivery of antenatal screening services, future research could investigate their attitudes and potential gaps in their training and knowledge to inform targeted interventions to improve service delivery.

The findings of this thesis highlighted the important role that private providers play in antenatal care and screening in Nepal, suggesting that the private sector could serve as a key lever for expanding coverage. At the same time, the use of private providers poses challenges related to quality assurance, standardisation of protocols, and integration with national reporting systems. Future research should explore strategies to incentivise private providers to deliver high-quality, affordable screening services while ensuring equitable access for women from poor and rural households. Lessons learned from models such as outsourcing, accreditation, or blended financing could inform the design of effective public-private partnerships that maximise coverage without compromising quality or equity.

A promising area for investigation is the role of rapid diagnostic tests in improving screening coverage. Research could assess the cost-effectiveness and feasibility of extending rapid diagnostic tests for syphilis and hepatitis B, drawing lessons from successful models such as the elimination of vertical transmission of HIV and syphilis in Thailand and Sri Lanka.

Future research could use preference-revealing methods such as discrete choice experiments (DCEs) to explore preferences for antenatal screening modalities, such as timing, health worker training or technology use. The preferences of different stakeholders, including pregnant women and health workers, could be elicited and translated into concrete strategies to increase screening uptake. Although this was planned as part of this PhD, funding applications to support this work have unfortunately not been successful.

While the modelling presented in this thesis suggested that integrated screening is highly cost-effective, further research is needed to assess its budgetary impact and affordability within Nepal's budgetary framework. Data are needed on short-, medium- and long-term budgetary requirements, as well as on the possibility of reallocating existing domestic resources without compromising other priority health services. Furthermore, given the importance of external donors in the Nepalese context and recent changes in the development partner landscape, their role in providing catalytic funding during the initial implementation phases and ensuring the long-term sustainability of investments must be considered. Transition strategies towards sustainable national financing will be necessary to ensure the continuity and resilience of the programme in the face of fluctuating donor support.

Moreover, the modelling of the cost-effectiveness of integrated antenatal screening in Nepal, conducted as part of this thesis, showed promising results. Extending this modelling to other countries and contexts could help to assess the wider applicability of integrated antenatal screening programmes and their potential to reduce transmission of these diseases. This would enable comparisons to be made between different settings with various health systems and disease burdens.

Finally, pilot studies are essential to assess the feasibility and scalability of integrated STI screening for pregnant women and to support the development of such programs in Nepal and similar settings. Pilot studies on integrated antenatal screening could also be conducted in different countries to provide data on their health impact, feasibility and cost-effectiveness, enabling comparisons between settings and informing strategies for wider roll-out.

During the design phase of the pilots, particular attention should be paid to selecting a diverse set of implementation sites that reflect Nepal's geographical, socio-economic, and health heterogeneity. Pilot projects should establish clear feasibility criteria, such as the proportion of women offered and accepting screening, the delays with which results are communicated to women, and the linkage with treatment services. Pilots should also incorporate equity analyses to assess whether disadvantaged groups are being reached. These pilot studies should go beyond assessing health outcomes and include research on key implementation factors such as stigma, community engagement, provider training, workload and availability of supplies. To this end, it is essential to incorporate a mixed-methods assessment, combining quantitative indicators and qualitative methods. In addition, attention should be paid to supply chain reliability, provider training, and integration with existing health information systems to ensure sustainability.

7.4. Policy implications

Specific and targeted interventions are necessary to increase the uptake of antenatal screening for HIV, syphilis, and hepatitis B in Nepal. The following policy recommendations are proposed to address the identified barriers in this thesis and promote the integration of syphilis and hepatitis B screening into existing HIV antenatal screening services. These strategies will require a multi-sectoral approach.

To ensure effective implementation of national guidelines at the local level and to secure the necessary funding, maternal and child health, including antenatal screening for HIV, syphilis and hepatitis B, must be considered a national priority in Nepal. This will require raising awareness among decision-makers at both national and local levels of the burden of HIV, syphilis and hepatitis B among mothers and children. In addition, this will require highlighting the wider benefits of adopting an integrated approach to healthcare, including its value for money.

Access to healthcare is the foundation of the cascade of care needed to prevent vertical transmission, with ANC visits being the entry point for screening. In this context, it is essential to integrate hepatitis B screening into the ANC protocol, as it is already the case for HIV and syphilis. As demonstrated in Chapter 6, promoting an integrated approach can improve efficiency and reduce duplication of effort by combining vertical disease-specific programmes with a broader approach to health system strengthening. Rather than a vertical disease-by-disease approach, an integrated approach should be considered, starting with the development of national guidelines. To eliminate vertical transmission of HIV, syphilis, and hepatitis B in Nepal, clear, integrated national guidelines should be developed for triple antenatal screening, fitting into the ANC protocol and following an opt-out strategy for all pregnant women. These guidelines could be based on the detailed HIV protocol already in place. Additionally, to support the national program and ensure alignment with local needs, local-specific guidelines and clinical standard operating procedures should be designed.

Considering the crucial role of donor funding in Nepal's healthcare system, particularly in STI screening (Chapter 3), this integrated approach must be discussed and advocated for with

donors. The cost-effectiveness of integrated antenatal screening for HIV, syphilis, and hepatitis B, as shown in Chapter 6, should serve as the key decision criterion in these discussions.

To address the lack of data on the prevalence of syphilis and hepatitis B (Chapter 3) and to strengthen advocacy for the prevention of vertical transmission, systematic monitoring and reporting of syphilis and hepatitis B cases are essential at all levels of the healthcare system. As shown by Thailand's success in eliminating vertical transmission of HIV and syphilis [286], systematic national monitoring is key to improving programmes at national and sub-national levels. To minimise the additional workload for health workers and avoid the need for extensive training in an entirely new system, syphilis and hepatitis B monitoring could be integrated into the IHMIS, which is already well-established and effective in Nepal. This approach could be reinforced by mandatory reporting at the national level. In the case of the development of an integrated antenatal screening programme for HIV, syphilis and hepatitis B, this could be complemented by the development of indicators to monitor progress toward the elimination of vertical transmission of HIV, syphilis and hepatitis B.

Given the context of federalisation described in Chapter 3 and its challenges discussed in Chapter 5, more effective collaboration between national and local governments should be encouraged to enable better planning and allocation of funds for screening. It is essential to clearly define the role of local governments in healthcare decision-making to avoid duplication of effort or inefficiencies due to misunderstandings.

In addition, given that financial constraints have been identified as a barrier to antenatal screening in Nepal, alongside the influence of geographical factors (Chapter 4), it is essential to standardise the prices of services in public health facilities and regulate fees in the private sector. This could reduce hospital overcrowding by allowing easier access to other health facilities and ensuring equitable access to care for all, in line with universal health coverage goals.

Given the important role of hospitals in service provision (Chapter 3) and the challenges posed by long waiting times and heavy workloads for healthcare staff in these facilities (Chapter 5), more importance should be given to primary healthcare centres and health posts. Strengthening the capacity of these structures could relieve congestion in federal and national hospitals and improve the quality of services. This would require equipping them with basic laboratory services. The disparity in the distribution of lab services could also be tackled with the promotion of rapid diagnostic tests, as recommended by WHO for their cost-effectiveness, reduced loss to follow-up, and increased syphilis screening coverage [294]. These tests are available at lower costs and require minimal training and lab infrastructure [295]. Based on integrated rapid-test approaches, Thailand's model has been recognised by WHO as having reached the elimination targets for the vertical transmission of HIV and syphilis [286]. A similar rapid-test approach should be prioritised in Nepal to facilitate the availability of antenatal screening in health facilities.

Considering the important role of the private health sector in Nepal (Chapter 3), strong coordination between public and private antenatal care providers should be ensured to improve

continuity of care and implement an effective referral strategy. This strategy could be supported by the development of clear national guidelines aimed at minimising unnecessary referrals to higher-level facilities and reducing the risk of loss to follow-up.

Given the persistent problem of test kit shortages (Chapter 3 and Chapter 5), it is essential to strengthen supply chain management at the national level. This should include building the capacity of staff to forecast and monitor stocks and should extend beyond high-level health facilities to local and provincial levels. If an integrated antenatal screening programme for HIV, syphilis and hepatitis B were to be developed, linking it to existing maternal and child health and STI services could make it easier to forecast equipment requirements. In addition, the adoption of integrated rapid tests for multiple diseases, such as combined syphilis and HIV tests currently available, could streamline the supply chain by reducing the variety of tests required, simplifying logistics and ensuring more consistent availability.

Given the stigma associated with HIV and the taboo surrounding STIs in Nepal, it is insufficient to rely solely on individual counselling. Community-wide awareness campaigns should be implemented covering HIV, syphilis and hepatitis B as well as other STIs, as discussed in Chapter 4. Awareness-raising efforts can start in schools but should also be spread through multi-channel social and behaviour change interventions that combine the media, social media, community group outreach, individual counselling, street theatre, rallies and other innovative approaches. Given the important role of FCHVs in the Nepalese health system concerning antenatal care and maternal and child health (Chapter 3), they should be involved in the design of the awareness campaign and should receive regular training on the issue of STIs and their screening during pregnancy. Involvement of persons living with HIV, syphilis and /or hepatitis B in the co-creation of materials to tackle stigma should also be a priority.

Given the significant influence of husbands on women's decision to undergo screening (Chapter 5) and the gender dynamics that often require women to seek permission to visit health facilities (Chapter 3), men's involvement should be encouraged during ANC visits. This could involve offering husbands the opportunity to be screened for STIs during ANC visits. Men's participation could also be encouraged through their involvement in community groups discussing antenatal care and related health topics. Similarly, given the influential role of mothers-in-law, particularly in rural areas, they should be involved in community discussions.

To reduce stigma and encourage the uptake of STI screening, the skills of health workers must also be strengthened through training aimed at increasing knowledge about STI screening and confidence in communicating results to women and partners (Chapter 5). Ongoing training of health workers at all levels of health facilities, including the private sector, should cover the modes of transmission of STIs and their management. This training should cover key aspects such as counselling for screening, treatment protocols, the involvement of husbands, the importance of confidentiality, and the need for consent as part of the opt-out strategy. To streamline efforts and avoid duplication with ANC training, STI-related training could be integrated into existing ANC training programs provided to health workers. Moreover, regular and sustained funding across all health facility levels is essential to ensure that such training remains accessible and consistently delivered.

8. References

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1. Literature review appendix

1.1. Literature review reporting checklist

To ensure transparency and consistency in the reporting of the research process, results of the systematic literature review were reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [43].

Section & Topic	#	Checklist item	Page
Introduction			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	27
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	28
Methods			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	30
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	29
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	29
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	30
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	30
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	30
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	30
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	31
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	30
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	31
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	31
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	31

	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	31
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	31
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	31
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	31
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	30
Results			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	32
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	32
Study characteristics	17	Cite each included study and present its characteristics.	32
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	156
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	34
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	37-46
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	37-46
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	37-46
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	37-46
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	37-46
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	37-46
Discussion			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	46-48
	23b	Discuss any limitations of the evidence included in the review.	46-48
	23c	Discuss any limitations of the review processes used.	46-48
	23d	Discuss implications of the results for practice, policy, and future research.	46-48

1.2. Full search terms used on Scopus

TITLE-ABS-KEY ("barriers" OR "facilitators" OR "factors" AND ("antenatal screening" OR "prenatal screening" OR "screening during pregnancy" OR "pre-natal screening" OR "antenatal testing" OR "prenatal testing" OR "testing during pregnancy" OR "pre-natal testing" OR ("screening" AND "pregnant women") OR ("testing" AND "pregnant women") OR ("screening" AND "pregnant wives") OR ("testing" AND "pregnant wives")) AND ("HIV" OR "syphilis" OR ("HBV" OR "hepatitis B")) AND ("Asia" OR "Asian"

OR "Afghanistan" OR "Armenia" OR "Azerbaijan" OR "Bahrain" OR "Bangladesh" OR "Bhutan" OR "Brunei" OR "Cambodia" OR "China" OR "Cyprus" OR "Georgia" OR "India" OR "Indonesia" OR "Iran" OR "Iraq" OR "Israel" OR "Japan" OR "Jordan" OR "Kazakhstan" OR "Kuwait" OR "Kyrgyzstan" OR "Laos" OR "Lebanon" OR "Malaysia" OR "Maldives" OR "Mongolia" OR "Myanmar" OR "Nepal" OR "North Korea" OR "Oman" OR "Pakistan" OR "Palestine" OR "Philippines" OR "Qatar" OR "Russia" OR "Saudi Arabia" OR "Singapore" OR "South Korea" OR "Sri Lanka" OR "Syria" OR "Taiwan" OR "Tajikistan" OR "Thailand" OR "Timor-Leste" OR "Turkey" OR "Turkmenistan" OR "United Arab Emirates" OR "Uzbekistan" OR "Vietnam" OR "Yemen") AND PUBYEAR AFT 2000

1.3. Quality appraisal checklists of the included studies

Citation	Title	Abstract	Back-ground	Objectives	Design	Setting	Participants	Variables	Data	Bias	Study size	Quantitative variables	Methods	Participants	Descriptive data	Outcome	Results	Other analyses	Keys results	Limitations	Interpretation	Generalisation	Funding	Score
Bharucha	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	52,17
Chu	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	95,65
Dinh	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	52,17
Hanh	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	82,61
Kakimoto	No	No	Yes	No	Yes	Yes	Yes	No	No	No	Yes	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	52,17
Khuu	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	82,61
Lee	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	78,26
Li	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	60,87
Nguyen	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	60,87
Pakki	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes	26,09
Pharris	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	95,65
Rogers	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	69,57
Sarin	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	82,61
Sasaki	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	69,57
Setiyawati	Yes	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	34,78
Sharma	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	95,65
Sinha	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	60,87
Todd	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	78,26
Wulandari	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	78,26

2. DHS data appendix

2.1. Results

Table 19 - Characteristics of pregnant women tested and not tested for HIV in 2016 (n=1,070) and 2022 (n=2,007) presented in percentages

		Not tested		Tested	
		2022	2016	2022	2016
<i>Predisposing characteristics</i>					
Age					
	15-19	89.2 (239)	85.7 (244)	10.8 (26)	14.3 (53)
	20-24	82.1 (672)	79.3 (582)	17.9 (139)	20.7 (180)
	25-29	76.7 (453)	75.5 (412)	23.3 (118)	24.5 (151)
	30-34	70.2 (182)	73.5 (191)	29.8 (72)	26.5 (54)
	35-39	81.8 (69)	87.2 (62)	18.2 (15)	12.8 (11)
	40-44	98.0 (14)	100.0 (27)	2.0 (1)	0.0 (0)
	45-49	100.0 (7)	100.0 (3)	0.00 (0)	0.0 (0)
Education					
	No education	95.0 (331)	93.6 (500)	4.93 (23)	6.4 (43)
	Incomplete primary	88.3 (487)	89.9 (215)	11.7 (59)	10.1 (26)
	Complete primary	84.8 (130)	87.4 (117)	15.2 (21)	12.6 (22)
	Incomplete secondary	76.0 (461)	76.1 (425)	23.9 (131)	23.9 (153)
	Complete secondary	58.7 (189)	67.4 (112)	41.3 (105)	32.6 (50)
	Higher	48.3 (38)	49.5 (152)	51.7 (32)	50.5 (155)
Literacy					
	Completely literate	48.3 (38)	49.5 (152)	51.7 (32)	50.5 (155)
	Can read a whole sentence	74.8 (969)	76.1 (685)	25.2 (286)	23.9 (232)
	Can read part of a sentence	87.3 (174)	87.7 (143)	12.8 (24)	12.3 (20)
	Cannot read at all	94.9 (454)	94.6 (540)	5.1 (28)	5.4 (42)
	No card with required language	31.1 (1)	100.0 (1)	68.9 (1)	0.0 (0)
Caste					
	Brahmin	55.4 (81)	48.3 (94)	44.6 (55)	51.7 (94)
	Chhetri	74.3 (393)	71.4 (325)	25.7 (107)	28.7 (125)
	Other	86.9 (252)	93.6 (287)	13.1 (34)	6.4 (22)
	Dalit	87.2 (363)	82.2 (236)	12.8 (50)	17.8 (58)
	Newar	57.9 (20)	73.0 (29)	42.2 (14)	26.9 (15)
	Janajati	78.7 (429)	79.2 (435)	21.3 (107)	20.8 (122)
	Muslim	94.4 (98)	91.2 (125)	5.6 (4)	8.8 (13)
Co-wives					
	None	79.6 (1594)	78.7 (1474)	20.8 (362)	21.3 (443)
	At least one	84.0 (42)	90.3 (47)	16.2 (9)	9.7 (6)
Children					
	0	88.9 (16)	90.4 (18)	11.1 (2)	9.6 (3)
	1	79.2(681)	72.6 (592)	20.8(179)	27.4 (242)
	2	93.7 (550)	77.1 (442)	6.3 (137)	22.9 (142)
	3	86.3 (239)	88.6 (236)	13.7 (38)	11.4 (38)

4	90.8 (99)	90.3 (127)	9.2 (10)	9.7 (16)
5	87.8 (36)	95.6 (59)	12.2 (5)	4.4 (5)
6	100.0 (10)	92.2 (25)	0.0 (0)	7.8 (3)
7	100.0 (3)	100.0 (14)	0.0 (0)	0.0 (0)
8+	100.0 (2)	100.0 (8)	0.0 (0)	0.0 (0)
Place of residence				
Mountain	81.3 (176)	86.1 (133)	18.7 (29)	13.9 (22)
Hill	72.8 (614)	71.5 (598)	27.2 (188)	28.5 (232)
Teraï	83.3 (846)	83.4 (790)	16.7 (154)	16.7 (195)
Knowledge of HIV				
Know	78.7 (222)	71.7 (479)	21.3 (60)	28.3 (189)
Do not know	82.0 (1414)	80.0 (1,042)	18.0 (311)	20.0 (260)
Knowledge of MTCT				
Know	72.9 (617)	76.5 (703)	27.1 (194)	23.5 (239)
Do not know	83.8 (1019)	81.1 (818)	16.2 (177)	18.9 (210)
Knowledge of medicines				
Know	68.8 (522)	67.0 (553)	31.2 (188)	33.0 (296)
Do not know	85.1 (1114)	86.9 (968)	14.9 (183)	13.1 (153)
Enabling factors				
Access health care				
No problem to access	71.1 (429)	63.1 (224)	28.9 (155)	36.9 (135)
At least one problem	83.8 (1207)	82.5 (1297)	16.2 (216)	17.5 (314)
Household decisions				
Cannot decide	81.8 (1111)	83.0 (1217)	18.6 (226)	17.0 (307)
Alone or jointly with the partner	75.8 (513)	66.1 (300)	24.2 (145)	33.9 (142)
Type of facility for ANC				
Home or other's home	52.2 (1)	100.0 (6)	47.8 (1)	0.0 (0)
Government hospital	71.9 (180)	65.7 (240)	28.1 (59)	34.3 (128)
Primary health care centre	76.4 (28)	79.8 (76)	23.6 (9)	20.6 (27)
Post/sub health post	83.2 (736)	83.8 (657)	16.8 (146)	16.2 (151)
Primary health care outreach clinic	71.0 (43)	87.4 (64)	29.0 (11)	12.6 (11)
Other public facilities	97.3 (10)	86.6 (6)	2.7 (1)	13.4 (1)
Private health facility	77.0 (497)	76.5 (325)	23.0 (133)	23.5 (115)
NGO	-	76.3 (13)	-	23.7 (4)
Other	79.5 (19)	86.1 (58)	20.5 (5)	13.9 (12)
Qualification of ANC provider				
Unskilled	92.4 (57)	92.4 (172)	7.6 (5)	7.6 (20)
Skilled provider	78.5 (1484)	76.5 (1273)	21.5 (363)	23.5 (429)
Number of ANC visits				
None	100.0 (52)	100.0 (76)	0.0 (0)	0.0 (0)
1	100.0 (47)	95.1 (76)	0.0 (0)	4.9 (5)
2-3	89.8 (238)	93.6 (367)	10.2 (23)	6.4 (35)
4+	76.5 (1255)	72.6 (1002)	23.6 (344)	27.5 (409)
Don't know	89.4 (44)	-	10.6 (4)	-
Wealth Index				
Poorest	85.7 (564)	87.4 (429)	14.3 (92)	12.6 (70)
Poorer	87.9 (385)	82.8 (332)	12.1 (59)	17.2 (86)
Middle	85.7 (305)	84.1 (341)	14.4 (55)	15.9 (82)

Richer	76.6 (257)	78.5 (287)	23.4 (75)	21.5 (96)
Richest	56.1 (125)	53.5 (132)	43.9 (90)	46.5 (115)
Need factors				
Contraceptive				
No method	82.6 (940)	80.2 (979)	17.4 (186)	19.8 (256)
Traditional method	72.6 (216)	78.6 (139)	27.7 (72)	21.4 (47)
Modern method	78.6 (480)	76.4 (403)	21.4 (113)	23.6 (146)
Desired pregnancy				
Wanted then	79.5 (1246)	78.1 (1181)	20.5 (286)	21.9 (368)
Wanted later	77.4 (275)	79.7 (208)	22.6 (69)	20.3 (61)
Wanted no more	88.4 (115)	87.0 (132)	11.6 (16)	13.0 (20)
Any STIs				
No	79.8 (1635)	79.0 (1518)	20.2 (369)	21.0 (446)
Yes	48.1 (1)	45.4 (3)	51.9 (2)	54.6 (3)
Genital discharge, sore or ulcer				
No	79.5 (1249)	80.7 (1349)	20.6 (286)	19.3 (379)
Yes	80.5 (387)	67.1 (172)	19.5 (85)	32.9 (70)

Notes: Freq. stands for frequencies and are presented in parentheses.

Table 20 – Odds ratios from multivariable logistic regression with fixed-effect at the cluster level on potential factors associated with HIV antenatal screening

	2022	2016
n_i	1,956	1,885
n_j	69	62
Predisposing characteristics		
Age	1.0	1.0
	(1.0, 1.1)	(1.0, 1.1)
Education		
Incomplete primary	1.1	1.3
	(0.6, 2.0)	(0.7, 2.3)
Complete primary	1.4	1.2
	(0.7, 2.9)	(0.6, 2.3)
Incomplete secondary	2.2***	2.1***
	(1.2, 4.1)	(1.3, 3.4)
Complete secondary	3.5***	2.2*
	(1.8, 6.7)	(1.2, 4.1)
Higher	3.9***	4.7***
	(1.7, 8.9)	(2.7, 8.2)
Caste		
Brahmin	1.5	1.6*
	(0.9, 2.5)	(1.0, 2.6)
Other	1.1	0.6
	(0.6, 2.0)	(0.3, 1.1)
Dalit	1.0	1.2
	(0.7, 1.6)	(0.7, 1.9)
Newar	1.2	1.3
	(0.5, 2.9)	(0.5, 3.2)
Janajati	1.1	0.8
	(0.8, 1.7)	(0.5, 1.2)
Muslim	0.5	1.0
	(0.1, 1.5)	(0.4, 2.2)
Co-wives	1.3	0.7

	(0.6, 3.1)	(0.3, 1.8)
Children	0.9	0.8
	(0.8, 1.2)	(0.7, 1.0)
Knowledge of HIV	1.2	1.3*
	(0.8, 1.7)	(1.0, 1.8)
Knowledge of vertical transmission	1.6***	1.0
	(1.2, 2.2)	(0.8, 1.4)
Knowledge of medicines	1.3*	2.2***
	(1.0, 1.8)	(1.7, 3.0)
Enabling factors		
Access health care	0.8	0.7
	(0.6, 1.1)	(0.5, 1.0)
Household decisions	1.1	1.7***
	(0.9, 1.5)	(1.3, 2.3)
Facilities with prevention of vertical transmission services	2.4	2.5***
	(1.5, 3.7)	(1.7, 3.7)
Number of ANC visits	2.4***	2.5***
	(1.5, 3.7)	(1.7, 3.7)
Wealth Index		
Poorer	1.0	1.5
	(0.6, 1.6)	(0.9, 2.4)
Middle	1.3	1.7*
	(0.8, 2.2)	(1.0, 2.9)
Richer	1.8**	1.8*
	(1.1, 3.1)	(1.1, 3.0)
Richest	2.9***	2.6**
	(1.6, 5.3)	(1.4, 4.8)
Need factors		
Contraceptive		
Traditional method	0.9	0.8
	(0.6, 1.3)	(0.5, 1.3)
Modern method	1.0	1.0
	(0.8, 1.4)	(0.7, 1.3)
Desired pregnancy		
Wanted later	1.4	0.8
	(0.9, 1.9)	(0.5, 1.1)
Wanted no more	1.0	1.0
	(0.5, 2.0)	(0.5, 1.9)
Any STIs	7.4	2.2
	(0.6, 84.7)	(0.3, 16.4)
Genital discharge, sore or ulcer	1.1	1.4
	(0.8, 1.5)	(1.0, 2.0)

Notes: ni: number of women in the sample; nj: number of districts; *p≤0.05; **p≤0.01; ***p≤0.001. 95% confidence intervals in parentheses. STIs = Sexually transmitted infections. HIV = Human Immunodeficiency Virus. ANC = Antenatal care.

2.2. Quantitative analysis reporting checklist

To ensure transparency and consistency in the reporting of the research process, results of the quantitative analysis were reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [48].

	#	Recommendation	Page
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	64-65

Objectives	3	State specific objectives, including any prespecified hypotheses	64-65
Method			
Study design	4	Present key elements of study design early in the paper	65-65
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	65-65
Participants	6	<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	65-65
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	65
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	65
Bias	9	Describe any efforts to address potential sources of bias	65
Study size	10	Explain how the study size was arrived at	65
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	65
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	67-69
		(b) Describe any methods used to examine subgroups and interactions	67-69
		(c) Explain how missing data were addressed	67-69
		(d) <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	67-69
		(e) Describe any sensitivity analyses	67-69
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	69-70
		(b) Give reasons for non-participation at each stage	69-70
		(c) Consider use of a flow diagram	69-70
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	69-70
		(b) Indicate number of participants with missing data for each variable of interest	69-70
Outcome data	15*	<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	70-73
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	70-73
		(b) Report category boundaries when continuous variables were categorized	70-73
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	70-73
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	73-81
Discussions			
Key results	18	Summarise key results with reference to study objectives	81-84
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	84
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	81-84
Generalisability	21	Discuss the generalisability (external validity) of the study results	81-84

2.3. Complementary analysis

Table 21 - Correlation matrix of the empowerment variables with predisposing characteristics, enabling factors and need factors

	Does not need permission to go to health facilities	Can make decisions about contraception	Can make decisions about her health care	Can decide when to visit family in parental home	Did not experience emotional violence	Did not experience less severe violence	Did not experience severe violence	Did not experience sexual violence	Can make decisions about household's large	Owens assets
Facility type	0.09	-0.05	-0.04	-0.06	-0.04	-0.12	-0.04	0.02	-0.04	0.03
Facilities with prevention of vertical transmission services	0.09	-0.05	-0.04	-0.06	-0.04	-0.12	-0.04	0.02	-0.04	0.03
Any STIs	-0.02	-0.05	-0.05	0.01	-0.05	-0.08	-0.14	-0.07	0.02	-0.02
Genital discharge, sore or ulcer	-0.02	0.01	-0.01	-0.01	-0.06	-0.13	-0.08	-0.05	0.01	-0.01
Desired pregnancy	-0.06	-0.11	-0.05	-0.04	-0.11	-0.19	-0.18	-0.15	0.00	0.01
Contraceptive	0.06	0.07	0.08	0.00	0.07	0.02	0.03	0.02	0.00	0.04
Wealth Index	0.21	0.04	-0.01	0.01	0.07	0.06	0.06	0.11	-0.02	0.16
Number of ANC visits	0.03	0.14	0.07	0.07	0.08	0.14	0.09	0.09	0.11	0.05
Knowledge of medicines	0.03	0.06	0.07	0.06	0.11	0.16	0.08	0.09	0.10	0.10
Knowledge of vertical transmission	-0.06	0.03	0.05	0.04	0.12	0.14	0.09	0.08	0.02	-0.01
Knowledge of HIV	-0.03	0.06	-0.06	-0.06	0.03	0.07	0.04	0.02	-0.06	-0.09
Environment of residence	0.09	-0.06	-0.13	-0.13	-0.09	-0.19	-0.08	0.02	-0.15	0.01
Children	0.03	-0.03	0.05	0.10	-0.10	-0.21	-0.12	-0.14	0.09	0.09
Co-wives	0.00	-0.02	0.04	0.02	-0.08	-0.12	-0.18	-0.12	0.00	0.01
Caste	-0.03	-0.06	0.01	-0.02	-0.01	-0.08	0.02	0.00	-0.03	-0.04
Education	0.15	0.13	0.08	0.10	0.15	0.23	0.12	0.13	0.05	0.10
Age	-0.01	0.03	0.04	-0.01	-0.03	-0.03	-0.07	-0.05	0.01	-0.04

Note: For the empowerment variable, a higher value (1) was given to categories considered to indicate greater empowerment and the reference category was coded 0.

3. Qualitative study appendix

3.1. Vignette 1 - A pregnant friend heard about ANC visits

Imagine that a close friend named Sarita visits you at home for tea. You are alone in the room; the rest of your household is going about its business. She is about the same age as you, living in your neighbourhood and she is pregnant too. She has heard about ANC visits on the radio and wants to know your opinion.

Sarita asks you what you think about ANC visits. What would you answer?

Sarita asks you where she can go to have an antenatal check-up. What would you answer?

She asks you if she is going to have to pay anything. What would you answer?

How would you describe to her the process of an ANC appointment from the time the appointment is made to the time the woman leaves the health facility?

- How long will she wait and where?
- Should she go alone?
- What will health workers do?

[If the interviewed woman refers to blood tests during the ANC visit directly, ask the following questions. If not, suggest that Sarita may need to have blood tests done during the visit for various things and then ask the following questions]

- Will the tests be explained?
- What will be the tests for?
- How will the results be communicated?

How long will she wait for lab results?

Why do you think Sarita could be reluctant to attend the ANC visit?

Why do you think Sarita could refuse blood tests during the ANC visit?

- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for anaemia?
- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for HIV, Hepatitis B or syphilis?
- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for STD?

How would you encourage her to go to an ANC visit?

What would you say to her if she is afraid of getting a blood test?

3.2. Informed consent form

Exploring feasibility and acceptability of integrated antenatal screening for HIV, HBV and syphilis in Nepal.

Name and Contact Details of the Principal Researcher:

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This study has been approved by the Nepal Health Research Council (n°s23/2022 P) and the UCL Research Ethics Committee (n°14301/001)

Part 1: Information Sheet

Introduction:

Hello! My name is _____ and I work for HERD. HERD is conducting a study to understand how to increase participation in antenatal blood testing. We are working with University College London on this project. So, I am going to give you information and invite you to be part of this research. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take the time to explain. If you have questions at any time, you can ask me.

Purpose of the study:

In this survey, in which you are invited to participate, we are trying to understand your perception and attitudes regarding antenatal blood tests for different purposes. This information will help us to understand what the problems are with blood tests during pregnancy and how they can be improved. We will hold discussions with health workers, but also with pregnant women, husbands, family members and policymakers.

Procedures:

If you accept, you will be asked to participate in an interview with us. During an interview, we will sit down with you in a place where you feel comfortable. The discussion will take around one or two hours. There are no right or wrong answers to questions – just ideas, experiences and opinions, which are all valuable. You do not need to share experiences that make you feel uncomfortable. It is important for us to hear all sides of an issue – the positive and the negative.

During the discussion we will write some notes to help us remember all that was discussed and, if you agree, we will tape record the discussion. We might also take pictures.

Confidentiality and anonymity:

The photos and the discussion recording will be used by the study team only for analysis and photos might also be used for illustration purposes in presentations and publications. No other use will be made of them without your written permission.

Your participation in this study will be kept private and any information you share with us will be kept entirely anonymous. As a standard practice, we will anonymize your name in the reports, publications, and presentations. None of the information revealing your identity will be disclosed. No one else will have access to the information documented during your interview with your name attached. The recordings will be destroyed 12 months after the end of the study. Transcripts of the recordings will be kept for at least 10 years and, ideally, indefinitely.

Risks and discomforts:

You do not have to answer any questions or take part in the interview if you do not want to or if answering some questions makes you uncomfortable.

Voluntary participation and withdrawal:

Participation in this research is completely voluntary. It is up to you whether you take part or not. If you do, you will be given this information sheet to keep and be asked to give consent. If you decide to take part you are still free to withdraw at any time and without giving a reason. If you decide to withdraw you will be asked what you wish to happen to the data you have provided up to that point. However, you cannot withdraw your data after it has been analysed/ incorporated into my analysis.

I hope that you will take part in this study since your participation will be extremely valuable to help us to understand how we can improve antenatal care available in your community and screening during pregnancy in Nepal. This will enable the government to improve current policies in terms of antenatal screening.

If you would like to ask any questions about the study, please do not hesitate.

If you would like to know more about this study, please contact Bibhu Thapaliya from HERD International: bibhu.thapaliya@herdint.com.

Part 2: Consent form

I confirm that:

- I understand that by ticking each box below I am agreeing to this part of the study.
- I understand that not ticking a box means that I DO NOT agree with that part of the study.
- I understand that by not agreeing to all parts of the study, I may not be eligible for the study.

I confirm that I have read the Information Sheet and I understand the purpose of this research.	☐
I have had the opportunity to ask questions which have been answered to my satisfaction.	☐
I understand that I will participate in an interview that will last for an hour or two.	☐
I understand that my participation in this research is completely voluntary.	☐
I understand that I am free to withdraw from the research without repercussions.	☐

I understand that I can halt the interview at any point if I feel uncomfortable.	☐
I consent to the processing of any personal information I provide for the purposes explained to me. I understand that according to data protection legislation, 'public task' will be the lawful basis for processing, and transferring to partners in the UK.	☐
I understand that all personal information will remain confidential and will be kept anonymous.	☐
I agree that my anonymised research data may be used by others for future research making sure that no one will be able to identify me.	☐
I agree that my participation will be audio recorded and that photos will be taken. I understand that my data gathered in this study, including audio recordings and photos, will be transferred stored securely at UCL.	☐
I consent to the use of photographs and audio recordings by the research team in reports, publications and presentations.	☐
I agree to be contacted again in the case of a follow-up study.	☐

Signing this document means that you voluntarily agree to participate in this research after understanding the information provided to you.

Name of Participant: _____

Date: _____

Signature or Thumbprint:

Name of Person Obtaining Consent: _____

Date: _____

Signature:

3.3. Participants' information sheet

The information in the information sheet and the consent form should be given to each participant prior to asking for consent. Generally, the sheet should be read aloud to the participant, unless they object to this and ask to read it themselves. The participant should be asked frequently if they understand or have any questions.

Any questions?

Please note the questions asked by the participant here:

Introduction:

Namaste, my name is _____. I am coming to talk to you today from HERD International about participation in antenatal blood testing.

I would like to audio record our conversation because I am not able to recall all the details and would like to remember everything you told me word for word. Would you permit me to start the audio recorder now?

Checklist before getting started:

- ☐ Take consent
- ☐ Take consent of guardian and assent of under 18s
- ☐ Make sure the interview location can be private
- ☐ Ask permission for audio recording
- ☐ Make sure you have pre-warned the participant (how long it might take...)

3.4. Topic guide – husbands

Background [*the purpose is to break the ice*]:

As a warm-up, I'm going to ask you a few questions to get to know you a little better. [*Make sure you have shared something about yourself and the other people present before cross-questioning the respondent*].

Information to collect: background, age, position, level of education, caste, marital status, nuclear or joint household.

Could you introduce yourself?

- How old are you?
- Where are you from?
- What is your occupation?

- Did you attend school?
- At what level did you leave school?
- What is your caste?
- Are you married?
- Do you live with your parents (maiti)?
- How many weeks pregnant is your wife?
- Is it her first pregnancy?
- If not, how many pregnancies has she had before?

Involvement in pregnancy:

To start, I would like to discuss your involvement in your wife's pregnancy.

How are you involved in your wife's pregnancy?

What types of health issues related to your wife's pregnancy do you discuss with her?

Antenatal care:

What do you know about antenatal visits?

- Where women should go to have an antenatal check-up?
- What is the process of an antenatal care appointment?
 - o Should women go alone?
 - o What do health workers do?
- Do women have to pay anything for an antenatal visit?

Why do you think pregnant women could be reluctant to attend antenatal visit?

What do you think about antenatal visits?

Has your wife attended antenatal care visits? If no, why not?

- Did she go alone?

Knowledge about blood tests during pregnancy:

I would like to know what you know about blood tests during pregnancy. There are no good or bad answers.

What blood tests should be done on pregnant women during antenatal care?

- What are the blood tests for?
- What diseases does a blood test look for?

[Explain that blood tests can be used to test for sexually transmitted diseases during pregnancy and in particular for HIV, syphilis and hepatitis B but also anaemia].

Knowledge about antenatal anaemia:

I would like to know what you know about anaemia during pregnancy. There are no good or bad answers.

What do you know about anaemia?

- What common symptoms have you heard of?
- How can it be prevented?
- What do you know about the health consequences of anaemia during pregnancy on the health of pregnant women?
- What do you know about the health consequences of anaemia during pregnancy on the health of the baby?

Knowledge about HIV:

Now, I would like to know what you know about HIV, syphilis and hepatitis B. There are no good or bad answers.

Have you ever heard of HIV? *[If no, do not ask the following questions about HIV]*

Do you know anyone who has been infected with HIV?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about HIV?

- What do you know about the health consequences of HIV during pregnancy on the health of pregnant women?
- What do you know about the health consequences of HIV during pregnancy on the health of the baby?

Knowledge about hepatitis B:

Have you ever heard of hepatitis B? *[If no, do not ask the following questions about hepatitis B]*

Do you know anyone who has been infected with hepatitis B?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about hepatitis B?

- What do you know about the health consequences of hepatitis B during pregnancy on the health of pregnant women?
- What do you know about the health consequences of hepatitis B during pregnancy on the health of the baby?

Knowledge about syphilis:

Have you ever heard of syphilis? *[If no, do not ask the following questions about syphilis]*

Do you know anyone who has been infected with syphilis?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about syphilis?

- What do you know about the health consequences of syphilis during pregnancy on the health of pregnant women?
- What do you know about the health consequences of syphilis during pregnancy on the health of the baby?

Knowledge about sexually transmitted diseases:

What do you know about sexually transmitted diseases?

- What common symptoms have you heard of?
- How are they transmitted?

How can they be prevented?

[Describe briefly the diseases considered.]

HIV is a virus that damages the cells in your immune system and weakens your ability to fight everyday infections and disease.

- *Most people experience a short flu-like illness 2 to 6 weeks after HIV infection, which lasts for a week or 2. After these symptoms disappear, HIV may not cause any symptoms for many years, although the virus continues to damage your immune system.*
- *HIV is transmitted through body fluids including semen, vaginal and anal fluids, blood and breast milk.*

Syphilis is a sexually transmitted infection.

- *Syphilis symptoms include small sores on the genitals and other areas including mouth, lips and hands, a rash on the palms of your hands and soles of your feet that can sometimes spread all over your body. It also includes flu-like symptoms, such as a high temperature, headaches and tiredness and swollen glands.*

Hepatitis B is a liver infection that is spread through blood, semen and vaginal fluids.

- *Symptoms of hepatitis B infection include high temperature, tiredness, pain in your upper tummy, feeling or being sick, patches of raised skin that may be itchy, yellowing of the skin and whites of the eyes.*

These three diseases can be transmitted from infected mother to their child during pregnancy. They lead to complications and even death if left untreated.]

Blood test:

During antenatal care, pregnant women can be offered to receive a blood test for different diseases.

Do you think they should accept it?

Why do you think a pregnant woman could refuse blood tests during the antenatal visit?

- Can you tell me any reasons that a pregnant woman would refuse a blood test if she knows it is to test for anaemia?
- Can you tell me any reasons that a pregnant woman would refuse a blood test if she knows it is to test for HIV, Hepatitis B or syphilis?
- Can you tell me any reasons that a pregnant woman would refuse a blood test if she knows it is to test for sexually transmitted diseases?

Vignette 1 – your wife has a genital sore:

Imagine that your wife tells you that she is worried because she has a genital sore that could be a symptom of a sexually transmitted disease.

What would you recommend her to do? *[If the interviewed husband refers to screening directly, ask the following questions. If he does not, suggest that she could go for a blood test for sexually transmitted diseases and then ask the following questions.]*

Would you encourage her to go for screening and why?

Why do you think your wife could be reluctant to attend the screening?

What would you tell her to encourage her to be screened or if she has some fears of getting screened for sexually transmitted diseases?

If your wife is concerned about the attitude of the health workers at the health facility.

- How do health workers usually treat pregnant women when they come to be tested for sexually transmitted diseases?

Do you think your wife needs to tell someone else that she has symptoms of sexually transmitted diseases?

- Do you think family members should be involved in the screening?

Integrated antenatal screening:

Blood tests during pregnancy are low in Nepal. One way to improve screening would be to offer pregnant women the opportunity to test for anaemia, HIV, syphilis and hepatitis B in a single

blood sample at their first ANC visit. Rapid tests would be conducted on blood samples with results in 30 minutes. Women would be able to refuse blood tests if they did not want them.

Do you think it is a good idea?

- Why/Why not?

Closing the interview:

We are now approaching the end of our discussion. Is there anything else you would like to talk about that was not mentioned in this interview? *Thank the participant.*

3.5. Topic guide – pregnant women

Background [*the purpose is to break the ice*]:

As a warm-up, I'm going to ask you a few questions to get to know you a little better. [*Make sure you have shared something about yourself and the other people present before cross-questioning the respondent*].

Information to collect: background, age, position, level of education, caste, marital status, nuclear or joint household, gestation age, number of pregnancies, number of antenatal care visits, blood test, tested during pregnancy.

Could you introduce yourself?

- How old are you?
- Where are you from?
- What is your occupation?
- Did you attend school?
- At what level did you leave school?
- What is your caste?
- Are you married?
- Do you live with your parents (maiti) or with your in-laws (sasural)?
- How many weeks pregnant are you?
- Is it your first pregnancy?
- If not, how many pregnancies have you had before?
- Have you attended antenatal care visits?
- Did you have blood tests during this pregnancy?
- Were you tested for any sexually transmitted diseases during this pregnancy?

Health information:

To start, I would like to discuss how you obtain information concerning your health.

What is your main source of health information?

- What kinds of health issues related to pregnancy do you discuss with your friends, husband, or family?

Knowledge about blood tests during pregnancy:

I would like to know what you know about blood tests during pregnancy. There are no good or bad answers.

What blood tests should be done on pregnant women during antenatal care?

- What are the blood tests for?
- What diseases are tested for using a blood test?

[Explain that blood tests can be used to test for sexually transmitted diseases during pregnancy and in particular for HIV, syphilis and hepatitis B but also anaemia].

Knowledge about antenatal anaemia:

I would like to know what you know about anaemia during pregnancy. There are no good or bad answers.

What do you know about anaemia?

- What common symptoms have you heard of?
- How can it be prevented?
- What do you know about the health consequences of anaemia during pregnancy on your health?
- What do you know about the health consequences of anaemia during pregnancy on the health of your baby?

Knowledge about HIV:

Now, I would like to know what you know about HIV, syphilis and hepatitis B. There are no good or bad answers.

Have you ever heard of HIV? *[If no, do not ask the following questions about HIV]*

Do you know anyone who has been infected with HIV?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about HIV?

- What do you know about the health consequences of HIV during pregnancy on your health?
- What do you know about the health consequences of HIV during pregnancy on the health of your baby?

Knowledge about hepatitis B:

Have you ever heard of hepatitis B? *[If no, do not ask the following questions about hepatitis B]*

Do you know anyone who has been infected with hepatitis B?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about hepatitis B?

- What do you know about the health consequences of hepatitis B during pregnancy on your health?
- What do you know about the health consequences of hepatitis B during pregnancy on the health of your baby?

Knowledge about syphilis:

Have you ever heard of syphilis? *[If no, do not ask the following questions about syphilis]*

Do you know anyone who has been infected with syphilis?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about syphilis?

- What do you know about the health consequences of syphilis during pregnancy on your health?
- What do you know about the health consequences of syphilis during pregnancy on the health of your baby?

Knowledge about sexually transmitted diseases:

What do you know about sexually transmitted diseases?

- What common symptoms have you heard of?
- How are they transmitted?

How can they be prevented?

Knowledge about blood tests during pregnancy:

What are the advantages of having a blood test during pregnancy for you and your baby?

What are the disadvantages of having a blood test during pregnancy for you and your baby?

[Describe briefly the diseases considered.]

HIV is a virus that damages the cells in your immune system and weakens your ability to fight everyday infections and disease.

- *Most people experience a short flu-like illness 2 to 6 weeks after HIV infection, which lasts for a week or 2. After these symptoms disappear, HIV may not cause any symptoms for many years, although the virus continues to damage your immune system.*
- *HIV is transmitted through body fluids including semen, vaginal and anal fluids, blood and breast milk.*

Syphilis is a sexually transmitted infection.

- *Syphilis symptoms include small sores on the genitals and other areas including mouth, lips and hands, a rash on the palms of your hands and soles of your feet that can sometimes spread all over your body. It also includes flu-like symptoms, such as a high temperature, headaches and tiredness and swollen glands.*

Hepatitis B is a liver infection that is spread through blood, semen and vaginal fluids.

- *Symptoms of hepatitis B infection include high temperature, tiredness, pain in your upper tummy, feeling or being sick, patches of raised skin that may be itchy, yellowing of the skin and whites of the eyes.*

These three diseases can be transmitted from infected mother to their child during pregnancy. They lead to complications and even death if left untreated.]

Vignette 1 - a pregnant friend heard about antenatal care visits:

Imagine that a close friend named Sarita visits you at home for tea. You are alone in the room, the rest of your household is going about its business. She is about the same age as you, living in your neighbourhood and she is pregnant too. She has heard about antenatal care visits on the radio and wants to know your opinion.

Sarita asks you what you think about antenatal visits. What would you answer?

Sarita asks you where she can go to have an antenatal check-up. What would you answer?

She asks you if she is going to have to pay anything. What would you answer?

How would you describe to her the process of an antenatal care appointment from the time the appointment is made to the time the woman leaves the health facility?

- How long will she wait and where?
- Should she go alone?
- What will health workers do?

[If the interviewed woman refers to blood tests during the antenatal visit directly, ask the following questions. If not, suggest that Sarita may need to have blood tests done during the visit for various things and then ask the following questions]

- Will the tests be explained?
- What will be the tests for?

- How will the results be communicated?

How long will she wait for lab results?

Why do you think Sarita could be reluctant to attend the antenatal visit?

Why do you think Sarita could refuse blood tests during the antenatal visit?

- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for anaemia?
- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for HIV, Hepatitis B or syphilis?
- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for sexually transmitted diseases?

How would you encourage her to go to an antenatal care visit?

What would you say to her if she is afraid of getting a blood test?

Vignette 2 – a pregnant friend has a genital sore:

Now imagine that Sarita tells you that she is worried because she has a genital sore that could be a symptom of a sexually transmitted disease.

What would you recommend her to do? *[If the interviewed woman refers to screening directly, ask the following questions. If she does not, suggest that Sarita could go for a blood test for sexually transmitted diseases and then ask the following questions.]*

Why do you think Sarita could be reluctant to attend the screening?

What would you tell her to encourage her to be screened or if she has some fears of getting screened for sexually transmitted diseases?

Sarita is concerned about the attitude of the health workers at the health facility.

- How do health workers usually treat pregnant women when they come to be tested for sexually transmitted diseases?
- She asks you if she will be able to ask questions to health workers. How will you reply?
- According to you, what would be the qualities of a good health worker in charge of screening for sexually transmitted diseases?

Sarita tells you that she has not yet told her family that she has symptoms of sexually transmitted diseases.

- Do you think she should tell her husband?
- Do you think family members should be involved in the screening?
- Would your answers have been different if the woman had been younger? Older? From a different caste than you?

Integrated antenatal screening:

Blood tests during pregnancy are low in Nepal. One way to improve screening would be to offer pregnant women the opportunity to test for anaemia, HIV, syphilis and hepatitis B in a single blood sample at their first ANC visit. Rapid tests would be conducted on blood samples with results in 30 minutes. Women would be able to refuse blood tests if they did not want them.

Would you accept such blood tests?

- Why/Why not?

Closing the interview:

We are now approaching the end of our discussion. Is there anything else you would like to talk about that was not mentioned in this interview? *Thank the participant.*

3.6. Topic guide – mothers-in-law

Background *[the purpose is to break the ice]:*

As a warm-up, I'm going to ask you a few questions to get to know you a little better. *[Make sure you have shared something about yourself and the other people present before cross-questioning the respondent].*

Information to collect: background, age, position, level of education, caste, marital status, nuclear or joint household.

Could you introduce yourself?

- How old are you?
- Where are you from?
- What is your occupation?
- Did you attend school?
- At what level did you leave school?
- What is your caste?
- Do you live with your daughter-in-law?
- How many weeks pregnant is your daughter-in-law?
- Is it her first pregnancy?
- If not, how many pregnancies has she had before?

Involvement in daughter-in-law pregnancy:

To start, I would like to discuss your involvement in the pregnancy of your daughter-in-law.

How are you involved in your daughter-in-law's pregnancy?

What kinds of health issues related to your daughter-in-law's pregnancy do you discuss with her?

Knowledge about blood tests during pregnancy:

I would like to know what you know about blood tests during pregnancy. There are no good or bad answers.

What blood tests should be done on pregnant women during antenatal care?

- What are the blood tests for?
- What diseases are tested for using a blood test?

What are the advantages of having a blood test during pregnancy for pregnant women and your baby?

What are the disadvantages of having a blood test during pregnancy for pregnant women and babies?

[Explain that blood tests can be used to test for sexually transmitted diseases during pregnancy and in particular for HIV, syphilis and hepatitis B but also anaemia].

Knowledge about antenatal anaemia:

I would like to know what you know about anaemia during pregnancy. There are no good or bad answers.

What do you know about anaemia?

- What common symptoms have you heard of?
- How can it be prevented?
- What do you know about the health consequences of anaemia during pregnancy on the health of pregnant women?
- What do you know about the health consequences of anaemia during pregnancy on the health of babies?

Knowledge about HIV:

Now, I would like to know what you know about HIV, syphilis and hepatitis B. There are no good or bad answers.

Have you ever heard of HIV? *[If no, do not ask the following questions about HIV]*

Do you know anyone who has been infected with HIV?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about HIV?

- What do you know about the health consequences of HIV during pregnancy on the health of pregnant women?
- What do you know about the health consequences of HIV during pregnancy on the health of babies?

Knowledge about hepatitis B:

Have you ever heard of hepatitis B? *[If no, do not ask the following questions about hepatitis B]*

Do you know anyone who has been infected with hepatitis B?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about hepatitis B?

- What do you know about the health consequences of hepatitis B during pregnancy on the health of pregnant women?
- What do you know about the health consequences of hepatitis B during pregnancy on the health of babies?

Knowledge about syphilis:

Have you ever heard of syphilis? *[If no, do not ask the following questions about syphilis]*

Do you know anyone who has been infected with syphilis?

- Do you know how this person contracted the disease?
- Can you describe his/her symptoms?
- What kind of health care did the person get for the disease?
- What kind of medication did that person have access to?

What do you know about syphilis?

- What do you know about the health consequences of syphilis during pregnancy on the health of pregnant women?
- What do you know about the health consequences of syphilis during pregnancy on the health of babies?

Knowledge about sexually transmitted diseases:

What do you know about sexually transmitted diseases?

What common symptoms have you heard of?

- How are they transmitted?
- How can they be prevented?

[Describe briefly the diseases considered.]

HIV is a virus that damages the cells in your immune system and weakens your ability to fight everyday infections and disease.

- *Most people experience a short flu-like illness 2 to 6 weeks after HIV infection, which lasts for a week or 2. After these symptoms disappear, HIV may not cause any symptoms for many years, although the virus continues to damage your immune system.*
- *HIV is transmitted through body fluids including semen, vaginal and anal fluids, blood and breast milk.*

Syphilis is a sexually transmitted infection.

- *Syphilis symptoms include small sores on the genitals and other areas including mouth, lips and hands, a rash on the palms of your hands and soles of your feet that can sometimes spread all over your body. It also includes flu-like symptoms, such as a high temperature, headaches and tiredness and swollen glands.*

Hepatitis B is a liver infection that is spread through blood, semen and vaginal fluids.

- *Symptoms of hepatitis B infection include high temperature, tiredness, pain in your upper tummy, feeling or being sick, patches of raised skin that may be itchy, yellowing of the skin and whites of the eyes.*

These three diseases can be transmitted from infected mother to their child during pregnancy. They lead to complications and even death if left untreated.]

Vignette 1 - a pregnant friend heard about antenatal care visits:

Imagine that a close friend named Sarita visits you at home for tea. You are alone in the room, the rest of your household is going about its business. She is about the same age than your daughter-in-law, living in your neighbourhood and she is pregnant. She has heard about antenatal care visits on the radio and wants to know your opinion.

Sarita asks you what you think about antenatal visits. What would you answer?

Sarita asks you where she can go to have an antenatal check-up. What would you answer?

She asks you if she is going to have to pay anything. What would you answer?

How would you describe to her the process of an antenatal care appointment from the time the appointment is made to the time the woman leaves the health facility?

- How long will she wait and where?
- Should she go alone?
- What will health workers do?

[If the interviewed woman refers to blood tests during the antenatal visit directly, ask the following questions. If not, suggest that Sarita may need to have blood tests done during the visit for various things and then ask the following questions]

- Will the tests be explained?
- What will be the tests for?
- How will the results be communicated?
- How long will she wait for lab results?

Why do you think Sarita could be reluctant to attend the antenatal visit?

Why do you think Sarita could refuse blood tests during the antenatal visit?

- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for anaemia?
- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for HIV, Hepatitis B or syphilis?
- Can you tell me any reasons that Sarita would refuse a blood test if she knows it is to test for sexually transmitted diseases?

How would you encourage her to go to an antenatal care visit?

What would you say to her if she is afraid of getting a blood test?

Vignette 2 – a pregnant friend has a genital sore:

Now imagine that Sarita tells you that she is worried because she has a genital sore that could be a symptom of a sexually transmitted disease.

What would you recommend her to do? *[If the interviewed woman refers to screening directly, ask the following questions. If she does not, suggest that Sarita could go for a blood test for sexually transmitted diseases and then ask the following questions.]*

Why do you think Sarita could be reluctant to attend the screening?

What would you tell her to encourage her to be screened or if she has some fears of getting screened for sexually transmitted diseases?

Sarita is concerned about the attitude of the health workers at the health facility.

- How do health workers usually treat pregnant women when they come to be tested for sexually transmitted diseases?
- She asks you if she will be able to ask questions to health workers. How will you reply?
- According to you, what would be the qualities of a good health worker in charge of screening for sexually transmitted diseases?

Sarita tells you that she has not yet told her family that she has symptoms of sexually transmitted diseases.

- Do you think she should tell her husband?
- Do you think family members should be involved in the screening?

Would your answers have been different if the woman had been younger? Older? From a different caste than you?

Integrated antenatal screening:

Blood tests during pregnancy are low in Nepal. One way to improve screening would be to offer pregnant women the opportunity to test for anaemia, HIV, syphilis and hepatitis B in a single

blood sample at their first ANC visit. Rapid tests would be conducted on blood samples with results in 30 minutes. Women would be able to refuse blood tests if they did not want them.

Would you accept such blood tests?

- Why/Why not?

Closing the interview:

We are now approaching the end of our discussion. Is there anything else you would like to talk about that was not mentioned in this interview? *Thank the participant.*

3.7. Topic guide – health workers

Background [*the purpose is to break the ice*]:

As a warm-up, I'm going to ask you a few questions to get to know you a little better. [*Make sure you have shared something about yourself and the other people present before cross-questioning the respondent*].

<i>Information to collect: background, function, workplace, daily work, tasks.</i>
--

Could you introduce yourself?

- How old are you?
- At what level did you leave school?
- What is your current position?
- What is your workplace and how does it work?
 - o Type of practice, number and kind of other support staff, infrastructure?
- How long have you been working at this facility?

Can you describe a typical day as a health worker?

- What are your responsibilities?
- What are your tasks?

Training and knowledge of current national guidelines:

Now, I will ask you some questions about your training and your knowledge of current national guidelines.

Which training did you receive in the past few years?

Have you ever been formally taught about blood tests, how to do them and what they are for?

Did you receive any training about antenatal screening for HIV, syphilis and hepatitis B?

- When did you receive it?
- How did you find it?

What are the national guidelines for antenatal screening for HIV, syphilis and hepatitis B in Nepal?

Antenatal visits:

Now, we will talk about antenatal visits.

Could you describe the process of an antenatal care appointment from the time the appointment is made to the time the woman leaves the health facility?

- Where can pregnant women go for antenatal visits? Do they need to make an appointment?
- How long do pregnant have to wait and where?
- Are they coming alone to this appointment?
- What will health workers do during this appointment?
- What do pregnant women have to pay for antenatal care visits?

In your opinion, what are the barriers for pregnant women to accessing antenatal visits?

Blood tests:

Now, I will ask you some questions about blood tests during pregnancy.

Are blood tests performed routinely during antenatal care visits?

- What are the tests for?
- Are the collection and purpose of the blood sample explained to pregnant women?
- Where is the blood sample analysed?
- What happens when the results are available?
- How long do pregnant women wait for the results from the laboratory?
- What are the costs involved for the patients and for the health structure for a blood test?

Which part of the blood screening process do you find the most difficult?

What are the issues in delivering blood testing?

What are pregnant women's reactions to receiving a blood test?

- Why do you think pregnant women could be reluctant to have blood tests?

Does the purpose of the blood test influence its acceptability by pregnant women? For example, will the reactions be different if the blood test is for anaemia or for sexually transmitted diseases screening?

Sexually transmitted diseases antenatal screening:

Now, I will ask you more about sexually transmitted diseases.

Do pregnant women routinely receive counselling for sexually transmitted diseases during antenatal care visits?

How do you diagnose pregnant women for sexually transmitted diseases during pregnancy?

Who is involved in the screening?

- Which are your responsibilities and which are the responsibilities of other professionals involved?

What happens when the results are available?

- What is the protocol for positive results?
- How do you record data?

What are the costs of HIV, syphilis and hepatitis B testing for the pregnant woman and for the health facility?

How many tests do you usually do per month?

Do all women accept to be screened?

Why do you think pregnant women could be reluctant to accept antenatal screening for HIV, syphilis and hepatitis B?

Do you think the husband and other family members should be involved in prenatal screening for sexually transmitted diseases?

What challenges do you face in the screening and diagnosis of sexually transmitted diseases in pregnant women?

How do you deal with these challenges?

- What could be the solutions?

How do health workers usually treat pregnant women when they come to be tested for sexually transmitted diseases?

National guidelines for screening for HIV states that “Service providers, particularly health care workers and law enforcement personnel, must be oriented, trained and held accountable for service delivery with strong advocacy for zero tolerance against discrimination.” What do you think about it?

- Is it applied in practice? Why?

Feasibility of an integrated antenatal screening for anaemia, HIV, syphilis and hepatitis B:

What would be the characteristics of ideal antenatal screening for anaemia, HIV, syphilis and hepatitis B in the Nepalese context?

Would this ideal screening protocol be applicable in the facility where you work?

What do you think about an integrated antenatal screening that would allow pregnant women to be screened for anaemia, HIV, syphilis and hepatitis B in a single blood sample at their first antenatal visit?

- Who should be in charge of implementing it? Why?

Do you think integrated antenatal screening is feasible in the Nepalese context?

- What would be the potential challenges for its implementation?
- What will be the solutions for these challenges?
- How integrated screening can be implemented successfully?

Closing the interview:

We are now approaching the end of our discussion. Is there anything else you would like to talk about that was not mentioned in this interview? *Thank the participant.*

3.8. Topic guide – decision-makers

Background [the purpose is to break the ice]:

As a warm-up, I'm going to ask you a few questions to get to know you a little better. *[Make sure you have shared something about yourself and the other people present before cross-questioning the respondent].*

Information to collect: background, function, workplace, daily work, tasks.

Could you introduce yourself?

- What is your current position?
- What are your responsibilities?
- What are your tasks?

Antenatal care visits:

Now, we will talk about antenatal visits.

What are the national guidelines for antenatal care during pregnancy in Nepal?

Could you describe the process of an antenatal care appointment from the time the appointment is made to the time the woman leaves the health facility?

- Where can pregnant women go for antenatal visits? Do they need to make an appointment?
- How long do pregnant have to wait and where?
- Are they coming alone to this appointment?
- What will health workers do during this appointment?
- What are the costs involved for the patients and for the health structure for antenatal care visits?

In your opinion, what are the barriers for pregnant women to accessing antenatal visits?

In your opinion, what are the barriers from the supply side to implementing antenatal visits?

Blood tests:

Now, I will ask you some questions about blood tests during pregnancy.

What are the national guidelines for blood tests during pregnancy in Nepal?

- Are blood tests performed routinely during antenatal care visits?
- What are the tests for?
- Are the collection and purpose of the blood sample explained to pregnant women?
- Where is the blood sample analysed?
- What happens when the results are available?
- How long do pregnant women wait for the results from the laboratory?
- What are the costs involved for the patients and for the health structure for a blood test?

Which part of the blood screening process do you think is the most challenging?

What are the issues in delivering blood testing?

Why do you think pregnant women could be reluctant to have blood tests?

Does the purpose of the blood test influence its acceptability by pregnant women? For example, will the reactions be different if the blood test is for anaemia or for sexually transmitted diseases screening?

Anaemia screening:

Let's talk about screening for anaemia during pregnancy.

What are the national guidelines for screening for anaemia during pregnancy?

Sexually transmitted diseases antenatal screening:

Now, I will ask you more about sexually transmitted diseases.

What are the national guidelines for antenatal screening for HIV, syphilis and hepatitis B in Nepal?

- Do pregnant women routinely receive counselling for sexually transmitted diseases during antenatal care visits?
- Who is involved in the screening?
- What happens when the results are available?
- What is the protocol for positive results?
- How is the data recorded?
- What are the costs of HIV, syphilis and hepatitis B testing for the pregnant woman and for the health facility?

Why do you think pregnant women could be reluctant to accept antenatal screening for HIV, syphilis and hepatitis B?

Do you think the husband and other family members should be involved in prenatal screening for sexually transmitted diseases?

What are the challenges in screening and diagnosing sexually transmitted diseases in pregnant women in Nepal?

- How do you deal with these challenges?
- What could be the solutions?

Health workers:

How do health workers usually treat pregnant women when they come to be tested for sexually transmitted diseases?

National guidelines for screening for HIV states that “Service providers, particularly health care workers and law enforcement personnel, must be oriented, trained and held accountable for service delivery with strong advocacy for zero tolerance against discrimination.” What do you think about it?

- Is it applied in practice? Why?

What training are health workers conducting antenatal visits supposed to receive?

- Who is supposed to train them?

What training health workers should receive about blood tests during pregnancy?

What training health workers should receive about antenatal screening for HIV, syphilis and hepatitis B?

Feasibility of an integrated antenatal screening for anaemia, HIV, syphilis and hepatitis B:

What would be the characteristics of ideal antenatal screening for anaemia, HIV, syphilis and hepatitis B in the Nepalese context?

What do you think about an integrated antenatal screening that would allow pregnant women to be screened for anaemia, HIV, syphilis and hepatitis B in a single blood sample at their first antenatal visit?

- Who should be in charge of implementing it? Why?

Do you think integrated antenatal screening is feasible in the Nepalese context?

- What would be the potential challenges for its implementation?
- What will be the solutions for these challenges?
- How integrated screening can be implemented successfully?

Closing the interview:

We are now approaching the end of our discussion. Is there anything else you would like to talk about that was not mentioned in this interview? *Thank the participant.*

3.9. Qualitative research reporting checklist

To ensure transparency and consistency in the reporting of the research process, results of the qualitative study were reported following the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [282].

No.	Topic	Item	Page
Introduction			
S3	Problem formulation	Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	64
S4	Purpose or research question	Purpose of the study and specific objectives or questions	64-65
Methods			
S5	Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., positivist, constructivist/interpretivist) is also recommended	93
S6	Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, or transferability	89-93 and 93
S7	Context	Setting/site and salient contextual factors; rationale	86
S8	Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale	89-93
S9	Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	93
S10	Data collection methods	Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale	89-93
S11	Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	89-93
S12	Units of study	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	89-93
S13	Data processing	Methods for processing data prior to and during analysis, including transcription, data entry, data management and	89-93

	security, verification of data integrity, data coding, and anonymization/deidentification of excerpts	
S14	Data analysis	Process by which inferences, themes, etc., were identified and developed, including researchers involved in data analysis; usually references a specific paradigm or approach; rationale
S15	Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale
Results/Findings		
S16	Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory
S17	Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings
Discussion		
S18	Integration with prior work, implications, transferability, and contribution(s) to the field	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field
S19	Limitations	Trustworthiness and limitations of findings

4. Cost-effectiveness appendix

4.1. Model parameters

Table 22 - Model parameters

Description	Base	Lower	Upper	References
<i>Transition probabilities for HIV</i>				
Transition probability from HIV to AIDS for mothers if treatment	0.006	0.003	0.010	[318]
Transition probability from HIV to AIDS for mothers if no treatment	0.060	0.030	0.090	[318]
Transition probability from AIDS to death for mothers if no treatment	0.030	0.015	0.045	[318]
<i>Transition probabilities for hepatitis B</i>				
Transition probability from chronic hepatitis B to active hepatitis B if no treatment	0.002	0.001	0.003	[322]
Transition probability from active hepatitis B to cirrhosis if no treatment	0.029	0.015	0.058	[322]
Transition probability from active hepatitis B to hepatocellular if no treatment	0.002	0.001	0.003	[322]
Transition probability from hepatocellular to death if no treatment	0.450	0.220	0.700	[322]
Transition probability from cirrhosis to hepatocellular if no treatment	0.034	0.010	0.100	[322]
Transition probability from cirrhosis to death if no treatment	0.031	0.030	0.038	[322]
<i>Transition probabilities for syphilis</i>				
Transition probability from early or latent to tertiary syphilis if no treatment	0.330	0.165	0.495	[318]
Transition probability from tertiary syphilis to death if no treatment	0.110	0.055	0.165	[318]
Transition probability from cured to early or latent syphilis after treatment (relapse)	0.236	0.118	0.354	[318]
<i>HIV-related costs</i>				
Screening for mother (\$/rapid test)				
Treatment for mother (\$/year)	45.00	40.50	49.50	[295]
Screening for newborn (\$/rapid test)	1.12	1.00	1.23	[295]
Treatment for children up to 15 years old (\$/year)	238.79	214.91	262.67	[295]
<i>Hepatitis B-related costs</i>				
Screening (\$/rapid test)	0.78	0.70	0.86	[295]
Confirmatory test (\$/ELISA test)	1.47	1.32	1.62	[335]
Treatment for mother (\$/year)	28.80	25.92	31.68	[295]
Treatment for newborn (\$/injection)	35.43	31.89	38.97	[336]
<i>Syphilis-related costs</i>				
Integrated syphilis/HIV screening (\$/rapid test)	1.23	1.11	1.35	[295]
Confirmatory test (\$/TPPA)	3.60	3.24	3.96	[336]
Treatment for mother (\$/injection)	0.15	0.14	0.17	[335]
Congenital syphilis treatment (\$/injection)	0.15	0.14	0.17	[335]
Congenital syphilis additional costs for birth complications (\$/newborn)	15.00	13.50	16.50	[337]
Neonatal death and stillbirths (\$/event)	33.75	30.38	37.13	[337]
<i>HIV-related DALY weights</i>				
HIV	0.143	0.006	0.377	[327]
AIDS, no treatment	0.582	0.406	0.743	[327]
AIDS, with treatment	0.078	0.052	0.111	[327]
<i>Hepatitis B-related DALY weights</i>				
Chronic hepatitis B	0.051	0.032	0.074	[327]
Active hepatitis B	0.133	0.088	0.190	[327]
Cirrhosis	0.220	0.123	0.404	[327]
Hepatocellular carcinoma	0.332	0.031	0.687	[327]
<i>Syphilis-related DALY weights</i>				
Early/Latent syphilis	0.006	0.002	0.012	[327]
Tertiary syphilis	0.310	0.032	0.669	[327]

Congenital syphilis (3 years)	0.048	0.001	0.290	[327]
<i>Other HIV-related parameters</i>				
Prevalence of HIV in pregnant women	0.0012	0.0010	0.0014	[338]
Probability of being AIDS infected when HIV-positive at t=0	0.206	0.165	0.247	[338]
Vertical transmission probability in the absence of treatment	0.215	0.172	0.258	[339]
Vertical transmission probability if treatment	0.02	0.016	0.024	[340]
Duration of HIV with treatment, newborn	15	7.5	22.5	[318]
Duration of HIV without treatment, newborn	2	1	3	[318]
Duration of AIDS with treatment, child	5	2.5	7.5	[318]
Duration of AIDS without treatment, child	1	0.5	1.5	[318]
Probability of a pregnant woman being screened	0.82	0.656	0.984	[120] Screening rate used in the model was based on actual HIV screening data from the National Centre for AIDS And STD Control that already takes into account opt-out screening and treatment. As a result, the opt-out rate was implicitly included in our analysis.
Probability of a child born to an HIV-positive woman being screened	0.927	0.742	1	[338]
Sensitivity of HIV rapid test	0.999	0.9	1	[317]
Specificity of HIV rapid test	0.999	0.9	1	[317]
Probability for an HIV-positive pregnant woman to receive treatment	0.77	0.67	0.89	[324]
Probability for an HIV-positive newborn to receive treatment	0.77	0.67	0.89	[324]
HIV treatment effect	0.1	0.08	0.12	[318]
<i>Other hepatitis B-related parameters</i>				
Prevalence of hepatitis B in pregnant women	0.005	0.004	0.006	[115]
Vertical transmission probability from mothers with chronic hepatitis B, no PMTCT	0.25	0.1	0.4	[320]
Vertical transmission probability from mothers with active hepatitis B, no PMTCT	0.8	0.7	0.9	[320]
Vertical transmission probability, PMTCT	0.01	0.00	0.05	[320]
Treatment coverage for mothers and children	0.77	0.67	0.89	As there is no official data on treatment coverage for hepatitis B in Nepal, I used HIV treatment coverage as a proxy, reflecting the integrated approach proposed in our model.
Sensitivity of hepatitis B rapid test	0.900	0.891	0.908	[322]
Specificity of hepatitis B rapid test	0.995	0.994	0.995	[322]
Sensitivity of hepatitis B confirmatory test (ELISA)	0.932	0.851	0.985	[322]
Specificity of hepatitis B confirmatory test (ELISA)	0.931	0.851	0.999	[322]
<i>Other syphilis-related parameters</i>				
Prevalence of syphilis in pregnant women	0.0016	0.0013	0.0019	[117]
Probability that syphilis infection is at the latent stage at t=0	0.75	0.6	0.9	[318]
Vertical transmission probability of foetal transmission if early syphilis	0.5	0.4	0.6	[318]
Vertical transmission probability of foetal transmission if latent syphilis	0.70	0.56	0.84	[318]
Probability of stillbirth given foetal transmission	0.21	0.168	0.252	[318]
Probability of neonatal death given foetal transmission	0.09	0.07	0.11	[318]
Probability of a pregnant woman receiving screening	0.003	0.0024	0.0036	[123]
Sensitivity of syphilis rapid test	0.9	0.8	1	[318]
Specificity of syphilis rapid test	0.957	0.9	1	[318]
Sensitivity of syphilis confirmatory test (TPPA)	0.92	0.8	1	[318]
Specificity of syphilis confirmatory test (TPPA)	0.99	0.98	1	[318]
Treatment coverage for mothers and children	0.77	0.67	0.89	As there is no official data on treatment coverage for syphilis in Nepal, I used HIV treatment coverage as a proxy, reflecting the integrated approach proposed in our model.
Probability of treatment success	0.95	0.76	1	[318]
<i>Other parameters</i>				
Probability for a pregnant woman to receive integrated screening for HIV and syphilis	0.82	0.656	0.984	Assumed that integration will achieve the same coverage as HIV screening alone.
Probability for a pregnant woman to receive integrated screening for HIV, syphilis and hepatitis B	0.82	0.656	0.984	Assumed that integration will achieve the same coverage as HIV screening alone.
Annual discount rate - costs	0.03	0.00	0.06	[318]

Annual discount rate - benefits	0.03	0.00	0.06	[318]
Mothers' life expectancy at birth (year)	65	52.0	78.0	[341]
Babies' life expectancy at birth (year)	68	54.4	81.6	[341]
Number of pregnant women (per year)	752506	602005	903007	[342]
Number of pregnant women with HIV under treatment at the time of their pregnancy	165	NA	NA	[324]
Number of required ANC visits	4	NA	NA	[119]
Weeks of the first ANC visits	12	9.6	14.4	[119]
ANC coverage of at least 1 visit	0.84	0.67	1.00	[119]
Median age at first birth for women aged 25-49 (year)	21	16.8	25.2	[100]
Hourly rate of nurses	1.20			[326]
Hourly rate of doctors	2.12			[326]
Conversion rate of Nepalese rupees in dollars	0.0075	0.0060	0.0090	[328]

4.2. Economic evaluation reporting checklist

To ensure transparency and consistency in the reporting of the research process, results of the economic evaluation were reported following the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist [329].

Topic	No.	Item	Page
Introduction			
Background and objectives	3	Give the context for the study, the study question, and its practical relevance for decision-making in policy or practice.	111
Methods			
Health economic analysis plan	4	Indicate whether a health economic analysis plan was developed and where available.	116-117
Study population	5	Describe characteristics of the study population (such as age range, demographics, socioeconomics, or clinical characteristics).	112
Setting and location	6	Provide relevant contextual information that may influence findings.	112
Comparators	7	Describe the interventions or strategies being compared and why chosen.	115
Perspective	8	State the perspective(s) adopted by the study and why chosen.	116
Time horizon	9	State the time horizon for the study and why appropriate.	116
Discount rate	10	Report the discount rate(s) and reason chosen.	116
Selection of outcomes	11	Describe what outcomes were used as the measure(s) of benefit(s) and harm(s).	116
Measurement of outcomes	12	Describe how outcomes used to capture benefit(s) and harm(s) were measured.	116
Valuation of outcomes	13	Describe the population and methods used to measure and value outcomes.	116
Measurement and valuation of resources and costs	14	Describe how costs were valued.	116
Currency, price date, and conversion	15	Report the dates of the estimated resource quantities and unit costs, plus the currency and year of conversion.	116
Rationale and description of model	16	If modelling is used, describe in detail and why used. Report if the model is publicly available and where it can be accessed.	112-115
Analytics and assumptions	17	Describe any methods for analysing or statistically transforming data, any extrapolation methods, and approaches for validating any model used.	112-115

Characterising heterogeneity	18	Describe any methods used for estimating how the results of the study vary for subgroups.	112-115
Characterising distributional effects	19	Describe how impacts are distributed across different individuals or adjustments made to reflect priority populations.	112-115
Characterising uncertainty	20	Describe methods to characterise any sources of uncertainty in the analysis.	117
Approach to engagement with patients and others affected by the study	21	Describe any approaches to engage patients or service recipients, the general public, communities, or stakeholders (such as clinicians or payers) in the design of the study.	115
Results			
Study parameters	22	Report all analytic inputs (such as values, ranges, references) including uncertainty or distributional assumptions.	117-122
Summary of main results	23	Report the mean values for the main categories of costs and outcomes of interest and summarise them in the most appropriate overall measure.	117-122
Effect of uncertainty	24	Describe how uncertainty about analytic judgments, inputs, or projections affect findings. Report the effect of choice of discount rate and time horizon, if applicable.	117-122
Effect of engagement with patients and others affected by the study	25	Report on any difference patient/service recipient, general public, community, or stakeholder involvement made to the approach or findings of the study	117-122
Discussion			
Study findings, limitations, generalisability, and current knowledge	26	Report key findings, limitations, ethical or equity considerations not captured, and how these could affect patients, policy, or practice.	122-123

Table 23 - Unit time and cost for antenatal screening for health workers

Variables	Intervention 1	Intervention 2	Intervention 3
Time (hours)			
<i>Administration</i>			
Data entry at health facility (per record)	0.25	0.50	0.67
<i>Training and supervision (every five years)</i>			
Training	21.00	45.00	60.00
Supervision of training	36.00	75.00	105.00
<i>Pregnancy screening and treatment</i>			
Counselling and testing	0.50	0.67	1.00
Confirmation of diagnosis	0.50	0.50	0.50
Treatment for adults	0.50	0.50	0.50
<i>Postpartum treatment</i>			
Treatment for exposed newborns	0.50	0.50	0.50
Workforce cost (US\$)			
<i>Administration (per record)</i>			
Data entry at health facility	0.30	0.60	0.80
<i>Training supervision (per year)</i>			
Training	5.02	10.77	14.36
Supervision of training	15.27	31.81	44.54
Training costs	20.29	42.58	58.89
<i>Pregnancy screening and treatment (per woman)</i>			
Counselling and testing	0.60	0.80	1.20
Confirmation	0.60	0.60	0.60
Treatment for adults	0.60	0.60	0.60
<i>Postpartum treatment (per newborn)</i>			
Treatment for exposed newborns	0.60	0.60	0.60

I assumed that nurses were responsible for most tasks, including administration, receiving training, screening, confirmation and delivering treatment. Doctors were responsible for training supervision. I assumed that training takes place once every five years. Nurses' and doctors' incomes were estimated based on the new salary scale for the public sector. See Appendix 4.1 for parameter details. The time required to prescribe treatment, carry out screening and attend training sessions was based on a cost-efficiency analysis of the triple-integrated screening carried out in Cambodia [320]. For the children tested, I did not take into account the cost of training, as this was already included in the mother's test, and newborns could only be tested if the mother was.

4.3. One-way sensitivity analysis

Table 24 - One-way sensitivity analysis of ICER for dual-integrated screening for HIV and syphilis compared to HIV screening only (base case scenario) and for triple-integrated screening for HIV, syphilis and hepatitis B compared to dual-integrated screening

	HIV and syphilis		HIV, syphilis and hepatitis B	
	Lower	Upper	Lower	Upper
HIV drug cost (mother)	18	18	114	114
HIV drug cost (child)	18	18	114	114
Integrated syphilis/HIV screening kit cost	16	21	114	114
Syphilis drug cost (mother)	18	18	114	114
Syphilis drug cost (child)	18	18	114	114
Hepatitis B screening kit cost	18	18	108	120
Hepatitis B drug cost (mother)	18	18	108	120
Hepatitis B drug cost (child)	18	18	114	114
Costs annual discount rate	18	18	199	86
Benefits annual discount rate	16	20	1148	75
Prevalence of HIV	18	18	114	114
Prevalence of hepatitis B	18	18	138	97
Prevalence of syphilis	23	15	114	114
Hourly rate of nurses	17	20	114	113
Hourly rate of doctors	18	18	114	114

Notes: HIV= Human immunodeficiency virus. NA= Not applicable. ICER= Incremental cost-effectiveness ratio.