Title

HIV Testing among Antenatal Care–Attending Pregnant Women and Male Partners in Cambodia: Primary and Secondary Data Analyses Using Cambodia Demographic Health Surveys (2005, 2010, and 2014), Case-Control Study and In-Depth Interview

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A dissertation submitted in partial satisfaction
of the requirements for the degree of Doctor of Philosophy
in Epidemiology

By
Phirom Toeng

2021

ABSTRACT OF THE DISSERTATION

HIV Testing among Antenatal Care–Attending Pregnant Women and Male Partners in Cambodia: Primary and Secondary Data Analyses using Cambodia Demographic Health Surveys (2005, 2010, and 2014), Case-Control Study and In-Depth Interview

By Phirom Toeng

Doctor of Philosophy in Epidemiology

University of California, Los Angeles, 2021

Professor Pamina M. Gorbach, Chair

Introduction

Cambodia has set a goal to test at least 95% of all pregnant women for HIV. Thanks to Cambodia's "Boosted Linked Response" strategy, the HIV testing rate among pregnant women attending antenatal care (ANC) has gradually increased but plateaued out at approximately 90% for the past several years. Moreover, since 2012, the strategy has failed to test more than one-fourth of male partners of ANC-attending pregnant women. Therefore, we examined factors associated with HIV testing during ANC among pregnant women and their male partners. In addition, we also explored men's barriers to attending ANC with their pregnant partners, and

their perspectives on three HIV testing alternative strategies (home-based HIV testing, free-of-charge pregnant woman–delivered HIV self-testing, and out-of-pocket community pharmacy–delivered HIV self-testing.

Methods

In Study 1, we pooled together three Cambodia Demographic Health Surveys (2005, 2010, and 2014) and adopted Anderson's Behavioral Model of Health Services to guide our data analysis. The study population consisted of all Cambodian women aged 15–49 years with one or more live births in the three years preceding each survey who attended ANC for the most recent birth (weighted N=11,181). In Study 2, we conducted a Case-Control study. The study population consisted of men who attended ANC with their pregnant partners from September 2020 to December 2020. The outcome was defined as declining or accepting an HIV test as part of ANC. 132 cases and 264 controls were recruited from three government-run ANC health facilities in Phnom Penh (the National Maternal and Child Health Center, Chaktomuk Referral Hospital, and Posenchey Health Center). An Extended Theory of Planned Behavior (ETPB) was applied to guide our data analysis. In Study 3, a qualitative study was nested within the Case-Control study. The study population consisted of 30 men (10 HIV testing decliners, 10 acceptors, and 10 ANC non-attendees). All participants were recruited using consecutive sampling from ANC and postpartum departments of the National Maternal and Child Health Center.

Results

In Study 1, HIV testing rates as part of ANC increased significantly by year (15.5% in 2005, 46.2% in 2010, and 77.4% in 2014, $p<0.001$). Women who received adequate pre-test counseling had consistently greater odds of being tested for HIV than those who did not: aOR=17.3 [95% CI: 12.4–24.0] in 2005, aOR=7.2 [95% CI: 5.9–8.9] in 2010, aOR=8.5 [95% CI:

6.5–11.2] in 2014, and aOR=8.9 [95% CI: 7.7–10.3] in the pooled dataset. In Study 2, male partners with a low intention to test and low perceived behavioral control (PBC) had greater odds of declining an HIV test (low intention with aOR=3.2 [95% CI: 1.8–5.6] and low PBC with aOR=1.8 [95% CI: 1.1–2.8]). A low intention to test was predicted by an absence of perceived risk of HIV infection (aOR=2.0 [95% CI: 1.1–3.6]), unsupportive subjective norms (aOR=2.3 [95% CI: 1.4–3.9]), and an absence of partner communication about HIV testing (aOR=3.0 [95% CI: 1.5–5.7]). In Study 3, barriers to attending ANC visits included individual-level factors (being unable to take time off work, waiting outside the health facility watching over an older child, not wanting to pay for a parking fee, and a negative attitude toward male ANC attendance), relationship-level factors (a negative couple dynamic, meaning men taking healthcare decisions alone as they considered themselves heads of the family), community-level factors (a negative attitude toward male ANC attendance), and health system-level factors (not being invited by providers to come inside the ANC consultation room). Concerns about home-based HIV testing included worries that neighbors would be suspicious, not being home at the time of the home visit, an inability to verify the identity of the testing team, the feeling of being coerced into testing, feeling offended by a home visit, the potential for contamination of testing instruments, the potential for confidentiality breaches by the testing team, and the potential for improper management of biological specimens. For pregnant woman–delivered HIVST, perceived concerns included a lack of pre-and post-test counseling, questionable accuracy of the test kit, instructions of use in foreign languages, not being capable of using the kit correctly, and questions about why the provider or his partner wanted him to be tested. For community pharmacy–delivered HIVST, perceived concerns included low availability, feeling shy or

embarrassed when purchasing the kits, cost, and potential lack of technical assistance provided by pharmacy staff.

Conclusion

HIV testing uptake among ANC-attending pregnant women in Cambodia can be increased by delivering high-quality pre-test counseling. Therefore, health system-level interventions should include regular refreshment training to counselors at ANC sites without understaffing issues and lower the ratio of ANC clients to counselors at ANC sites plagued by understaffing issues. Among male partners, trans-theoretical approaches could be adopted to increase their intention to test by altering their risk perception, subjective norms, and partner communication. Potential community-level interventions using mass media, peer educators, and small-group education sessions may be useful in changing men's behavior. Home-based HIV testing and HIV self-testing have the potential to become complementary services to the current ANC-based HTC.

The dissertation of Phirom Toeng is approved.

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ABBREVIATIONS

AIDS	Acquired immunodeficiency syndrome
aOR	Adjusted odd ratio
aPD	Adjusted prevalence difference
aPR	Adjusted prevalence ratio
aPP	Adjusted predicted probability
ANC	Antenatal care
ART	Anti-retroviral therapy
BLR	Boosted Linked Response
CDHS	Cambodia Demographic Health Survey
ETPB	Extended Theory of Planned Behavior
HB-HTC	Home-based HIV testing and counseling
HIVST	HIV self-testing
HPITC	Health provider–initiated testing and counseling approach
HTC	HIV Testing and Counseling
IEC	Information, education, and communication
IRB	Institutional Review Board
LR	Linked Response
MoH	Ministry of Health of Cambodia
NCHADS	National Center for HIV/AIDS, Dermatology and STDs
NECHR	National Ethics Committee for Health Research
NMCHC	National Maternal and Child Health Center
PLHIV	People living with HIV
PMTCT	Prevention of Mother-to-Child Transmission
TPB	Theory of Planned Behavior
UCLA	University of California, Los Angeles
UHS	University of Health Sciences (Cambodia)
UNAIDS	Joint United Nations Program on HIV/AIDS
UNICEF	United Nations International Children's Emergency Fund
VCCT	Voluntary confidential counseling and testing
WHO	World Health Organization
95% CI	95% Confidence Interval

TABLES

FIGURES

APPENDIX

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Although I have experienced ups and downs throughout my doctoral journey, I count myself lucky to have an extremely supportive and caring family. I have been provided with all kinds of unconditional support. Thanks for everything you have done for me.

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Mom Khay, ***Phirom Toeng***, Valérie Mahiou-Leddet, Fathi Mabrouki, Kim Sothea, Evelyne Ollivier, Riad Elias and Sok-Siya Bun. HPLC Analysis and Cytotoxic Activity of Vernonia cinerea. Natural Product Communications. 2012; 7(10):1259–1262.

CHAPTER 1: Introduction

1.1. HIV in the world

In 2014, the Joint United Nations Program on HIV/AIDS announced ambitious "90-90-90" targets to fast-track the global fight against HIV/AIDS by 2020. These three targets were: 90% of people living with HIV (PLHIV) were diagnosed, 90% of those diagnosed were receiving antiretroviral therapy (ART) and 90% of people on ART were achieving viral suppression (UNAIDS, 2014).

It appears that these "90-90-90" targets have not been achieved. Five years later (as of late 2019), only about 81% of the approximately 38 million people living with HIV had been diagnosed, 67% were receiving ART, and 59% had achieved viral suppression, according to the WHO's latest global estimates (WHO, 2020).

1.2. HIV in Cambodia

The first HIV case in Cambodia was reported in 1991 (Nariddh, 1994, Project, 2003). Owing to the flourishing sex industry between 1995 and 1998 (NCHADS, 2012), HIV prevalence among commercial sex workers aged less than 20 hit 40.8% in 1998; for older workers (≥20), the prevalence was a stunning 43.4%. To respond to the epidemic, Cambodia implemented surveillance and disease monitoring as well as aggressive prevention control programs, including a goal of 100% condom use (Saphonn et al., 2004). From 1997 to 2003, there was a significant increase in condom use from 53% to 96% among direct female sex workers and from 30% to 84% among indirect female sex workers (Gorbach et al., 2006). Since the peak, HIV prevalence among the adult population (15–49 years) has gradually decreased from 1.7% in 1998 to 0.6% in 2016 (WHO, 2017).

As of December 2016, strong programmatic efforts have resulted in 83% (58,338) of all PLHIV being diagnosed, 97% of those diagnosed being referred for antiretroviral therapy (ART), and 81% of those on ART sustaining viral load suppression (DoS/PEPFAR, 2017).

As of 2017, Cambodia was one of the only six countries to have achieved the UNAIDS's 90-90-90 targets (UNAIDS, 2018b). This widely congratulated success a full three years before the deadline prompted the government to set an even more ambitious national deadline of reaching 95-95-95 targets and reducing new HIV infections to fewer than 300 per year by 2025, five years ahead of the global schedule of 2030 (UNAIDS, 2018a).

This impressive feat seemed to suggest that the HIV epidemic in Cambodia had been well contained. However, a massive 2014 iatrogenic outbreak of HIV transmission from an unlicensed medical practitioner performing injections in Roka, a rural commune of Battambang province (Vun, 2016, Saphonn et al., 2017) indicates ongoing vulnerabilities and the need for continuing surveillance and control measures.

1.3. HIV testing and counseling among pregnant women in Cambodia

Based on the current national guidelines on HIV testing services in Cambodia, pregnant women can be tested for HIV through two mechanisms: facility-based and community-based. For facility-based HIV testing and counseling (HTC), a health provider-initiated testing and counseling approach (HPITC) has been in place since 2013 to routinely offer finger-prick HIV and syphilis testing to all ANC-attending pregnant women, especially in their first trimester. Although retesting HIV-negative women is not generally recommended, guidelines state that it should be done in the third trimester for women at high risk, such as entertainment women, women who inject drugs, women with HIV-positive male partners, or women who have a perceived risk of HIV infection. For community-based HTC, designed to reach pregnant women

who do not attend ANC during pregnancy, the guidelines recommend that finger-prick HIV and syphilis testing should be done through outreach ANC activities at the community level (NCHADS, 2017).

Among pregnant Cambodian women, the crude prevalence of HIV reached 3.2% in 1997. It declined gradually, from 1.6% in 2003, to 1.1% in 2006, 0.4% in 2010, and 0.28% in 2014 (NCHADS/NMCHC, 2018).

Cambodia has set a goal to eliminate HIV transmission from mother to child by 2025. However, to be WHO elimination–certified, Cambodia must achieve five process indicators: (1) population-level ANC coverage (at least one visit per pregnancy) ≥ 95%, (2) ≥ 95% of pregnant women knowing their HIV status, (3) ART coverage of ≥ 95% of HIV positive pregnant women, (4) syphilis testing for ≥ 95% of pregnant women, and (5) treatment of ≥ 95% syphilis-seropositive women (NCHADS/NMCHC, 2018).

Although Cambodia already achieved the first indicator, there are still significant barriers to testing pregnant women with HIV (NCHADS/NMCHC, 2018). Official data obtained from the national prevention of mother-to-child transmission (PMTCT) program showed that, between 2017 and 2020, Cambodia provided ANC to over one million pregnant women across all government-run ANC facilities in the country (337,464 in 2017, 339,691 in 2018, 332,854 in 2019, and 331,473 in 2020). Nearly none of these women knew their HIV status at the time of their first ANC visit (1.6% in 2017, 1.1% in 2018, 1.3% in 2019, and 1.5% in 2020). More than two-thirds of the women who did not know their status received voluntary HIV testing (86.7% in 2017, 90.9% in 2018, 93.4% in 2019, and 91.8% in 2020). Among those receiving testing, far fewer than 1% received reactive test results (0.08% in 2017, 0.06% in 2018, 0.05% in 2019, and 0.05% in 2020). Relatively big proportions of those with reactive test results received

confirmatory testing (82.7% in 2017, 66.7% in 2018, 87.6% in 2019, and 71.8% in 2020). Among those receiving confirmatory testing, the true positive rates were 73.1% in 2017, 76.2% in 2018, 75.4% in 2019, and 73.8% in 2020 (NMCHC, 2020).

The numbers above show that approximately 10% of pregnant women who attended ANC at least once for their most recent child and did not know their HIV status at the time of their first visit were not tested for HIV, even though the current national guidelines explicitly state that all ANC-attending pregnant women should be offered confidential HIV testing and counseling as part of routine ANC by health providers. Unfortunately, the current reporting system does not capture or collect data on why they were not tested. Study 1 (Chapter 2) is therefore dedicated to this question.

1.4. HIV testing and counseling among male partners of pregnant women in Cambodia

According to the guidelines for the prevention of mother-to-child transmission of HIV and syphilis, all male partners of pregnant women should be offered voluntary HIV testing and counseling, especially if the women are found to be HIV-positive, have STIs, or have a history of high-risk behavior. At ANC facilities, a mothers' class or pre-test counseling for individuals or couples should be offered. For logistical reasons, a mothers' class, also known as group counseling, should be conducted if there are enough clients. In addition, if a pregnant woman and her male partner wish to receive pre-and post-test counseling separately or together, their preferences should be accommodated. As for pregnant women, HIV testing for male partners at ANC facilities is generally available as a single finger-prick rapid test (NMCHC, 2016).

Based on data from Cambodia's national PMTCT program, between 2017 and 2020, less than one-fourth of male partners of ANC-attending pregnant women were tested for HIV (17.2% in 2017, 18.6% in 2018, 18.4% in 2019, and 17.7% in 2020). Among those who were tested, less

than 2% had reactive results using a finger-prick rapid test (0.3% in 2017, 0.5% in 2018, 0.6% in 2019, and 1.1% in 2020). Surprisingly, less than half of those with reactive results received confirmatory testing (44.3% in 2017, 23.8% in 2018, 19.2% in 2019, and 25.2% in 2020). Among those who received confirmatory testing, the true positive rates were as follows: 74.2% in 2017, 55.6% in 2018, 50.7% in 2019, and 37.2% in 2020 (NMCHC, 2020).

The current national reporting system does not capture two important indicators: (1) the total number of men who attend ANC visits with their pregnant partners and (2) the total number of ANC-attending male partners who decline an HIV test after receiving individual or couple or group pre-test counseling. Since those two numbers are not known, the low HIV testing rate among male partners (approximately 17% or 18%) can be explained by one or more scenarios: (1) a large proportion of men did not attend ANC with their pregnant partners, (2) of the men who attended ANC with their pregnant partners, a large proportion was not offered an HIV test if some ANC providers did not consider male partners a priority group for HIV testing, and/or (3) a large proportion of ANC-attending men were offered an HIV test but declined for some reason.

Therefore, we conducted two studies to examine scenarios #1 and #3. A quantitative study (Chapter 3) aimed to identify factors that made ANC-attending men more likely to decline an HIV test. A qualitative study (Chapter 4) aimed to understand why men did not attend ANC and their perspectives on other HIV testing alternatives (home-based HTC, free-of-charge pregnant woman–delivered HIVST, and out-of-pocket community pharmacy–delivered HIVST). Scenario #2 was beyond the scope of this research.

CHAPTER 2 (Study 1): Factors Associated with HIV Testing among ANC-Attending Pregnant Women: Secondary Data Analysis Using Cambodia Demographic Health Surveys (2005, 2010, and 2014)

2.1. Abstract

Introduction: Prenatal HIV testing is an important contributor to healthy outcomes for women, their male partners, and infants. As of 2020, Cambodia has not reached its target of testing at least 95% of pregnant women for HIV. Coverage has stagnated at about 90% for several years. This study aimed to identify key predictors of HIV testing among pregnant women attending antenatal care (ANC).

Methods: We pooled three de-normalized rounds of CDHS (2005, 2010, and 2014). The study population consisted of all Cambodian women aged 15–49 years with one or more live births in the three years preceding each survey who attended ANC for the most recent birth (crude N=11,054 and weighted N=11,181). The outcome of interest was defined as being tested for HIV as part of ANC. Anderson's Behavioral Model of Health Services was applied to guide our secondary data analysis. Adjusted odds ratios and their corresponding 95% confidence intervals were computed by using the fixed-effect multiple logistic regression. Adjusted predicted probabilities, prevalence differences, prevalence ratios, and their corresponding 95% confidence intervals were estimated using logistic regression-based marginal standardization to the total population.

Results: A total of 11,181 Cambodian women with one or more live births in the three years preceding each CDHS round attended ANC for the most recent birth. HIV testing uptake rates as part of ANC significantly increased each year (15.5% in 2005, 46.2% in 2010, and

77.4% in 2014, p<0.001). Compared to women with no education at all, those with secondary or higher education had greater odds of being tested (aOR=1.4 [95% CI: 1.1–1.8]). Compared to unemployed women, those in the agriculture sector had lower odds of being tested (aOR=0.6 [95% CI: 0.5–0.7]). Odds were greater for women living in urban areas (aOR=1.9 [95% CI: 1.5–2.5]). Women receiving adequate pre-test counseling had substantially greater odds of being tested (aOR=8.9 [95% CI: 7.7–10.3]). Adjusted probabilities of being tested for HIV as part of ANC between two hypothetical scenarios (*adequate vs. inadequate pre-test counseling*) were as follows: in 2005 (aPP= 42.3% [95% CI: 37.1–47.5] vs aPP=6.1% [95% CI: 4.8–7.4]), in 2010 (aPP=66.1% [95% CI: 62.9–69.2] vs aPP=25.5% [95% CI: 22.8–28.1]) and in 2014 (aPP=91.2% [95% CI: 89.5–92.8] vs aPP=56.3% [95% CI: 52.3–60.3]). The adjusted prevalence ratios (*ref: inadequate counseling*) were as follows: in 2005 (aPR=6.9 [95% CI: 5.3–8.6]), in 2010 (aPR=2.6 [95% CI: 2.3–2.9]), and in 2014 (aPR=1.6 [95% CI: 1.5–1.7]). The adjusted prevalence differences (*ref: inadequate counseling*) were as follows: in 2005 (aPD=36.2% [95% CI: 30.9–41.4]), in 2010 (aPD=40.6% [95% CI: 36.7–44.6]), and in 2014 (aPD=34.9% [95% CI: 30.5–39.3]).

Conclusion: Among all the factors significantly associated with HIV testing as part of ANC, the quality of pre-test counseling was the strongest predictor. Therefore, to increase HIV testing uptake among ANC-attending pregnant women in Cambodia, delivering high-quality pre-test counseling seems to be the intervention with the most potential impact. To achieve that, two health system-level approaches are proposed: (1) at ANC sites with chronically low HIV testing coverage but without understaffing issues, regular refreshment training should be provided to ANC counselors on how to deliver high-quality counseling to all ANC-attending pregnant women, and an evaluation and monitoring of performance should be periodically conducted

(e.g., on a monthly or quarterly basis) and (2) at ANC sites with chronically low HIV testing coverage and with understaffing issues (high ratio of ANC clients to counselors), the number of counselors at the sites should be increased to a sufficient level, along with regular refreshment training on how to deliver high-quality counseling.

2.2. Introduction

2.2.1. Background

Globally, as of 2017, more than 1.4 million pregnant women are estimated to be living with HIV (WHO, 2019c). Between 25% and 30% of children who acquire the virus from their mothers do not survive past their first birthday (WHO, 2006). HIV can be transmitted from an HIV-infected mother to her child during pregnancy, labor, delivery, or breastfeeding. Without intervention, transmission rates typically range from 15% to 45%. However, with effective interventions, the rate can be reduced to less than 5% (WHO, 2021).

A recent modeling study, conducted as part of the development of the World Health Organization's guidelines on HIV testing services in 2015 (WHO, 2015a), concluded that testing all pregnant women for HIV achieves the best health outcomes and is cost-effective in the long run across a wide range of HIV prevalence settings (Ishikawa et al., 2016). Therefore, as in the 2015 guidelines, the WHO's 2019 guidelines continue to recommend that all pregnant women should be tested for HIV and syphilis at least once and as early as possible through provider-initiated counseling and testing (PITC) (WHO, 2019a).

To address the health needs of pregnant women, their male partners, and babies in Cambodia, two governmental institutions under the Ministry of Health (the National Maternal and Child Health Center, or NMCHC, and the National Center for HIV/AIDS, Dermatology, and STDs, or NCHADS) collaborated with local and international non-governmental organizations to

launch a pilot project on the prevention of mother-to-child transmission (PMTCT) at NMCHC in 2001. At the pilot site, two services were offered: (1) opt-in HIV testing and counseling to all ANC- receiving pregnant women and their partners and (2) single-dose Nevirapine to all HIV-positive mothers during labor and their infants after delivery. In 2003, the project was scaled up to eight sites, and, later, the national level (NMCHC, 2007).

In 2006, following the recommendation of the WHO, the HIV testing modality was changed from "opt-in" to "opt-out" (NMCHC, 2007). "Opt-out" refers to an approach in which an ANC provider is required to inform a woman and her male partner that HIV testing is part of standard ANC. They are said to opt out of testing if they explicitly refuse to take the test (Walmsley, 2003). At Cambodia's ANC sites, HIV pre-test counseling was offered to all pregnant women and their male partners, and verbal consent for the test was obtained (WHO, 2014).

By August 2007, PMTCT services were available at 112 health facilities across the country. However, their uptake remained low (NMCHC, 2007). By the end of 2008, nationally, only 29% of pregnant women had received HIV testing and only 27% of the HIV-positive ones were on antiretroviral therapy (NCHADS, 2008). Such low uptake was due several challenges, including poor referral mechanisms. A new "Linked Response" approach (Figure 2-1) was therefore piloted in two provinces (Prey Veng and Takeo) in 2008–2009 to ensure that all pregnant women would be properly referred to HIV testing services. This approach has been described in detail elsewhere (Delvaux et al., 2011).

At the pilot sites, several HIV/syphilis testing and reproductive health indicators significantly improved. For instance, in 2007 (before the pilot), only 6% of pregnant women at the sites were tested for HIV, with this figure jumping to 86%, in 2009. The "Linked Response"

approach was subsequently scaled up nationwide (Delvaux et al., 2011, White et al., 2013). By 2012, 956 out of a total of 1,004 government-run health facilities across Cambodia had implemented the "Linked Response"/PMTCT approach, and the proportion of ANC-attending pregnant women tested for HIV had increased from 34.4% in 2008 to 86.1% in 2012 (Sim et al., 2015).

In 2013, Cambodia revised its "Linked Response" approach to achieve the virtual elimination of new pediatric HIV infections in Cambodia. This "Boosted Linked Response" (Figure 2-2) required a minimum of 95% national HIV testing coverage. The "Boosted Linked Response" further centralized HIV/syphilis services by introducing finger-prick rapid testing at health centers, implementing more active follow-up mechanisms to improve retention in care, and improving counseling around adherence to treatment by health providers and peer counselors (NCHADS/NMCHC, 2013).

2.2.2. Study justification

The "Boosted Linked Response" has been implemented nationwide since 2013. As described in Section 1.3 (Chapter 1), between 2017 and 2020, more than two-thirds of the women who did not know their HIV status during their first ANC visit to government-run facilities received voluntary HIV testing (86.7% in 2017, 90.9% in 2018, 93.4% in 2019, and 91.8% in 2020). In other words, approximately 10% of pregnant women who attended ANC at least once for their most recent child and did not know their HIV status at the time of their first visit were not tested for HIV as part of routine ANC (NMCHC, 2020).

The current PMTCT reporting mechanism does not capture data on why some ANC-attending pregnant women decline the offer of an HIV test, but it is critical to have a better understanding of factors associated with HIV testing among these women. The findings of our

present study, the first of its kind ever conducted on Cambodian ANC-attending pregnant women, can be used by the Ministry of Health to update its current HIV testing and counseling strategy to test at least 95% of pregnant women for HIV.

2.3. Specific aim, conceptual framework, and hypotheses

2.3.1. Specific aim

The main aim of this study was to conduct secondary data analysis using three rounds of CDHS data (2005, 2010, and 2014) to identify individual factors associated with HIV testing as part of ANC among pregnant Cambodian women.

2.3.2. Conceptual framework

The conceptual framework of the present study was adapted from Anderson's Behavioral Model of Health Services Use. The model was developed in 1968 by Ronald M. Andersen, health services professor at UCLA, to identify the determinants of health care utilization (Andersen, 1968, Andersen and Newman, 1973, Aday and Andersen, 1974, Aday et al., 1980). Among several conceptual frameworks developed since the early 1960s, this model has been the most widely used for studying health care utilization (Von Lengerke et al., 2014, Ricketts and Goldsmith, 2005)

In the original model, Andersen suggested that people's use of a particular health service relied on three components: their predisposition to use the service, factors that enable or impede its use, and their need for care. Factors affecting their predisposition to use the service included demographic factors (e.g., age and gender), social structure (e.g., education, occupation, and ethnicity), and health beliefs (e.g., attitudes, values, and knowledge about their health and health services). Enabling factors were comprised of two levels: community (e.g., access to a health facility and short waiting time at the facility) and personal (e.g., income and health insurance).

Last, any intervention to increase the use of the service must incorporate two critical aspects: perceived and evaluated need. A perceived need was defined as "how people view their own general health and functional state, as well as how they experience symptoms of illness, pain, and worries about their health and whether or not they judge problems to be of sufficient importance and magnitude to seek professional help." Evaluated need was defined as "professional judgment about people's health status and their need for medical care" (Andersen, 1995, p.3).

Over time, the widespread implementation of the model produced empirical evidence about its robustness and flaws. Multiple revisions have enhanced its validity and reliability in predicting health services utilization, not changing the fundamental components of the model, but essentially resulting in additions. The fifth revision suggested that health services use is best understood by health policymakers when focusing on the predisposing, enabling, and need factors both on the contextual and individual levels (Andersen, 2008). The sixth revision, the latest, incorporates two additional components: (1) genetic susceptibility or family history of a particular health condition as an individual predisposing factor and (2) quality of life as an outcome factor (Andersen et al., 2014).

Anderson's Behavioral Model of Health Services Use framework has been applied to examine factors associated with HIV testing as part of ANC among pregnant women in Mozambique (Yaya et al., 2019), Zimbabwe (Maruva et al., 2014), and Nigeria (Adebayo, 2015).

Figure 2-3 portrays the present study's conceptual framework, adapted from the sixth version. Health behavior (the outcome of interest) was defined as HIV testing as part of ANC. As in the original sixth version, individual predisposition, enabling factors, and need factors were assumed to predict HIV testing during ANC visits. However, we could not investigate the

influence of contextual characteristics and genetic susceptibility on HIV testing because none of the three CDHS datasets included information on these elements.

In the adapted model, potential individual predisposing factors included (but were not limited to): biological factors (age), social factors (occupation, marital status, and education), and health beliefs (comprehensive knowledge of HIV/AIDS, knowledge of mother-to-child transmission, HIV/AIDS discriminatory attitude, and HIV/AIDS stigmatizing attitude).

Potential individual enabling factors in the adapted model included financing (household wealth) and organization. The organization was further broken down into two elements: social support and organization of services. Social support refers to "the amount of emotional, informational, tangible, and affectionate support generated through the social network"; while organization of services may include "means of transportation, reported travel time, and waiting time for care" (Andersen et al., 2014, p.39). Thus, household wealth, exposure to media (as a proxy for the social support), and area of residence (as a proxy for the organization of services) were selected as potential enabling factors in the analysis.

Finally, potential need factors in the adapted model consisted of the following: a perceived need for HIV testing (history of STI or STI symptoms in the twelve months preceding each round of data collection and a history of multiple lifetime sexual partners) and an evaluated need (whether the women reported being offered adequate HIV pre-test counseling by a provider as part of ANC).

2.3.3. Hypotheses

- **Hypothesis #1:** ANC-attending pregnant women possessing certain individual predisposing characteristics (being younger, married, better educated, employed, and with comprehensive knowledge of HIV/AIDS, adequate knowledge of mother-to-child

transmission, HIV/AIDS discriminatory attitude, and HIV/AIDS stigmatizing attitude) had greater odds of being tested for HIV as part of ANC.

- **Hypothesis #2:** ANC-attending pregnant women possessing certain individual enabling characteristics (being wealthier, being exposed to at least one type of media at least once a week, and living in urban areas) had greater odds of being tested for HIV as part of ANC.
- **Hypothesis #3:** ANC-attending pregnant women possessing certain individual need characteristics (with STI/STI symptoms in the twelve months prior to each round of CDHS, a history of more than one lifetime sexual partner, or being offered adequate HIV pre-test counseling) had greater odds of being tested for HIV as part of ANC.

2.4. Methods

2.4.1. Study design

This study was conducted using data from Cambodia Demographic Health Surveys (CDHS) (2005, 2010, and 2014). These datasets are freely available upon request from the Demographic Health Survey Program.

2.4.2. Data sources

All three rounds of CDHS (2005, 2010, and 2014) are large, nationally representative, cross-sectional household surveys, with multilevel cluster survey design. The surveys were jointly implemented by two Cambodian institutions (the Directorate General for Health of the Ministry of Health and the National Institute of Statistics of the Ministry of Planning), with technical assistance from ICF International (National Institute of Public Health, 2006, National Institute of Statistics, 2011, National Institute of Statistics, 2015).

In the first stage of each round, a probability proportional to size (PPS) sampling approach was used to select clusters. In the second stage, "Equal Probability Systematic" approach was applied to select 24 households from every urban cluster and 28 households from every rural cluster. All women aged 15–49 years who were either residents of the selected households or visitors present in the households on the night before the survey were eligible to be interviewed. The total crude number of eligible women for an individual face-to-face interview was 17,256 in 2005, 19,237 in 2010, and 18,012 in 2014. 98% of the women in each round completed the interview (National Institute of Public Health, 2006, National Institute of Statistics, 2011, National Institute of Statistics, 2015).

2.4.3. Study population

In the present analysis, the study population consisted of all Cambodian women with one or more live births in the three years preceding each round of CDHS who attended ANC at least once for the most recent birth. The total crude number of such women was 11,054 (3,166 in 2005, 4,014 in 2010, and 3,874 in 2014); the total weighted number was 11,181 (3,100 in 2005, 4,134 in 2010, and 3,967 in 2014).

2.4.4. Statistical analysis

- **Variables of interest**

As described in the Conceptual Framework above, the selection of potential predictors of HIV testing was guided by Anderson's Behavioral Model of Health Services Use, which focuses on three individual constructs: predisposing, enabling, and need factors.

The outcome was measured with a CDHS question: "I don't want to know the results, but were you tested for the AIDS virus as part of antenatal care?" The following variables were included in the analysis:

- **Outcome of interest:** HIV testing as part of ANC (yes, no).
- **Potential individual predisposing factors:** 5-year age groups (15–19, 20–24, 25–29, 30–34, 35 and above), education attended or completed (none, primary, secondary, university), marital status (never married, married/living with a partner, widowed/divorced/separated), occupation (not working, agricultural sector, non-agricultural sector), comprehensive knowledge of HIV/AIDS (yes, no), knowledge of mother-to-child transmission (adequate, inadequate), HIV/AIDS discriminatory attitude (yes, no), and HIV/AIDS stigmatizing attitude (yes, no).
- **Potential individual enabling factors:** Wealth quintiles (lowest, second, middle, fourth, highest), area of residence (urban, rural), and being exposed to at least one type of media at least once a week (yes, no).
- **Potential individual need factors:** STI or STI symptoms in the 12 months preceding each round of CDHS (yes, no), number of lifetime sexual partners (1, >1), and HIV pre-test counseling (adequate, inadequate). Per DHS's definition, when an HIV counselor at ANC talked with a woman about all three of the following topics: (1) babies getting the AIDS virus from their mother, (2) things that you can do to prevent getting the AIDS virus, and (3) getting tested for the AIDS virus, the woman was considered to have received adequate counseling (Croft, 2018).

Table 2-1 describes in detail how variables of interest were constructed.

➢ **Descriptive statistics**

Frequency and percentage were used to describe variables of interest. Individual sampling weights for women, strata, and primary sampling units (PSU) variables were applied to account for CDHS's complex sampling design. STATA 13 (Stata Corp, College Station, Texas,

USA) was the statistical software program used, with the command "svy, subpop()" as recommended by the UCLA Statistical Consulting Group for analyzing a subpopulation (ANC-attending pregnant women) of survey data (IDRE, 2020).

- **Inferential statistics**

Before pooling the three rounds of CDHS, the sampling weight in each survey was de-normalized following DHS's de-normalization procedure (Ren, 2004). Then the de-normalized weight was applied when doing the pooled analyses.

Collinearity between predictor variables of interest was checked by computing the tolerance using the formula $1-R^2$ and the variance inflation factor (VIF) by 1/tolerance. The procedure is specifically recommended by the UCLA Statistical Consulting Group for checking collinearity in survey data (IDRE, 2021).

Proportions were compared using a regular chi-square test. For each survey, simple and multiple logistic regressions were employed to compute crude odds ratios (ORs) of being tested for HIV as part of ANC and their corresponding 95% confidence intervals (CIs). Meanwhile, for the pooled dataset, a fixed-effect multiple logistic regression was used to estimate the ORs and their corresponding 95% CIs. The use of the fixed-effect regression was recommended by the DHS statistical team (Pullum and Elkasabi, 2019). A significance level was set at a p-value of <0.05.

Logistic regression-based marginal standardization to the total population was used to compute the adjusted probability of being tested for HIV as part of ANC, effect measure estimates (prevalence ratio and prevalence difference), and their corresponding 95% CIs. The marginal standardization is the most appropriate approach that allows inference to the total population from which the data are drawn (Muller and MacLehose, 2014).

2.4.5. Protection of human subjects

All three rounds of CDHS were reviewed and approved by the ICF's Institutional Review Board and the National Ethics Committee of Health Research of Cambodia.[1] The use of the data was also reviewed and approved by the Institutional Review Board of the University of California, Los Angeles.

2.5. Results

2.5.1. Descriptive statistics

The proportions of women who were offered an HIV test as part of their ANC significantly increased by year (17% in 2005, 50.1% in 2010, and 80.1% in 2014, $p<0.001$). Among those who were offered a test, uptake rates were high (88.4% in 2005, 89.4% in 2010, and 95.9% in 2014, $p<0.001$).

Table 2-2 describes the individual characteristics as defined by Andersen's Behavioral Model (predisposing, enabling, and need factors) among the study population.

- **HIV testing as part of ANC (outcome of interest)**

The number of ANC attendees who received HIV testing as part of ANC saw a five-fold increase between 2005 and 2014 (15.5% in 2005, 46.2% in 2010, and 77.4% in 2014, $p<0.001$).

- **Potential individual predisposing factors**

The vast majority of ANC attendees were in three age groups (20–24, 25–29, and 30–34 years old). Over half of the women attended or completed primary school: 60% in 2005, 56% in 2010, and 51% in 2014 ($p<0.001$). Most were married or living with a partner: 95.6% in 2005, 96.2% in 2010, and 95.8% in 2014. As Cambodia is an agriculture-based society, more women

[1] Details on the ethical review of the CDHS data can be found at www.dhsprogram.com/methodology/Protecting-the-Privacy-of-DHS-Survey-Respondents.cfm.

depended on agriculture to make a living than were unemployed or had non-farm employment: 47.6% in 2005, 47.7% in 2010, and 31.8% in 2014 ($p<0.001$).

Close to half of the women were considered to have comprehensive knowledge of HIV/AIDS, although fewer every year: 47.6% in 2005, 42.8% in 2010, and 41.7% in 2014 ($p<0.05$). In terms of knowledge of mother-to-child transmission of HIV, only about a quarter (25.4%) had adequate knowledge in 2005; the proportion jumped to 45.9% in 2010 and 48.1% in 2014 ($p<0.001$).

An HIV/AIDS discriminatory attitude has consistently been around 60%, with a modest increase over time: 57.2% in 2005, 60.7% in 2010, and 65.8% in 2014 ($p<0.001$). Additionally, an HIV/AIDS stigmatizing attitude remained relatively high but with a modest decrease over the years: 60.8% in 2005, 57.7% in 2010, and 50.2% in 2014 ($p<0.001$).

- **Potential individual enabling factors**

The majority of ANC-attending pregnant women resided in rural areas: 84.3% in 2005, 83.2% in 2010, and 84.8% in 2014. Over half of the women had been exposed to at least one type of mass media channel (TV, radio, and newspaper/magazine) at least once a week: 75.9% in 2005, 63.2% in 2010, and 64.8% in 2014 ($p<0.001$). Household wealth was categorized as quintiles: lowest, lower, middle, fourth and highest.

- **Potential individual need factors**

The prevalence of STI or STI symptoms in the 12 months preceding each survey saw modest but statistically significant variations: 8.9% in 2005, 11.9% in 2010, and 11.4% in 2014 ($p<0.01$). An overwhelming majority reported having only one lifetime sexual partner: 93.4% in 2005, 94.9% in 2010, and 93.6% in 2014. Less than a quarter (21.5%) of ANC attendees were given adequate HIV pre-test counseling as part of ANC in the 2005 CDHS round. However,

significantly more women received adequate counseling in subsequent rounds: 51.7% in 2010 and 61.8% in 2014 ($p<0.001$).

2.5.2. Factors associated with HIV testing uptake as part of ANC

Table 2-3 presents the crude and adjusted odds ratios between HIV testing uptake as part of ANC and potential individual predisposing, enabling, and need factors among ANC-attending pregnant women. These factors were all included in the multivariate logistic regression model.

- **Potential individual predisposing factors**

In the pooled analysis, compared to uneducated women, those with secondary or higher education had greater odds of being tested for HIV as part of ANC (aOR=1.4 [95% CI: 1.1–1.8]). Additionally, compared to unemployed women, those who were employed in agriculture were less likely to be tested for HIV (aOR=0.6 [95% CI: 0.5–0.7]).

Interestingly, being tested for HIV was not found to be associated with the following characteristics of the women: age, comprehensive knowledge of HIV/AIDS, knowledge of mother-to-child transmission of HIV, HIV/AIDS discriminatory attitude, and HIV/AIDS stigmatizing attitude. Marital status was dropped from the final model due to empty cells.

- **Potential individual enabling factors**

In the pooled analysis, compared to rural women, those residing in urban areas had greater odds of being tested for HIV as part of ANC (aOR=1.9 [95% CI: 1.5–2.5]). Compared to women in the lowest wealth quintile, those in the highest quintile had greater odds of being tested for HIV (aOR=1.8 [95% CI: 1.3–2.5]). Media exposure was not significantly associated with HIV testing.

- **Potential individual need factors**

In all CDHS rounds and the pooled dataset, women who received adequate HIV pre-test counseling as part of their ANC visit had greater odds of being tested for HIV than those who did not: aOR=17.3 [95% CI: 12.4–24.0] in 2005, aOR=7.2 [95% CI: 5.9–8.9] in 2010, aOR=8.5 [95% CI: 6.5–11.2] in 2014, and aOR=8.9 [95% CI: 7.7–10.3] in the pooled dataset. History of STI or STI symptoms in the twelve months prior to each survey round and the number of lifetime sexual partners were not significantly associated with HIV testing.

2.5.3. Predicted probability of being tested for HIV as part of ANC

Among the factors significantly associated with being tested for HIV as part of ANC, the quality of HIV pre-test counseling was the strongest predictor. We, therefore, computed the crude and adjusted predicted probabilities of being tested for HIV in each CDHS round, using marginal standardization to the total population, which allows inference to the total population. Each adjusted estimate represents the average probability of being tested for HIV if all women had been given adequate or inadequate pre-test counseling during ANC while holding other covariates constant.

As shown in Table 2-4, the adjusted probabilities of being tested for HIV between two hypothetical scenarios (*adequate vs inadequate HIV pre-test counseling*) were: in 2005 (aPP=42.3% [95% CI: 37.1–47.5] vs aPP=6.1% [95% CI: 4.8–7.4]), in 2010 (aPP=66.1% [95% CI: 62.9–69.2] vs aPP=25.5% [95% CI: 22.8–28.1]) and in 2014 (aPP=91.2% [95% CI: 89.5–92.8] vs aPP=56.3% [95% CI: 52.3–60.3]). These findings demonstrate the positive impact of adequate counseling on the probability of being tested for HIV among pregnant Cambodian women who attended ANC.

2.5.4. Effect measure estimates

Table 2-5 presents crude and adjusted prevalence ratios and prevalence differences of HIV testing as part of ANC using marginal standardization to the total population. The estimates compare the prevalence of HIV testing by pre-test counseling status (*adequate vs. inadequate*) among ANC-attending pregnant women in each CDHS round, with the inadequate counseling considered the reference group.

The adjusted prevalence ratios of HIV testing were as follows: in 2005 (aPR=6.9 [95% CI: 5.3–8.6]), in 2010 (aPR=2.6 [95% CI: 2.3–2.9]), and in 2014 (aPR=1.6 [95% CI: 1.5–1.7]). In other words, the adjusted prevalence of HIV testing by round among adequate counseling receivers was 6.9 (in 2005), 2.6 (in 2010), and 1.6 (in 2014) times the adjusted prevalence of HIV testing among the inadequate receivers.

Moreover, the adjusted prevalence differences were similar in all three rounds: in 2005 (aPD=36.2% [95% CI: 30.9–41.4]), in 2010 (aPD=40.6% [95% CI: 36.7–44.6]), and in 2014 (aPD=34.9% [95% CI: 30.5–39.3]). In other words, the difference in the adjusted prevalence of HIV testing among those who received adequate counseling versus those who did not was 36.2% in 2005, 40.6% in 2010, and 34.9% in 2014.

2.6. Discussion

The main goal of this study was to identify factors associated with HIV testing as part of ANC among pregnant Cambodian women. Four rounds of DHS surveys have been conducted in Cambodia (2000, 2005, 2010, and 2014), but as the questionnaires were partly modified with each DHS phase and some variables of interest not measured in 2000, only the last three rounds were used for the present analysis.

Concerning the outcome of interest, there was a significant increase in HIV testing coverage among ANC-attending pregnant women between 2005 and 2014. The women who

were interviewed in the 2005 round attended ANC before implementation of the routine opt-out health provider-initiated testing and counseling (HPITC) approach. Before 2006, under the opt-in HPITC approach, an HIV test was only offered to a woman by an ANC provider based on an actual HIV risk assessment (evaluated need), and formal informed consent was obtained. However, under the opt-out HPITC approach, all women are (or should be) offered an HIV test. Therefore, we suspected that the women in the CDHS rounds of 2005 were more likely to have a higher degree of actual HIV risk at the time of their visits compared to those from 2010 and 2014. However, according to our bivariate analysis of two well-known HIV risk factors (STI or STI symptoms in the twelve months before the interview and number of lifetime sexual partners) and being offered an HIV test as part of ANC, there were no significant differences between each factor and being offered an HIV test in all three CDHS rounds. In other words, the women did not have significantly different HIV risks regardless of whether they were receiving ANC in the opt-in or opt-out era.

The present analysis was guided by the three individual constructs from Anderson's Behavioral Model of Health Services Use (predisposing, enabling, and need factors). In the pooled multiple logistic regression model, among all potential individual predisposing factors, only education was found to be positively associated with HIV testing uptake. In other words, better-educated women, especially those having attended or completed high school or higher, were more likely to be tested for HIV as part of ANC compared to those with no formal education at all, findings which are consistent with previous studies (Awopegba et al., 2020, Gunn et al., 2016, Ejigu and Tadesse, 2018). Similar to pregnant women in Mozambique, Cambodian women who were subsistence farmers were also less likely to be tested for HIV compared to their unemployed counterparts (Yaya et al., 2019). One explanation is that those

female farmers were more likely to live in rural areas, where access to health services was probably limited. Women's ages were not associated with HIV testing, in line with another study using Ethiopian DHS data (Ejigu and Tadesse, 2018).

For individual enabling factors, in our pooled analysis, women living in urban areas and coming from the highest household wealth quintile had increased odds of being tested for HIV compared to those living in rural areas and coming from the lowest wealth quintile. Other previous secondary data analyses, conducted using DHS data of some African countries, have reported similar findings regarding urban/rural differences and wealth (Yaya et al., 2019, Awopegba et al., 2020, Gunn et al., 2016, Lakhe et al., 2020, Ejigu and Tadesse, 2018). One study in Cambodia found that women receiving ANC services in Phnom Penh, an urban area, were more likely to be tested for HIV than those receiving ANC services outside Phnom Penh (Sasaki et al., 2010).

Programmatic factors may have impacted HIV testing as well. For instance, before 2013, women living in urban areas were more likely to be offered an HIV test because of the low availability of HIV testing services in rural areas. Finger-prick rapid testing was implemented in 2013 to overcome these logistical constraints of laboratory-based HIV testing. Before 2013, HIV counselors offered pre-and post-test counseling to pregnant women (at ANC sites or fields), but HIV testing required a blood draw; this requirement was the leading factor affecting HIV testing coverage. Blood samples obtained from the women had to be transported by to the nearest laboratory for HIV testing because most ANC centers did not have laboratory services (Kanal et al., 2005). The staff was also responsible for bringing back the test results from the laboratory. The results were to be released the same day as testing. In Cambodia, there are three levels of health facilities: national (e.g., national or tertiary hospitals), provincial (e.g., provincial referral

hospitals) and operational district (e.g., health centers and health posts). Health centers and health posts are typically located in rural or low-density areas (MoH, 2016). Our study used three rounds of CDHS data (2005, 2010, and 2014), meaning an overwhelming majority of pregnant women in the three rounds attended ANC before the introduction of the finger-prick rapid testing in 2013.

Regarding potential individual need factors, being offered adequate HIV pre-test counseling was the only need factor associated with HIV testing as part of ANC. It is important to reiterate that adequate counseling in the present study was defined exactly in the same way as it was defined by the DHS team: an HIV counselor at ANC talking with a woman about all three of the following topics: (1) babies getting the AIDS virus from their mother, (2) things that you can do to prevent getting the AIDS virus, and (3) getting tested for the AIDS virus (Croft, 2018). The findings from this study suggest that the role of counselors was and is vitally important to promote HIV testing among pregnant Cambodian women. This strongly supports UNAIDS and WHO findings that the quality of pre-test counseling during routine ANC and postpartum care is a factor that determines whether or not a pregnant woman accepts an offer of an HIV test by a counselor (UNAIDS, 1999a, WHO, 2010).

A recent study in Cambodia found that 67% of women in Banteay Mean Chey province were not offered HIV testing at all during routine ANC (in contravention of the national guidelines), potentially due to understaffing. The authors recommended that the number of trained HIV counselors be increased so that the ratio of ANC clients to counselors is lower, to help counselors to provide high-quality HIV counseling and testing (Sau et al., 2016).

Another study, in Battambang province, demonstrated that high HIV testing acceptance rate was achieved when the counselors were adequately trained: 97.6% for the previously

untested ANC clients. Unfortunately, the male partner acceptance rate was as low as 38.6% (Heller et al., 2011). This seems to suggest that high-quality counseling was more effective in enhancing HIV testing uptake among pregnant women than among their male partners. Therefore, future research should explore factors that motivate male partners to accept an HIV test as part of ANC.

The significant public health impact of adequate pre-test counseling was further confirmed by adjusted prevalence ratios and differences in each round of CDHS. However, we did not find any previous studies that performed marginal standardization to the total population to compute the marginal effect of adequate pre-test counseling on HIV testing uptake. The statistical method is relatively new, and therefore may not be widely used by health researchers yet (Muller and MacLehose, 2014).

- **Strengths and limitations**

Regarding strengths, each round of CDHS had a large sample size of ANC-attending pregnant women, which increased even more when the three datasets were pooled together (crude N=11,054, weighted N=11,181). Such a large sample size helped enhance statistical power by generating precise confidence intervals for each potential predictor of interest. Second, all surveys were conducted on a nationally representative sample, allowing us to infer the findings to the general population of pregnant Cambodian women. Third, there is a consensus in the scientific community that all DHS data, including CDHS, are of high quality and managed with standardized approaches. Fourth, the response rate in each CDHS was almost 100%. Therefore, selection bias due to non-response was unlikely.

In terms of limitations, first, data on some potential confounders were not collected. As a result, they could not be adjusted for in the multivariate logistic regression analysis. Second, the

effect of contextual determinants on HIV testing during ANC could not be investigated because data on contextual factors (e.g., health care delivery system characteristics, external environmental factors, community enabling factors, and health provider-related factors), described in detail elsewhere (Phillips et al., 1998), were not available. Third, a poor recall could not be ruled out, which may have caused a non-differential misclassification of potential predictor variables. Fourth, all surveys are cross-sectional by design, therefore, causality cannot be inferred from the statistical associations between predictors and the outcome. Fifth, CDHS data were collected by face-to-face interviews, raising the possibility of social desirability bias, or bias in which participants are more likely to report behaviors that are viewed favorably by the interviewer. Lastly, conceptually, Anderson's Behavioral Model of Health Services Use was developed to explore factors that lead individuals to actively seek a particular health service. It is worth noting that none of the three rounds of CDHS captured the proportions of women who specifically asked for an HIV test. As in most countries, it was the ANC providers, mostly midwives, who initiated testing on Cambodian women with particular risk factors (opt-in HPITC) or all women (opt-out HPITC). This implies that the women generally did not attend ANC with a prior intention to seek HIV testing. However, although Anderson's Behavioral Model of Health Services Use may not be a perfect framework for studying such passive outcomes, it has been adapted for similar studies (Andersen et al., 2000, Kaya et al., 2019, Hammond et al., 2010, Stein et al., 2007, Stein et al., 2012).

2.7. Conclusion

This is the first study to identify factors predicting HIV testing as part of ANC among pregnant Cambodian women with one or more live births in the three years preceding each round of CDHS (2005, 2010, and 2014) who attended ANC at least once for their most recent child. The three datasets were pooled together for statistical power. The selection of variables was

guided by Anderson's Behavioral Model of Health Services Use, which proposes that people's use of particular health services is influenced by three individual factors (predisposing, enabling, and need characteristics).

Results obtained from the multivariate logistic regression model on the pooled dataset suggest that education, occupation, and area of residence are weak predictors of HIV testing. By contrast, the quality of HIV pre-test counseling is a strong predictor. The significance of adequate counseling was further elucidated when computing the adjusted predicted probability of HIV testing and the prevalence ratio and difference for each round of CDHS.

In summary, to increase HIV testing uptake among ANC-attending pregnant women in Cambodia, delivering high-quality pre-test counseling appears to be the intervention with the most potential impact. To achieve that, two health system-level approaches are proposed: (1) at ANC sites with chronically low HIV testing uptake but without understaffing issues, regular refreshment training should be provided to ANC counselors on how to deliver high-quality HIV pre-test counseling to all ANC-attending pregnant women, and performance monitoring and evaluation should be periodically conducted (e.g., on a monthly or quarterly basis) and (2) at ANC sites with chronically low HIV testing uptake and with understaffing issues (a high ratio of ANC clients to counselors), the number of counselors at the sites should be increased to a sufficient level and regular refreshment training provided on how to deliver high-quality counseling to the women.

Lastly, little is known about how to increase male partner testing in ANC settings. Therefore, the following chapter focuses on identifying factors that determine whether an ANC-attending man is more likely to decline or accept an HIV test. An Extended Theory of Planned Behavior is implemented, using the quality of HIV pre-test counseling as one of the external

determinants that might influence his decision. It is interesting to see how the effect of counseling differs in two different populations: ANC-attending pregnant women and men.

2.8. Tables and figures

2.8.1. List of tables

Table 2-1: Variables of interest and their definitions

Outcome	**HIV testing as part of ANC:** *I don't want to know the results, but were you tested for the AIDS virus as part of your antenatal care?*
Potential individual predisposing factors	**Age:** *How old were you at your last birthday?* This variable was categorized into five age-groups: 15-19, 20-24, 25-29, 30-34, 35 and above.
	Education: *What is the highest level of school you attended: none, primary, secondary, or higher?*
	Marital status: *What is your marital status now: are you widowed, divorced, or separated?*
	Occupation: *What is your occupation, that is, what kind of work do you mainly do?*
	Comprehensive knowledge of HIV/AIDS (composite variable): *1. Can people reduce their chance of getting the AIDS virus by having just one uninfected sex partner who has no other sex partners?* *2. Can people reduce their chance of getting the AIDS virus by using a condom every time they have sex?* *3. Can people get the AIDS virus from mosquito bites?* *4. Can people get the AIDS virus by sharing food with a person who has AIDS?* *5. Is it possible for a healthy-looking person to have the AIDS virus?* --- Remarks: ➢ Binary coding: ▪ Yes (all 5 correct answers) ▪ No (otherwise) ➢ "Don't know" was coded as incorrect answer
	Knowledge of mother-to-child transmission of HIV (composite variable): *1. Can the virus that causes AIDS be transmitted from a mother to her baby during pregnancy?* *2. Delivery?* *3. Breastfeeding?* *4. Are there any special drugs that a doctor or a nurse can give to a woman infected with the AIDS virus to reduce the risk of transmission to the baby?* --- Remarks: ➢ Binary coding: ▪ Adequate (all 4 correct answers) ▪ Inadequate (otherwise) ➢ "Don't know" was coded as incorrect answer.

	HIV/AIDS discriminatory attitude (composite variable): *1. Would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had the AIDS virus?* *2. If a relative of yours became sick with the virus that causes AIDS, would you be willing to care for him/her?* *3. If a female teacher has the AIDS virus, but is not sick, should she be allowed to continue teaching in the school?* *4. If a member of your family got infected with the AIDS virus, would you want it to remain a secret or not?* --- Remarks: ➢ Binary coding: ▪ Yes (respondents were considered to have discriminatory attitude only if they responded "No" to at least one of questions 1–3 or "Yes" to question 4). ▪ No (otherwise) ➢ "Don't know/Not sure/Depends" was coded as missing.
	HIV/AIDS stigmatizing attitude (composite variable): *1. Do you agree or disagree with the following statement: People with the AIDS virus should be ashamed of themselves?* *2. Do you agree or disagree with the following statement: People with the AIDS virus should be blamed for bringing the disease into the community?* --- Remarks: ➢ Binary coding: ▪ Yes (respondents were considered to have stigmatizing attitude if they responded "Agree" to at least one of two questions). ▪ No (otherwise) ➢ "Don't know/No opinion" was coded as missing.
Potential individual enabling factors	**Wealth index:** *in quintiles (lowest, second, middle, fourth, highest)*
	Area of residence: *rural vs urban*
	Media exposure (composite variable): *1. Do you read a newspaper or magazine, at least once a week, less than once a week or not at all?* *2. Do you listen to the radio, at least once a week, less than once a week or not at all?* *3. Do you watch television, at least once a week, less than once a week or not at all?* *4. Do you access to internet, at least once a week, less than once a week or not at all?* *exposure to at least one type of media at least once a week* --- Remark: ➢ Binary coding: ▪ Yes (exposed to any media channel at least once a week) ▪ No (otherwise)

Potential individual need factors	**STI or STI symptoms in the last 12 months (composite variable):** *1. Now I would like to ask you some questions about your health in the last 12 months. During the last 12 months, have you had a disease which you got through sexual contact?* *2. Sometimes women experience a bad-smelling abnormal genital discharge. During the last 12 months, have you had a bad smelling abnormal genital discharge?* *3. Sometimes women have a genital sore or ulcer. During the last 12 months, have you had a genital sore or ulcer?* --- Remark: ➢ Binary coding: ▪ Yes (respondents were considered to have stigmatizing attitude if they responded "Yes" to at least one of three questions). ▪ No (otherwise) ➢ "Don't know" was coded as missing.
	Number of lifetime sexual partners (binary): *In total, with how many different people have you had sexual intercourse in your lifetime?*
	Been offered HIV pre-test counseling as part of ANC (composite variable): *During any of the antenatal visits for your last birth were you given any information about:* *1. Babies getting the AIDS virus from their mother?* *2. Things that you can do to prevent getting the AIDS virus?* *3. Getting tested for the AIDS virus?* --- Remark: ➢ Binary coding: ▪ Adequate (respondents were considered to have received adequate counseling if they responded "Yes" to all three questions above). ▪ No (otherwise) ➢ "Don't know" was coded as missing.

Table 2-2: Description of pregnant women aged 15–49 years with one or more live births in the three years preceding each CDHS round who attended ANC at least once for the most recent child (note: all numbers and percentages are weighted)

Variables	CDHS 2005 (Weighted N=3,100)	CDHS 2010 (Weighted N=4,134)	CDHS 2014 (Weighted N=3,947)	p-value
	n (%)	n (%)	n (%)	
Outcome of interest				
Tested for HIV as part of antenatal care				
No	2,542 (84.5)	2,071 (53.8)	807 (22.6)	**<0.001**
Yes	465 (15.5)	1,776 (46.2)	2,761 (77.4)	
Potential individual predisposing factors				
Age				
15-19	135 (4.4)	177 (4.3)	202 (5.2)	
20-24	932 (30.1)	1,132 (27.4)	1,152 (29.2)	
25-29	781 (25.2)	1,449 (35.1)	1,219 (30.9)	**<0.001**
30-34	627 (20.2)	729 (17.6)	909 (23.0)	
35 and above	624 (20.1)	646 (15.6)	465 (11.7)	
Education				
None	548 (17.7)	634 (15.3)	451 (11.4)	
Primary	1,860 (60.0)	2,317 (56.0)	2,013 (51.0)	**<0.001**
Secondary	664 (21.4)	1,107 (26.8)	1,348 (34.2)	
Higher	27 (0.9)	77 (1.9)	134 (3.4)	
Marital status				
Never married	2 (0.1)	2 (0.1)	0 (0)	
Married/Living with a partner	2,964 (95.6)	3,980 (96.2)	3,781 (95.8)	>0.05
Widowed/Divorced/Separated	134 (4.3)	153 (3.7)	166 (4.2)	

Occupation				
	Not working	13 (0.4)	882 (21.3)	1,142 (29.0)	
	Agriculture	1,470 (47.6)	1,969 (47.7)	1,253 (31.8)	**<0.001**
	Non-agriculture	1,604 (52.0)	1,281 (31.0)	1,546 (39.2)	
Comprehensive knowledge of HIV/AIDS				
	No	1,614 (52.4)	2,333 (57.2)	2,267 (58.3)	**<0.05**
	Yes	1,469 (47.6)	1,746 (42.8)	1,621 (41.7)	
Knowledge of mother-to-child transmission of HIV				
	Inadequate	2,313 (74.6)	2,206 (54.1)	2,047 (51.9)	**<0.001**
	Adequate	787 (25.4)	1,873 (45.9)	1,900 (48.1)	
HIV/AIDS discriminatory attitude				
	No	1,319 (42.8)	1,604 (39.3)	1,329 (34.2)	**<0.001**
	Yes	1,761 (57.2)	2,474 (60.7)	2,557 (65.8)	
HIV/AIDS stigmatizing attitude				
	No	1,197 (39.2)	1,714 (42.3)	1.945 (49.8)	**<0.001**
	Yes	1,853 (60.8)	2,333 (57.7)	1,959 (50.2)	
Potential individual enabling factors				
Wealth index (in quintiles)				
	Lowest	670 (21.6)	960 (23.2)	866 (21.9)	
	Second	645 (20.8)	835 (20.2)	760 (19.3)	
	Middle	556 (17.9)	806 (19.5)	774 (19.6)	>0.05
	Fourth	580 (18.7)	771 (18.7)	733 (18.6)	
	Highest	649 (21.0)	762 (18.4)	814 (20.6)	
Residence				
	Rural	2,612 (84.3)	3,441 (83.2)	3,347 (84.8)	>0.05
	Urban	488 (15.7)	694 (16.8)	600 (15.2)	

Being exposed to at least one type of media (TV, radio, newspaper/magazine)				
Not at all/less than once a week	746 (24.1)	1,521 (36.8)	1,389 (35.2)	**<0.001**
At least once a week	2,353 (75.9)	2,613 (63.2)	2,558 (64.8)	
Potential individual need factors				
STI or STI symptoms in the last 12 months				
No	2,825 (91.1)	3,640 (88.1)	3,495 (88.6)	**<0.01**
Yes	275 (8.9)	494 (11.9)	452 (11.4)	
Number of lifetime sexual partners				
1	2,891 (93.4)	3,921 (94.9)	3,688 (93.6)	>0.05
>1	203 (6.6)	213 (5.1)	252 (6.4)	
Been offered adequate HIV pre-test counseling as part of ANC				
No	2,333 (78.5)	1,834 (48.3)	1,345 (38.2)	**<0.001**
Yes	640 (21.5)	1,966 (51.7)	2,174 (61.8)	

Table 2-3: Univariate and multivariate logistic regression results by CDHS round (2005, 2010 and 2014) and pooled dataset

	CDHS 2005 (Weighted N=3,100)		CDHS 2010 (Weighted N=4,134)		CDHS 2014 (Weighted N=3,947)		Pooled (Weighted N=11,181)	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Time adjustment variable for fixed effects logistic regression (pooled analysis)								
CDHS round								
2005	na	na	na	na	na	na	1.0 (ref)	1.0 (ref)
2010	na	na	na	na	na	na	4.7 (3.7-5.9)***	**3.7 (3.0-4.6)*** **
2014	na	na	na	na	na	na	18.7 (14.8-23.7)***	**16.9 (13.3-21.5)*** **
Potential individual predisposing factors								
Age								
15-19	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
20-24	0.9 (0.6-1.5)	1.0 (0.6-1.9)	1.2 (0.8-1.7)	1.1 (0.6-1.8)	1.6 (1.1-2.6)*	**1.8 (1.1-3.2)***	1.1 (0.9-1.4)	1.3 (0.9-1.8)
25-29	0.7 (0.4-1.2)	0.9 (0.5-1.7)	0.9 (0.6-1.4)	0.8 (0.5-1.4)	1.5 (1.0-2.5)	1.4 (0.8-2.3)	1.1 (0.8-1.3)	1.0 (0.7-1.4)
30-34	0.7 (0.4-1.1)	0.7 (0.3-1.3)	1.0 (0.6-1.5)	0.8 (0.5-1.4)	1.4 (0.9-2.3)	1.6 (0.9-2.6)	1.0 (0.8-1.3)	1.0 (0.7-1.4)
35 and above	0.6 (0.4-1.1)	0.8 (0.4-1.6)	0.8 (0.5-1.2)	0.7 (0.4-1.2)	1.0 (0.6-1.7)	1.3 (0.7-2.6)	0.7 (0.5-0.8)**	0.9 (0.6-1.4)
Education								
None	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Primary	1.2 (0.8-1.7)	0.8 (0.5-1.2)	1.3 (1.0-1.7)	1.1 (0.7-1.5)	1.3 (1.0-1.8)	1.2 (0.8-1.6)	1.4 (1.2-1.6)***	1.1 (0.9-1.3)
Secondary or higher	3.2 (2.0-5.1)***	0.9 (0.5-1.6)	3.1 (2.3-4.2)***	1.5 (1.0-2.2)	2.4 (1.7-3.3)***	**1.7 (1.1-2.5)** **	3.3 (2.7-3.9)***	**1.4 (1.1-1.8)***
Occupation								
Not working	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Agriculture	0.1 (0.1-0.7)*	0.5 (0.1-2.4)	0.4 (0.3-0.5)***	**0.6 (0.4-0.7)*** **	0.7 (0.5-0.9)*	0.7 (0.5-1.0)	0.2 (0.2-0.3)***	**0.6 (0.5-0.7)*** **
Non-agriculture	0.8 (0.2-4.2)	1.2 (0.3-5.4)	1.0 (0.8-1.2)	**0.7 (0.5-0.9)***	1.0 (0.8-1.4)	0.9 (0.6-1.2)	0.5 (0.4-0.6)***	0.8 (0.7-1.0)
Comprehensive knowledge of HIV/AIDS								
No	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Yes	2.1 (1.6-2.8)***	0.9 (0.6-1.2)	1.7 (1.4 -2.0)***	**1.3 (1.1-1.6)***	1.3 (1.1-1.6)*	0.9 (0.7-1.2)	1.3 (1.1-1.4)***	1.1 (0.9-1.3)
Knowledge of mother-to-child transmission of HIV								
Inadequate	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Adequate	1.9 (1.4-2.5)***	0.9 (0.7-1.3)	1.4 (1.2-1.7)***	0.9 (0.8-1.1)	1.7 (1.4-2.2)***	0.9 (0.7-1.2)	2.1 (1.8-2.3)***	0.9 (0.8-1.1)
HIV/AIDS discriminatory attitude								
No	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Yes	0.9 (0.7-1.2)	1.1 (0.8-1.5)	0.9 (0.8-1.1)	0.9 (0.8-1.1)	0.7 (0.5-0.9)**	**0.7 (0.5-0.9)***	1.0 (0.9-1.1)	0.9 (0.8-1.0)
HIV/AIDS stigmatizing attitude								
No	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Yes	0.6 (0.5-0.8)***	**0.7 (0.5-0.9)***	0.8 (0.6-0.9)**	0.9 (0.7-1.1)	0.8 (0.6-0.9)*	1.1 (0.8-1.4)	0.7 (0.6-0.8)***	0.9 (0.8-1.0)

Potential individual enabling factors									
Residence									
	Rural	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	Urban	6.2 (4.4-8.8)***	**1.9 (1.2 -2.8)****	5.0 (3.8-6.6)***	**2.4 (1.7-3.4)*****	1.6 (1.2-2.1)**	1.3 (0.8-2.0)	2.7 (2.3-3.3)***	**1.9 (1.5-2.5)*****
Wealth index									
	Lowest	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	Second	1.4 (0.9-2.2)	1.1 (0.6-1.9)	1.1 (0.8-1.4)	0.9 (0.7-1.3)	1.2 (0.8-1.6)	1.0 (0.7-1.6)	1.1 (0.9-1.3)	1.0 (0.8-1.2)
	Middle	2.0 (1.2-3.4)**	1.4 (0.7-2.8)	1.5 (1.2-1.9)**	1.2 (0.9-1.7)	1.6 (1.1-2.3)*	1.2 (0.8-1.9)	1.4 (1.2-1.7)***	1.2 (1.0-1.5)
	Fourth	3.1 (1.9-5.1)***	1.7 (0.9-3.3)	2.0 (1.5-2.6)***	1.2 (0.8-1.7)	1.4 (0.9-2.1)	1.0 (0.6-1.6)	1.5 (1.2-1.9)***	1.1 (0.9-1.5)
	Highest	12.3 (7.6-20.1)***	**4.2 (2.0-8.5)****	5.9 (4.3-8.2)***	**2.1 (1.3-3.4)***	1.7 (1.1-2.5)*	0.9 (0.5-1.8)	3.0 (2.4-3.7)***	**1.8 (1.3-2.5)***
Been exposed to at least one type of media (TV, radio, newspaper/magazine)									
	Not at all/less than once a week	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	At least once a week	2.7 (1.9-3.8)***	1.2 (0.8-1.9)	1.7 (1.4-2.0)***	1.0 (0.8-1.2)	1.7 (1.4-2.1)***	1.3 (1.0-1.6)	1.3 (1.1-1.4)***	1.1 (0.9-1.3)
Potential individual need factors									
History of STI or STI symptoms in the last 12 months									
	No	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	Yes	1.0 (0.6-1.5)	0.9 (0.5-1.5)	0.9 (0.7-1.1)	1.2 (0.9-1.6)	0.9 (0.6-1.2)	1.1 (0.8-1.5)	1.0 (0.8-1.2)	1.1 (0.9-1.3)
Number of lifetime sexual partners									
	1	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	>1	1.1 (0.7-1.6)	1.5 (0.9-2.4)	0.8 (0.6-1.2)	0.8 (0.6-1.2)	1.1 (0.7-1.7)	1.2 (0.7-1.9)	1.0 (0.8-1.2)	1.1 (0.8-1.4)
Been offered adequate HIV pre-test counseling as part of ANC									
	No	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	Yes	19.7 (14.7-26.3)***	**17.3 (12.4-24.0)*****	7.0 (5.8-8.5)***	**7.2 (5.9-8.9)*****	8.2 (6.3-10.5)***	**8.5 (6.5-11.2)*****	10.3 (9.0-11.8)***	**8.9 (7.7-10.3)*****

Marital status was dropped from the final multivariate logistic regression model because of empty cells.
* P-value <0.05
** P-value <0.01
*** P-value <0.001

Table 2-4: Crude and adjusted predicted probability (aPP) of being tested for HIV among ANC-attending pregnant women by pre-test counseling status (adequate vs inadequate)

CDHS round	Adequate pre-test counseling		Inadequate pre-test counseling	
	Crude PP (95% CI)	aPP (95% CI)*	Crude PP (95% CI)	aPP (95% CI)*
2005	52.6 (46.8 – 58.3)	42.3 (37.1 – 47.5)	5.3 (4.2 – 6.5)	6.1 (4.8 – 7.4)
2010	67.9 (64.7 – 71.1)	66.1 (62.9 – 69.2)	23.2 (20.6 – 25.8)	25.5 (22.8 – 28.1)
2014	91.2 (89.6 – 92.9)	91.2 (89.5 – 92.8)	56.1 (52.2 – 60.0)	56.3 (52.3 – 60.3)

* Marginal standardization: adjusted for covariates (age, education, occupation, comprehensive knowledge of HIV/AIDS, knowledge of mother-to-child transmission of HIV, HIV/AIDS discriminatory attitude, HIV/AIDS stigmatizing attitude, residence, wealth index, media exposure, history of STI or STI symptoms in the last 12 months, and number of lifetime sexual partners). The target population of interest is the total population of ANC-attending pregnant women aged 15-49 years who were interviewed in each CDHS round. The obtained marginal quantities reflect a weighted average over the distribution of the covariates, and they are equivalent to quantities obtained by standardizing to the total population.

Table 2-5: Effect measure estimates comparing prevalence of being tested for HIV among ANC-attending pregnant women by pre-test counseling status (reference group: inadequate)

CDHS round	Prevalence ratio		Prevalence difference (%)	
	Crude PR (95% CI)	aPR (95% CI)*	Crude PD (95% CI)	aPD (95% CI)*
2005	9.8 (7.7 – 12.0)	6.9 (5.3 – 8.6)	47.2 (41.6 – 52.9)	36.2 (30.9 – 41.4)
2010	2.9 (2.6 – 3.3)	2.6 (2.3 – 2.9)	44.7 (40.9 – 48.6)	40.6 (36.7 – 44.6)
2014	1.6 (1.5 – 1.7)	1.6 (1.5 – 1.7)	35.1 (31.0 – 39.3)	34.9 (30.5 – 39.3)

* Marginal standardization: adjusted for covariates (age, education, occupation, comprehensive knowledge of HIV/AIDS, knowledge of mother-to-child transmission of HIV, HIV/AIDS discriminatory attitude, HIV/AIDS stigmatizing attitude, residence, wealth index, media exposure, history of STI or STI symptoms in the last 12 months, and number of lifetime sexual partners). The target population of interest is the total population of ANC-attending pregnant women aged 15-49 years who were interviewed in each CDHS round. The obtained marginal quantities reflect a weighted average over the distribution of the covariates, and they are equivalent to quantities obtained by standardizing to the total population.

2.8.2. List of figures

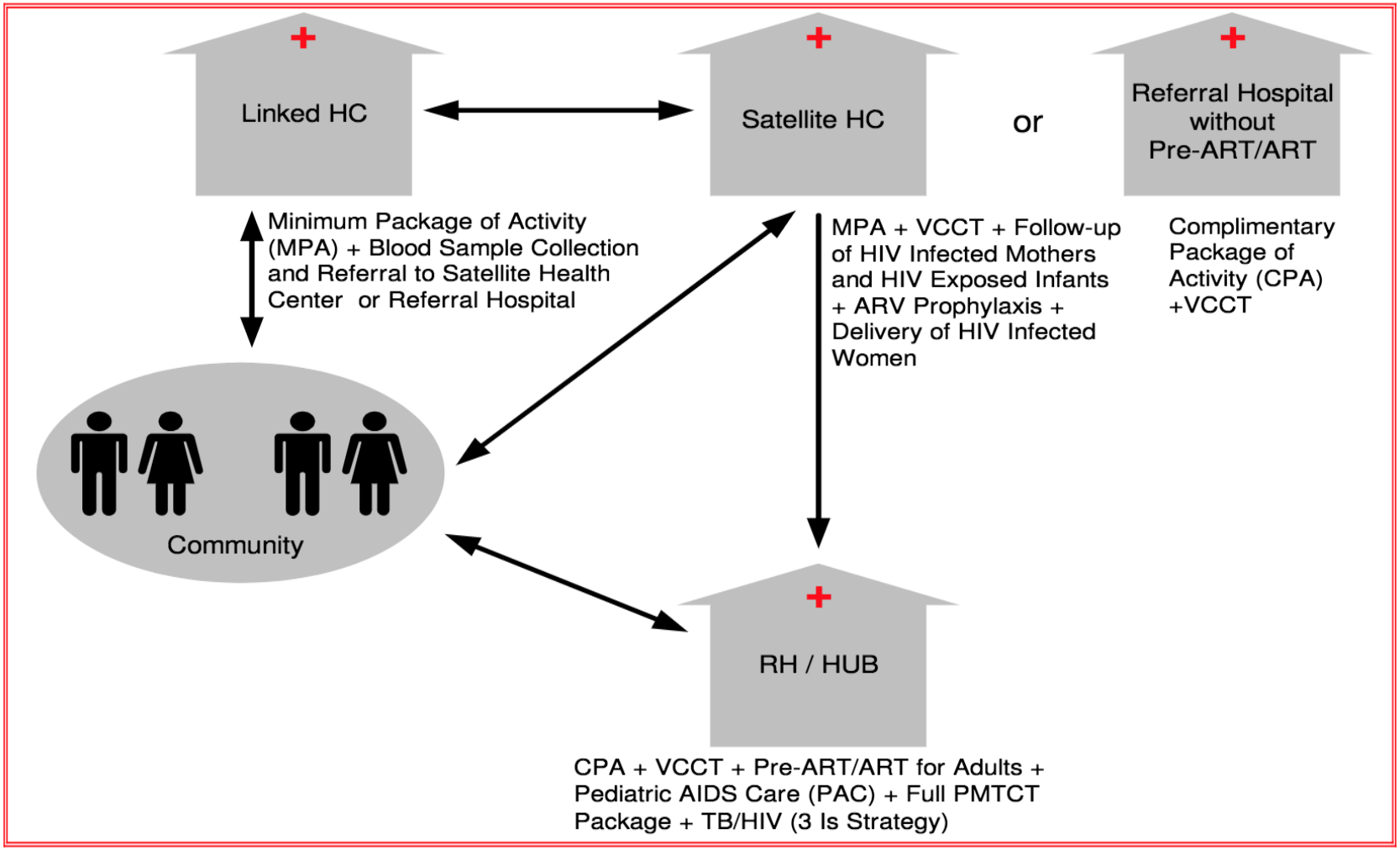

Figure 2-1: Linked-Response approach (NCHADS/NMCHC, 2013)

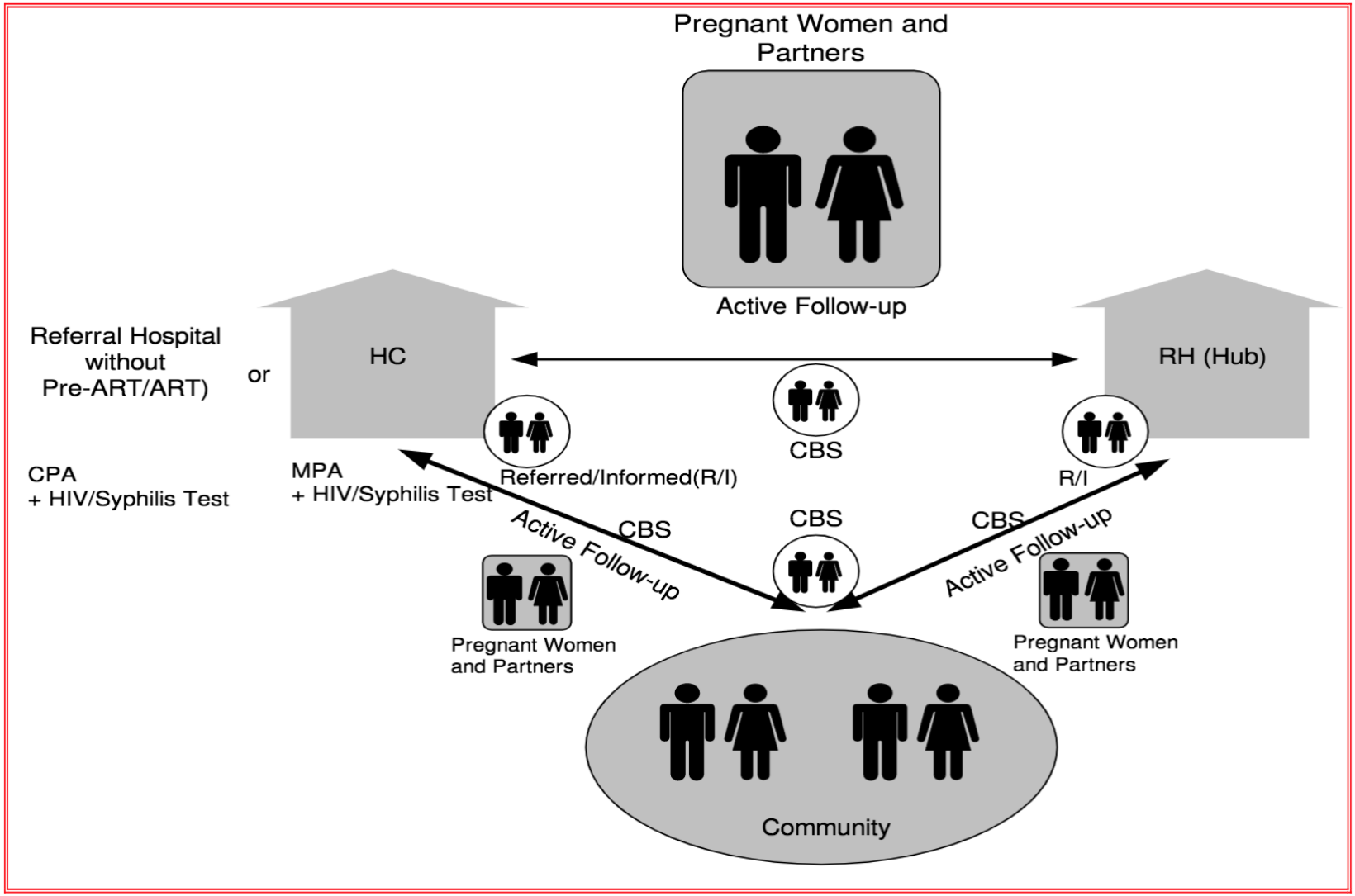

Figure 2-2: Boosted Linked-Response approach (NCHADS/NMCHC, 2013)

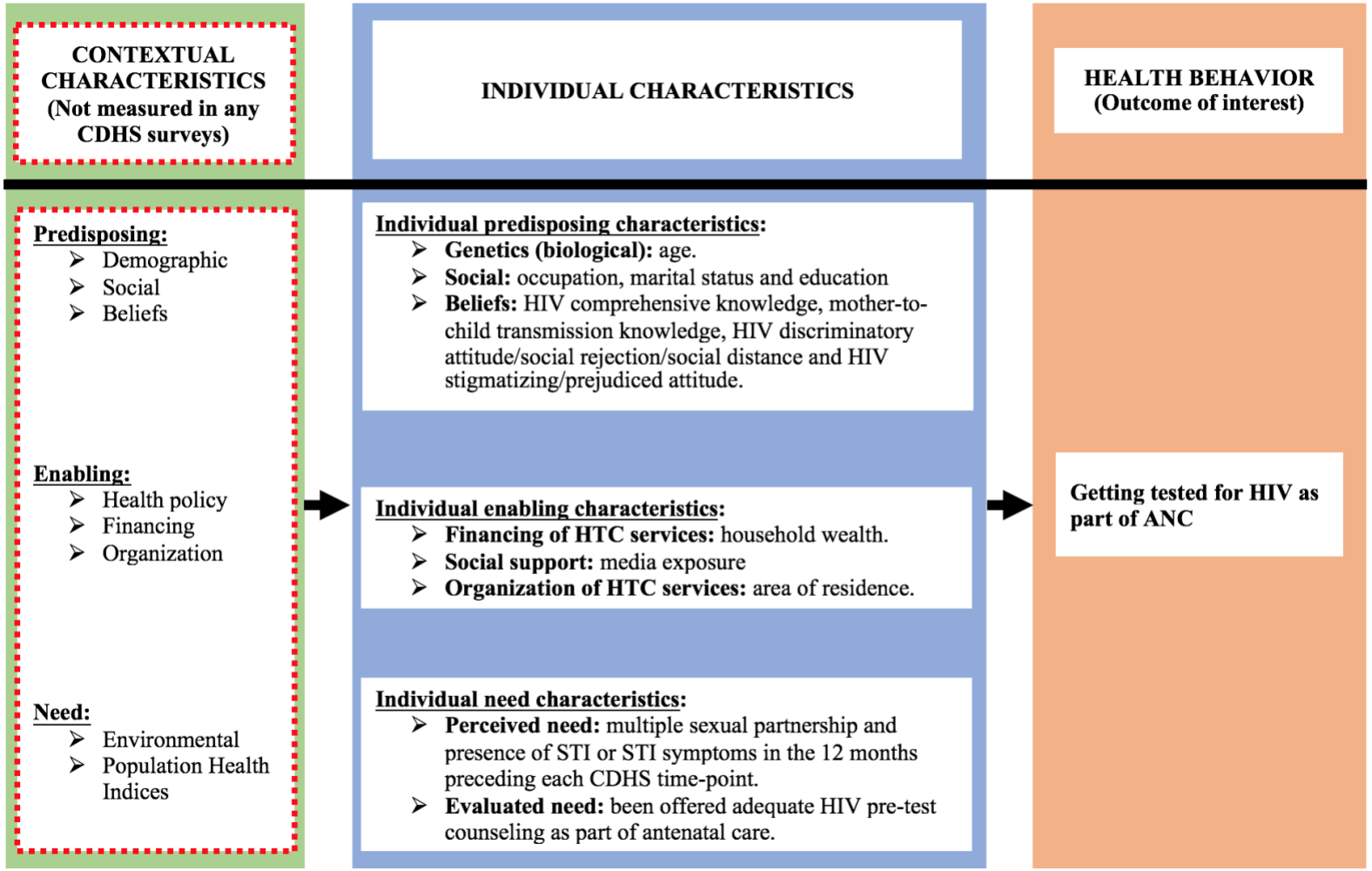

Figure 2-3: Conceptual framework, adapted from (Andersen et al., 2014)

[Note: The influence of contextual characteristics on HIV testing could not be examined. Per DHS's definition, when an HIV counselor at ANC talked with a woman about all three of the following topics: (1) babies getting the AIDS virus from their mother, (2) things that you can do to prevent getting the AIDS virus, and (3) getting tested for the AIDS virus, the woman was considered to have received adequate counseling (Croft, 2018)].

CHAPTER 3 (Study 2): Factors Associated with HIV Testing among ANC-Attending Male Partners in Cambodia: Case-Control Study Applying an Extended Theory of Planned Behavior

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3.1. Abstract

Background: Male partner testing is associated with a decreased risk of vertical (mother-to-child) transmission of HIV. However, men's participation in antenatal HIV testing and counseling is low worldwide. Similarly, in Cambodia, testing coverage for HIV among male partners of ANC-attending pregnant women has stayed below 20% since 2012. Therefore, in this study, we aimed to identify factors that determine whether ANC-attending male partners would decline or accept an HIV test after being counseled, applying an Extended Theory of Planned Behavior (ETPB).

Methods: An unmatched Case-Control study was conducted. The study population consisted of all eligible men who attended ANC with their pregnant partners from September 2020 to December 2020. A total of 132 cases and 264 controls were recruited from three government-run ANC facilities in Phnom Penh (the National Maternal and Child Health Center, Chaktomuk Referral Hospital, and Posenchey Health Center). An Extended Theory of Planned Behavior (ETPB) was applied to guide our data analysis. Multiple logistic regression was used to compute adjusted odds ratios and their corresponding 95% confidence intervals.

Results: In model 1, male partners with a low intention to test and low perceived behavioral control (PBC) had greater odds of declining an HIV test (low intention aOR=3.2 [95% CI: 1.8–5.6], low PBC aOR=1.8 [95% CI: 1.1–2.8]). In model 2 (basic TPB), a low intention to test was predicted by a negative attitude toward male partner testing during ANC

(aOR=1.9 [95% CI: 1.1–3.3]) and unsupportive subjective norms about male partner testing during ANC (aOR=2.5 [95% CI: 1.5–4.0]). In model 3 (ETPB), a low intention to test for HIV was predicted by an absence of perceived risk of HIV infection (aOR=2.0 [95% CI: 1.1–3.6]), unsupportive subjective norms (aOR=2.3 [95% CI: 1.4–3.9]), and an absence of partner communication about HIV testing (aOR=3.0 [95% CI: 1.5–5.7]).

Conclusion: Any attempt to increase HIV testing among men requires trans-theoretical approaches to increase their intention to test by raising risk perceptive, changing subjective norms, and increasing partner communication. In Cambodia, complementary interventions aimed at individual behavioral change should be based largely on an "Information, Education, and Communication" framework. Mass media-based, peer-based, and small-group education interventions using the existing network of community health volunteers, officially called "village health support group leaders" would likely be helpful.

3.2. Introduction

3.2.1. Background

Despite men's positive views on the benefits of the prevention of mother-to-child transmission (PMTCT) of HIV, their participation in prenatal HIV testing is low (WHO, 2012a). For instance, studies showed that male testing rates at ANC settings (mainly in Africa) ranged from 3% (Falnes et al., 2011) to 8%−15% (Chandisarewa et al., 2007, Farquhar et al., 2001, Msuya et al., 2006, Katz et al., 2009).

With its "Boosted Linked Response" approach, Cambodia has provided free HIV testing to more than two-thirds of ANC-attending pregnant women as part of routine ANC (86.7% in 2017, 90.9% in 2018, 93.4% in 2019, and 91.8% in 2020). In contrast, only a small fraction of their male partners received HIV testing (17.2% in 2017, 18.6% in 2018, 18.4% in 2019, and

17.7% in 2020), according to data from the national PMTCT program (NMCHC, 2020). Testing rates among Cambodian male partners in previous years were similar: 17.5% in 2012 (WHO, 2014), 16.6% in 2013, and 16.8% in 2014 (NAA, 2015).

3.2.3. Study justification and rationale

Testing men during their partners' pregnancies is associated with a decreased risk of vertical transmission (Aluisio et al., 2011). To increase male partner testing uptake, barriers must be identified. Multiple studies, mainly conducted in Africa, identified barriers such as fear of knowing one's status, a lack of knowledge regarding HIV, HIV/AIDS-associated stigma and discrimination, a perception by men that ANC facilities are "women's spaces", a perception by men that reproductive health is "women's work", and not feeling welcomed by providers (WHO, 2012a).

The barriers to HIV testing specific to Cambodian ANC-attending men are poorly understood. The only study of this population was conducted at ANC sites in Battambang province. It demonstrated that when adequately counseled by well-trained midwives, the acceptance rate among pregnant women was extraordinarily high (97.6%). Despite having received the same quality of pre-test counseling as their pregnant partners, up to 61.4% of men declined an HIV test. However, the study did not explore factors associated with declining the offer (Heller et al., 2011). The purpose of the present study is therefore to identify factors that determine whether ANC-attending male partners decline or accept an HIV test after being counseled, applying the Extended Theory of Planned Behavior (ETPB).

3.3. Specific aims, conceptual framework, and hypotheses

3.3.1. Specific aims

- **Aim 1:** To examine the influence of intention to test for HIV during ANC among ANC-attending male partners on actual HIV testing.
- **Aim 2:** To identify predictors of intention to test for HIV during ANC among ANC-attending male partners employing the basic Theory of Planned Behavior (TPB).
- **Aim 3:** To identify predictors of intention to test for HIV during ANC among ANC-attending male partners employing the Extended Theory of Planned Behavior (ETPB).

3.3.2. Conceptual framework

The Theory of Reasoned Action (TRA), developed by Martin Fishbein and Icek Ajzen in 1975, proposed that a volitional human behavior is a direct function of an individual's intention to perform the behavior; and intention is, in turn, jointly influenced by two individual psychological determinants: (1) attitude and (2) subjective norms. "Attitude" was defined as the degree to which a person has a favorable or unfavorable evaluation of performing the behavior in question, and "subjective norms" were defined as the perceived social pressure (e.g., family members, partner, friends, colleagues, or neighbors) to perform or not to perform the behavior (Fishbein and Ajzen, 1977, Azjen, 1980). A diagram of the TRA model is shown in Figure 3-1.

Recognizing that intention alone might not sufficiently predict a behavior, Ajzen later extended the TRA model by adding "perceived behavioral control" (PBC) as a psychological determinant to the original model. PBC is an individual's perception of whether the behavior in question will be easy or difficult to perform. Specifically, a person who finds it difficult to perform a behavior will be less likely to do it. The extended model was named the "Theory of Planned Behavior (TPB)," and assumes that, in addition to attitude and subjective norms, PBC is equally a direct determinant of intention (Ajzen, 1985, Ajzen and Madden, 1986, Ajzen, 1991). The diagram of the TPB model is shown in Figure 3-2.

Conceptually, TPB assumes that attitude, subjective norms, and PBC should be sufficient to fully predict intention, and intention and PBC should be sufficient to fully predict a behavior. In other words, adding extra variables to the TPB model should not improve or enhance the prediction of either intention or behavior (Ajzen, 2011). Although the TPB model has emerged as a prominent conceptual framework used by scientists to understand human behaviors of interest and develop effective interventions to effect behavioral change (Steinmetz et al., 2016, Tornikoski and Maalaoui, 2019, King, 1999), it has also been criticized for its assumption of "sufficiency" (Sniehotta et al., 2014).

Indeed, it has been proposed that one or more predictors be added to address this problematic assumption (Conner and Armitage, 1998), leading to the so-called "Extended Theory of Planned Behavior (ETPB)" (Conner, 2015, Sniehotta et al., 2014). Ajzen was not against including additional predictor variables for the sake of parsimony. However, such addition should only be performed after careful deliberation and empirical research (Ajzen, 2011, Ajzen, 2020).

ETPB has gained popularity in both health and non-health research realms. For instance, several previous studies have applied the framework to understand factors influencing HIV testing in a wide range of populations: women engaging in compensated dating (Mo et al., 2019), ANC-attending pregnant women (Mirkuzie et al., 2011), university students (Ayodele, 2017), health professionals (Abamecha et al., 2013), female sex workers (Batona et al., 2015), male clients of female sex workers (Lau et al., 2020), men who have sex with men (Meadowbrooke et al., 2014, Knussen et al., 2004), teachers (Kakoko et al., 2006), married individuals (Mtenga et al., 2015), ethnic minority subjects (McGarrity and Huebner, 2014), and the general population (Grispen et al., 2011).

In the present study, ETPB was applied to understand which factors best predict HIV testing decisions (declining or accepting a test) and an intention to test for HIV among Cambodian men who attended ANC with their pregnant partners.

In the adpated model (Figure 3-3), there were four traditional TPB constructs and a set of potential external factors:

- Intention to test for HIV during ANC
- Attitude toward male partner HIV testing during ANC
- Subjective norms about male partner HIV testing during ANC
- Perceived behavioral control (PBC)
- External factors (descriptive norms, knowledge of mother-to-child transmission of HIV, quality of HIV pre-test counseling, partner communication, perceived risk of HIV infection, history of HIV/syphilis testing as a couple, and perceived provider's endorsement of testing).

The APA Dictionary of Psychology explicitly defines descriptive norms as "any of various consensual standards social norms that describe how people typically act, feel, and think in a given situation" (APA, 2020). Perceived provider's endorsement of testing refers to whether or not a man felt that a provider weakly or strongly wanted him to be tested for HIV during the pre-test counseling session (Fernandez, 2000).

The study's variables are operationalized in detail in Section 3.4.7.

3.3.3. Hypotheses

"Declining an HIV test" was defined as the presence of the outcome of interest. "Having a low intention to test for HIV" was defined as the presence of the main exposure of interest. The present unmatched Case-Control study aimed to test the following hypotheses:

- **Hypothesis 1 (model 1):** Male partners with a low intention to test and low perceived behavioral control had greater odds of declining an HIV test compared to those with the opposite characteristics.
- **Hypothesis 2 (model 2):** Male partners with a negative attitude, unsupportive subjective norms, and low perceived behavioral control had greater odds of having a low intention compared to those with the opposite characteristics (basic TPB model).
- **Hypothesis 3 (model 3):** Male partners with certain characteristics (a negative attitude, unsupportive subjective norms, low perceived behavioral control, unsupportive descriptive norms, inadequate knowledge of mother-to-child transmission of HIV, inadequate HIV pre-test counseling, an absence of partner communication, an absence of perceived risk of HIV infection, no history of couple HIV/syphilis testing, and weak perceived provider's endorsement of testing) had greater odds of having a low intention compared to those with the opposite characteristics (ETPB model).

3.4. Methods

3.4.1. Study design

This study employed an embedded parallel mixed methods design, which consisted of an unmatched Case-Control study and a qualitative study with in-depth interviews. The Case-Control study was the primary study and the qualitative study was nested within the Case-Control study.

Both quantitative (Study 2) and qualitative data (Study 3) were collected, in order to answer different research questions and test different hypotheses. The collection and analysis of qualitative data occurred at the same time as the quantitative data collection (in parallel or concurrently) for the sake of efficiency.

3.4.2. Study setting

The study was conducted at three government-run ANC facilities in Phnom Penh, the capital city of Cambodia, with local institutional support from the National Center for HIV/AIDS, Dermatology and STD, the University of Health Sciences in Cambodia, Cambodia's national PMTCT program, and Phnom Penh's Municipal Health Department. The three facilities (the National Maternal and Child Health Center, Chaktomuk Referral Hospital, and Posenchey Health Center) were selected for their high number of ANC visits in the six months preceding the data collection.

3.4.3. Source population

The source population consisted of all men who attended ANC with their pregnant partners at one of the three participating government-run ANC facilities during the study period. Male ANC attendance was defined as accompanying a pregnant partner to an ANC facility and being physically present during the whole ANC consultation.

3.4.4. Study population and eligibility criteria

The study population consisted of all eligible men who attended ANC with their pregnant partners from September 2020 to December 2020 and who declined/accepted an offer of an HIV test. A case was defined as a man who attended ANC with his pregnant partner but declined an HIV test after receiving individual or couple or group pre-test counseling. A control was defined as a man who attended ANC with his pregnant partner and accepted an HIV test after receiving individual or couple or group pre-test counseling.

Inclusion criteria for both cases and controls included age (a minimum of 18 years old) and being willing and able to give oral informed consent. Men who were known to be HIV-positive were excluded.

3.4.7. Data collection

- **Study instrument**

A pre-tested structured questionnaire, adapted from multiple sources (Brody et al., 2019, Fernandez, 2000, Mirkuzie et al., 2011, National Institute of Statistics, 2015), was used to collect data on socio-demographic characteristics, intention, attitude, subjective norms, perceived behavioral control, descriptive norms, history of couple HIV/syphilis testing, knowledge of mother-to-child transmission of HIV, perceived risk of HIV infection, quality of HIV pre-test counseling, partner communication, and perceived endorsement of the provider for an HIV test during pre-test counseling.

To assess each TPB construct, a bipolar scale of 5 points (1–5), 7 points (1–7), or even 9 points could be used (Ajzen, 2021). The 5-point scale was chosen, as, during the interview, it was easy and quick for the interviewer to read out the complete list of all scale labels or descriptors to each respondent (Dawes, 2008). It also reduced respondents' level of frustration, leading to a higher quality of data and a lower non-response rate (Babakus and Mangold, 1992, Revilla et al., 2014).

In the present study, the 5-point bipolar scale (1–5) was used. The midpoint (value of 3) did not represent "don't know, don't care, not applicable, or prefer not to answer," but rather fell conceptually between 2 and 4, which interviewers were trained to explain to each participant. For participants responding with a "don't know, don't care, not applicable, or prefer not to answer" to a particular question, the interviewers probed further to confirm that the participants fully understood the question and scale.

In the final analysis, all continuous variables were dichotomized. Arithmetic mean was used as the cut-off point. The well-known central limit theorem assumes that, in a sample size of

30 or higher, the distribution of the mean (average) will be approximately normal (LaMorte, 2016). The total sample size was 396.

To facilitate the interview process for both the interviewers and participants, all points on the scale were labeled. For the intention to test for HIV (low vs. high), there were three questions (adapted from Mirkuzie et al., 2011): (1) Did you want to test for HIV during ANC? (2) Did you intend to test for HIV during ANC? and (3) Did you plan to test for HIV during ANC? For each item, there were five score options and their corresponding labels: 1 (definitely no), 2 (no), 3 (neutral), 4 (yes), and 5 (definitely yes). Individual scores of each question were summed, and the total score below the mean was categorized as "low intention."

To measure the respondents' attitudes toward male partner testing during ANC (negative vs. positive), we had three questions (adapted from Mirkuzie et al., 2011): (1) How harmful/ beneficial did you think that male partner testing for HIV during ANC would be? (2) How bad/good did you think that male partner testing for HIV during ANC would be? and (3) How unnecessary/necessary did you think that male partner testing for HIV during ANC would be? The five score options and corresponding labels were: 1 (definitely harmful/bad/unnecessary), 2 (harmful/bad/unnecessary), 3 (neutral), 4 (beneficial/good/necessary), and 5 (definitely beneficial/good/necessary). Individual scores of each question were summed, and the total score below the mean was categorized as "negative attitude."

To measure subjective norms about male partner testing during ANC (unsupportive vs. supportive), the interviewer first asked each participant to name three important people (e.g., family members, best friends, or close neighbors). Then the interviewer asked each participant about how much they agreed or disagreed with the following statements (adapted from Mirkuzie et al., 2011): (1) People who are important to me thought that I should test for HIV during ANC,

and (2) People who are important to me would appreciate me if I test for HIV during ANC. For each statement, there were five options: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly disagree). Individual scores of each statement were summed, and the total score below the mean was categorized as "unsupportive subjective norms."

For descriptive norms about male partner testing during ANC (unsupportive vs. supportive), the interviewer first asked each participant to name three important men (e.g., brothers, uncles, best friends, or close neighbors). Then the interviewer asked each participant about how much they agreed or disagreed with only one statement (adapted from Mirkuzie et al., 2011): Men whom I know and who are important to me would themselves test for HIV during ANC. There were five options: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly disagree). A total score below the mean was categorized as "unsupportive descriptive norms."

For perceived behavioral control (PBC) concerning male partner HIV testing during ANC (low vs. high), there were a total of five items (adapted from Mirkuzie et al., 2011): Each item consisted of two components (control belief strength and control belief power). For each item, the individual scores of its two components were first multiplied. Then the five resultant scores were summed, and a total score below the mean was categorized as "low perceived behavioral control."

The first PBC item had two questions: (1) Did you feel scared to know the result if you tested for HIV during ANC? (1 (definitely no), 2 (no), 3 (neutral), 4 (yes), and 5 (definitely yes)) and (2) Given that feeling, how easy/difficult would it be for you to test for HIV during ANC? (1 (definitely easy), 2 (easy), 3 (neutral), 4 (difficult), and 5 (definitely difficult)).

The second PBC item had two questions: (1) Did you feel scared to disclose your result to your partner if you tested positive? (1 (definitely no), 2 (no), 3 (neutral), 4 (yes), and 5 (definitely yes)) and (2) Given that feeling, how easy/difficult would it be for you to test for HIV during ANC (if you felt scared to disclose the result)? (1 (definitely easy), 2 (easy), 3 (neutral), 4 (difficult), and 5 (definitely difficult)).

The third PBC item had two questions: (1) Did you feel concerned that your HIV test result would not be kept confidential, especially if you tested positive? (1 (definitely no), 2 (no), 3 (neutral), 4 (yes) and 5 (definitely yes)) and (2) Given that feeling, how easy/difficult would it be for you to test for HIV during ANC (if you felt concerned that the results would not be kept confidential)? (1 (definitely easy), 2 (easy), 3 (neutral), 4 (difficult), and 5 (definitely difficult)).

The fourth PBC item had two questions: (1) Did you feel concerned that people would discriminate against you if you tested positive? (1 (definitely no), 2 (no), 3 (neutral), 4 (yes), and 5 (definitely yes)) and (2) Given that feeling, how easy/difficult would it be for you to test for HIV during ANC (1 (definitely easy), 2 (easy), 3 (neutral), 4 (difficult), and 5 (definitely difficult)).

The fifth PBC item had two questions: (1) Are you afraid of needles? (1 (definitely no), 2 (no), 3 (neutral), 4 (yes), and 5 (definitely yes)) and (2) Given that feeling, how easy/difficult would it be for you to test for HIV during ANC (if you were afraid of needles)? The options were: 1 (definitely easy), 2 (easy), 3 (neutral), 4 (difficult), and 5 (definitely difficult).

The perceived provider's endorsement of testing during pre-test counseling (weak vs. strong) was measured by one question (adapted from Fernandez, 2000): How weak/strong was your provider's endorsement of an HIV test during the pre-test counseling session? The options

were as follows: 1 (definitely weak), 2 (weak), 3 (neutral), 4 (strong), and 5 (definitely strong). A total score below the mean was categorized as a "weak perceived provider's endorsement".

Per DHS's definition (Croft, 2018), pre-test counseling (inadequate vs. adequate) was constructed from three CDHS questions: During this particular ANC visit, were you given any information about (1) babies getting the AIDS virus from their mother? (2) things that you can do to prevent getting the AIDS virus? and (3) getting tested for the AIDS virus? The options were yes or no. A man was considered to have received adequate counseling if an HIV counselor talked about all three issues with him.

Knowledge of mother-to-child transmission of HIV (inadequate vs. adequate) was measured by four CDHS questions: (1) Can the virus that causes AIDS be transmitted from a mother to her baby during pregnancy? (2) Can the virus that causes AIDS be transmitted from a mother to her baby during delivery? (3) Can the virus that causes AIDS be transmitted from a mother to her baby during breastfeeding? (4) Are there any special drugs that a doctor or a nurse can give to a woman infected with the AIDS virus to reduce the risk of transmission to the baby? Each question had three possible responses: yes, no, and don't know. "Don't know" was classified as an incorrect answer. Only a man with all four correct answers (yes to all) was considered to have adequate knowledge of mother-to-child transmission of HIV.

Partner communication (absence vs. presence) was measured by one pre-tested question: Did your partner ever ask you to test for HIV during this pregnancy? The options were: yes, no. A man who was personally asked by his partner to test for HIV at some point during her pregnancy (either before or after pre-test counseling) was categorized as having a "presence of partner communication."

Perceived risk of HIV infection (absence vs. presence) was measured by one question (adapted from Brody et al., 2019): Did you feel that you were at risk for HIV? The options were: yes, no, not sure. "Not sure" was coded as "yes."

A history of HIV/syphilis testing as a couple (absence vs. presence) was measured by two questions (adapted from Brody et al., 2019): (1) Have you ever been tested for HIV as a couple? and (2) Have you ever been tested for syphilis as a couple? For each item, the options were: yes, no, don't remember. "Don't remember" was classified as missing. A man with a "yes" response to one of the two questions was categorized as having a "presence of a history of HIV/syphilis testing as a couple."

- **Assessment of outcome**

The binary outcome of the present Case-Control study was defined as "declining or accepting an HIV test after receiving pre-test counseling." Each working day, the research team worked closely with providers on duty at the ANC unit to identify who was a case and who was a control. Misclassification of the outcome was therefore highly unlikely. Identification and recruitment of cases and controls are described in detail in Section 3.4.8.

- **Assessment of socio-demographic characteristics and potential predictors**

Data on socio-demographic characteristics and potential predictors were collected by face-to-face interviews. Regular training was given to all interviewers to minimize temporal ambiguity and ensure that the data were collected in the same way for both cases and controls. Unfortunately, the outcome was known prior to the interview, so we could not mask the outcome from the interviewers. To minimize interviewer bias, the interviewers were not informed of the study hypotheses.

3.4.8. Recruitment process

The actual recruitment was done by referral. The national PMTCT guidelines recommend that when a pregnant woman and her partner are both present at an ANC clinic, they are offered HIV pre-test counseling (as individuals, a couple, or as part of a group). This is a routine procedure at all health facilities across the country. Therefore, to recruit male partners from the ANC setting, two interviewers were permanently stationed at each participating health facility, coordinating closely with ANC providers on duty.

According to the national guidelines, after HIV pre-test counseling (individual, couple, or group), the accompanying male partner should decide whether to be tested for HIV. These were the detailed steps taken to recruit male partners from the ANC setting, all of which took place in a private space within the health facility:

- **Step 1:** After receiving the counseling, if the male partner declined or accepted the offer of an HIV test, the provider read a script written in Khmer to refer him to the research team as a potential research participant. It is important to emphasize that the provider did not recruit the male partner for ethical reasons. In other words, the role of the provider was only to initiate contact with the potential research participant. If the male partner was not interested in learning more information about the study, he could decline to meet with the research team. He was referred to the interviewer if and only if he indicated an interest in the research.
- **Step 2:** If he was interested, he met with an interviewer (from the research team). The interviewer read a recruitment script written in Khmer and then provided an overview of the study. A detailed information sheet about the study written in Khmer was also provided for further information.

- **Step 3:** The interviewer then asked the man if he was interested in participating in the research. If interested, a screening consent was obtained orally. Once consent had been provided, a few questions were asked of the man to determine his eligibility.
- **Step 4:** If the man was found to be eligible for the study, oral informed consent was obtained.
- **Step 5:** A face-to-face interview was conducted.
- **Step 6:** After the interview, the study participant received a non-monetary gift package (two bars of soap and one box of toothpaste).
- **Step 7:** The same steps (1–6) were repeated until the final sample sizes were met (132 cases and 264 controls).

3.4.9. Sample size calculation

The final sample size was calculated using StatsDirect (StatsDirect Ltd, Merseyside, UK), a statistical software package. No existing studies applied the Theory of Planned Behavior to predict HIV testing among ANC-attending male partners. However, one study in Ethiopia employed the theory to explain HIV testing acceptance among pregnant women seeking care in ANC settings. In that study, the intention to test for HIV was dichotomized as "low vs. high." Among pregnant women who accepted an HIV test, 70% had had a high intention; among those who declined to be tested, only 50% had had a high intention (Mirkuzie et al., 2011).

To calculate the sample size needed in the present study, we used estimates obtained from the study in Ethiopia as proxies. These were the parameters used to do the sample size calculation:

- Assumed probability of exposure in the control group = 50%
- Expected odds ratio = 2

- Probability of incorrectly rejecting the null hypothesis (alpha) = 5%
- Probability of correctly detecting a real effect (power) = 80%
- Number of controls per case = 2
- Correlation coefficient for exposure between case and controls (r) = 0.2

Based on these parameters, a total of 396 men (132 cases and 264 controls) were required after accounting for a 10% potential refusal rate or errors.

3.4.10. Statistical analysis

- **Descriptive statistics**

Mean, median, standard deviation, and range were used to describe continuous variables. Frequency and percentage were used to describe categorical variables. STATA 13 (Stata Corp, College Station, Texas, USA) was used. Cronbach's alpha was computed to assess the reliability or internal consistency of each TPB construct. An arbitrary alpha value of 0.6 or higher is considered acceptable, whereas an alpha of 0.95 or higher indicates redundant items in the scale (Hulin et al., 2001).

- **Inferential statistics**

A Chi-square test was used to compare proportions. An unpaired 2-sample t-test (equal variances) was employed to compare two arithmetic means, and Levene's test was performed to test the equality of variances. Medians were compared by using the non-parametric two-sample Wilcoxon rank-sum (Mann-Whitney) test. Simple and multiple logistic regressions were used to conduct univariate and multivariate analyses between potential predictors and outcomes of interest.

Empirically, the original Theory of Planned Behavior is modeled as two multiple regressions. In other words, two multiple regressions are necessary. The first regression consists

of two predictors (intention and perceived behavioral control) and one outcome (behavior of interest). The second regression contains three predictor variables (attitude, subjective norms, and perceived behavioral control) and one outcome (the intention to perform a particular behavior) (Hankins et al., 2000).

Therefore, in the present study, the first and second regressions were modeled as follows: (1) the effect of a low intention to test and low PBC on the actual behavior of interest (declining an offer of an HIV test) and (2) a negative attitude, unsupportive subjective norms, and low PBC on a low intention to test.

A third regression was modeled based on the Extended TPB model, which included external variables that might predict intention. Variables in the third model included a negative attitude, unsupportive subjective norms, low PBC, and a set of external factors: unsupportive descriptive norms, inadequate knowledge of mother-to-child transmission of HIV, inadequate pre-test counseling, an absence of partner communication, an absence of perceived risk of HIV infection, a lack of a history of HIV/syphilis testing as a couple, and a perception of the provider's endorsement as weak.

3.4.11. Protection of human subjects

Verbal informed consent was obtained from all research participants. The participation was anonymous, and no biological specimens or HIV test results were collected. The study protocol was reviewed and approved by the Institutional Review Board of the University of California, Los Angeles (UCLA IRB #19-002251) and the National Ethics Committee for Health Research of Cambodia (NECHR #165) in 2020.

3.5. Results

3.5.1. Socio-demographic characteristics

Table 3-1 describes the background characteristics of the study population. Of all eligible subjects, participation was over 99% for both cases and controls. Only a couple of people declined to give an interview due to time constraints. Almost half of the cases (49.2%) and controls (48.1%) were recruited from the National Maternal and Child Health Center. The other two facilities accounted for about a quarter each: Chaktomuk Referral Hospital yielded 25% of cases and 26.9% of controls, and Posenchey Health Center yielded 25.8% of cases and 25% of controls. More than half of respondents were permanently living outside Phnom Penh: 68.9% of cases and 67.4% of controls.

The age range of the study participants was as follows: cases (mean=30.5 years, median=30 years and range=20–41 years) and controls (mean=29.6 years, median=29 years, and range=20–47 years). The vast majority were in these three 5-year age groups: 23–27, 28–32 and 33–37. The vast majority also had some or complete secondary-level education. For marital status, 85.6% of cases and 90.1% of controls were married. Moderately large proportions of cases (61.4%) and controls (69.3%) reported living together for less than five years. Approximately half of the female partners were pregnant for the first time: cases (43.9%) and controls (49.1%). Respondents were predominantly employed in the non-agricultural sector: cases (93.1%) and controls (93.5%).

None of these socio-demographic characteristics differed significantly between cases and controls: participating health facility, permanent area of residence, mean age, median age, level of formal education, current marital status, duration of civil union or domestic partnership, pregnancy number for the female partner, and occupation.

3.5.2. Assessment of TPB constructs

Cronbach's alpha for each Theory of Planned Behavior construct was computed and is shown in Table 3-2. All the constructs were found to have acceptable reliability or internal consistency: intention (0.94), behavioral attitude (0.72), subjective norms (0.61), and perceived behavioral control (0.77).

3.5.3. Factors influencing intention to test and actual HIV testing during ANC

Three separate analyses were conducted to test the study's three hypotheses. Results for each hypothesis are presented as follows:

- **Hypothesis 1 (model 1): Male partners with a low intention to test and low perceived behavioral control had greater odds of declining an offer of an HIV test during ANC compared to those with the opposite characteristics.**

An intention to test and perceived behavioral control were included as predictors in univariate and multivariate logistic regression models, and the results are shown in Table 3-3.

In the univariate model, a refusal of an offer of HIV test was individually predicted by a low intention to test (OR=3.2 [95%CI: 1.8–5.3]) and low PBC (OR=1.7 [95%CI: 1.1–2.8]).

In the multivariate model, men with a low intention to test had greater odds of declining the test offer during ANC (aOR=3.2 [95% CI: 1.8–5.6]). As anticipated, the more obstacles the men perceived, the greater odds of declining the testing offer (aOR=1.8 [95% CI: 1.1–2.8]).

- **Hypothesis 2 (model 2): Male partners with a negative attitude, unsupportive subjective norms, and low perceived behavioral control had greater odds of having a low intention to test for HIV during ANC compared to those with the opposite characteristics (basic TPB model).**

Table 3-4 presents the results obtained from the univariate and multivariate regression analyses. In the univariate model, a low intention to test was individually predicted by a negative attitude (OR=2.1 [95%CI: 1.2–3.7]), unsupportive subjective norms (OR=2.7 [95%CI: 1.7–4.3]), but not by low PBC (OR=1.3 [95%CI: 0.6–2.1]).

In the multivariate model, men with a negative attitude had greater odds of having a low intention to test (aOR=1.9 [95% CI: 1.1–3.3]), as did those with unsupportive subjective norms (aOR=2.5 [95% CI: 1.5–4.0]). However, low PBC was not significantly associated with a low intention to test (aOR=1.1 [95% CI: 0.6–2.1]).

- **Hypothesis 3 (model 3): Male partners with certain characteristics (a negative attitude, unsupportive subjective norms, low perceived behavioral control, unsupportive descriptive norms, inadequate knowledge of mother-to-child transmission of HIV, inadequate HIV pre-test counseling, an absence of partner communication, no perceived risk of HIV infection, no history of HIV/syphilis testing as a couple, and weak perceived provider's endorsement) had greater odds of having a low intention to test for HIV during ANC, compared to those with opposite characteristics (ETPB model).**

In univariate logistic regression (Table 3-5), a low intention was significantly associated with a negative attitude (OR=2.1 [95% CI: 1.2–3.7]), unsupportive subjective norms (OR=2.7 [95% CI: 1.7–4.3]), inadequate knowledge of mother-to-child transmission of HIV (OR=1.8 [95% CI: 1.1–3.0]), an absence of partner communication (OR=4.1 [95% CI: 2.2–7.5]), a low perceived risk of HIV infection (OR=2.1 [95% CI: 1.2–3.7]), no history of HIV/syphilis testing as a couple (OR=0.5 [95% CI: 0.3–0.8]), and a weak perceived provider's endorsement (OR=1.7 [95% CI: 1.1–2.8]).

In multivariate model (Table 3-5), only three characteristics retained their statistical associations with low intention: unsupportive subjective norms (aOR=2.3 [95% CI: 1.4–3.9]), an absence of partner communication (aOR=3.0 [95% CI: 1.5–5.7]), and a low perceived risk of HIV infection (aOR=2.0 [95% CI: 1.1–3.6]).

3.6. Discussion

To our knowledge, this is the first epidemiological study that implemented Extended Theory of Planned Behavior to understand intended and actual HIV testing during ANC among men who attended ANC visits with their pregnant partners. The study aimed to test three hypotheses.

With respect to the first hypothesis (model 1), intention and perceived behavioral control directly predicted actual HIV testing during ANC. This means that men with a low intention to test to begin with and low perceived behavioral control had greater odds of declining an offer of an HIV test, a finding that is perfectly consistent with the theory (Ajzen, 1991, Ajzen, 2011, Ajzen, 2021). Remarkably, this contradicts the findings from the study in Ethiopia that aimed to identify factors associated with HIV testing among ANC-attending pregnant women. In the Ethiopian study, HIV testing was only influenced by intention, not by PBC (Mirkuzie et al., 2011). This discrepancy may have been due to one of two reasons: (1) different study populations (male vs. female), and (2) different techniques for measuring PBC. In the Ethiopian study, PBC was measured by focusing on four components: fear of knowing HIV test results, fear of disclosing HIV test results to partners, concerns about confidentiality, and concerns about discrimination. The PBC construct in the present study included a fifth component (fear of needles) because some questionnaire pre-testers reported fear of needles as a key factor that made them hesitant to take an HIV test.

Regarding the second hypothesis (model 2), our findings indicate that the intention to test for HIV is directly predicted by attitude and subjective norms but not perceived behavioral control (PBC). In other words, the intention could be increased by improving attitudes toward male HIV testing during ANC and subjective norms. PBC's lack of significant contribution to the prediction of intention was not surprising because the relative importance of the three factors is theoretically dependent on behavior and population, which means that in some behaviors or populations, only one is found to significantly predict intention (Ajzen, 2021).

Regarding the third hypothesis (model 3), which aimed to assess the contribution of the original TPB constructs (attitude, subjective norms, and PBC) and selected external factors, only perceived risk, subjective norms, and partner communication were found to be significantly associated with intention. Men who did not believe that they were at risk of HIV infection prior to their ANC visit were more likely to have a low intention to test for HIV. This connection between perceived risk and intention is in line with findings from previous studies conducted on a host of other populations, such as the general population in Thailand (Musumari et al., 2020) and university students in Nigeria (Ayodele, 2017).

Meanwhile, men who did not feel they were under pressure from their close associations to test for HIV during ANC were more likely to have a low intention. In other words, there was a significant association between subjective norms and an intention to test for HIV, and such an association has also been detected in other studies conducted on different populations, including health professionals in Ethiopia (Abamecha et al., 2013), shop-floor workers in South Africa (Weihs et al., 2018), and ANC-attending pregnant women in Ethiopia (Mirkuzie et al., 2011).

Furthermore, when personally requested by pregnant partners to test for HIV either prior to that ANC visit or right after HIV pre-test counseling during the visit, men were more likely to

have a high intention to test. This demonstrates that partner communication played a huge role in encouraging men to test for HIV during ANC through increasing intention, and the findings support other studies that recommend partner communication on HIV testing (Mbizvo and Bassett, 1996, Schatz, 2005, Manopaiboon et al., 2007, Godlonton and Thornton, 2017, Zulu and Chepngeno, 2003).

HIV/AIDS behavioral change programs have been piloted and implemented in different populations and socio-cultural contexts to alter risk perception, subjective norms, and partner communication. Although approaches at the individual level (e.g., mass media and small group discussion, peer education, and counseling) have indicated a positive impact on altering the factors, approaches at other levels (e.g., relationship, community, structural, and societal/policy) constitute a critical complement. Many of the latter interventions have been based on well-known theories such as the Theory of Reasoned Action (precursor to the Theory of Planned Behavior), the Diffusion of Innovation Theory, and the Theory of Social Influence (UNAIDS, 1999b).

Remarkably, the quality of HIV pre-test counseling during routine ANC care did not have a significant influence on the intention to test among ANC-attending male partners in both bivariate and multivariate models. We also examined the bivariate relationship between the counseling and actual HIV testing during ANC but did not observe a significant association either. Therefore, unlike among pregnant women (Study 1 in Chapter 2), the quality of pre-test counseling did not have any effect on HIV testing, as the quality of pre-test counseling was the same for the men and women. This is consistent with a pilot study in Cambodia that demonstrated that, despite receiving the same pre-test counseling, the HIV testing acceptance rate was quite high among pregnant women, but quite low among their male partners (Heller et

al., 2011). One study in rural Uganda and another in rural Malawi reported similar findings, that high-quality antenatal HIV counseling was not sufficient to encourage men to take an HIV test during ANC (Semrau et al., 2005, Homsy et al., 2006).

It is worth noting that the Ministry of Health of Cambodia has introduced point-of-care by midwives as a routine component of ANC since 2009, meaning all counselors at ANC units within government-run facilities, especially at community health centers, are generally staffed by midwives (Heller et al., 2011). Given that all male partners in the previous pilot and present Case-Control studies, both conducted in Cambodia, received counseling from midwives, gender differences in the Cambodian context could have played a role in making the men in the studies less inclined to accept an HIV test. To address gender dynamic issues at ANC clinics, maternal and child health programs, in Africa in particular, have proposed or even piloted so-called "male-friendly clinics." Although there is no common operational definition of such intervention, the main concept is to create a more male-friendly ANC environment, with male waiting rooms and restrooms (Mohlala et al., 2012), using neutral language such as "family clinic" rather than "women's clinic" (Manjate Cuco et al., 2015), having a separate room within the clinic so that men do not feel outnumbered by women (Sakala et al., 2021), providing ANC-attending couples with specially trained couples' counselors and private rooms for HIV testing and family planning (Audet et al., 2016), or having male nurses and counselors (DoS/PEPFAR, 2018). In the Cambodian context, should these "male-friendly clinics" be introduced? From health policy and scientific perspectives, the answer is negative. Since no study has ever been conducted to confirm if Cambodian male partners' HIV testing uptake is diminished by having midwives as pre-test counselors, it would not be a sound idea to introduce "male-friendly" clinics.

As described above, in the present study, the quality of pre-test counseling was not associated with HIV testing uptake among ANC-attending male partners. As all counselors were midwives, one question is: how might the uptake have changed if the counselors had been physicians rather than midwives? We could not find any studies testing this hypothesis in a relevant population and setting, and can only speculate about whether a healthcare worker of higher professional status (e.g., a physician) would be more able to influence men to be tested for HIV.

- **Strengths and limitations**

The present study has several strengths and limitations. In terms of strengths, first, confounding bias was minimized by applying the extended form of Theory of Planned Behavior, a conceptual framework used by world health researchers and policymakers to study human behavior and make impactful evidence-based policies or interventions. The original TPB in the present study had several constructs, which we added to after an extensive literature review. We, therefore, had a high degree of certainty that potential confounding bias due to unmeasured confounders was minimal.

Second, in terms of information bias, misclassification of the outcome was avoided by recruiting ANC-attending male partners immediately following HIV pre-test counseling. The interviewers worked closely with the HIV pre-test counselors at each participating health facility to identify new cases (HIV testing decliners) and new controls (HIV testing acceptors). In consequence, it is highly unlikely that a case could have mistakenly been classified as control and vice versa. Misclassification of potential predictor variables of interest due to recall bias was minimized by asking participants about variables, except their lifetime history of HIV testing as a couple, which had occurred immediately before receiving HIV pre-test counseling. Such a

short recall period ensured that the cases were not more likely to recall information better than the controls. In addition, for the history of testing as a couple, recall bias was not likely because being tested for HIV (whether alone or as a couple) is typically a major life event. Moreover, although we could not blind interviewers to the case or control status of participants, we minimized interviewer bias by blinding the interviewers to the hypotheses of the study.

Third, selection bias due to self-selection was unlikely because the response rates in both groups were over 99% and very little data was missing for each variable.

Fourth, a random selection of study controls was not possible because we did not have a frame of the source population at the start of the data collection. Therefore, for practical and logistical reasons, we recruited cases and controls simultaneously until our desired sample size was met. Since more men accepted HIV testing, we were able to recruit 264 controls more quickly than 132 cases. In other words, once 264 controls were successfully recruited, the interviewers at the three participating ANC sites stopped recruiting controls altogether but continued to wait for new cases to arise. Although practical and economical, such a recruitment strategy suggests that a non-random subset of the source population was sampled as our study controls. Therefore, the validity of the estimates obtained from the study (aOR and their corresponding 95% CIs) depends on the assumption that the distribution of the main exposure of interest (the intention to test for HIV during ANC) was the same in the selected control series as in a random sample of the source population. Theoretically, this assumption is met when two conditions are fulfilled: (1) the catchment populations are identical and (2) the main exposure is independent of the outcome (Miettinen, 1985a, Miettinen, 1985b, Wacholder et al., 1992a, Wacholder et al., 1992b). The first condition was not relevant to the present study because we recruited both cases and controls from the same source population. In other words, if controls

had been recruited from other medical services or wards (e.g., surgery, dentistry, or urology), then it would have been necessary to ensure that both cases and controls came from the same catchment areas of the hospital. For the second condition, before receiving pre-test counseling from an ANC provider, most men did not know that free HIV testing was available for couples during ANC. This suggests that most men attended ANC with their pregnant partners without any prior intention to test for HIV, meaning the main exposure of interest (intention) seemed unrelated to the reason for admission of the controls. Therefore, in the present study, selection bias due to inappropriate selection of controls was not likely to have occurred.

In terms of limitations, first, since all interviews were conducted face-to-face and approximately half of the interviewers were female, social desirability bias cannot be ruled out. Some respondents may have felt more comfortable with same-sex interviewers.

Second, male partners were recruited only from three health facilities in Phnom Penh, the capital city of Cambodia. In consequence, the study findings can only be generalized or extrapolated with caution.

Third, in the design stage, we planned to recruit incident cases and then the next two age-matched controls (ratio of 1:2) to gain statistical efficiency. However, during data collection, the matching feature could not be preserved due to logistical constraints and the heavy workload on both interviewers and ANC counselors. Had matching been feasible, we may have been able to determine more precise confidence intervals for each potential predictor variable in the ETPB model.

Fourth, Cronbach's alpha, first developed to measure internal consistency or reliability of a scale with more than one item, has a numerical value between 0 and 1 (Cronbach, 1951). As a rule of thumb, a desirable range of alpha is 0.7-0.95 (Nunnally, 1994, Bland and Altman, 1997,

DeVellis, 2016, Taber, 2018), with a value greater than 0.95 indicating that some items in the scale are redundant (Streiner, 2003). An alpha value of as low as 0.6 may be considered acceptable (Hulin et al., 2001, Hume et al., 2006). Alpha may be small due to one or both of the following reasons: a small number of items in the scale or poor correlation between items (e.g., questions or statements) in the scale (Perera et al., 2011, Streiner, 2003). In the present study, we computed an alpha for each construct: intention to test (0.94), attitude (0.72), perceived behavioral control (0.77), and subjective norms (0.61). As described in Section 3.4.7, the subjective norms construct was measured by four items adapted from the Ethiopian study, which had an alpha of 0.75 for subjective norms (Mirkuzie et al., 2011). Initially, when all four items were included in the construct, the resultant alpha was only 0.50, lower than in the Ethiopian study; such a discrepancy could be due to differences in social and cultural contexts between Ethiopian ANC-attending pregnant women and Cambodian ANC-attending male partners. According to Ajzen, as there is no standard TPB questionnaire, the reliability of each TPB scale may vary between populations. In practice, when a scale has a low Cronbach's alpha, one or two poorly correlated items can be dropped to increase its internal consistency (Ajzen, 2021). In the present study, two items (1. People who are important to me encouraged me to test for HIV during ANC and 2. My partner agreed that I should test for HIV during ANC) were found to be poorly correlated and were therefore dropped from the subjective norms construct. As a result, the alpha jumped from 0.50 to 0.61, and the small resultant alpha of 0.61 was then due to a small number of correlated items rather than a poor internal consistency of the scale.

3.7. Conclusion

The present study sheds light on how to motivate ANC-attending male partners to accept an HIV test offer during ANC. Declining the test offer was significantly predicted by a low

intention to test and low perceived behavioral control. A low intention to test was, in turn, strongly predicted by a negative attitude and unsupportive subjective norms in the traditional TPB model. In the extended TPB, which is more robust than the basic TPB, we were able to identify three predictors operating through intention, at different levels: the individual level (an absence of perceived risk of HIV infection), the relationship level (an absence of partner communication about HIV testing), and the community level (unsupportive subjective norms). Unlike among ANC-attending pregnant women (Study 1 in Chapter 2), pre-test counseling did not have a significant effect on HIV testing uptake among male partners during ANC, whether directly or indirectly through intention.

Therefore, any attempt to increase HIV testing among Cambodian ANC-attending male partners requires trans-theoretical approaches to aggressively address the three actionable risk factors: risk perception, subjective norms, and partner communication. In the Cambodian context, potential complementary interventions aimed at individual behavioral change should be based largely on an "Information, Education and Communication" framework, as described in the final chapter.

Since the present study did not focus on socio-cultural and health system-level factors, a qualitative study (Study 3 in Chapter 4) was conducted to examine whether other factors (e.g., community and health system factors) play a role in male partners' decisions to attend ANC and agree to be tested for HIV. Moreover, we also explored male partners' perspectives on three testing modalities (home-based HIV testing and counseling, free-of-charge pregnant woman–delivered HIVST, and out-of-pocket community pharmacy–delivered HIVST).

3.8. Tables and figures

3.8.1. Tables

Table 3-1: Socio-demographic characteristics of ANC-attending male partners

Characteristics	Case (N=132)	Control (N=264)	p–value
	n (%)	n (%)	
Health facility			
NMCHC	65 (49.2)	127 (48.1)	
Chaktomuk RH	33 (25.0)	71 (26.9)	0.92
Posenchey HC	34 (25.8)	66 (25.0)	
Permanent area of residence			
Phnom Penh	91 (68.9)	178 (67.4)	0.76
Outside Phnom Penh	41 (31.1)	86 (32.6)	
Age (completed years)			
Mean ± SD	30.5 ± 5.5	29.6 ± 6.2	0.13
Median	30	29	0.05
Range	(20–41)	(20–47)	
5-year age-groups			
18-22	8 (6.1)	34 (12.9)	
23-27	32 (24.2)	70 (26.5)	
28-32	51 (38.6)	85 (32.2)	0.16
33-37	22 (16.7)	48 (18.2)	
38 and above	19 (14.4)	27 (10.2)	
Education			
None	2 (1.5)	5 (1.9)	
Primary	31 (23.5)	73 (27.6)	0.14
Secondary	62 (47.0)	139 (52.7)	
University	37 (28.0)	47 (17.8)	
Current marital status			
Married	113 (85.6)	238 (90.1)	0.18
Living together as if married	19 (14.6)	26 (9.9)	
Duration of union			
0–5 years	81 (61.4)	183 (69.3)	0.11
> 5 years	51 (38.6)	81 (30.7)	
Pregnancy number of female partner			
1st pregnancy	58 (43.9)	129 (49.1)	0.34
2nd or above	74 (56.1)	134 (50.9)	
Occupation			
Unemployed	3 (2.3)	2 (0.8)	
Agriculture sector	6 (4.6)	15 (5.7)	0.41
Non-agriculture sector	123 (93.1)	247 (93.5)	

Table 3-2: Descriptive statistics for TPB constructs

TPB constructs	N	Cronbach's alpha	Number of items (possible score range)	Mean ± SD
Intention to test for HIV during ANC	396	0.94	3 (3–15)	5.2 ± 3.9
Behavioral attitude toward male partner HIV testing during ANC	396	0.72	3 (3–15)	14 ± 1.4
Subjective norms concerning male partner HIV testing during ANC	396	0.61	2 (2–10)	9.2 ± 1.1
Perceived behavioral control	396	0.77	5 (25–125)	10 ± 11.5

Table 3-3: Crude and adjusted associations between binary intention and PBC and male partner HIV testing during ANC

Model 1 (hypothesis 1)	Case (N=132)	Control (N=264)	OR (95% CI)	aOR (95% CI)
	n (%)	n (%)		
Intention to test				
High	18 (13.6)	89 (33.7)	1.0 (ref)	1.0 (ref)
Low	114 (86.4)	175 (66.3)	3.2 (1.8–5.3)***	3.2 (1.8–5.6)***
Perceived behavioral control				
High	96 (72.7)	217 (82.2)	1.0 (ref)	1.0 (ref)
Low	36 (27.3)	47 (17.8)	1.7 (1.1–2.8)*	1.8 (1.1–2.8)*

Notations: * *P-value <0.05,* ** *P-value <0.01,* *** *P-value <0.001*

Table 3-4: Crude and adjusted association between binary TPB variables and intention (low intention during ANC is the binary dependent variable)

Model 2 (hypothesis 2)	Low intention (N=289)	High intention (N=107)	OR (95% CI)	aOR (95% CI)
	n (%)	n (%)		
Attitude				
Positive	198 (68.5)	88 (82.2)	1.0 (ref)	1.0 (ref)
Negative	91 (31.5)	19 (17.8)	2.1 (1.2–3.7)**	1.9 (1.1–3.3)*
Subjective norms				
Supportive	135 (46.7)	75 (70.1)	1.0 (ref)	1.0 (ref)
Unsupportive	154 (53.3)	32 (29.9)	2.7 (1.7–4.3)***	2.5 (1.5–4.0)***
Perceived behavioral control				
High	225 (77.8)	88 (82.2)	1.0 (ref)	1.0 (ref)
Low	64 (22.2)	19 (17.8)	1.3 (0.7–2.3)	1.1 (0.6–2.1)

Notations: * *P-value <0.05,* ** *P-value <0.01,* *** *P-value <0.001*

Table 3-5: Crude and adjusted association between binary ETPB variables and intention (low intention is the binary dependent variable)

Model 3 (hypothesis 3)	Low intention (N=289)	High intention (N=107)	OR (95% CI)	aOR (95% CI)
	n (%)	n (%)		
Attitude				
Positive	198 (68.5)	88 (82.2)	1.0 (ref)	1.0 (ref)
Negative	91 (31.5)	19 (17.8)	2.1 (1.2–3.7)**	1.7 (0.9–3.2)
Subjective norms				
Supportive	135 (46.7)	75 (70.1)	1.0 (ref)	1.0 (ref)
Unsupportive	154 (53.3)	32 (29.9)	2.7 (1.7–4.3)***	2.3 (1.4–3.9)**
Perceived behavioral control (PBC)				
High	225 (77.8)	88 (82.2)	1.0 (ref)	1.0 (ref)
Low	64 (22.2)	19 (17.8)	1.3 (0.7–2.3)	1.1 (0.6–2.1)
Descriptive norms				
Supportive	164 (56.8)	65 (60.8)	1.0 (ref)	1.0 (ref)
Unsupportive	125 (43.2)	42 (39.2)	1.2 (0.8–1.9)	1.0 (0.6–1.7)
Knowledge of mother-to-child transmission of HIV				
Adequate	59 (20.4)	34 (31.8)	1.0 (ref)	1.0 (ref)
Inadequate	230 (79.6)	73 (68.2)	1.8 (1.1–3.0)*	1.3 (0.8–2.3)
Pre-test counseling				
Adequate	50 (17.7)	23 (21.9)	1.0 (ref)	1.0 (ref)
Inadequate	232 (82.3)	82 (78.1)	1.3 (0.7–2.3)	1.0 (0.5–1.8)
Partner communication				
Yes	23 (8.0)	28 (26.2)	1.0 (ref)	1.0 (ref)
No	265 (92.0)	79 (73.8)	4.1 (2.2–7.5)***	3.0 (1.5–5.7)**
Perceived risk of HIV				
Yes	41 (14.2)	28 (26.2)	1.0 (ref)	1.0 (ref)
No	248 (85.8)	79 (73.8)	2.1 (1.2–3.7)**	2.0 (1.1–3.6)*
History of HIV/syphilis testing as a couple				
Yes	76 (26.3)	45 (42.1)	1.0 (ref)	1.0 (ref)
No	213 (73.7)	62 (57.9)	0.5 (0.3–0.8)**	0.7 (0.4–1.1)
Perceived provider's endorsement				
Strong	174 (60.2)	77 (72.0)	1.0 (ref)	1.0 (ref)
Weak	115 (39.8)	30 (28.0)	1.7 (1.1–2.8)*	1.4 (0.8–2.3)

Notations: * *P-value <0.05, ** P-value <0.01, *** P-value<0.001*

3.8.2. Figures

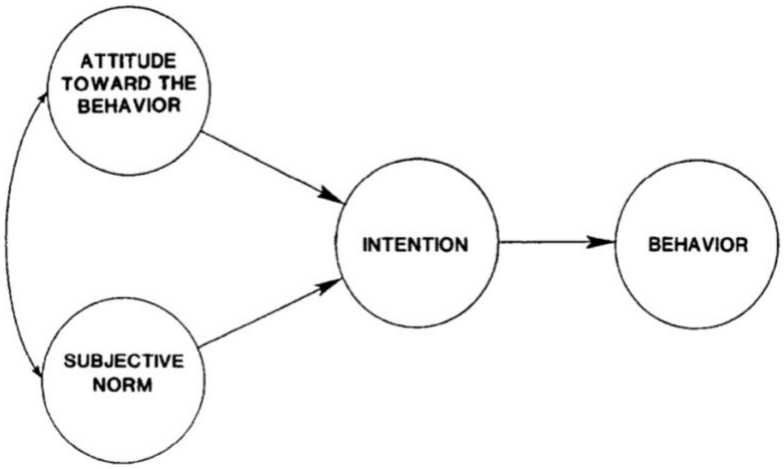

Figure 3-1: Theory of Reasoned Action (Ajzen and Madden, 1986)

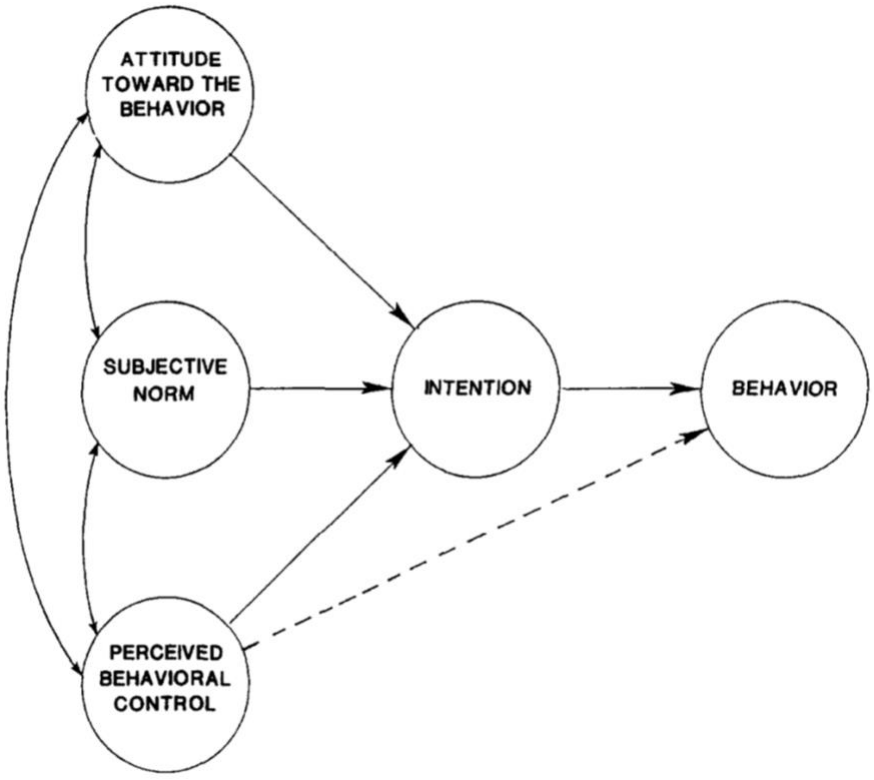

Figure 3-2: Theory of Planned Behavior (Ajzen and Madden, 1986)

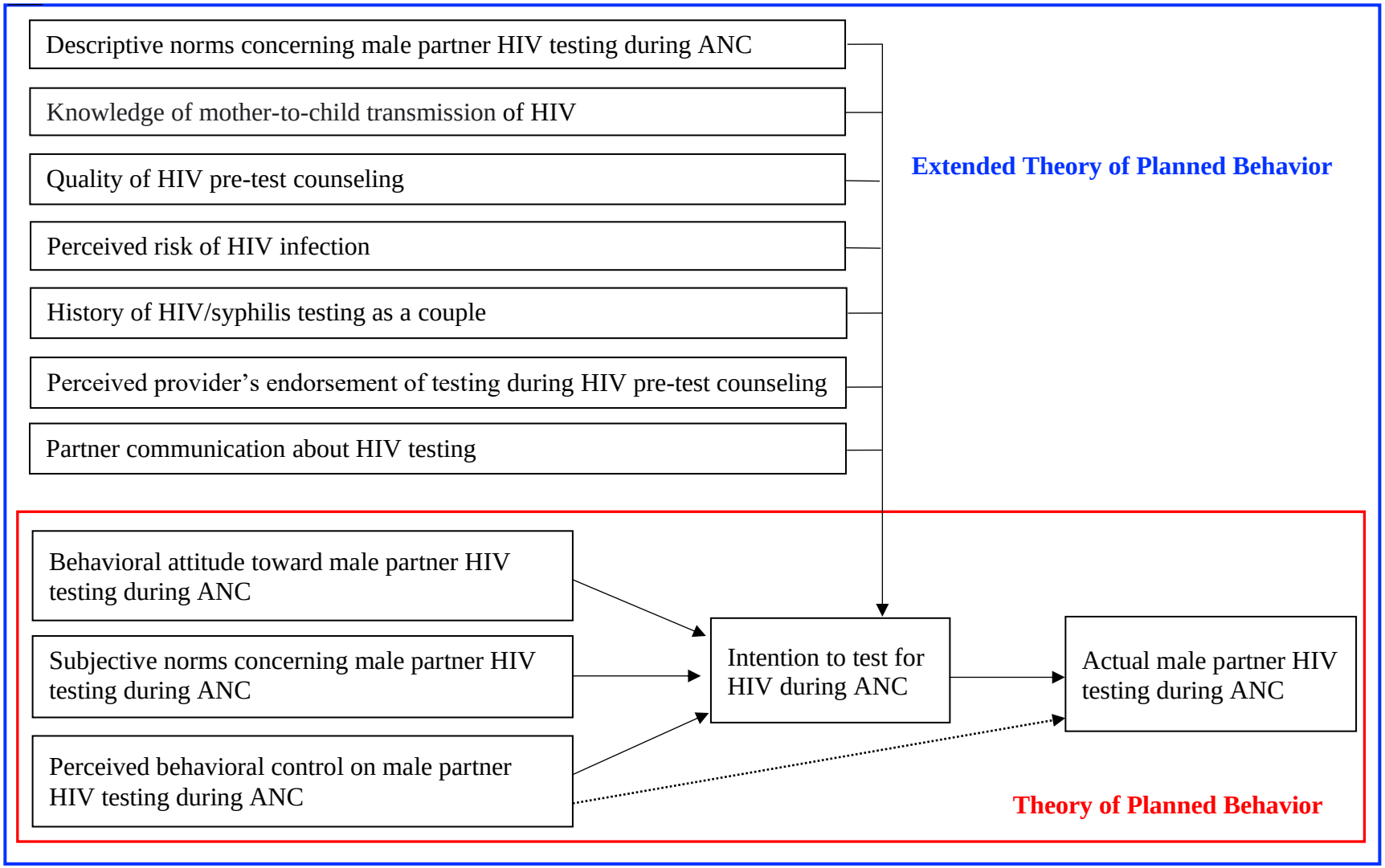

Figure 3-3: Conceptual model used in the present Case-Control study, adapted from (Mirkuzie et al., 2011)

CHAPTER 4 (Study 3): Perspectives on Male Antenatal Care Attendance, Home-Based HIV Testing (HB-HTC), and HIV self-testing (HIVST) by Male Partners of Pregnant Women: Exploratory Research in Cambodia

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4.1. Abstract

Background: Male partner testing is associated with a decreased risk of vertical transmission of HIV. The current one-size-fits-all "Boosted Linked Response" approach in Cambodia has never tested even one-fourth of male partners of all ANC-attending pregnant women for HIV. We conducted an exploratory qualitative study to identify barriers to men attending ANC and to explore the perceived benefits of and concerns about home-based HIV testing and counseling (HB-HTC), free-of-charge pregnant woman–delivered HIV self-testing, and out-of-pocket community pharmacy–delivered HIV self-testing.

Methods: This qualitative study was nested within the parent Case-Control study (Study 2 in Chapter 3). A total of 30 male partners (10 HIV testing decliners, 10 acceptors, and 10 ANC non-attendees) were recruited for in-depth interviews using consecutive sampling from the ANC and postpartum departments of the National Maternal and Child Health Center (NMCHC) in Phnom Penh. All 30 interviews were audio-taped and transcribed. All transcripts were coded using NVivo 12 (QSR International, Doncaster, Australia). Mean, median, range, frequency, and percentage were computed to describe men's basic socio-demographic characteristics. Hybrid inductive and deductive thematic analysis was used.

Results: Barriers to attending ANC included, at the individual level: being unable to take time off work, waiting outside the health facility watching over an older child, not wanting to pay for a parking fee, and a negative attitude toward male ANC attendance; at the relationship

level: a negative couple dynamic with men taking healthcare decisions alone as they considered themselves to be the heads of the family; at the community level: a negative attitude toward male ANC attendance; and at the health system level: not being invited by ANC providers to come into the ANC consultation room or be engaged in ANC. Concerns about HB-HTC included worries that neighbors would be suspicious, not being home at the time of the home visit, an inability to verify the identity of the testing team, feeling coerced into testing, feeling offended by a home visit, the potential for contamination among testing instruments, fear of confidentiality breaches by the testing team, and the potential for poor or improper management of biological specimens. For free-of-charge pregnant woman–delivered HIVST, concerns included a lack of pre-and post-test counseling, questions about the reliability/accuracy of the test kit, instructions for use being in foreign languages, being incapable of using the kit correctly, and questions about why the provider or his partner wanted him to be tested. For out-of-pocket community pharmacy–delivered HIVST, perceived concerns included low availability, feeling shy or embarrassed when purchasing the kits, the cost of the kits, and a lack of technical assistance from pharmacy staff.

Conclusion: ANC-based HTC has been a cornerstone of the HIV testing and counseling program for pregnant women and their male partners for a decade. Our findings strongly suggest that both home-based HTC and HIV self-testing have the potential to become complementary HIV testing modalities to increase HIV testing coverage among male partners of pregnant women. However, the degree of effectiveness of each approach will depend heavily on how well men's concerns about them are addressed.

4.2. Introduction

4.2.1. Background

The "Boosted Linked Response" approach has encouraged an impressive number of pregnant women to attend ANC and be tested for HIV. In 2014, approximately 95% of pregnant women in the country attended at least once (National Institute of Statistics, 2015), and about 75% of the women were tested for HIV and received their test results (NMCHC, 2016). The HIV testing coverage has continued to increase to approximately 90% in 2017–2020: 86.7% in 2017, 90.9% in 2018, 93.4% in 2019, and 91.8% in 2020 (NMCHC, 2020).

But HIV testing coverage among male partners of ANC-attending pregnant women has not significantly changed since the implementation of the "Boosted Linked Response" approach in 2013. Data directly obtained from the national program on the prevention of mother-to-child transmission (PMTCT) shows that less than one-fourth of male partners were tested for HIV: 17.2% in 2017, 18.6% in 2018, 18.4% in 2019, and 17.7% in 2020 (NMCHC, 2020). This represents a critical gap in the current "Boosted Linked Response" approach.

Compared to women, Cambodian men are also less likely to use clinical health services. As a result, men are more likely to start ART at later stages of HIV infection (NCHADS, 2017). However, studies have shown that some strategies, including home-based HIV testing and counseling (Krakowiak et al., 2016, Osoti et al., 2014, Osoti et al., 2015) and HIV self-testing (Masters et al., 2016, Matovu et al., 2018, Thirumurthy et al., 2016) are effective in reaching men who do not attend ANC with their pregnant partners.

4.2.2. Home-based HIV testing and counseling (HB-HTC)

Home-based HIV testing and counseling is defined by the WHO as "HIV testing and counseling (HTC) services conducted by trained HTC service providers in someone's home."

The main purpose of HB-HTC is to overcome some of the barriers to HIV testing, namely the stigma associated with it, potentially encouraging more couples to test for HIV than other HTC models. It also facilitates early diagnosis for HIV-positive individuals. It has been associated with an increase in follow-up by providers for HIV-exposed infants (WHO, 2012b), and HIV testing and counseling of family members and partners of HIV-positive individuals (Lugada et al., 2010). A study in Kenya found more than a 2-fold increase in male partner access and men undergoing HTC at home when it was available (Osoti et al., 2014). Another study, also in Kenya, similarly showed that pregnant women and their male partners preferred HB-HTC to facility-based testing (Osoti et al., 2015).

4.2.3. HIV self-testing (HIVST)

HIV self-testing is defined by the WHO as an approach where someone collects his or her own blood or saliva, uses the specimen to take the HIV test, and interprets the result on their own (WHO, 2016). It provides complimentary coverage to existing HIV testing services administered by health care providers (Indravudh et al., 2018). It has much potential to expand HIV testing and improve prevention and control (Johnson et al., 2014, Myers et al., 2013).

According to the WHO's 2016 guidelines, there are two types of HIVST: directly assisted and unassisted. "Directly assisted" refers to direct in-person support, demonstrations, or explanations by a healthcare professional on how to perform a self-test and interpret the results. "Unassisted HIVST" refers to a self-test using an HIVST kit using the manufacturer-provided instructions for use without in-person demonstration of assistance (WHO, 2016). Although HIVST is supposed to be done at home for the sake of privacy, adolescents in rural Mozambique in one study preferred to do it at a health center (76%) for increased security, privacy, and/or the presence of a counselor (Hector et al., 2018).

HIVST, in general, has high feasibility, acceptability, and accuracy across a range of distribution channels and populations, and is positively associated with increased testing coverage (Indravudh et al., 2018). HIVST is as accurate as testing done by professionally trained health care workers (Figueroa et al., 2018). It has the same capacity of facility-based HIV testing services to capture people testing for the first time, people who are diagnosed late, and HIV-positive testers among men who have sex with men (Zhang et al., 2017).

Multiple systematic reviews and meta-analyses of studies on HIVST from both developed and developing countries have found encouraging results. For instance, HIVST is preferred to facility-based testing because of its increased convenience and confidentiality, particularly among stigmatized populations (Qin et al., 2018). Similarly, it has been associated with a two-fold increase of testing among men in general and a nearly two-fold increase in the frequency of testing among men who have sex with men (Johnson et al., 2017). A pilot study on woman–delivered HIVST, or "secondary distribution of HIVST kits," demonstrated that HIVST significantly promoted partner testing and couples testing among ANC-attending pregnant women and their ANC non-attending male partners in Kenya (Masters et al., 2016).

4.2.4. Study justification and rationale

According to the current National Consolidated Guidelines on HIV testing services in Cambodia, pregnant women and their male partners can be tested for HIV through two mechanisms: ANC-based and community-based. For ANC-based HTC, a health provider-initiated testing and counseling approach (HPITC) has been in effect since 2013, routinely offering finger-prick HIV testing to all ANC-attending pregnant women and their male partners. For ANC non-attending pregnant women and their male partners, finger-prick HIV testing is supposed to be done through outreach ANC at the community level (NCHADS, 2017).

As described in Section 4.2.1, while most pregnant women agreed to be tested for HIV, a much smaller fraction of their male partners have done so (NMCHC, 2020, WHO, 2014, NAA, 2015). The root cause of such discrepancy needs to be identified and complementary HIV testing modalities explored (e.g., home-based HTC, free-of-charge pregnant woman–delivered HIVST, and out-of-pocket community pharmacy–delivered HIVST).

In Cambodia, currently, home-based HTC is not a national standard tool for pregnant women and especially their male partners. The WHO released HIVST guidelines in 2016. As of 2019, only 77 countries have adopted HIVST policies, while many others are currently developing them (Figure 4-1). The gap between policy uptake and pragmatic implementation is due to several factors. The most important is probably the insufficient evidence and the lack of national-level investment to guide implementation and scale-up (WHO, 2019b). Cambodia has had a policy on HIVST since 2017 but has not implemented it yet (NCHADS, 2017).

One qualitative study has assessed the acceptability of HIVST in key populations in Cambodia: transgender women, men who have sex with men, and female entertainment workers (Pal et al., 2016). However, to the best of our knowledge, there is no research on the acceptability of HIVST among male partners of pregnant women in Cambodia.

Therefore, in the present study, we aimed to identify barriers/facilitators to attending ANC and accepting an offer of an HIV test during ANC, and to explore the perceived benefits of and concerns about two alternatives (home-based HTC and HIVST) among ANC-attending and ANC non-attending male partners. For HIVST, we focused on two distribution modalities: free-of-charge pregnant woman–delivered HIVST (also known as the secondary distribution of HIVST kits, where a pregnant woman brings home an HIVST kit for her husband after being asked to do so by a midwife at the ANC clinic) and out-of-pocket community-pharmacy

delivered HIVST. We were interested in the community pharmacy–delivered HIVST modality because pharmacies are often cited as the first point of contact for people seeking care for a variety of health concerns, especially in urban areas (National Institute of Statistics, 2015). Many Cambodians have expressed a preference for pharmacies for several reasons: the availability of a wide range of drugs, short waiting times, and the ability to control the cost of care (Yang et al., 2004).

4.3. Specific aims, conceptual framework, and hypotheses

4.3.1. Specific aims

- **Aim 1:** To identify barriers to being tested for HIV among ANC-attending men.
- **Aim 2:** To identify facilitators of being tested for HIV among ANC-attending men.
- **Aim 3:** To identify barriers to attending ANC among ANC non-attending men.
- **Aim 4:** To explore men's concerns about and perceived benefits of home-based HTC (HB-HTC), free-of-charge pregnant woman–delivered HIVST, and out-of-pocket community pharmacy–delivered HIVST.
- **Aim 5:** To solicit suggestions from men on how to increase testing of men during their partners' pregnancies.

4.3.2. Conceptual framework

The conceptual framework used in the present study (Figure 4-2) was adapted from a qualitative study on the acceptability of woman–delivered HIVST to the male partner in Malawi (Choko et al., 2017). In the adapted framework, we assumed that ANC-attending men declined or accepted an HIV test due to barriers or facilitators operating at different levels (individual, relationship, community, and health system). Barriers at different levels may also have prevented men from attending ANC with their pregnant partners for the most recent child. By not attending

ANC, men would have been less likely to be tested for HIV when their female partners were pregnant.

Therefore, we expected that an introduction of three new testing approaches (free-of-charge home-based HTC, free-of-charge pregnant woman–delivered HIVST, and out-of-pocket community pharmacy–delivered HIVST) would potentially be able to address some or all of the barriers cited by the three groups of male partners (decliners, acceptors, and ANC non-attendees). If men found the approaches attractive or believed that the benefits would outweigh their concerns, they would be more receptive to them, and testing and linkage to care or prevention would likely increase.

4.3.3. Hypotheses

- **Hypothesis #1 (Aim 1):** Factors operating beyond the individual level prevented ANC-attending men from accepting an HIV test during ANC. The unit of analysis consisted of 10 men who declined an HIV test after receiving pre-test counseling from an HIV counselor.
- **Hypothesis #2 (Aim 2):** Factors operating beyond the individual enabled ANC-attending men to accept an HIV test. The unit of analysis consisted of 10 who accepted an HIV test after receiving pre-test counseling from an HIV counselor.
- **Hypothesis #3 (Aim 3):** Factors operating beyond the individual level prevented ANC-attending men from attending ANC. The unit of analysis consists of 10 men who did not attend ANC even once for the most recent pregnancy.
- **Aims 4 and 5:** No hypothesis would be tested. The unit of analysis consisted of 30 men (10 decliners, 10 acceptors, and 10 ANC non-attendees).

4.4. Methods

4.4.1. Study design

This study employed an embedded parallel mixed methods design (unmatched Case-Control study and qualitative study). The Case-Control study was the primary study (Study 2 in Chapter 3) and the qualitative part was nested within the Case-Control study. Both quantitative and qualitative data were collected in parallel or concurrently, but were analyzed independently to answer different research questions.

4.4.2 Study setting

In Study 2 (the Case-Control study), there were three participating health facilities (the National and Maternal Child Health Center, Chaktomuk Referral Hospital, and Posenchey Health Center). However, we did not start collecting data at all three sites at the same time for logistical and administrative reasons, meaning the three sites entered our study approximately one week apart. Since we began data collection at NMCHC, we recruited enough study participants for Study 3 (qualitative study) in the first week. Therefore, all the study participants in Study 3 were recruited from a single facility (NMCHC).

4.4.3. Study population

The study population consisted of three homogeneous groups of men:

- **Group 1 (decliners):** Men who attended ANC with their pregnant partners and received HIV pre-test counseling but declined an offer of an HIV test.
- **Group 2 (acceptors):** Men who attended ANC with their pregnant partners, received HIV pre-test counseling, and accepted an offer of an HIV test.
- **Group 3 (ANC non-attendees):** Men who did not attend ANC even once for their partners' most recent pregnancy.

4.4.4. Inclusion criteria

- **Group 1 (decliners):** at least 18 years old and willing and able to give verbal consent.
- **Group 2 (acceptors):** at least 18 years old and willing and able to give verbal consent.
- **Group 3 (ANC non-attendees):** at least 18 years old and willing and able to give verbal consent.

4.4.5. Exclusion criteria

- **Group 1 (decliners):** previously known to be HIV-positive.
- **Group 2 (acceptors):** previously known to be HIV-positive.
- **Group 3 (ANC non-attendees):** attended ANC with a female partner at least once during her most recent pregnancy and previously known to be HIV-positive.

4.4.6. Data collection

A pre-tested semi-structured in-depth interview guide (Appendix 1) was employed to collect qualitative data. The guide was adapted from a qualitative study on the acceptance of woman–delivered HIVST by her male partner in Malawi (Choko et al., 2017).

Per experts' recommendations (Gorbach and Galea, 2007), we collected data through in-depth interviews. This method was considered the most appropriate because it allowed us to explore individuals' views delicately, and the main and probing questions were not too sensitive. Key informant interviews and focus groups were not considered appropriate because the key informant interview is better for extracting viewpoints from experts or policymakers on a particular topic. Focus groups would not work well because although the main and probing questions were not too sensitive, there may still be some aspects about which study participants may not want to speak openly in front of other men. We also did not have enough physical space to conduct focus group discussions.

Face-to-face in-depth interviews occurred in a private space at the National Maternal and Child Health Center and were conducted by male and female fourth-year students earning a Bachelor of Public Health of the University of Health Sciences in Cambodia under the supervision of the principal investigator. To quicken the process, we had one interviewer and one note-taker for each interview.

Both the interviewers and note-takers had formal training and experience in collecting qualitative data and doing verbatim transcription. Before the fieldwork, they were provided with additional training and detailed information about the study's protocol.

In group 1, to recruit 10 decliners for the final analysis, we consecutively approached 11 men who had just participated in the parent Case-Control study (one of the first 10 men declined to be interviewed due to time constraints), meaning the response rate was approximately 90%.

In group 2 (acceptors), all of the first 10 men who had just participated in the Case-Control study agreed to be interviewed, making the response rate 100%. In group 3 (ANC non-attendees), one man declined to participate because he did not want to be interviewed for personal reasons. Therefore, we had to approach a total of 11 men, which translated to a response rate of 90%.

In total, 30 interviews were conducted, lasting half an hour on average. A gift package consisting of three household items (two bars of soap and one box of toothpaste) was offered to each man who completed an interview.

Verbatim transcription was done after each interview. Transcripts were not returned to the participants for comment and/or correction and the participants could not provide feedback on the study's findings because we did not collect their names, phone numbers, or home addresses.

4.4.7. Recruitment strategy

As described in Section 4.4.1, this study employed embedded parallel mixed methods. In terms of sampling, a truly random sample may not be needed in qualitative research because qualitative variables (e.g., perceptions and opinions) are not normally distributed, and the recommended sample sizes are generally too small (less than 40) for statistical inference. However, whenever and wherever possible, selecting a random sample using systematic sampling is still the best practice (Gorbach and Galea, 2007).

When using an embedded mixed-method approach, participants can be randomly selected from a complete list of all survey respondents (Gorbach and Galea, 2007). We also considered randomly selecting participants from three separate complete lists: (1) all ANC-attending male partners at all three facilities who declined an HIV test and participated in our primary study as cases (n=132), (2) all ANC-attending male partners at all three facilities who accepted HIV testing and participated in our primary study as controls, and (3) all men who accompanied their female partners to a facility for labor and delivery (the NMCHC and Chaktomuk referral hospital, because there are no maternity services at Posenchey Health Center). However, we concluded that the approach would run into logistical and practical issues. We had anticipated that it would take at least three months to recruit 132 cases and 264 controls for the Case-Control study, and as a result, it would be difficult to re-contact the randomly selected participants for in-depth interviews (potential loss to follow-up), and they would have a hard time recalling what happened a couple of months ago during ANC or labor and delivery (potential poor recall).

Therefore, we proceeded with consecutive sampling instead of simple random sampling or systematic sampling. Consecutive sampling is generally considered the best type of non-

probability sampling (Thewes et al., 2018, Polit and Beck, 2009). Study participants were recruited as follows:

- **Group 1 (decliners):** At the ANC department at the NMCHC, some men participated in the Case-Control study as "cases" each day. Ten cases were selected by using consecutive sampling. There was no need to re-screen them for eligibility because they had already been screened once to participate in the parent Case-Control study. Verbal consent for an in-depth interview was obtained. Once the interview was completed, the participant was provided with a gift package.
- **Group 2 (acceptors):** As in Group 1, each day, some male partners participated in the Case-Control study as "controls." Ten controls were also selected by using consecutive sampling. A re-screening for eligibility was not required because they had already been screened once to participate in the parent Case-Control study. Verbal consent for an in-depth interview was obtained. Once the interview was completed, the participant was provided with a gift package.
- **Group 3 (ANC non-attendees):** Ten ANC non-attendees were recruited from the post-partum ward using consecutive sampling based on the time of birth of their babies. Men in this group had to be screened for eligibility because they had not participated in the parent Case-Control study. Verbal consent for an in-depth interview was obtained. Once the interview was completed, the participant was provided with a gift package.

4.4.8. Sample size calculation

There is no sample size calculation formula in qualitative research. However, a sample size of 10 is considered adequate for homogeneous populations (Sandelowski, 1995). Therefore, we decided to recruit only 10 decliners, 10 acceptors, and 10 ANC non-attendees. Aims 1, 2, and

3 had a sample size of 10 individuals each, and Aims 4 and 5 had a sample size of 30 individuals each.

4.4.9. Data analysis

- **Coding:** All 30 interviews were audio-taped and transcribed verbatim. All transcripts, in Khmer, were coded using NVivo 12 (QSR International, Doncaster, Australia). Each transcript was coded twice by the principal investigator to ensure accuracy and consistency.
- **Descriptive statistics:** Mean, median and range were used to describe two variables: (1) the age of the men and their pregnant partners and (2) the highest cost of an HIVST kit that men were willing to pay. Frequency and percentage were used to describe categorical variables (education, current marital status, duration of union with current female partner, number of pregnancies with current female partner, and occupation).
- **Hybrid inductive and deductive thematic analysis:** A hybrid approach allows investigators to begin coding with pre-defined codes or themes derived from prior knowledge and update the codes as they encounter new content during the coding process (Fereday and Muir-Cochrane, 2006).

All representative quotations in this study are presented in tables instead of in the text. This practice allows more of the study participants' actual words to be heard (Gorbach and Galea, 2007).

4.4.10. Protection of human subjects

Verbal consent was obtained from all research participants. All interviews were conducted in a private space within each facility to ensure privacy. Each interview was audio-recorded, but no video was taken. The study protocol was reviewed and approved by the

Institutional Review Board of the University of California Los Angeles (UCLA IRB #19-002251) and the National Ethics Committee for Health Research of Cambodia (NECHR #165) in 2020.

4.5. Results

4.5.1. Socio-demographic profile

Table 4-1 describes the background characteristics of the study population. The men's ages were as follows: decliners (mean=31.9 years, median=30 years, and range=24–41 years), acceptors (mean=27.9 years, median=27.5 years, and range=22–37 years), and ANC non-attendees (mean=31.8 years, median=32 years, and range=20–41 years).

Their current female partners were slightly younger across the three groups: decliners' partners (mean=29.3 years, median=29 years, and range=21–42 years), acceptors' partners (mean=25.5 years, median=24 years, and range=19–33 years), and ANC non-attendees' partners (mean=31.3 years, median=32 years, and range=20–40 years).

In terms of education, most men had attended or completed high school (100% for decliners, 60% for acceptors, and 70% for ANC non-attendees). Two acceptors (20%) reported attending university, while none of the ANC non-attendees did so. Regarding current marital status, all decliners and ANC non-attendees were married at the time of the interview. Only one acceptor (10%) reported being unmarried but living together.

Large proportions of decliners (70%) and acceptors (80%) reported living together for less than five years. Conversely, 90% of ANC non-attendees reported living together for over five years. Over half of the partners of decliners and ANC non-attendees were pregnant for the second or third time respectively: decliners (70%) and ANC non-attendees (80%). In contrast, among acceptors, 70% of their partners were pregnant for the first time. None of the respondents

were unemployed. Most were in the non-agricultural sector: decliners (90%), acceptors (100%), and ANC non-attendees (70%)

4.5.2. Barriers to being tested for HIV during ANC (Aim 1)

- **<u>Hypothesis</u>: Factors operating beyond the individual level prevented men from accepting an offer of an HIV test during ANC.**

The unit of analysis consisted of all ten ANC-attending male partners who declined an offer of an HIV test after receiving pre-test counseling. Data suggested that they declined the offer for several reasons that operated at different levels: individual (an absence of perceived risk of HIV infection and fear of needles) and relationship (a negative couple dynamic). Representative quotes are presented in Table 4-2.

At the individual level, regarding risk perception, eight men described themselves as at no risk of HIV largely due to at least one of the two following reasons: (1) they had not had sex with any other women during their marriage or (2) they had recently been tested for HIV with negative results *(Table 4-2: I.1–I.3).* Two men admitted that they were not afraid to test for HIV, but rather the needle *(Table 4-2: I.4).*

At the relationship level, two of the ten decliners stated that they were the only ones who made all healthcare decisions for their pregnant partners and children because they considered themselves the head of their family *(Table 4-2: R.1).* This information was used as a proxy for "a negative couple dynamic."

In summary, some ANC-attending male partners who declined an HIV test during ANC identified barriers at the individual and relationship level, confirming the hypothesis that barriers to HIV testing among ANC-attending male partners of pregnant women operated beyond the individual level.

4.5.3. Factors facilitating HIV testing during ANC (Aims 2)

- **<u>Hypothesis</u>: Factors operating beyond the individual level enabled men to accept an offer of an HIV test during ANC.**

The unit of analysis consists of all ten ANC-attending male partners who accepted an offer of an HIV test after receiving pre-test counseling. They were asked to identify factors that prompted them to accept the offer of an HIV test. Representative quotes are presented in Table 4-3.

Men accepted the test offer for multiple reasons at the individual level (a perceived risk of HIV infection, being worried about the health of one's partner and unborn child, and wanting to know one's HIV status), relationship level (personal request from his partner to accept the test offer and/or a positive couple dynamic), and health system level (the fact that the test was free-of-charge and/or a feeling of being required by a provider to test together with a pregnant partner) *(Table 4-3).*

At the individual level, four men stated that they decided to be tested because they felt at risk of HIV infection *(Table 4-3: I.1 & I.2).* One of the men explained that he had had multiple casual sexual partners in the past *(Table 4-3: I.1).* Another man said that, as a chef at a restaurant, he often had cuts on his fingers or other minor injuries, which he believed put him at risk of contracting HIV *(Table 4-3: I.2).*

Another four men considered the safety of their unborn child a priority, and they thought that if they and/or their pregnant partners tested positive for HIV, appropriate measures would be taken in a timely manner to keep their unborn baby from contracting HIV *(Table 4-3: I.3–I.4).* Three men accepted the test offer simply because they had never been tested for HIV before and wanted to know their status *(Table 4-3: I.5).*

At the relationship level, one man said that he had tested negative for HIV four or five months ago. However, his partner suspected that he may have had casual sexual partners since then, so during this ANC visit, she specifically asked to be tested again *(Table 4-3: R.1).*

At the health system level, one man agreed to be tested for HIV because he believed (mistakenly) that male partner HIV testing during ANC was a requirement. His intrinsic motivation to know his HIV status also played a role in his decision *(Table 4-3: H.1).*

All in all, men identified numerous factors that prompted them to be tested during ANC at different levels. Thus, the data confirmed the hypothesis that factors leading men to accept HIV testing operated beyond the individual level.

4.5.4. Barriers to attending ANC with pregnant partners (Aim 3)

- **<u>Hypothesis</u>: Factors operating beyond the individual level prevented men from attending ANC with their pregnant partners.**

The unit of analysis consisted of all ten men who did not attend ANC at least once with their current female partners during their most recent pregnancy. The men were asked to identify factors that prevented them from doing so. Representative quotes are presented in Table 4-4.

The data suggested men did not attend ANC due to several factors operating at different levels: individual (busy at work, waiting outside the health facility, and a negative attitude toward male ANC attendance), relationship (a negative couple dynamic), community (a negative community attitude toward accompanying pregnant partners to ANC) and health system (not being invited by providers to come inside the ANC check-up room) *(Table 4-4).*

Regarding barriers at the individual level, about half of the men said that their work schedules simply did not allow them to accompany their partners to a health center for routine ANC check-ups *(Table 4-4: I.1–I.3).* One of the men told us that he worked in the fishing

industry and spent most of his time at the fishing site *(Table 4-4: I.2).* Another man worked in construction, where it is not easy for him to take a day off without emergency reasons, as he could be fired *(Table 4-4: I.3).*

A total of three men reported that they accompanied their pregnant partners to a health center but were not physically present with them for the whole ANC consultation. One of them did not want to pay for a motorcycle parking fee *(Table 4-4: I.4),* and another was busy watching over an older child *(Table 4-4: I.5).*

In terms of individual negative attitude toward male partner ANC attendance, a couple of men believed that their physical presence during the whole ANC check-up was not important *(Table 4-4: I.6-I.8).* The first man agreed that a man was supposed to attend ANC with his pregnant partner, but if she could do it alone, that would also be fine *(Table 4-4: I.6).* The second man argued that he would not be worried about his partner during her unaccompanied ANC visits because he assumed that she would be well taken care of by the providers at the facility and that there would be relevant information, education, and communication (IEC) materials (e.g., posters) hung on the walls at the facility, so she could read them on her own for more information *(Table 4-4: I.7).* The third man at first believed that it was okay to not attend ANC with his partner but later felt guilty after learning that other men attended ANC with their partners *(Table 4-4: I.8).*

At the relationship level, two men expressed a negative couple dynamic. Both said that they commonly made decisions on health-related matters for their partners and children because they perceived themselves as the heads of the family *(Table 4-4: R.1).*

At the community level, one man said that he had been mocked by his neighbors when he told them he was planning to accompany his pregnant partner to ANC, with them asking him:

"Why do you have to accompany her to the health center? Let her ride a motorcycle to the health center on her own!" or "Although she does not work and always stays home, she still doesn't want to ride a motorcycle to the health center on her own!" *(Table 4-4: C.1).*

At the health system level, two men reported accompanying their pregnant partners to the health center. Unfortunately, the ANC providers only invited their partners to the ANC check-up room, for unknown reasons *(Table 4-4: H.1 & H.2).*

To sum up, the data confirmed the hypothesis that barriers to attending ANC among male partners of pregnant women operated beyond the individual level.

4.5.5. New HIV testing alternatives (HB-HTC and HIVST)

A hybrid approach of inductive and deductive thematic analysis was used to identify the perceived benefits, concerns, and men's preferences regarding each HIV testing alternative. The unit of analysis for each alternative was all 30 male partners of pregnant women (10 decliners, 10 acceptors, and 10 ANC non-attendees).

4.5.5.1. Home-based testing and counseling (HB-HTC)

- **Perceived benefits of HB-HTC**

The vast majority of men (n=24) described HB-HTC as convenient, time-saving, cost-saving, private, and conducive to creating or maintaining trust among all members of the household through mutual disclosure of test results, whereas the remaining six men could not think of potential benefits of being tested for HIV at home *(Table 4-5: PB.1–PB.13).*

Regarding privacy, two men (one decliner and one acceptor) stressed that being tested for HIV at home by a trained provider would provide more privacy than being tested at a health facility. At a facility, the men feared that they might run into familiar faces, and having

conversations with them about HIV testing would be embarrassing and awkward *(Table 4-5: PB.11)*.

Lastly, three non-ANC-attending men indicated that with HB-HTC, their family members could be present with them during the testing process, and such arrangement would prove that they are good partners and fathers *(Table 4-5: PB.12 & PB.13)*.

- **Perceived concerns about HB-HTC**

Almost all men (n=28) identified one or more concerns about being tested for HIV at home: worry that neighbors would be suspicious, not being home at the time of the visit, an inability to verify the identity of the testing team, feeling coerced into testing, feeling offended by a home visit, the potential for contamination of testing instruments, confidentiality breaches by the testing team, and poor or improper management of biological specimens *(Table 4-5: PC.1–PC.16)*.

Remarkably, many men (n=23, with 7 decliners, 8 acceptors, and 8 ANC non-attendees) were worried that a home visit by an HIV testing team would provoke suspicions from people in their community (e.g., neighbors and villagers) that someone in their family had been infected with HIV. Such conjecture could potentially lead to discrimination against the family in question *(Table 4-5: PC.1–PC.7)*.

"Not being home at the time of the visit" and "an inability to verify the identity of the HIV testing team" were the second and third most reported concerns. Specifically, five men (two decliners, two acceptors, and one ANC non-attendee) stated that they would not be home during regular business hours due to work *(Table 4-5: PC.8 & PC.9)*. The non-attendee explained further that he would welcome a home visit, but his wife would have to phone him from the health facility to arrange it *(Table 4-5: PC.9)*.

Four men (one decliner and three ANC non-attendees) voiced deep concerns over the verifiability of the identity of the testing team. One of the non-attendees recalled a massive iatrogenic outbreak of HIV in a rural commune (Roka, in Battambang province) in late 2014. It was caused by an unlicensed, self-proclaimed medical doctor who reused syringes and needles for injections *(Table 4-5: PC.10).* Another non-attendee recommended that the testing team be escorted by local authorities, without which he would not agree to be tested *(Table 4-5: PC.11).*

One acceptor felt that a home visit by the HIV testing team would qualify as coercion *(Table 4-5: PC.12).* Another acceptor said that he would feel offended if a health provider came to test him for HIV at his home. He would rather go to a health facility on his own if he wanted to test for HIV *(Table 4-5: PC.13).* One decliner was also worried that portable instruments used to perform the testing could be contaminated *(Table 4-5: PC.14).*

Two men (one decliner and one ANC non-attendee) were worried that their HIV test results would not be kept confidential, with results accidentally or intentionally leaked by the testing team *(Table 4-5: PC.15).* Another man assumed that the team would visit many homes and draw blood from multiple people in a single day, before sending all of the specimens to a laboratory. He was worried that the specimens might be miscoded or otherwise mismanaged *(Table 4-5: PC.16).*

4.5.5.2. HIV self-testing (HIVST)

- **Perceived benefits of HIVST in general**

The HIVST kit is a new product that virtually none of the 30 men had ever heard of. After being introduced to it, men (n=27) in the three groups identified the following perceived benefits of HIVST: confidentiality, privacy, convenience, time savings, rapid results, sophisticated technology, and a lack of the stigma associated with seeking testing at a facility;

however, the remaining three men (two decliners and one ANC non-attendee) could not think of any. The first four benefits (confidential, private, convenient, and time-saving), as anticipated, were the most cited (n=25). HIVST can be performed at home and at any time, reducing logistical constraints (e.g., transportation costs and long waiting times at a health center) *(Table 4-6: PB.1–PB.8).*

Among the 27 men, three believed that HIVST would be the best choice for men who do not want anybody else, including health providers, to know if they test positive for HIV *(Table 4-6: PB.6 & PB.7).* Two men (one decliner and one ANC non-attendee), who reported a fear of needles, said that oral HIVST would be an attractive option because its sophisticated technology would allow individuals to collect only a few drops of saliva to perform the self-test. There would be no pain associated with the approach *(Table 4-6: PB.8).*

Another man thought that single men would find it particularly attractive because they may be more likely to feel shy and embarrassed than men who are in a union or divorced when seeking testing at a health facility *(Table 4-6: PB.9).*

- **Perceived concerns about HIVST in general**

Most men (n=25) also came up with one or more perceived problems of HIVST: a lack of pre-and post-test counseling leading to an increased chance of developing depression, committing suicide, or harming others; a reduced chance of disclosing test results to one's partner; a reduced chance of being linked to care; questionable reliability/accuracy of the test kit; instructions of use potentially in foreign languages (e.g., English or French); and a lack of experience using the kit. The remaining five men could not think of any such drawbacks *(Table 4-6: PC.1–PC.15).*

Specifically, a couple of men were seriously worried that, for those with reactive (respondents called it "positive") test results, a lack of proper counseling could lead to extremely damaging individual and/or community/societal consequences such as ill-intentioned contemplation of transmitting HIV to other innocent people in their communities *(Table 4-6: PC.2)* and depression or suicidal thoughts *(Table 4-6: PC.3).*

Some men indicated that a lack of mutual disclosure among couples may prove to be counterproductive and damaging. In other words, if men or their partners choose to do the self-test alone and then hide the test results from one another, they would create huge mistrust in the family *(Table 4-6: PC.5, PC.7 & PC8).*

Four men expressed concerns that although confidentiality is one of the major appeals of HIVST, it could also lead to a reduced chance of being linked to care as men may not know what to do, where to go, and whom to contact if their test was reactive *(Table 4-6: PC.11).*

Some men (n=7) also questioned the reliability or accuracy of the kit *(Table 4-6: PC.12 & PC.13).* In addition, three men were worried that the instructions of use would potentially be in foreign languages (e.g., English or French), stating that if the product is available in Cambodia in the future, instructions should be in Khmer *(Table 4-6: PC.14).* One man was concerned that he may not know how to use the kit correctly *(Table 4-6: PC.15).*

- **HIVST distribution modalities (pregnant woman–delivered vs. community pharmacy)**
  - **Free-of-charge pregnant woman–delivered HIVST (secondary distribution of HIVST)**

Men were asked to pinpoint perceived benefits of and barriers to each distribution mechanism. Almost all of the respondents (n=25) viewed the pregnant woman–delivered HIVST approach as a perfect choice for busy men who could not afford to take time off from work to

accompany their pregnant partners to a health facility for routine ANC, especially if the kit is free of charge. Perceived benefits of the woman–delivered approach are as follows: convenience, cost (free), time savings, ability to be performed in the presence of the female partner at home, and ability to disclose the result to the partner upon self-testing *(Table 4-7: WD.1-WD.7).*

At the same time, potential concerns regarding the pregnant woman–delivered mechanism were also raised by a small fraction of men (n=4), including questionable accuracy of the self-test kit, difficulty using the kit correctly, questions about why the provider or his partner wanted him to be tested, and fear of self-testing *(Table 4-7: WD.8-WD.11).* For instance, one man stated that even if the provider gave crystal clear instructions to his partner, and his partner in turn correctly explained to him how to use it, he would still not trust the result because the product was too new or unfamiliar to him. He would also wonder why the provider wanted him to be tested *(Table 4-7: WD.9).* Another man reported that the thought of testing for HIV at a proper health facility would already be nerve-racking, let alone self-testing for HIV at home *(Table 4-7: WD.11).*

- **<u>Out-of-pocket community pharmacy–delivered HIVST</u>**

Making HIVST available at community pharmacies was endorsed by about half of the men (n=15: 8 decliners, 6 ANC non-attendees, and 5 acceptors). In other words, the men liked the idea of the kit being commercially available at community pharmacies, stating that they would buy it when needed. They perceived such availability as convenient, time-saving, quick, and confidential *(Table 4-8: CP.1–CP.5).*

Regarding convenience, cited by 9 men (5 decliners, 3 ANC non-attendees, and 1 acceptor), being able to buy a kit from a pharmacy would allow men to self-test whenever they felt at risk of contracting HIV or whenever they wanted to know their HIV status without

traveling long distances to a health facility to be tested *(Table 4-8: CP.1 & CP.2).* By avoiding a trip to a facility, 3 men (2 acceptors and 1 ANC non-attendee) described the community pharmacy option as time-saving *(Table 4-8: CP.3).*

Concerning confidentiality, 2 men (1 acceptor and 1 ANC non-attendee) stated that if they thought that they might have been exposed to HIV and if the kit were available at a pharmacy, they would simply buy it and then self-test secretly without telling anyone about it, including their partners *(Table 4-8: CP.4 & CP.5).*

However, potential concerns about community pharmacy–delivered HIVST were brought up by approximately one-third of the men (n=11: 2 decliners, 5 acceptors, and 4 ANC non-attendees). They described factors that might prevent them from purchasing the kits at the pharmacies: low availability, feeling shy or embarrassed when purchasing the kits, cost, the potential lack of technical assistance from pharmacy personnel, being unable to get an official test result slip, the questionable quality of test kit, and cost *(Table 4-8: CP.6–CP.10).*

In terms of availability, one man (acceptor) stated that he would not know which pharmacies sell the kit *(Table 4-8: CP.6).* Another (ANC non-attendee) was concerned that pharmacy personnel would not be well equipped, trained, or willing to provide him with technical assistance, for example by helping him interpret the self-test result *(Table 4-8: CP.8).*

A couple of men (2 acceptors and 1 ANC non-attendee) felt uneasy about the questionable quality of the HIVST kits sold at private pharmacies, with one of them saying that he would only use a kit directly distributed by a health facility *(Table 4-8: CP.9).* A false reactive or non-reactive HIV test result could have a significant psychological impact.

HIVST kits sold at community pharmacies would not be free. Therefore, all men were asked about the highest price they would be willing to pay for a kit. Some men said that it should

be similar to that of a home pregnancy test. For men who declined an HIV test during ANC visit, an acceptable price range was 0.25–4 USD (mean=2.1 USD, median=2.5 USD); and for men who accepted HIV testing during an ANC visit, the range was 1.25–10 USD (mean=3.7 USD, median=2 USD). Men who did not attend ANC with their pregnant partners were willing to pay drastically more (range=0.5–50 USD, mean=11.3 USD, median=4 USD).

4.5.5.3. Men's most preferred testing modality

All 30 male partners were asked to select one out of four HIV testing options in the hypothetical event that their female partners become pregnant again in the future. The four options were: (1) free-of-charge ANC-based HTC, (2) free-of-charge home-based HTC, (3) free-of-charge pregnant woman–delivered HIVST, and (4) out-of-pocket community pharmacy–delivered HIVST.

Two-thirds of men said that they would choose free-of-charge ANC-based HTC (n=20). They briefly gave a wide range of reasons behind their selections such as being able to kill two birds with one stone (accompanying his wife to ANC and being tested for HIV at the same time), being able to receive proper pre-and post-test counseling, being able to take the test together and mutually disclosure the results, an acceptable level of confidentiality, the cost (free), the effect of maintaining or building trust among couples, and the accuracy of the test results *(Table 4-9: UC.1 – UC.6)*.

Six men said that they would go with HIVST if it was a possibility in the future. Specifically, 3 men (1 decliner, 1 acceptor, and 1 ANC non-attendee) would be interested in the pregnant woman–delivered HIVST approach as it is convenient, time-saving, free-of-charge, and painless, and they were generally willing to try the new product *(Table 4-9: UC.7 & UC.8)*. The

remaining 3 (all acceptors) would prefer to purchase the kit from a community pharmacy because they believed that would be convenient and quick *(Table 4-9: UC.9 & UC.10).*

If it were to be made available in the future, 4 men (2 decliners and 2 ANC non-attendees) would opt for free-of-charge HB-HTC because of the high degree of privacy, the reduced chance of a road accident, the convenience, and the time savings *(Table 4-9: UC.11–UC.13).*

4.5.6. Men's suggestions for increasing HIV testing (Aim 5)

At the end of each interview, all 30 men were asked to suggest potential strategies that could be implemented by health authorities to increase HIV testing coverage among male partners of pregnant women.

Approximately one-third of the men could not think of any. Among those who could (n=18), a wide range of potential measures were brought up: (1) use mass media to increase community awareness about the benefits of male HIV testing during their partners' pregnancies, (2) set up community-based/mobile testing venues, (3) provide HIV pre-test counseling to all ANC-attending male partners, (4) hang educational posters on the walls of all health facilities about the benefits of testing, (5) make male partner testing during ANC visits mandatory, and (6) provide HIV testing and counseling services at health facilities on Sundays (*Table 4-10*).

To illustrate, 10 men (3 decliners, 4 acceptors, and 3 ANC non-attendees) suggested that health authorities launch campaigns to increase awareness about the benefits of male partner HIV testing during pregnancy through television and community meetings, specifically targeting male partners as they are generally the driver of heterosexual transmission of HIV among couples *(Table 4-10: GS.1–GS.6).*

In addition, 2 men (1 decliner and 1 ANC non-attendee) believed that making HIV testing available at other specific locations in the community would be attractive, as men do not have to go to a health facility *(Table 4-10: GS.7 & GS.8)*.

Three acceptors insisted that ANC providers dedicate more time or effort to explaining the benefits of male partner HIV testing *(Table 4-10: GS.9 & GS.10)*. One said that he had not received any information about male partner testing during his previous ANC visits with his partner, and as a result, he continued to mistakenly believe that only testing his partner for HIV would be sufficient. Fortunately, during the most recent ANC visit, he was provided with the information and agreed to be tested without hesitation *(Table 4-10: GS.10)*.

One man (acceptor) thought that hanging IEC materials on walls of health facilities (e.g., posters) would be helpful because men could read them on their own *(Table 4-10: GS.11)*. Another man (decliner) wished that health authorities would make male partner HIV testing mandatory *(Table 4-10: GS.12)*. Another suggested that making HIV testing and counseling available at health facilities during weekends, especially on Sundays, would likely help working men *(Table 4-10: GS.13)*.

Some of the proposed interventions were at the community level (e.g., awareness-raising campaigns) and others were at the health system level (e.g., providing counseling to all ANC-attending male partners, posting educational posters, providing services on Sundays, and making testing of male partners mandatory). Interestingly, men could not or did not generate potential interventions at individual and relationship levels.

4.6. Discussion

This study, which was nested within the primary study (unmatched Case-Control study), had five aims: (1) identify barriers to accepting HIV testing among decliners, (2) identify

facilitators to accepting HIV testing among acceptors, (3) identify barriers to attending ANC among ten men who did not attend ANC with their female partners at least once during the most recent pregnancy, (4) explore male partners' perceived benefits of and concerns about four HIV testing and counseling alternatives and their preferred testing modality, and (5) solicit suggestions on how to persuade more male partners of pregnant women to be tested for HIV. The conceptual framework was adapted from a study of male partners of pregnant women in Malawi (Choko et al., 2017).

For **Aim 1**, we hypothesized that barriers operating beyond the individual level had prevented the decliners from accepting an HIV test offer at ANC settings. The data confirmed that the men cited barriers operating at two levels (individual and relationship). These findings are partly supported by the Malawi study. Specifically, in our study, male partners cited only two individual-level factors: (1) fear of needles and (2) an absence of or low perceived risk of HIV infection before that particular ANC visit either because they had not had any casual sexual partners or had recently tested negative for HIV. By contrast, the Malawian men cited completely different individual-level factors (fear of stigma, a perceived lack of confidentiality, fear of blame, fear of divorce, and fear of a partner's reaction). Such a discrepancy could be due to the studies' slightly different populations. The men in our study were all recruited from the ANC setting, meaning they had attended ANC with their pregnant partners but declined an HIV test, while the men in the Malawi study were recruited after obtaining their contact information from their ANC-attending female partners, indicating that they most likely did not attend ANC with their pregnant partners (Choko et al., 2017). These two groups of men, therefore, may have had different background HIV risks to begin with. However, other studies with the same or similar populations have also reported the same two individual-level factors: no perceived risk of

HIV (Lolekha et al., 2014, Pollahan et al., 2019, Yee et al., 2020) and fear of needles (Lolekha et al., 2014, Yeganeh et al., 2017, Ehiri et al., 2016).

For **Aim 2**, we hypothesized that factors operating beyond the individual enabled or pushed the acceptors to accept HIV testing offer during ANC, which was confirmed by our findings. The acceptors cited reasons at the individual level (feeling at risk of HIV infection prior to that particular ANC visit, being worried about the health of their partner and unborn child, and wanting to know their HIV status), the relationship level (partner communication, meaning a request by their pregnant partners to be tested), and the health system level (the perception of a strong push from providers to be tested).

For **Aim 3**, we hypothesized that factors operating beyond the individual level prevented ANC non-attendees from attending ANC with their partners, which was confirmed by the data. ANC non-attendees described factors operating at the individual level (being busy at work, waiting outside the health facility for various reasons, and a negative attitude toward male ANC attendance), the relationship level (men taking healthcare decisions alone as they considered themselves to be heads of the family), the community level (a negative attitude toward male ANC attendance), and the health system level (not being invited by ANC providers to come inside the consultation room).

According to the literature, male partners in other countries have also expressed individual-level difficulties, for example, being away from work or other income-generating activities (Larsson et al., 2010, Byamugisha et al., 2010, Orne-Gliemann et al., 2010, Reece et al., 2010, Falnes et al., 2011, Vermeulen et al., 2016, Ongolly and Bukachi, 2019, Choko et al., 2017, Boniphace et al., 2021). Like some male partners in our study, those in other countries also believed that their presence during ANC was not important unless problems arose (Vermeulen et

al., 2016, Mohlala et al., 2012). However, waiting outside the facility watching over an older child or not wanting to pay for a parking fee was unique to our study because we explicitly defined male ANC attendance as accompanying a pregnant partner to a health facility AND remaining physically present during the entire ANC consultation. Other studies only included men who did not accompany their pregnant partners to a health facility.

At the relationship level, some Cambodian ANC non-attendees reported that they generally made all health care decisions for all members of their households, without any discussion with their female partners. Several studies have shown that pregnant women have better maternal outcomes when they make family decisions jointly with their partners, especially on health-related matters. For instance, in Nigeria and Ethiopia, pregnant women who made family decisions jointly with their partners were more likely to attend the recommended four or more ANC visits than those who did not have a voice in the matter (Ononokpono et al., 2013, Gudayu, 2015, Ononokpono and Azfredrick, 2014).

At the community level, similar to one Cambodian man who was ridiculed by his neighbors when talking about attending ANC with his wife, a Malawi man was mocked when he told some friends that his wife had asked him to come to an ANC clinic (Choko et al., 2017), and a Tanzanian counterpart explained that people in his community would judge a man negatively when he was seen escorting his wife to an ANC clinic, saying, “This man has been charmed by his wife” (Boniphace et al., 2021).

At the health system level, some ANC non-attendees reported that they had, in fact, escorted their wives to a health facility for ANC in the past, but had never been called into the ANC consultation room. This suggests that if Cambodian men are invited or requested to come into the ANC room, they would comply. Along similar lines, male partners in Africa have faced

negative attitudes by staff (Theuring et al., 2009, Reece et al., 2010, Ongolly and Bukachi, 2019), a lack of common courtesy from staff, not being allowed to enter the ANC clinic with their partners (Byamugisha et al., 2010, Theuring et al., 2009, Larsson et al., 2010), and a reluctance by staff to encourage male attendance to ANC (Misiri et al., 2004). In general, some men felt unwelcome and disrespected (Larsson et al., 2010).

For **Aim 4**, we did not test a hypothesis but conducted a thematic analysis to explore thirty male partners' perceived benefits of and concerns about three HIV testing and counseling alternatives (HB-HTC and two forms of HIVST) and their preferred choice out of the four testing options (the three just described, plus conventional HTC at the ANC clinic). First, with regards to HB-HTC, Cambodian men perceived the benefits as follows: convenient, time-saving, cost-saving, private, and conducive to creating trust among all members of the household through mutual disclosure of test results. Men in a qualitative study conducted in Malawi and Zambia similarly described HB-HTC as acceptable, convenient, time-saving, and money-saving (given the costs of transportation) (Hershow et al., 2019). Male partners of pregnant/postpartum women in Lesotho thought that HB-HTC would be comfortable and constitute a supportive environment for testing and counseling couples and families together (Mantell et al., 2014). Male partners in Western Kenya found HB-HTC more private than ANC settings (Krakowiak et al., 2020).

Unsurprisingly, Cambodian male partners also expressed concerns about HB-HTC: worries that neighbors would be suspicious, not being home at the time of the visit, the potential difficulty verifying the identity of the testing team, the potential for contamination among testing instruments, fear of confidentiality breaches by the testing team, poor or improper management of biological specimen, and logistical constraints on the part of the HIV testing team. Male

partners in other countries expressed similar concerns about HB-HTC: in Malawi and Zambia, missing the visit because of being busy at work, the lack of privacy or confidentiality, and the potential for community-level HIV/AIDS-associated stigma and discrimination among men (Hershow et al., 2019), and, in Lesotho, the lack of confidentiality/privacy, potential coercion to test, conflict within the family, and fear of HIV/AIDS-associated stigma among men (Mantell et al., 2014).

Second, concerning HIV self-testing (HIVST) in general, male partners of pregnant women in our study described it as confidential, convenient, time-saving, quick, high-tech, and having less stigma than that which is associated with seeking HIV at a health facility. A separate qualitative study conducted in Cambodia on the acceptability of HIVST among three HIV key populations (transgender women, men who have sex with men, and entertainment workers) also showed that they perceived HIVST as confidential, convenient, time-saving, and high-tech (Pal et al., 2016); though the two study populations were different, their perceived benefits of HIVST did not greatly diverge, with reduced stigma the only notable exception. Specifically, among Cambodian male partners of pregnant women, HIVST constitutes an approach that could help them avoid the embarrassment caused by seeking HIV testing at a health facility. Nevertheless, none of the key population members said that HIVST would help them with the stigma issue, and this could be partly explained by the fact that the Ministry of Health of Cambodia and partner local/international non-governmental organizations have been implementing HIV/AIDS interventions on the key populations for decades. As members of those populations have long been provided with regular HIV testing and counseling services, seeking HIV testing at a health facility is likely no longer considered something to be ashamed of.

With free-of-charge pregnant woman–delivered HIVST, most respondents described it as a perfect choice, particularly for busy men who cannot afford to take time off from work to accompany their pregnant partners to a health facility for routine ANC. They provided several reasons, namely that it is convenient, free of charge, time-saving, able to be done with the female partner at home, and allows for immediate disclosure of the test result to the partner. Those in Malawi and Zambia similarly believed that woman–delivered HIVST would be convenient, ensure confidentiality, allow them to avoid the clinic, and, interestingly, to do testing alone (Hershow et al., 2019). Those in Zambia and Malawi also reported similar perceived benefits: convenience, removal of stigma associated with men attending ANC and testing for HIV, and confidentiality (Choko et al., 2017).

Cambodian male partners also raised potential concerns about HIVST in general: a lack of pre-and post-test counseling, a lack of test results disclosure to partners or healthcare providers, a lack of linkage to care, questionable reliability/accuracy, instructions of use in foreign languages, and a lack of experience or familiarity with the kit. Our findings are mostly consistent with other studies (Pal et al., 2016, Hershow et al., 2019). With free-of-charge woman–delivered HIVST, in addition to the general concerns about HIVST cited above, Cambodian men particularly had questions about why the provider or his partner wanted him to be tested for HIV. Men in Malawi and Zambia shared this concern, as such a request might make men suspicious that their partner was engaging in promiscuous behavior (Hershow et al., 2019).

Regarding out-of-pocket community pharmacy–delivered HIVST, Cambodian male partners thought it would be convenient, time-saving, and quick. They would be able to know their HIV status confidentially because they could buy it and then self-test secretly without telling anyone about it, including their partners.

In addition to the general concerns about HIVST described above, some specific concerns related to community pharmacy–delivered HIVST were also raised: low availability of HIVST kits, feeling shy or embarrassed when purchasing the kits, cost, the potential lack of technical assistance provided by pharmacy personnel, the questionable quality/reliability of the test kit, and being unable to get an official test result slip. There does not appear to be any other study focused on male partners of pregnant women, making direct comparisons impossible. Still, in a pilot study in Kenya, general pharmacy clients raised concerns about and perceived benefits of HIVST largely similar to our findings (Mugo et al., 2017).

Free-of-charge HIVST would be welcomed by male partners in our study. However, if they did need to pay for it, an acceptable price range would be 0.25–4 USD (mean=2.1 USD and median=2.5 USD) among decliners, 1.25–10 USD (mean=3.7 USD and median=2 USD) among acceptors, and 0.5–50 USD (mean=11.3 USD and median=4 USD) among ANC non-attendees. It is important to note that a few outliers, especially in the ANC non-attending group, affected the mean. Most respondents thought that HIVST kits and home pregnancy test kits should be priced similarly, and a home pregnancy test kit in Cambodia generally costs less than 5 USD, depending on the brand.

In a previous study conducted on key populations in Cambodia, respondents also gave an acceptable price range for an HIVST kit in Cambodia: transgender women (range=1.25–10 USD, mean=3.1 USD, and median=2.5 USD), female entertainment workers (range=0.5–12 USD, mean=4.2 USD, and median=3 USD) and men who have sex with men (range=0.5–10 USD, mean=3.7 USD, and median=1.5 USD) (Pal et al., 2016). The findings from both studies combined suggest that an HIVST kit should not cost more than 5 USD to attract people to buy it.

For **Aim 5**, we solicited all thirty men's suggestions on how best to increase HIV testing among male partners of pregnant women. Hypothetical interventions included the following: (1) use mass media to increase community awareness about benefits of male partner HIV testing during pregnancy, (2) set up community-based/mobile testing venues (3) provide HIV pre-test counseling to all ANC-attending male partners, (4) hang educational posters about benefits of male partner HIV testing during pregnancy on walls across all health facilities, (5) make male partner HIV testing during pregnancy or ANC visit mandatory, and (6) provide HIV testing and counseling at health facilities on Sundays.

For (1) and (2), a study conducted by the WHO found that reproductive health programs that combined different types of intervention, in particular community outreach, mobilization, and mass media campaigns, were the most effective in achieving behavioral or health outcomes, meaning that medical interventions at health system level alone would not be as effective (Barker et al., 2007). Therefore, it seems clear that multiple strategies used together would be most effective.

For (3), it is obvious that some men in our present study were not aware of the availability of male partner HIV testing and counseling services at the ANC unit despite having visited ANC with their female partner multiple times in the past. This lack of awareness suggests that not all midwives are fully ready to involve men in PMTCT programs. Studies conducted in other countries have reported that most PMTCT programs are woman-centric (Clark et al., 2020, Misiri et al., 2004, Aarnio et al., 2009).

For (4), some male partners thought that hanging IEC materials (e.g., posters, leaflets, and videos) on the walls of health facilities would be useful in informing men of the benefits of male partner HIV testing during pregnancy because they could read them on their own.

According to the latest edition of the National Guidelines for the Prevention of Mother-to-Child Transmission of HIV and Syphilis, such materials have positively changed the knowledge, attitudes, and practices of clients and service providers (NMCHC, 2016). The messages in the materials would need to point out the benefits of specifically *male* ANC attendance and HIV testing and counseling.

For (5), some Cambodian men believed that making male partner HIV testing mandatory during pregnancy or ANC visits would force men to attend ANC and accept HIV testing. However, such a strategy would run into challenging ethical issues, as shown by several pilot studies in Africa. In the pilots, pregnant women who did not bring their partners to ANC were denied all ANC-related services, which resulted in critically late entry into ANC for some (Mgata and Maluka, 2019, Mamba et al., 2017, Peneza and Maluka, 2018). Such a strategy could have a similar effect in Cambodia.

For (6), to address barriers to attending ANC and being tested for HIV with pregnant partners, some men suggested that ANC and HIV testing services be offered during the weekend, especially on Sundays. Such a strategy has been piloted in Africa with mixed results. For instance, a pilot in Nairobi (Kenya) did not see much impact from the expanded clinic hours (Katz et al., 2009), while another in Lusaka (Zambia) did see a meaningful increase of participation of ANC attendance and HIV testing among couples (Allen et al., 2003). In Cambodia, although such a strategy would certainly be welcomed by couples, it remains to be seen if it would be acceptable to health providers. A recent health system review by the WHO describes challenges to Cambodia's health infrastructure and workforce, such as maintaining a viable rural health workforce that is proportionally distributed across urban and rural areas, the need to develop more expertise in more medical and nursing specialties, and widespread dual

practice by government staff (meaning that many medical professionals hold more than one job). A recent survey conducted by the University of Health Sciences (Cambodia) found that this was true of almost half of its graduates (Khim et al., 2020). In addition, low salaries and limited incentives are common topics raised by providers in the public sector (WHO, 2015b). Therefore, without a proper incentivizing mechanism, expanding ANC and HIV testing services into weekends could potentially receive strong pushback from health providers.

- **Strengths and limitations**

This study has several strengths. First, it is the first in Cambodia to explore concerns about and perceived benefits of home-based HTC and HIV self-testing among male partners of pregnant women (n=30). It, therefore, provides much-needed knowledge for launching a pilot study of the two approaches in this specific population and potentially in other populations as well (e.g., the general population and targeted general populations). Cambodia's targeted general populations include both in-country migrants (factory workers, construction workers, taxi drivers, moto-taxi drivers, etc.) and out-country migrants and their partners, pregnant women who never visit ANC or are never tested for HIV, and partners or ex-partners of people living with HIV or in key populations.

Second, although qualitative research is more a hypothesis-generating than a hypothesis-testing method, it has helped build a more complete picture of what drove men to decline or accept HIV testing during ANC and prevented them from attending ANC with their pregnant partners in the first place.

Our study also has limitations. First, the two testing approaches (home-based HIV testing and counseling and HIV self-testing) were hypothetical, meaning none of the thirty male partners experienced them. They were only able to identify "perceived" benefits of and concerns about

each approach. A pilot study would enable study participants to identify the actual benefits of and concerns regarding each approach. Second, since this is a qualitative study with small sample sizes and consecutive sampling, a form of convenience sampling, the results were not representative of our target populations (all Cambodian HIV testing decliners, acceptors, and ANC non-attendees). Third, as all in-depth interviews were done face-to-face and one-on-one, a potential social desirability bias still could not be ruled out despite the interviewers being well trained. Fourth, the study did not include other key stakeholders (e.g., ANC providers, community leaders, community health volunteers, community pharmacy owners or staff, or health policymakers). Compared to the long-established ANC-based HIV testing and counseling mechanism, home-based HTC and HIV self-testing require new arrangements (e.g., logistics, counseling, and linkage to confirmatory testing and care). Hence, stakeholders' insights into the two approaches would be helpful.

4.7. Conclusion

The present study confirmed our three hypotheses. For the first hypothesis, ANC-attending male partners identified barriers to accepting HIV testing at the individual level (a fear of needles and an absence of perceived risk of HIV infection) and the relationship level (a negative couple dynamic, with men taking healthcare decisions alone). For the second hypothesis, ANC-attending male partners reported factors operating at more than one level as well: individual (feeling at risk of HIV infection, being worried about the health of wife and unborn child, and wanting to know one's HIV status), relationship level (partner communication, or being personally asked by their pregnant partners to be tested for HIV during ANC), and health system (a strong perceived push or endorsement from providers to be tested). For the third hypothesis, ANC non-attending male partners brought up barriers to attending ANC at more than

one level: individual (being busy at work, waiting outside the health facility watching over an older child or not wanting to pay for a motorcycle parking fee, and having a negative attitude toward male ANC attendance), relationship (a negative couple dynamic), community (a negative attitude toward male ANC attendance), and health system (not being invited by ANC providers to come into the ANC consultation room). Therefore, the findings, in general, suggest that whether men accept or decline HIV testing during ANC or attend ANC with their pregnant partners is not just influenced by individual-level factors, but also by factors at the level of their relationship, community, and health system. To increase HIV testing acceptance during ANC and ANC attendance rates among male partners of pregnant women, interventions operating beyond the individual level are needed.

In terms of home-based HIV testing and counseling, men reported perceived benefits such as convenience, time savings, cost savings, privacy, and the ability to create/maintain trust among all members of the household through mutual disclosure of test results. In contrast, men were also worried about problems such as suspicious neighbors, not being home at the time of the visit, an inability to verify the identity of the testing team, the potential for contamination of testing instruments, potential breaches of confidentiality by the testing team, and poor or improper management of biological specimens. Without addressing these concerns, home-based HTC may not be highly effective in reaching men who do not want to be tested for HIV during ANC and who cannot or do not attend ANC with their pregnant partners.

Regarding HIV self-testing in general, men perceived it as confidential, convenient, time-saving, quick, high-tech, and with a reduced stigma. Woman–delivered HIVST was considered the best choice for busy men who cannot afford to take time off from work to accompany their pregnant partners to a health facility for routine ANC, especially if the kit is free of charge.

Perceived benefits of the woman–delivered approach were as follows: convenient, free of charge, time-saving, being able to do the self-test with the presence of the female partner at home, and being able to disclose the test result to the partner upon self-testing. They also stated that they would trust the quality or authenticity of the HIVST kit as long as it was distributed by providers at the health facility. Regarding community pharmacy–delivered HIVST, men believed that it would be convenient, time-saving, and confidential.

With respect to HIV self-testing in general, men's perceived concerns include a lack of pre-and post-test counseling (leading to a reduced chance of disclosing test results to a partner or healthcare professional, a lack of referrals to care, and an increased chance of developing depression, committing suicide, or harming others), questionable reliability/accuracy of the test kit, instructions of use in foreign languages, and a lack of experience using the kit. With woman–delivered HIVST, men were concerned about the accuracy of the self-test kit, not being capable of using the kit correctly, questions about why the provider or his partner wanted him to be tested, and being scared to self-test. With community-pharmacy delivered HIVST, several concerns were elicited: low availability, feeling shy or embarrassed when purchasing the kits, the cost, the potential lack of technical assistance provided by pharmacy personnel, the questionable quality of test kit, and the inability to get an official test result slip from the pharmacy. While men were enthusiastic about HIV self-testing, their concerns must be taken into account when designing and planning a pilot study in the future.

To sum up, ANC-based HTC has been a cornerstone of HIV testing and counseling for pregnant women and their male partners for the past decade. The approach has led approximately 90% of pregnant women to be tested for HIV. However, for the past several years, consistently less than 20% of male partners of pregnant women have received HIV testing. The findings from

this study strongly suggest that both home-based HTC and HIV self-testing have much potential to become complementary HIV testing modalities to increase HIV testing coverage among male partners of pregnant women. However, the degree of effectiveness of each approach depends on how well men's concerns about them are addressed.

4.8. Tables and figures

4.8.1. Tables

Table 4-1: Socio-demographic status of ANC-attending and ANC non-attending male partners

Characteristics	ANC-attendees (n=20)		ANC non-attendees (n=10)
	Acceptors (n=10)	Decliners (n=10)	
Age of male partner (years)			
Mean	27.9	31.9	31.8
Median	27.5	30	32
Range	22–37	24–41	20–41
Age of current female spouse (years)			
Mean	25.5	29.3	31.1
Median	24	29	32
Range	19–33	21–42	20–40
Formal education of male partner (n, %)			
None	1 (10)	0 (0)	0 (0)
Primary	1 (10)	0 (0)	3 (30)
Secondary	6 (60)	10 (100)	7 (70)
University	2 (20)	0 (0)	0 (0)
Marital status with current female partner			
Married	9 (90)	10 (100)	10 (100)
Living together as if married	1 (10)	0 (0)	0 (0)
Duration of union with current female partner			
0–5 years	8 (80)	7 (70)	1 (10)
>5 years	2 (20)	3 (30)	9 (90)
Number of pregnancy with current female partner			
1st pregnancy	7 (70)	3 (30)	2 (20)
2nd or 3rd pregnancy	3 (30)	7 (70)	8 (80)
Occupation of male partner			
Unemployed	0 (0)	0 (0)	0 (0)
Agricultural sector	0 (0)	1 (10)	3 (30)
Non-agricultural sector	10 (100)	9 (90)	7 (70)

Table 4-2: Barriers to HIV testing during ANC among ANC-attending male partners

Individual level	**Absence of perceived risk of HIV infection prior to that ANC visit** **I.1.** [I declined the test offer] because I have not had casual sex partners. And I was not interested in getting tested for HIV [this time] because I already got tested multiple times [with negative results] in the past *(40 years old, decliner).* **I.2.** While sitting inside the ANC room with my wife, [the provider] came to me and asked if I already got tested for HIV. I replied "Yes, I used to get tested." Then she asked me if I wanted to get tested again. I replied "No, I don't want because I just got tested [with negative results] about ten months ago" *(24 years old, decliner).* **I.3.** [I declined] because I just got tested for HIV [with negative result] about a month ago. So why do it again? I heard people say that getting tested for HIV too often is a no-no (*41 years old, decliner).* **Fear of needles** **I.4.** [I declined] because I am afraid of needles (*36 years old, decliner).*
Relationship level	**Negative couple dynamic** **R.1.** I am the who makes all health care decisions because I am the head of the family (*36 years old, decliner).*
Community level	None identified.
Health system level	None identified.

Table 4-3: Facilitators to HIV testing during ANC among ANC-attending male partners

Individual level	**Presence of perceived risk of HIV infection and/or free-of-charge** **I.1.** I was worried about my wife and unborn child. And in the past, I also had multiple sexual partners. I felt at risk [of HIV], so I accepted HIV testing (*26 years old, acceptor).* **I.2.** I used to get tested for HIV in the past, but that was long time ago. [During his ANC visit], I was told it would be free, so I accepted it. Plus, I have had finger cuts all the time because I am a chef. Sometimes, I also have injuries from other causes (*28 years old, acceptor).* **Worrying about unborn child** **I.3.** I wanted to know my [HIV] status. If I had HIV, I would have asked the providers to prescribe HIV medications to prevent my unborn child [from getting HIV] (*26 years old, acceptor).* **I.4.** I was worried about my unborn child. Assuming I had HIV, we would be able to prevent my unborn child from getting HIV. Now there are HIV medicines, so there was no need to worry about it (*29 years old, acceptor).* **Wanting to test** **I.5.** I had never gotten tested for HIV before (*27 years old, acceptor).*
Relationship level	**Partner communication** **R.1.** [During this ANC visit], my wife asked me to get tested again because the last time I got tested was about four or five months ago. She was afraid that I may have had casual sexual partners. She did not trust me, so she asked me to get tested again (*29 years old, acceptor).*
Community level	None identified
Health system level	**Requirement by staff** **H.1.** I accepted HIV testing because I thought it was a requirement, and if I [tested positive], they could help me. Moreover, I also wanted to learn my own status (*37 years old, acceptor).*

Table 4-4: Barriers to attending ANC among male partners of pregnant women

Individual level	**<u>Inability to take time off work</u>** **I.1.** [I could not attend ANC with my wife] because I was always busy at work [as a driver at an institution]. Although I was not always on active duty, I still had to be available upon request (*38 years old, ANC non-attendee).* **I.2.** Well, I was busy at the fishing site. Actually, I also felt guilty for not being able to attend ANC with my wife, but I had to go fishing to earn money (*29 years old, ANC non-attendee).* **I.3.** [I could not attend ANC with my wife] because I worked every day. As a construction worker, I was not paid on a daily basis, but monthly. As a rule, whenever I wanted to take a day off, I had to give [my employer] a reason. However, when the work at the site was overwhelming, they still might not grant the permission regardless of the reason. They might blame me for that or even fire me (*38 years old, ANC non-attendee).* **<u>Parking fee</u>** **I.4.** I saw that all vehicles had to be parked in a parking lot [with a fee], and I did not want to do that. So I dropped [my wife] in front of the health center because it was within walking distance, and I was just waiting outside. Well, I thought that when [my wife] was at the health facility, the providers would clearly explain everything to her. In addition, at the facility, there are posters that should have given her more relevant information (*41 years old, ANC non-attendee).* **<u>Inability to go inside ANC room due to watching over a child</u>** **I.5.** I did accompany her to the health center, but I did not go inside the ANC room because I was busy watching over my child (*29 years old, ANC non-attendee).* **<u>Negative attitude toward attending ANC with pregnant spouses</u>** **I.6.** Well, husbands are supposed to do ANC with their pregnant wives. However, it should also be fine for the wives to attend ANC alone. (*26 years old, ANC non-attendee).* **I.7.** Well, I thought that when [my wife] was at the health facility, the providers would clearly explain everything to her. In addition, at the facility, there are posters that should have given her more relevant information (*41 years old, ANC non-attendee).* **I.8.** At first, I thought it was OK to not attend ANC with my wife. But later, I felt guilty for that, after I found out that other men attended ANC with their wives (*25 years old, ANC non-attendee).*
Relationship level	**<u>Negative couple dynamic</u>** **R.1:** I make health care decisions for my wife and kids because I am the head of the family (*35 years old, ANC non-attendee).*
Community level	**<u>Negative community attitude toward male antenatal care attendance</u>** **C.1:** I personally heard negative or mocking words. I was asked "Why do you have to take her to the health center? Let her ride a motorcycle to the health center on her own!" The person even mocked or teased her [behind her back, saying] that "Although she doesn't work, and she always stays home, she still doesn't want to ride a motorcycle to the health center on her own!" *(20 years old, ANC non-attendee).*
Health system level	**<u>Not being invited to antenatal care</u>** **H.1:** I was physically present at the health center [in the waiting lounge/space], but the staff did not invite me to come inside the ANC room (*20 years old, ANC non-attendee).* **H.2:** I was sitting on a bench outside the health center. The staff did not invite me to come inside the health center (*36 years old, ANC non-attendee).*

Table 4-5: Perceived benefits of and concerns about home-based HTC

Perceived benefits of HB-HTC	**Being convenient, time-saving, and cost-saving** **PB.1.** If home-based testing was available, it would be good for husbands who are too busy to attend ANC with their pregnant wives. It would be time-saving (*40 years old, decliner).* **PB.2.** A home visit [by a provider] would be good. When the provider came to my home, I would not have to go to a health facility [for HIV testing]. It would be time-saving, cost-saving, and private. (*27 years old, decliner).* **PB.3.** It takes time to go to a health facility, and there is a long waiting time. If a provider came to my home, that would be good. The provider could offer counseling [and testing at home] (*40 years old, decliner).* **PB.4.** I would not have to waste time traveling to a health facility. I would not have to spend any money [to go to the facility], and we could have whole family counseling [and testing] at home. It would be more convenient than [going to a health facility] (*26 years old, acceptor).* **PB.5.** It would be good if the testing was done outside my working hours. So I could have enough time for a provider to do [HIV testing and counseling] (*23 years old, acceptor).* **PB.6.** It would be time-saving because we would not have to wait at a health facility. Plus, we would not need to pay for gasoline [to travel to the facility], and we would not be late for work (*37 years old, acceptor).* **PB.7.** It would be time-saving. For example, if a provider came in the evening, I would be home (*26 years old, ANC non-attendee).* **PB.8.** For me, a home visit by a provider would be good. I am busy. I do not have means of transportation, and I am living far away from a health facility (*35 years old, ANC non-attendee).* **PB.9.** I would be happy if a provider made an effort to come to my home and provide testing. The good thing about it is that I would not need to spend time going to a health facility (*41 years old, ANC non-attendee).* **PB.10.** I would not need to spend money to get tested [for HIV at another location] (*35 years old, ANC non-attendee).* **Privacy/confidentiality** **PB.11.** The good thing about [HB-HTC] is that I would not need to go to a health facility. I would be worried that I may meet a lot of people [at the facility]. If I was getting tested at home, outsiders would not be aware of it (*27 years old, acceptor).* **Trust from family** **PB.12.** Getting tested for HIV at home would prove to my wife that I did not have sexual affairs outside marriage (*38 years old, ANC non-attendee).* **PB.13.** Getting tested [for HIV] at home would be good because all family members would be there (e.g., my wife, older sister and mother). So everyone would be aware of my test result right away (*38 years old, ANC non-attendee).*
Perceived concerns regarding HB-HTC	**Worries that neighbors would be suspicious** **PC.1.** [Neighbors] would probably think that I have a disease if they saw a provider coming to my home. Villagers would think that I am a playboy [with many casual sexual relationships] (*30 years old, decliner).* **PC.2.** I think it would not be acceptable. My neighbors would think badly of me if they saw a medical provider coming to my home. It would be okay if the provider sets up a [temporary] testing venue in the street (*36 years old, decliner).* **PC.3.** [Neighbors] would possibly think that I have HIV if they saw a provider coming to test me at home. Some would be afraid of me and the others would not come near me out of HIV transmission fears (*23 years old, acceptor).*

	PC.4. They would think that I may have irresponsibly behaved or I had HIV. The fact that a medical provider coming to someone's home would never indicate good things. (*32 years old, acceptor).* **PC.5.** It would be hard to describe [testing for HIV at home] because if a medical provider came to multiple homes, it would be fine. However, if the provider only came to my home, I am not sure what they [neighbors] would feel about it, but most likely, they would think of me in a negative way (*27 years old, acceptor).* **PC.6.** They would feel suspicious of the visit or worried that an HIV outbreak was happening in the community. That's why a medical provider come to my home (*29 years old, acceptor).* **PC.7.** They would definitely feel suspicious of something going on with me. They would certainly ask me about the motive of the medical team visit. They would believe that I may have HIV (*20 years old, ANC non-attendee).* **Not being home during the visit** **PC.8.** [Home-based testing] would work only if men were free. If they were not, the testing team would not be able to meet with them anyway (*29 years old, decliner).* **PC.9.** My wife would have to phone me first to arrange a home visit because I am always busy at work, sometimes until 6 or 7 pm. So the testing team must let me choose the date and time (*38 years old, ANC non-attendee).* **An inability to verify the identity of the testing team** **PC.10.** I would feel worried that the [unidentified] team may intentionally infect me like what was happening in Battambang province, and we all have heard of it. (*26 years old, ANC non-attendee).* **PC.11.** I think that if local authorities (e.g., head of village or commune) informed me in advance that an official HIV testing team from a health center or hospital would come to test me for HIV at my home, I would not have any suspicion about the identity of the team. However, without such notification from local authorities, I would not get tested because I don't know them. They may not have verifiable paperwork, especially in rural areas where people don't know where these people would be exactly from (*29 years old, ANC non-attendee)* **Feeling coerced into HIV testing** **PC.12.** [HIV testing] is considered as a private matter, so when a provider came to someone's home to do it, it would sound like the provider is coercing the man into HIV testing (*27 years old, acceptor).* **Feeling offended by a home visit** **PC.13.** If I wanted to test for HIV, I would go to a health facility on my own. I would feel offended if a provider came to test me at my home (*29 years old, acceptor).* **Potential for contamination among testing instruments** **PC.14.** I would particularly be worried that the testing devices/instruments would not be properly disinfected (*24 years old, decliner)* **Potential breach of confidentiality** **PC.15.** The man in question may not welcome the HIV testing team to his home due to fears of confidentiality breaches (*35 years old, ANC non-attendee).* **Poor or improper management/miscoding of blood specimen** **PC.16.** With getting tested at home, blood specimens may be miscoded (*40 years old, decliner)*

Table 4-6: Perceived benefits of and concerns about HIV self-testing

Perceived benefits of HIVST	**Confidential/private/convenient/time-saving** **PB.1.** [HIVST] would be a good option if available. We could self-test secretly at home. If the result [turned out to be reactive], we could go to a hospital for treatment. It would be good especially for shy individuals—they could use it to self-test at home (*40 years old, decliner).* **PB.2.** It would be a good choice. It is a high-tech product with rapid test results. We could self-test and there would be no need to go to a health facility. So it would be time-saving (*30 years old, decliner).* **PB.3.** We would not need to go to a health facility to get tested. [HIVST] would be convenient, easy to perform, and give quick results (*40 years old, decliner).* **PB.4.** [HIVST] would be time-saving, and I would not need to face many questions from a medical provider when going to a health facility to get tested (*36 years old, decliner).* **PB.5.** [HIVST] would be a good option. It would allow husbands or wives or both to self-test. By knowing our [HIV] status, we would be able to take appropriate measures to prevent transmission to other people. Husbands could self-test first to know their status, and when their wives are pregnant one or two months, they could ask their wives to use the kit to self-test (if the women didn't agree to go to a health facility to get tested or they said they already got tested but did not disclose their test results to the husbands) (*29 years old, ANC non-attendee).* **PB.6.** [HIVST] would be useful for men who feel at risk of HIV and do not want other people to know their test results (*37 years old, acceptor).* **PB.7.** [HIVST] would be useful for people who want to keep test results hidden from medical providers (*28 years old, ANC non-attendee)* **PB.8.** I would like [HIVST] because it does not involve a needle stick (*25 years old, ANC non-attendee).* **No stigma associated with seeking HIV testing facility** **PB.9:** [HIVST] would be good for single individuals. They may feel embarrassed or shy [to go to a health facility] (*37 years old, acceptor).*
Concerns about HIVST	**Lack of counseling** **PC.1.** The bad thing about self-testing is that there would be no counseling from a trained medical provider. For example, if the result turned out to be positive, we would not have any medicines to take (*30 years old, decliner).* **PC.2.** For everyone, if tested positive for HIV, would not be able to accept the truth, so they could think of harming other innocent people. If there was a medical provider giving them proper counseling, comforting them, educating them, they would be fine. In other words, without receiving counseling, it would be possible that the individuals [positive self-testers] may intentionally cut their fingers and infect other people in the community with their blood. So I don't think HIVST should be implemented. HIV testing should be done at a health facility instead because medical providers would be able to offer proper HIV counseling and treatment (*29 years old, acceptor).* **PC.3.** I don't think it would be a good approach. If we bought it and performed self-testing, without counseling from a trained medical provider, we would be depressed [if tested positive] and may think of committing suicide. Obviously, everyone would feel depressed if they had HIV. So a counselor would be able to steer us away from depression by explaining us that there is effective HIV treatment (*29 years old, acceptor).*

	<u>Lack of disclosure</u> **PC.4.** The bad thing about [HIVST] is that after self-testing [with reactive test result], men would probably keep [the result] secret forever (*27 years old, decliner).* **PC.5.** HIVST would be a bad option if both husband and wife did not mutually disclose their test results (*41 years old, decliner).* **PC.6.** Without knowing their husbands' test results, the wives would probably be at risk of getting HIV from the husbands (*40 years old, decliner).* **PC.7.** For married couples, with HIVST, a lack of disclosure of the test result would probably indicate infidelity (*26 years old, acceptor).* **PC.8.** I think that some husbands with a perceived risk of HIV infection would prefer the self-testing option. They would go buy a kit without telling their wives about it (*25 years old, acceptor).* **PC.9.** I don't think it would be a good option due to a lack of disclosure. Even if it was available [in the future], I would not use it. I'd rather go to get tested at a facility (*26 years old, ANC non-attendee).* **PC.10.** I think it would not be a good approach. For example, if we self-tested positive and we did not tell anybody about it, it would be harmful because other people might unintentionally get it from us. (*25 years old, ANC non-attendee).* **<u>Lack of linkage to care</u>** **PC.11.** HIVST would be good only if we had access to HIV treatment after the results turned out to be positive (*32 years old, decliner).* **<u>Accuracy/reliability issue</u>** **PC.12.** If [HIVST] gave accurate results, it would be great. However, if it did not, it would be problematic (*40 years old, decliner).* **PC.13.** I would be worried about its accuracy. I would not trust the test results. For example, if the result turned out to be negative, but assuming I got tested at a facility instead, it may have turned out to be positive (*27 years old, acceptor).* **<u>Instruction in foreign languages</u>** **PC.14.** In general, [an HIVST kit] would have instructions of use in English and French. So if the product was available in Cambodia, it would be good to have instructions of use in Khmer (*29 years old, ANC non-attendee)* **<u>Do not know how to use</u>** **PC.15.** We would not know how to use a [HIVST kit] (*23 years old, acceptor).*

Table 4-7: Perceived benefits of and concerns about free-of-charge pregnant woman–delivered HIV self-testing (secondary distribution of HIVST)

Perceived benefits of pregnant woman–delivered HIVST	**<u>Being convenient/time-saving/cost-saving</u>** **WD.1.** It would be a good solution for a husband who could not attend ANC with his wife. In other words, if the husband was too busy to attend ANC, an ANC provider could ask the wife to bring it to the husband (*40 years old, decliner)* **WD.2.** I don't think there would be any problem with that. I would use it so that my wife and I would know our HIV statuses. In addition, it would also be convenient, and my wife and I are both afraid of needles (*29 years old, decliner).* **WD.3**. [Woman–delivered HIVST] would be free-of-charge, time-saving, and convenient (*31 years old, acceptor).* **WD.4.** [Woman–delivered HIVST] would be a good solution because both of us would be able to self-test together [at home] (*29 years old, acceptor).* **WD.5.** I think [pregnant woman–delivered HIVST] would be a good solution. If I could not go to get tested at a health facility, I would self-test [at home] (*35 years old, ANC non-attendee).* **WD.6.** If available, I think it would be good. I would not need to go to a health facility to get tested. I would be able to do it on my own. In other words, if my wife brought it home from a hospital, I would be able to self-test at home. That would be convenient (*35 years old, ANC non-attendee).* **<u>Being able to disclose HIVST result to wife on the spot</u>** **WD.7:** [Woman–delivered HIVST] would be a good approach. When self-testing [at home], my wife would also know my test result *(38 years old, ANC non-attendee).*
Perceived concerns about pregnant woman–delivered HIVST	**<u>Questionable accuracy</u>** **WD.8.** I think [pregnant woman–delivered HIVST] would not be good because the problem is that the test result would not be 100% accurate. I would not able to know for sure if the result was true or false (*30 years old, decliner).* **<u>Questions about why the provider or his partner wanted him to be tested</u>** **WD.9.** If I could not attend ANC with [my wife] and a health provider asked her to bring an HIVST kit to me, I would still use it, although I may feel slightly suspicious of such request. I think that her ANC provider would have explained to her about how to use it, and in turn she would be able to tell me how to use it. But still, I would probably not be 100% confident about the test result because the product would be too new to the market. So I would still seek testing again at a health facility (*37 years old, acceptor).* **<u>Incapable of using the kit</u>** **WD.10.** I don't think it would be good because I would not be capable of using it [correctly] (*32 years old, acceptor).* **<u>Scared to self-test</u>** **WD.11.** Although an ANC provider would have explained to my wife about how to use the HIVST kit, honestly I still would not dare to use it. Just hearing about HIV would already be scary enough, and I believe most people would not dare to self-test (*38 years old, ANC non-attendee).*

Table 4-8: Perceived benefits of and concerns about out-of-pocket community pharmacy–delivered HIV self-testing

Perceived benefits of community pharmacy–delivered HIVST	**Convenient/time-saving** **CP.1.** If it was available [at a pharmacy], it would be nice. Whenever I felt at risk, I would be able to buy it and self-test (*40 years old, decliner).* **CP.2.** If it was available at a pharmacy, and if I felt at risk of HIV, I would definitely buy it to self-test to know my status. It would be convenient (*38 years old, ANC non-attendee).* **CP.3.** [Buying it from a pharmacy] would be quicker than going to a health facility (*26 years old, acceptor).* **Confidentiality** **CP.4.** If available at a pharmacy, I would possibly buy it to self-test. If I felt at risk of HIV, I would buy it secretly (*35 years old, ANC non-attendee).* **CP.5.** If [my wife] asked me to buy it, I would do so and self-test. But if she did not, I would buy it without letting her know whenever I wanted to self-test (*25 years old, acceptor)*
Concerns about community pharmacy–delivered HIVST	**Availability issues** **CP.6.** I would find it difficult to buy it because I do not know which pharmacies sell it (*22 years old, acceptor).* **Stigma associated with HIVST purchase** **CP.7.** I would feel embarrassed when buying it from a pharmacy (*31 years old, acceptor).* **Lack of technical assistance and no official result slip** **CP.8.** I may not buy it because when go to buy a HIVST kit at a pharmacy, the pharmacy personnel may not give any instructions of use. They just take the money, hand the kit over to you, then that's it! They may not tell us to come back with the test results so that they could help read the results (*38 years old, ANC non-attendee).* **Questionable quality of test kit** **CP.9.** I would not buy it because I believe that only HIVST kits distributed by health facilities would be accurate or acceptable (*29 years old, ANC non-attendee).* **Cost** **CP.10.** I would probably not buy it unless it is affordable (*35 years old, ANC non-attendee).*

Table 4-9: Men's preferred HIV testing modality

ANC-based HTC, community pharmacy–delivered HIVST, woman–delivered HIVST, or home-based HTC?	**ANC-based HTC** **UC.1.** I would choose [ANC-based HTC] because I could attend ANC with my wife, receive counseling from a medical provider, get tested, and mutually disclose HIV test results at the hospital (*40 years old, decliner).* **UC.2.** I would choose [ANC-based HTC] because couple testing would allow [my wife and I] to show trust toward each other. Even if we tested positive, providers would ensure confidentiality for us, meaning they would not disclose our results to anybody else (*27 years old, decliner).* **UC.3.** I would choose [ANC-based HTC] because I would attend ANC with her anyway. I would not allow her to ride a motorcycle to a health facility on her own out of fear that she may fall due to her morning sickness (*23 years old, acceptor).* **UC.4.** For me, I would choose ANC-based HTC because I would feel most assured that there are generally many providers at the health facility (*26 years old, ANC non-attendee).* **UC.5.** I would choose [ANC-based HTC] because health providers [at the facility] would give us more accurate test results (*35 years old, ANC non-attendee).* **UC.6.** I would choose to get tested as a couple at a facility because there are better testing devices or equipment (*29 years old, ANC non-attendee).* **Pregnant woman–delivered HIVST** **UC.7.** I would choose [pregnant woman–delivered HIVST] because I want to try it to see if it would be 100% accurate (*37 years old, acceptor).* **UC.8.** I would choose [pregnant woman–delivered HIVST] because it would be convenient and time-saving. I would not need to go buy it (*36 years old, ANC non-attendee).* **Community pharmacy–delivered HIVST** **UC.9.** I would prefer to buy an HIVST kit from a pharmacy because it would be convenient. I could buy one whenever I feel at risk of HIV (*26 years old, acceptor).* **UC.10.** Buying an HIVST kit from a pharmacy would be the best. I could just go to a pharmacy and buy it. That would be convenient and quick (*28 years old, acceptor).* **Home-based HTC** **UC.11.** I would choose HB-HTC because it would be convenient and time-saving (*29 years old, ANC non-attendee).* **BC.12.** I would prefer to get tested at home because I would not need to worry about a potential road accident (*41 years old, decliner).* **UC.13.** Among the four options, I would prefer [HB-HTC]. At home, there would not be a lot of people (*29 years old, ANC non-attendee).*

Table 4-10: General suggestions on how to increase men's HIV testing during their partners' pregnancies

Launching community awareness-raising campaigns

GS.1. Health authorities should create educational videos about male partner testing during their wives' pregnancies. A lot of men would watch them, and the videos would encourage men to get tested for HIV (*27 years old, decliner).*

GS.2. I would like to request health authorities to launch awareness-raising campaigns, and the main message should be encouraging male partners to attend ANC and accept HIV testing (*30 years old, decliner).*

GS.3. I would like the Ministry of Health to increase awareness of HIV, especially by focusing on men because men are the driver of HIV heterosexual transmission (*26 years old, acceptor).*

GS.4. I would like health authorities to conduct awareness-raising campaigns to inform men that male partner testing [during wife's pregnancy] would be beneficial to the infants (*27 years old, acceptor).*

GS.5. Health authorities should organize community education sessions that would last one or two days each and ask men to participate (*25 years old, ANC non-attendee).*

GS.6. A head of village or commune should ask men to join community education sessions about HIV [testing] (*36 years old, ANC non-attendee).*

Launching community-based testing campaigns

GS.7. I would want the Ministry of Health to conduct community-based HIV testing. It would be convenient and time-saving [for male partners] to get tested (*41 years old, decliner).*

GS.8. If a head of village or commune came to each household and asked [male partners] to get tested, men would likely comply. They would not refuse (*35 years old, ANC non-attendee).*

Counseling husbands during ANC

GS.9. When a couple attend ANC together, health providers could use this opportunity to counsel the husband (*23 years old, acceptor).*

GS.10. During my previous ANC visits [with my wife], I did not receive testing because I was not informed about its availability. Previously, I thought that if my wife already got tested, there would be no need to test me as well. But during this particular visit, the health provider explained to me the benefits of male partner testing, so I accepted the test offer from health provider (*37 years old, acceptor).*

Using poster

GS.11. I would want health authorities to hang posters on walls at all [ANC] facilities. Men would get a lot of information from the posters (*25 years old, acceptor).*

Making male partner testing during ANC mandatory

GS.12. It would work if the government mandated that both husbands and wives must get tested for HIV during ANC as a preventive measure regardless of whether they wanted to do it or not. In other words, for the benefits of the unborn child and wife, although [husbands] would not want to get tested, we could not opt out (*29 years old, decliner).*

Providing HIV testing and counseling on Sundays

GS.13. Men are mostly free on Sundays. So asking men to come to get tested on Sundays would work (*38 years old, ANC non-attendee).*

4.8.2. Figures

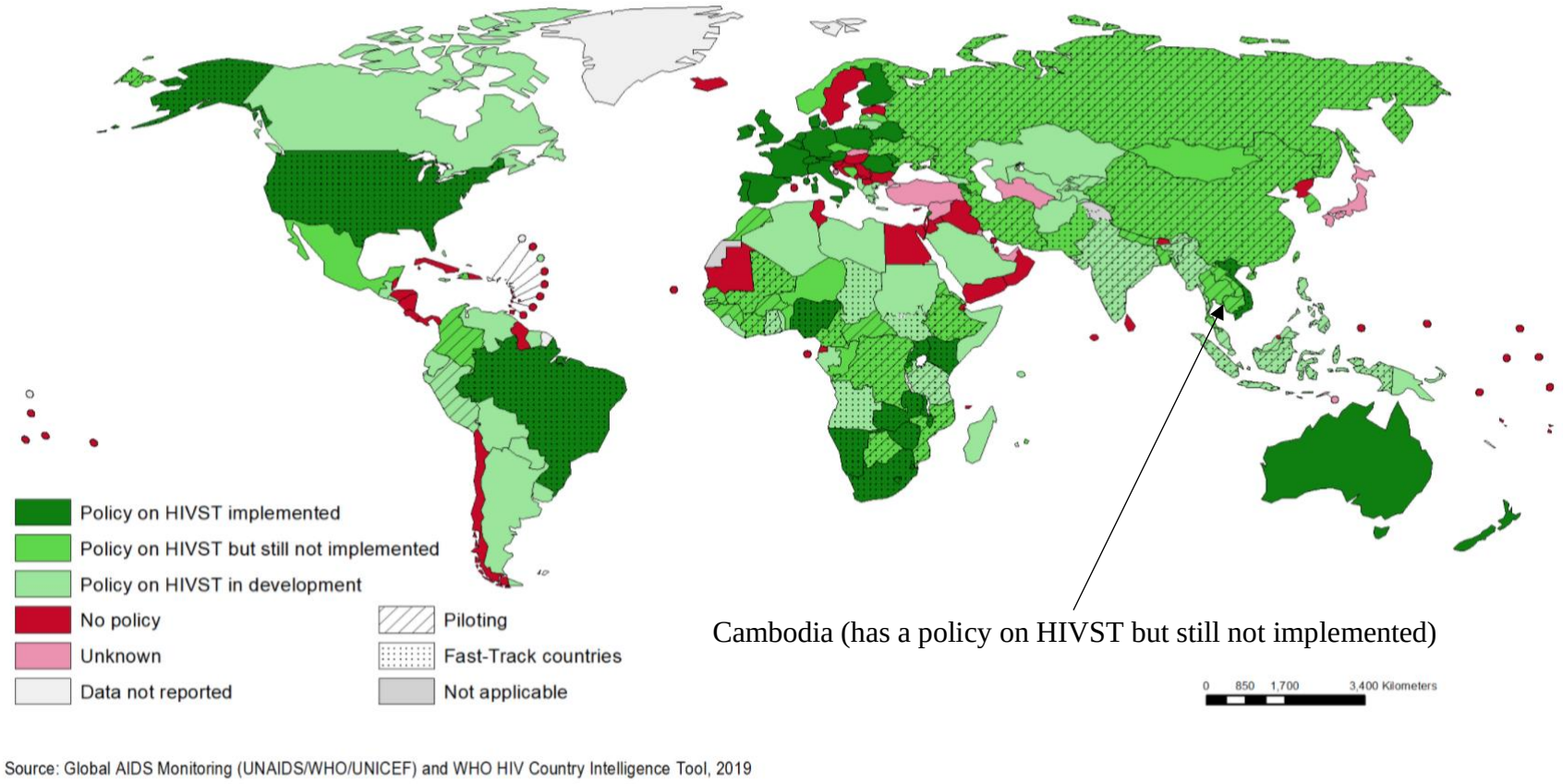

Figure 4-1: HIV self-testing (HIVST) in national policies as of July 2019 (WHO, 2019b)

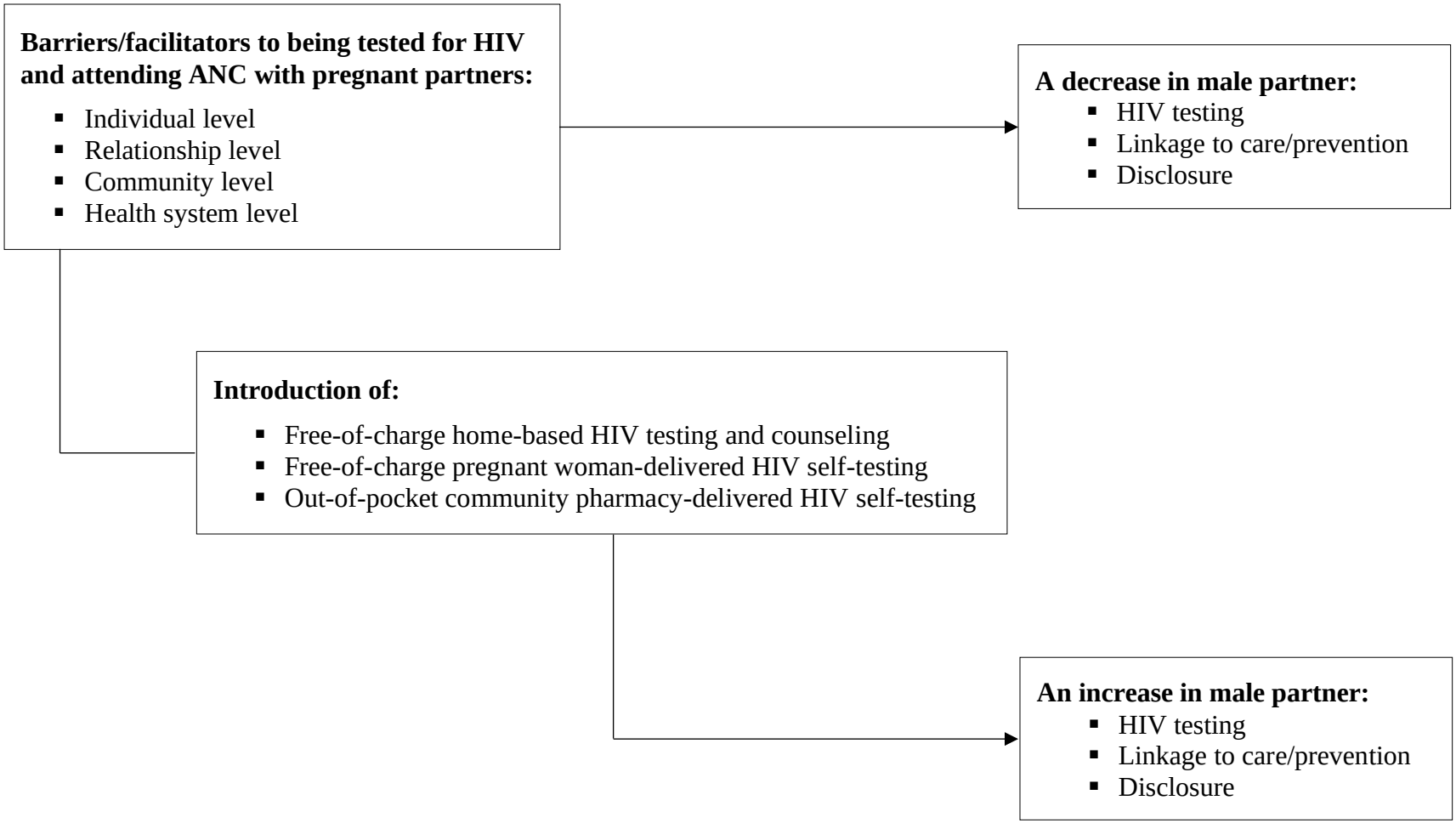

Figure 4-2: Conceptual framework
[Adapted from a qualitative study of antenatal care in Malawi on the acceptability of woman–delivered HIV self-testing to the male partner (Choko et al., 2017)]

CHAPTER 5: Public Health Implications

Cambodia launched its very first PMTCT pilot in 2001. Seven years later, PMTCT services were available at 112 health facilities across Cambodia. Despite such a successful scale-up, the uptake of PMTCT services remained well below expectation. The introduction of the "Linked Response" approach in 2008 was considered a defining event in the history of Cambodia's HIV testing and counseling for pregnant women, their HIV-exposed infants, and their male partners. With the new approach, HIV testing coverage among pregnant women skyrocketed. In 2013, the "Linked Response" approach was revised to aim for at least 95% of pregnant women being tested for HIV. One of the ultimate goals of the revised approach, named the "Boosted Linked Response," was to achieve the virtual elimination of new pediatric infections in Cambodia.

Seven years after the introduction of the "Boosted Linked Response" approach, Cambodia still had not reached its intended target of testing at least 95% of pregnant women for HIV. The approach has lost its momentum, with testing rates stagnating at about 90% for the past several years. Disappointingly—and curiously—the testing coverage among male partners of ANC-attending pregnant women has remained below 20% since 2012. It is, therefore, crucial to identify the key predictors of HIV testing among ANC-attending pregnant women and their male partners and explore complementary HIV to reach men who do not attend ANC with their pregnant partners.

We conducted three studies. In the first study, we pooled together three rounds of CDHS (2005, 2010, and 2014) and adopted Anderson's Behavioral Model of Health Services to guide our data analysis. Findings from the study indicated that the quality of HIV pre-test counseling

was the strongest predictor of HIV testing among ANC-attending pregnant women. A new strategy may not be needed to reach 95%, as the current "Boosted Linked Response" approach appears to have functioned relatively well but potentially with some fixable operational flaws. Based on the findings, the most obvious and practical first step is to identify all ANC sites across the country that have had chronically had an HIV testing rate lower than the national average. The second step would be to determine which sites are understaffed (with a high ratio of ANC clients to counselors). For understaffed sites with low HIV testing coverage, the number of counselors should be increased to a sufficient level, with regular refreshment training on how to deliver high-quality counseling to the women. For sites with low coverage but that are not understaffed, regular refreshment training should be provided to ANC counselors on how to deliver high-quality counseling, and performance monitoring and evaluation should be periodically conducted (e.g., on a monthly or quarterly basis).

Studies 2 and 3 employed embedded parallel mixed design; the primary study was Case-Control, with a qualitative component nested within it. Both quantitative and qualitative data were collected in parallel. The findings of the Case-Control study (Study 2) showed that a refusal of an HIV test was directly predicted by a low intention to test and low perceived behavioral control. In the basic TPB model, a low intention was directly predicted by a negative attitude and unsupportive subjective norms toward/about male partner testing during ANC. In the Extended TPB model, which was more robust than the basic TPB model, a low intention was directly predicted by subjective norms, perceived risk of HIV infection, and partner communication. The qualitative component (Aims 1 and 2 in Study 3) identified other factors that also influenced men's decisions about whether to decline HIV testing during ANC, at both the individual level (fear of needles and an absence of perceived risk) and the relationship level (a negative couple

dynamic, meaning the men are generally making health care decisions for all family members). It also identified factors that influenced men's decisions to accept HIV testing during ANC at the individual level (feeling at risk of HIV, being worried about the health of his wife and unborn child, and wanting to know one's HIV status), relationship level (partner communication, or being requested by their pregnant partners to be tested during the visit), and the health system level (a strong perceived push or endorsement from providers to be tested).

Here are the burning questions: what should we do to increase HIV testing uptake among ANC-attending male partners? In addition to risk perception, subjective norms, and partner communication, should we also act on all factors identified in the qualitative study so that potential future interventions will be more effective?

To answer these questions, a brief discussion of two factors is useful: the fear of needles and a strong perceived push or endorsement by the provider. In the quantitative analysis (Case-Control study), we combined "fear of needles" with other four psychological components (fear of testing for HIV, fear of disclosing test results, confidentiality concerns, and discrimination concerns) in the Perceived Behavioral Control construct (PBC). The results obtained from both univariate and multivariate logistic regressions showed that PBC did not influence the intention to test for HIV during ANC. The perceived provider's endorsement was significantly associated with the intention to test only in the univariate logistic regression but not in the multivariate model. In other words, when a man already felt at risk of HIV before the ANC visit, was personally requested by his partner to be tested for HIV, and believed that his important people would support him if he agreed to be tested during ANC, he would be more likely to accept the offer of a test, meaning fear of needles and perceived provider's endorsement were no longer relevant. Moreover, although the quantitative study did not specifically examine the influence of

couple dynamics (whether a pregnant woman has a voice in her own health-related matters) on intention to test for HIV during ANC, partner communication was included in the analysis as a proxy for a couple dynamic. We assumed that being capable of requesting her male partner to test for HIV indicated that the woman had a positive dynamic in her relationship. Therefore, by examining both qualitative and quantitative data, we can conclude that our Extended Theory of Planned Behavior proved to be valid and robust, which further means that potential interventions that act on or alter risk perception, subjective norms, and partner communication would be sufficient to increase the HIV testing rate among ANC-attending male partners. In the Cambodian context, potential complementary interventions aimed at individual behavioral change should be based largely on an "Information, Education and Communication" framework.

Regarding risk perception, two potential interventions could be taken: (1) mass media campaigns (e.g., television and social media such as Facebook) to increase men's awareness of modes of HIV transmission and prevention, including the benefits of male partner HIV testing during pregnancy, and (2) peer education, which has been adopted in several countries to change individual behavior.

Cambodia already has a relatively large network of community health volunteers, officially called "village health support group (VHSG) leaders," who help increase reproductive, maternal, and newborn health knowledge in their own communities. They promote timely service utilization by conducting regular health education sessions and home visits and playing a role as an important point-of-contact for community members who want health information. However, in terms of maternal and child health aspects, the scope of their work seems to be largely focused on pregnant women instead of both women and their male partners. Since the

network is readily available and robust across the country, we could work with them and make them active peer educators for male partners of pregnant women in their own communities.

Subjective norms, one of the key constructs of the Theory of Planned Behavior, refer to the perceived social pressure from close associations to perform a particular behavior. In the present study, male partners with unsupportive subjective norms had greater odds of declining an offer of an HIV test during ANC. Potential interventions based on two similar but distinct theories (Diffusion of innovation theory and Social influence or inoculation model) should be introduced. The common feature of both theories is that they rely on changing community or societal norms by using widely respected peers as role models. In this context, when a male partner sees or hears that his role model(s) accept HIV testing during an ANC visit, he will likely do the same. Over time, such practice will eventually diffuse and become the new norms, widely adopted in the community.

However, this begs the question of how to apply these theories in the real world. The most obvious intervention would likely still be a collaboration with village health support group (VHSG) leaders, meaning that, during regular health education sessions, male community volunteers who attended ANC with their pregnant partners and accepted HIV testing themselves should encourage not just women alone but couples to join the sessions. During the sessions, the volunteers should share their personal positive experiences of the visit and encourage other male partners to do the same. The volunteers, regardless of gender, could also invite other men who just attended ANC and accepted HIV testing to share their own experiences.

Partner communication was considered to be positive/present when a pregnant woman discussed HIV testing at some point during pregnancy with her male partner or even went as far as requesting prior to or during that particular visit (before or after receiving HIV pre-test

counseling) that he be tested for HIV. The findings show that an absence of partner communication about HIV testing was significantly associated with increased odds of declining an HIV test. The job of initiating a conversation with male partners about HIV testing during ANC entirely falls on the women. Communication is an art, so not every woman would find it stress-free to request her male partner to be tested for HIV, as he may feel offended. Peers could teach pregnant women how to convince their male partners to attend ANC and accept HIV testing. A strong engagement with community health volunteers should be key to the peer-based intervention because they typically have close relationships with and are trusted by community members. To illustrate, the volunteers should identify pregnant women who succeeded in convincing their male partners to attend ANC and accept HIV testing. The volunteers should then organize regular small group education sessions where the successful women share how they did so.

Persuading male partners to be tested for HIV during ANC would not work if the men do not attend ANC in the first place. In Aim 3 (Study 3), we attempted to identify barriers to attending ANC among men. The men reported barriers operating at four different levels: individual (being busy at work, waiting outside the health facility watching over an older child, not wanting to pay for a motorcycle parking fee and a negative attitude toward male ANC attendance), relationship (a negative couple dynamic with men taking healthcare decisions alone as they considered themselves heads of the family), community (a negative attitude toward male ANC attendance) and health system (not being invited by ANC providers to come inside the ANC consultation room or engaged in ANC.). Trans-theoretical approaches are also needed to act on these identified barriers. However, the potential interventions or solutions proposed below may not be effective because the barriers to attending ANC were identified from only ten one-

on-one interviews, which is more of a hypothesis-generating method than a hypothesis-testing one. Therefore, further quantitative research applying an Extended Theory of Planned Behavior or another appropriate theory must be conducted because some of the identified barriers may not significantly predict the outcome of interest (attending/not attending ANC with pregnant partners) at the target population level, which consists of all male partners of pregnant women in Cambodia. Again, all hypothetical solutions below were proposed on the assumption that all of the factors identified in the qualitative study (Aim 3) were significant predictors of attending or not attending ANC visits at the target population level.

Among the barriers identified at the individual level, probably only a negative attitude toward male ANC attendance could be altered. In the Theory of Planned Behavior, an attitude toward performing a particular behavior is obtained by first multiplying the strengths of each accessible belief by subjective evaluation of the outcome or experience. Then the resulting products are summed. This indicates that overall attitude could be positively altered by either increasing the value of each accessible belief or subjective evaluation. Regarding economic barriers (being busy at work or not wanting to pay for a parking fee), probably home-based HIV testing or HIV self-testing would be able to address them.

At the relationship level, in some couples, the men make all of the important decisions, including health-related matters. One way to address this would be to empower women through peer-based or small group-based interventions. For example, the existing network of community health volunteers could teach women how to convince their male partners to attend ANC; at the same time, the men should be encouraged to accept women making decisions as well.

At the community level, potential interventions based on the two theories described above (Diffusion of innovation theory and Social influence or inoculation model) should also be

able to change the community or social norms by using influential peers as role models. As time goes by, all men would come to believe attending ANC with their partners is something that they should be proud of when talking to other men in the community.

At the health system level, some ANC providers (mostly midwives) may think that engaging male partners in ANC is not beneficial to the mental and physical health of the ANC-attending pregnant women. This could be considered a negative attitude, which may lead to undesirable behavior. As a result, although the male partners were physically present at the facility, the providers did not invite them to the ANC consultation room. In this context, it is essential to change ANC providers' attitudes toward engaging or involving male partners in ANC through training. In addition, some ANC sites may have serious understaffing issues. For example, if only one midwife is capable of providing counseling and performing finger prick rapid testing to all incoming clients including pregnant and male partners, the midwife, despite having a positive attitude, does not engage or involve men in ANC. Potential interventions at the health system level should take both issues into account.

In terms of home-based HIV testing and counseling (HB-HTC) and HIV self-testing (HIVST), men raised perceived benefits of and concerns about each approach. Although the majority of men still preferred the gold standard ANC-based HTC, some were open to embracing free-of-charge HB-HTC or free-of-charge woman–delivered HIVST or out-of-pocket community pharmacy–delivered HIVST. This indicates that all these testing approaches have the potential to complement the current practice, ANC-based HTC. However, other relevant key stakeholders' insight into the approaches must be explored. These other stakeholders include ANC providers, community leaders, community health volunteers, community pharmacy owners or staff, and health policymakers. A pilot study of each approach is needed to examine if they generate

meaningful impact in the real world and whether they are logistically feasible without overburdening the healthcare system of Cambodia.

Appendix 1: In-depth interview guide, adapted from (Choko et al., 2017).

Section 1: Barriers to HIV testing at an antenatal care (ANC) setting		
Section 1.1: Individual level		
	Main questions	**Probing questions**
1.	You attended ANC with your wife but refused HIV testing. Why?	a) What other personal factors prevented you from accepting an HIV test at ANC? Why? b) Prior to this particular visit, how did you feel about accompanying your wife for antenatal care? Why?
2.	You attended ANC with your wife and accepted HIV testing. Why?	a) What personal factors could have prevented you from accepting HIV testing at ANC? Why? b) Prior to this particular visit, how did you feel about accompanying your partner/wife for antenatal care? Why?
3.	You did not attend ANC during your wife's most recent pregnancy. Why?	a) How do you feel about accompanying your wife for antenatal care? Why? b) What personal factors that may prevent you from accepting HIV testing at ANC? Why?
Section 1.2: Community level		
	Main questions	**Probing questions**
4.	What did people in your community say about men who attended ANC with their partners?	a) Which stories are positive? b) Which stories are negative? c) Which stories are most common? Why?
5	What did people in your community say about men who got tested for HIV (*not talking about HIV testing for marriage purpose)*?	a) Which stories are positive? b) Which stories are negative? c) Which stories are most common? Why?
6.	What did people in your community say about men who got tested for HIV at ANC together with their partners?	a) Which stories are positive? b) Which stories are negative? c) Which stories are the most common? Why?
Section 1.3: Health system level		
	Main questions	**Probing questions**
7.	What did community members say about how ANC services are offered and organized at this/that particular health facility?	a) Which stories are positive? b) Which stories are negative? c) Which stories are the most common? Why?
8.	How do you feel about how ANC services are offered and organized at this/that particular health facility?	a) Which stories are positive? b) Which stories are negative?

9.	What have you heard about HIV testing services at this/that particular health facility?	a) Which stories are positive? b) Which stories are negative? c) Which stories are the most common? Why?
Section 2: Couple dynamics		
	Main questions	**Probing questions**
10.	In your family, how are decisions made about health care? 1. You alone 2. Your wife alone 3. You and your (wife) jointly 4. Someone else	Why?
11.	You attended ANC with your wife but refused HIV testing. Had you been tested for HIV prior to this ANC visit?	a) And did that affect your decision? b) Did your wife ask you to get tested? If YES, how? If NO, why?
12.	You attended ANC with your partner/wife and accepted HIV testing. Did your wife ask you to get tested?	a) If YES, how? b) If NO, why?
13.	You did not attend ANC during your wife's most recent pregnancy. Have you ever accompanied her to ANC before?	a) And did that affect your decision? b) Did she ever tell you that she received HIV testing during ANC? How? c) If yes, did she ever disclose her HIV testing results to you? How? d) Did she ever ask you to get tested for HIV during her most recent pregnancy?
Section 3: Advantages of ANC-based HIV testing and counseling		
Section 3.1: ANC-based HTC		
	Main questions	**Probing questions**
14.	You attended ANC with your wife but refused HIV testing. Did you see any disadvantages of getting tested at ANC?	a) Any advantages? b) Did disadvantages outweigh advantages or vice-versa?
15.	You attended ANC with your wife and accepted HIV testing. Prior to HIV testing, did you see any advantages of getting tested at ANC?	a) Any disadvantages? b) Did advantages outweigh disadvantages or vice-versa?
16.	You did not attend ANC during your wife's most recent pregnancy. Do think that getting tested for HIV at ANC offers any advantages?	a) Any disadvantages? b) Do advantages outweigh disadvantages or vice-versa?
Section 3.2: HIV self-test and Home-based HTC		
	Main questions	**Probing questions**
17.	Have you ever heard of home pregnancy kit? If yes, how? Has your wife ever used it?	a) Have you ever heard of HIV self-testing (HIVST)? If yes, how? Have you used it? b) What do you feel about HIVST? Any potential pros? Any potential cons?

		c) What do you think of these delivery approaches? - Health center staff gives HIVST to your partner/wife during her ANC visit (assuming you are busy at work), and then she gives it to you? Why? - What if HIVST is available at a private pharmacy? Why? How much can you afford to buy it?
18.	What do you think about home-based HIV testing and counseling (HB-HTC)?	a) In your opinion, would HB-HTC be accepted among male partners of pregnant women? Why? b) What would be community concerns about HB-HTC? Why? c) What would be your concerns or worries about HB-HTC? Why? d) What would your neighbors think/feel if the HB-HTC team is present at your home? Why?
19.	What would be other approaches that could be used to increase uptake of HIV testing among male partners of ANC-attending pregnant women?	Why?
Section 4: Men's preferred HIV testing modality		
	Main questions	**Probing questions**
20.	Assuming your wife will be pregnant again in the future, you would have the four options below: 1. ANC-based HTC (free-of-charge) 2. Home-based HTC (free-of-charge) 3. Woman-delivered HIVST kit (free-of-charge) 4. HIVST kit from a private pharmacy Among the four, which one would you choose?	Why?

CHAPTER 7: References

AARNIO, P., OLSSON, P., CHIMBIRI, A. & KULMALA, T. 2009. Male involvement in antenatal HIV counseling and testing: exploring men's perceptions in rural Malawi. *AIDS care,* 21**,** 1537-1546.

ABAMECHA, F., GODESSO, A. & GIRMA, E. 2013. Intention to voluntary HIV counseling and testing (VCT) among health professionals in Jimma zone, Ethiopia: the theory of planned behavior (TPB) perspective. *BMC Public Health,* 13**,** 140.

ADAY, L. A. & ANDERSEN, R. 1974. A framework for the study of access to medical care. *Health services research,* 9**,** 208.

ADAY, L. A., ANDERSEN, R. & FLEMING, G. V. 1980. Health care in the US: Equitable for whom?

ADEBAYO, O. 2015. *Adapting and Applying the Anderson's Behavioural Model to Understand Factors Influencing Uptake of Antenatal-Integrated HIV Testing in Nigeria: A Multilevel Analysis.* Master's degree Master, University of Groningen.

AJZEN, I. 1985. From intentions to actions: A theory of planned behavior. *Action control.* Springer.

AJZEN, I. 1991. The theory of planned behavior. *Organizational behavior and human decision processes,* 50**,** 179-211.

AJZEN, I. 2011. The theory of planned behaviour: Reactions and reflections. Taylor & Francis.

AJZEN, I. 2020. The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies,* 2**,** 314-324.

AJZEN, I. 2021. *Theory of Planned Behavior: Frequently Asked Questions* [Online]. Available: https://people.umass.edu/aizen/faq.html [Accessed January 1st 2021].

AJZEN, I. & MADDEN, T. J. 1986. Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of experimental social psychology,* 22**,** 453-474.

ALLEN, S., MEINZEN-DERR, J., KAUTZMAN, M., ZULU, I., TRASK, S., FIDELI, U., MUSONDA, R., KASOLO, F., GAO, F. & HAWORTH, A. 2003. Sexual behavior of HIV discordant couples after HIV counseling and testing. *Aids,* 17**,** 733-740.

ALUISIO, A., RICHARDSON, B. A., BOSIRE, R., JOHN-STEWART, G., MBORI-NGACHA, D. & FARQUHAR, C. 2011. Male antenatal attendance and HIV testing are associated with decreased infant HIV infection and increased HIV free survival. *Journal of acquired immune deficiency syndromes (1999),* 56**,** 76.

ANDERSEN, R. 1968. A behavioral model of families' use of health services. *A behavioral model of families' use of health services.*

ANDERSEN, R., BOZZETTE, S., SHAPIRO, M., ST CLAIR, P., MORTON, S., CRYSTAL, S., GOLDMAN, D., WENGER, N., GIFFORD, A. & LEIBOWITZ, A. 2000. Access of vulnerable groups to antiretroviral therapy among persons in care for HIV disease in the United States. HCSUS Consortium. HIV Cost and Services Utilization Study. *Health services research,* 35**,** 389.

ANDERSEN, R. & NEWMAN, J. F. 1973. Societal and individual determinants of medical care utilization in the United States. *The Milbank Memorial Fund Quarterly. Health and Society***,** 95-124.

ANDERSEN, R. M. 1995. Revisiting the behavioral model and access to medical care: does it matter? *Journal of health and social behavior***,** 1-10.

ANDERSEN, R. M. 2008. National health surveys and the behavioral model of health services use. *Medical care,* 46**,** 647-653.

ANDERSEN, R. M., DAVIDSON, P. L. & BAUMEISTER, S. E. 2014. Improving access to care. *Changing the US health care system: key issues in health services policy and management. San Francisco: Jossey-Bass,* 36**,** 33-69.

APA. 2020. The APA Dictionary of Psychology. The American Psychology Association. Washington, DC.

AUDET, C. M., BLEVINS, M., CHIRE, Y. M., ALIYU, M. H., VAZ, L. M., ANTONIO, E., ALVIM, F., BECHTEL, R., WESTER, C. W. & VERMUND, S. H. 2016. Engagement of men in antenatal care services: increased HIV testing and treatment uptake in a community participatory action program in Mozambique. *AIDS and Behavior,* 20**,** 2090-2100.

AWOPEGBA, O. E., KALU, A., AHINKORAH, B. O., SEIDU, A.-A. & AJAYI, A. I. 2020. Prenatal care coverage and correlates of HIV testing in sub-Saharan Africa: Insight from demographic and health surveys of 16 countries. *PloS one,* 15**,** e0242001.

AYODELE, O. 2017. The theory of planned behavior as a predictor of HIV testing intention. *American Journal of Health Behavior,* 41**,** 147-151.

AZJEN, I. 1980. Understanding attitudes and predicting social behavior. *Englewood Cliffs*.

BABAKUS, E. & MANGOLD, W. G. 1992. Adapting the SERVQUAL scale to hospital services: an empirical investigation. *Health services research,* 26**,** 767.

BARKER, G., RICARDO, C., NASCIMENTO, M. & ORGANIZATION, W. H. 2007. *Engaging men and boys in changing gender-based inequity in health: Evidence from programme interventions*, World Health Organization.

BATONA, G., GAGNON, M.-P., SIMONYAN, D. A., GUEDOU, F. A. & ALARY, M. 2015. Understanding the intention to undergo regular HIV testing among female sex workers in Benin: a key issue for entry into HIV care. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 68**,** S206-S212.

BLAND, J. M. & ALTMAN, D. G. 1997. Statistics notes: Cronbach's alpha. *Bmj,* 314**,** 572.

BONIPHACE, M., MATOVELO, D., LAISSER, R., SWAI, H., YOHANI, V., TINKA, S., MWAIKASU, L., MERCADER, H., BRENNER, J. L. & MITCHELL, J. 2021. Men perspectives on attending antenatal care visits with their pregnant partners in Misungwi district, rural Tanzania: a qualitative study. *BMC Pregnancy and Childbirth,* 21**,** 1-8.

BRODY, C., CHHOUN, P., TUOT, S., SWENDEMAN, D. & YI, S. 2019. Childhood conditions, pathways to entertainment work and current practices of female entertainment workers in Cambodia: Baseline findings from the Mobile Link trial. *PloS one,* 14**,** e0216578.

BYAMUGISHA, R., TUMWINE, J. K., SEMIYAGA, N. & TYLLESKÄR, T. 2010. Determinants of male involvement in the prevention of mother-to-child transmission of HIV programme in Eastern Uganda: a cross-sectional survey. *Reproductive health,* 7**,** 1-9.

CHANDISAREWA, W., STRANIX-CHIBANDA, L., CHIRAPA, E., MILLER, A., SIMOYI, M., MAHOMVA, A., MALDONADO, Y. & SHETTY, A. K. 2007. Routine offer of antenatal HIV testing (" opt-out" approach) to prevent mother-to-child transmission of HIV in urban Zimbabwe. *Bulletin of the World Health organization,* 85**,** 843-850.

CHOKO, A. T., KUMWENDA, M. K., JOHNSON, C. C., SAKALA, D. W., CHIKALIPO, M. C., FIELDING, K., CHIKOVORE, J., DESMOND, N. & CORBETT, E. L. 2017. Acceptability of woman-delivered HIV self-testing to the male partner, and additional interventions: a qualitative study of antenatal care participants in Malawi. *Journal of the International AIDS Society,* 20.

CLARK, J., SWEET, L., NYONI, S. & WARD, P. R. 2020. Improving male involvement in antenatal care in low and middle-income countries to prevent mother to child transmission of HIV: A realist review. *PloS one,* 15**,** e0240087.

CONNER, M. 2015. Extending not retiring the theory of planned behaviour: a commentary on Sniehotta, Presseau and Araújo-Soares. *Health Psychology Review,* 9**,** 141-145.

CONNER, M. & ARMITAGE, C. J. 1998. Extending the theory of planned behavior: A review and avenues for further research. *Journal of applied social psychology,* 28**,** 1429-1464.

CROFT, T. N., AILEEN M. J. MARSHALL, COURTNEY K. ALLEN, ET AL 2018. Guide to DHS Statistics. Rockville, Maryland, USA.

CRONBACH, L. J. 1951. Coefficient alpha and the internal structure of tests. *psychometrika,* 16**,** 297-334.

DAWES, J. 2008. Do data characteristics change according to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales. *International journal of market research,* 50**,** 61-104.

DELVAUX, T., SAMRETH, S., BARR-DICHIARA, M., SEGUY, N., GUERRA, K., NGAUV, B., OUK, V., LAGA, M. & MEAN, C. 2011. Linked response for prevention, care, and treatment of HIV/AIDS, STIs, and reproductive health issues: results after 18 months of implementation in five operational districts in Cambodia. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 57**,** e47-e55.

DEVELLIS, R. F. 2016. *Scale development: Theory and applications*, Sage publications.

DOS/PEPFAR. 2017. *Strategic Direction Summary Cambodia Country Operational Plan* [Online]. PEPFAR. Available: https://www.pepfar.gov/documents/organization/272005.pdf [Accessed July 10 2019].

DOS/PEPFAR. 2018. *Male-Friendly Clinics in Lesotho: Demand Creation Targeting HIV-Infected Men to Access Comprehensive Health Services* [Online]. Washington DC: DoS/PEPFAR. Available: https://www.pepfarsolutions.org/solutions/2018/11/6/male-friendly-clinics-demand-creation-targeting-hiv-infected-men-to-access-comprehensive-health-services [Accessed May 7 2021].

EHIRI, J. E., IWELUNMOR, J., IHEANACHO, T., BLACKSTONE, S., OBIEFUNE, M. C., OGIDI, A. G., AHUNANYA, F. U., NNADI, D., PATEL, D. & HUNT, A. T. 2016. Using a cultural framework to understand factors influencing HIV testing in Nigeria. *International quarterly of community health education,* 37**,** 33-42.

EJIGU, Y. & TADESSE, B. 2018. HIV testing during pregnancy for prevention of mother-to-child transmission of HIV in Ethiopia. *PloS one,* 13**,** e0201886.

FALNES, E. F., MOLAND, K. M., TYLLESKÄR, T., DE PAOLI, M. M., MSUYA, S. E. & ENGEBRETSEN, I. M. 2011. " It is her responsibility": partner involvement in prevention of mother to child transmission of HIV programmes, northern Tanzania. *Journal of the International AIDS Society,* 14**,** 1-12.

FARQUHAR, C., KIARIE, J. N., RICHARDSON, B. A., KABURA, M. N., JOHN, F. N., NDUATI, R. W., MBORI-NGACHA, D. A. & JOHN-STEWART, G. C. 2001. Antenatal couple counseling increases uptake of interventions to prevent HIV-1 transmission. *AIDS (London, England),* 15**,** 815.

FEREDAY, J. & MUIR-COCHRANE, E. 2006. Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods,* 5**,** 80-92.

FIGUEROA, C., JOHNSON, C., FORD, N., SANDS, A., DALAL, S., MEURANT, R., PRAT, I., HATZOLD, K., URASSA, W. & BAGGALEY, R. J. T. L. H. 2018. Reliability of HIV rapid diagnostic tests for self-testing compared with testing by health-care workers: a systematic review and meta-analysis.

FISHBEIN, M. & AJZEN, I. 1977. Belief, attitude, intention, and behavior: An introduction to theory and research.

GODLONTON, S. & THORNTON, R. L. 2017. Marital Investment under Uncertainty: Couples HIV Testing and Marital Stability.

GORBACH, P. M. & GALEA, J. 2007. Qualitative methods. *Behavioral interventions for prevention and control of sexually transmitted diseases.* Springer.

GORBACH, P. M., SOPHEAB, H., CHHORVANN, C., WEISS, R. E. & VUN, M. C. 2006. Changing behaviors and patterns among Cambodian sex workers: 1997-2003. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 42**,** 242-247.

GRISPEN, J. E., RONDA, G., DINANT, G.-J., DE VRIES, N. K. & VAN DER WEIJDEN, T. 2011. To test or not to test: a cross-sectional survey of the psychosocial determinants of self-testing for cholesterol, glucose, and HIV. *BMC Public Health,* 11**,** 112.

GUDAYU, T. W. 2015. Proportion and factors associated with late antenatal care booking among pregnant mothers in Gondar town, north West Ethiopia. *African journal of reproductive health,* 19**,** 93-99.

GUNN, J. K., ASAOLU, I. O., CENTER, K. E., GIBSON, S. J., WIGHTMAN, P., EZEANOLUE, E. E. & EHIRI, J. E. 2016. Antenatal care and uptake of HIV testing among pregnant women in sub-Saharan Africa: a cross-sectional study. *Journal of the International AIDS Society,* 19**,** 20605.

HAMMOND, W. P., MATTHEWS, D. & CORBIE-SMITH, G. 2010. Psychosocial factors associated with routine health examination scheduling and receipt among African American men. *Journal of the National Medical Association,* 102**,** 276-289.

HANKINS, M., FRENCH, D. & HORNE, R. 2000. Statistical guidelines for studies of the theory of reasoned action and the theory of planned behaviour. *Psychology and Health,* 15**,** 151-161.

HECTOR, J., DAVIES, M.-A., DEKKER-BOERSEMA, J., ALY, M. M., ABDALAD, C. C. A., LANGA, E. B. R., EHMER, J., HOBBINS, M. A. & JEFFERYS, L. F. J. P. O. 2018.

Acceptability and performance of a directly assisted oral HIV self-testing intervention in adolescents in rural Mozambique. 13**,** e0195391.

HELLER, T., KUNTHEA, S., BUNTHOEUN, E., SOK, K., SEUTH, C., KILLAM, W., SOVANNA, T., SATHIARANY, V. & KANAL, K. 2011. Point-of-care HIV testing at antenatal care and maternity sites: experience in Battambang Province, Cambodia. *International journal of STD & AIDS,* 22**,** 742-747.

HERSHOW, R. B., ZIMBA, C. C., MWEEMBA, O., CHIBWE, K. F., PHANGA, T., DUNDA, W., MATENGA, T., MUTALE, W., CHI, B. H. & ROSENBERG, N. E. 2019. Perspectives on HIV partner notification, partner HIV self-testing and partner home-based HIV testing by pregnant and postpartum women in antenatal settings: a qualitative analysis in Malawi and Zambia. *Journal of the International AIDS Society,* 22**,** e25293.

HOMSY, J., KALAMYA, J. N., OBONYO, J., OJWANG, J., MUGUMYA, R., OPIO, C. & MERMIN, J. 2006. Routine intrapartum HIV counseling and testing for prevention of mother-to-child transmission of HIV in a rural Ugandan hospital. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 42**,** 149-154.

HULIN, C., NETEMEYER, R. & CUDECK, R. 2001. Can a reliability coefficient be too high? *Journal of Consumer Psychology,* 10**,** 55-58.

HUME, C., BALL, K. & SALMON, J. 2006. Development and reliability of a self-report questionnaire to examine children's perceptions of the physical activity environment at home and in the neighbourhood. *International Journal of Behavioral Nutrition and Physical Activity,* 3**,** 1-6.

IDRE. 2020. *HOW CAN I ANALYZE A SUBPOPULATION OF MY SURVEY DATA IN STATA?* [Online]. UCLA Statistical Consulting Group. Available: https://stats.idre.ucla.edu/stata/faq/how-can-i-analyze-a-subpopulation-of-my-survey-data-in-stata/ [Accessed: September 30th, 2020].

IDRE. 2021. *HOW CAN I CHECK FOR COLLINEARITY IN SURVEY REGRESSION? | STATA FAQ* [Online]. Los Angeles: UCLA Institute for Digital Research & Education. Available: https://stats.idre.ucla.edu/stata/faq/how-can-i-check-for-collinearity-in-survey-regression/ [Accessed May 9 2021].

INDRAVUDH, P. P., CHOKO, A. T. & CORBETT, E. L. J. C. O. I. I. D. 2018. Scaling up HIV self-testing in sub-Saharan Africa: a review of technology, policy and evidence. 31**,** 14.

FERNANDEZ, M.I. 2000. Acceptance of HIV Testing During Prenatal Care. *Public Health Reports*. 115, 460–468.

ISHIKAWA, N., DALAL, S., JOHNSON, C., HOGAN, D. R., SHIMBO, T., SHAFFER, N., PENDSE, R. N., LO, Y. R., GHIDINELLI, M. N. & BAGGALEY, R. 2016. Should HIV testing for all pregnant women continue? Cost-effectiveness of universal antenatal testing

compared to focused approaches across high to very low HIV prevalence settings. *Journal of the International AIDS Society,* 19**,** 21212.

JOHNSON, C., BAGGALEY, R., FORSYTHE, S., VAN ROOYEN, H., FORD, N., MAVEDZENGE, S. N., CORBETT, E., NATARAJAN, P., TAEGTMEYER, M. J. A. & BEHAVIOR 2014. Realizing the potential for HIV self-testing. 18**,** 391-395.

JOHNSON, C. C., KENNEDY, C., FONNER, V., SIEGFRIED, N., FIGUEROA, C., DALAL, S., SANDS, A. & BAGGALEY, R. J. J. O. T. I. A. S. 2017. Examining the effects of HIV self-testing compared to standard HIV testing services: a systematic review and meta-analysis. 20**,** 21594.

KAKOKO, D. C., ÅSTRØM, A. N., LUGOE, W. L. & LIE, G. T. 2006. Predicting intended use of voluntary HIV counselling and testing services among Tanzanian teachers using the theory of planned behaviour. *Social science & medicine,* 63**,** 991-999.

KANAL, K., CHOU, T. L., SOVANN, L., MORIKAWA, Y., MUKOYAMA, Y. & KAKIMOTO, K. 2005. Evaluation of the proficiency of trained non-laboratory health staffs and laboratory technicians using a rapid and simple HIV antibody test. *AIDS research and therapy,* 2**,** 1-4.

KATZ, D. A., KIARIE, J. N., JOHN-STEWART, G. C., RICHARDSON, B. A., JOHN, F. N. & FARQUHAR, C. 2009. Male perspectives on incorporating men into antenatal HIV counseling and testing. *PloS one,* 4**,** e7602.

KAYA, S., SAIN GUVEN, G., AYDAN, S. & TOKA, O. 2019. Predictors of hospital readmissions in internal medicine patients: Application of Andersen's Model. *The International journal of health planning and management,* 34**,** 370-383.

KHIM, K., GOLDMAN, L. N., SHAW, K., MARKUNS, J. F. & SAPHONN, V. 2020. Assessment of dual practice among physicians in Cambodia. *Human resources for health,* 18**,** 1-8.

KING, R. 1999. Sexual behaviour change for HIV: Where have theories taken us? 1999. *Geneva, UNAIDS*.

KNUSSEN, C., FLOWERS, P. & CHURCH, S. 2004. The intentions of gay men in taking an HIV test. *Culture, health & sexuality,* 6**,** 45-59.

KRAKOWIAK, D., KINUTHIA, J., OSOTI, A. O., ASILA, V., GONE, M. A., MARK, J., BETZ, B., PARIKH, S., SHARMA, M. & BARNABAS, R. 2016. Home-based HIV testing among pregnant couples increases partner testing and identification of serodiscordant partnerships. *Journal of acquired immune deficiency syndromes (1999),* 72**,** S167.

KRAKOWIAK, D., MAKABONG'O, P., GOYETTE, M., KINUTHIA, J., OSOTI, A. O., ASILA, V., GONE, M. A., MARK, J. & FARQUHAR, C. 2020. Reaching hard-to-reach men through home-based couple HIV testing among pregnant women and their male partners in western Kenya: a qualitative study. *BMC Public Health,* 20**,** 1-9.

LAKHE, N. A., MBAYE, K. D., SYLLA, K. & NDOUR, C. T. 2020. HIV screening in men and women in Senegal: coverage and associated factors; analysis of the 2017 demographic and health survey. *BMC Infectious Diseases,* 20**,** 1.

LAMORTE, W. 2016. *Central Limit Theorem* [Online]. Boston: Boston University School of Public Health. Available: https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_probability/BS704_Probability12.html#:~:text=The%20central%20limit%20theorem%20states,will%20be%20approximately%20normally%20distributed. [Accessed May 24 2021].

LARSSON, E. C., THORSON, A., NSABAGASANI, X., NAMUSOKO, S., POPENOE, R. & EKSTRÖM, A. M. 2010. Mistrust in marriage-Reasons why men do not accept couple HIV testing during antenatal care-a qualitative study in eastern Uganda. *BMC public health,* 10**,** 1-9.

LAU, C. Y., WANG, Z., FANG, Y., IP, M., WONG, K. M., CHIDGEY, A., LI, J. & LAU, J. T. 2020. Prevalence of and factors associated with behavioral intention to take up home-based HIV self-testing among male clients of female sex workers in China–an application of the Theory of Planned Behavior. *AIDS care***,** 1-10.

LOLEKHA, R., KULLERK, N., WOLFE, M. I., KLUMTHANOM, K., SINGHAGOWIN, T., PATTANASIN, S., SOMBAT, P., NAIWATANAKUL, T., LEARTVANANGKUL, C. & VORAMONGKOL, N. 2014. Assessment of a couples HIV counseling and testing program for pregnant women and their partners in antenatal care (ANC) in 7 provinces, Thailand. *BMC international health and human rights,* 14**,** 1-10.

LUGADA, E., LEVIN, J., ABANG, B., MERMIN, J., MUGALANZI, E., NAMARA, G., GUPTA, S., GROSSKURTH, H., JAFFAR, S. & COUTINHO, A. 2010. Comparison of home and clinic-based HIV testing among household members of persons taking antiretroviral therapy in Uganda: results from a randomized trial. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 55**,** 245-252.

MAMBA, K. C., MUULA, A. S. & STONES, W. 2017. Facility-imposed barriers to early utilization of focused antenatal care services in Mangochi District, Malawi–a mixed methods assessment. *BMC pregnancy and childbirth,* 17**,** 1-8.

MANJATE CUCO, R. M., MUNGUAMBE, K., BIQUE OSMAN, N., DEGOMME, O., TEMMERMAN, M. & SIDAT, M. M. 2015. Male partners' involvement in prevention of mother-to-child HIV transmission in sub-Saharan Africa: a systematic review. *SAHARA-J: Journal of Social Aspects of HIV/AIDS,* 12**,** 87-105.

MANOPAIBOON, C., KILMARX, P. H., SUPAWITKUL, S., CHAIKUMMAO, S., LIMPAKARNJANARAT, K., CHANTAROJWONG, N., XU, F., VAN GRIENSVEN, F. & MASTRO, T. D. 2007. HIV communication between husbands and wives: effects on husband HIV testing in northern Thailand. *Southeast Asian journal of tropical medicine and public health,* 38**,** 313.

MANTELL, J., DICARLO, A., REMIEN, R., ZERBE, A., MORRIS, D., PITT, B., NKONYANA, J., ABRAMS, E. & EL-SADR, W. 2014. 'There's no place like home': perceptions of home-based HIV testing in Lesotho. *Health Education Research,* 29**,** 456-469.

MARUVA, M., GWAVUYA, S., MARUME, M., MUSARANDEGA, R. & MADZINGIRA, N. 2014. Knowledge of HIV status at ANC and utilization of maternal health services in the 2010-11 Zimbabwe Demographic and Health Survey. DHS Working Papers.

MASTERS, S. H., AGOT, K., OBONYO, B., NAPIERALA MAVEDZENGE, S., MAMAN, S. & THIRUMURTHY, H. 2016. Promoting partner testing and couples testing through secondary distribution of HIV self-tests: a randomized clinical trial. *PLoS medicine,* 13**,** e1002166.

MATOVU, J. K., KISA, R., BUREGYEYA, E., CHEMUSTO, H., MUGERWA, S., MUSOKE, W., VRANA, C. J., MALEK, A. M., KORTE, J. E. & WANYENZE, R. K. 2018. 'If I had not taken it [HIVST kit] home, my husband would not have come to the facility to test for HIV': HIV self-testing perceptions, delivery strategies, and post-test experiences among pregnant women and their male partners in Central Uganda. *Global health action,* 11**,** 1503784.

MBIZVO, M. T. & BASSETT, M. T. 1996. Reproductive health and AIDS prevention in sub-Saharan Africa: the case for increased male participation. *Health policy and planning,* 11**,** 84-92.

MCGARRITY, L. A. & HUEBNER, D. M. 2014. Behavioral intentions to HIV test and subsequent testing: The moderating role of sociodemographic characteristics. *Health Psychology,* 33**,** 396.

MEADOWBROOKE, C. C., VEINOT, T. C., LOVELUCK, J., HICKOK, A. & BAUERMEISTER, J. A. 2014. Information behavior and HIV testing intentions among young men at risk for HIV/AIDS. *Journal of the Association for Information Science and Technology,* 65**,** 609-620.

MGATA, S. & MALUKA, S. O. 2019. Factors for late initiation of antenatal care in Dar es Salaam, Tanzania: A qualitative study. *BMC pregnancy and childbirth,* 19**,** 1-9.

MIETTINEN, O. S. 1985a. The "case-control" study: valid selection of subjects. *Journal of chronic diseases,* 38**,** 543-548.

MIETTINEN, O. S. 1985b. Theoretical epidemiology: principles of occurrence research in medicine. *Theoretical epidemiology: principles of occurrence research in medicine.*

MIRKUZIE, A. H., SISAY, M. M., MOLAND, K. M. & ÅSTRØM, A. N. 2011. Applying the theory of planned behaviour to explain HIV testing in antenatal settings in Addis Ababa-a cohort study. *BMC health services research,* 11**,** 196.

MISIRI, H. E., TADESSE, E. & MUULA, A. S. 2004. Are public antenatal clinics in Blantyre, Malawi, ready to offer services for the prevention of vertical transmission of HIV? *African Journal of Reproductive Health***,** 64-70.

MO, P. K., LAU, J. T., XIN, M. & FONG, V. W. 2019. Understanding the barriers and factors to HIV testing intention of women engaging in compensated dating in Hong Kong: The application of the extended Theory of Planned Behavior. *PloS one,* 14**,** e0213920.

MOH. 2016. *HEALTH STRATEGIC PLAN 2016-2020: Quality, Effective and Equitable Health Services* [Online]. Phnom Penh: DEPARTMENT OF PLANNING & HEALTH INFORMATION. Available: http://hismohcambodia.org/public/fileupload/carousel/HSP3-(2016-2020).pdf [Accessed April 14 2021].

MOHLALA, B. K., GREGSON, S. & BOILY, M.-C. 2012. Barriers to involvement of men in ANC and VCT in Khayelitsha, South Africa. *AIDS care,* 24**,** 972-977.

MSUYA, S. E., MBIZVO, E., HUSSAIN, A., URIYO, J., SAM, N. E. & STRAY-PEDERSEN, B. 2006. HIV among pregnant women in Moshi Tanzania: the role of sexual behavior, male partner characteristics and sexually transmitted infections. *AIDS research and therapy,* 3**,** 1-10.

MTENGA, S. M., EXAVERY, A., KAKOKO, D. & GEUBBELS, E. 2015. Social cognitive determinants of HIV voluntary counselling and testing uptake among married individuals in Dar es Salaam Tanzania: Theory of Planned Behaviour (TPB). *BMC public health,* 15**,** 213.

MUGO, P. M., MICHENI, M., SHANGALA, J., HUSSEIN, M. H., GRAHAM, S. M., DE WIT, T. F. R. & SANDERS, E. J. J. P. O. 2017. Uptake and acceptability of oral HIV self-testing among community pharmacy clients in kenya: A feasibility study. 12**,** e0170868.

MULLER, C. J. & MACLEHOSE, R. F. 2014. Estimating predicted probabilities from logistic regression: different methods correspond to different target populations. *International journal of epidemiology,* 43**,** 962-970.

MUSUMARI, P. M., TECHASRIVICHIEN, T., SRITHANAVIBOONCHAI, K., TANGMUNKONGVORAKUL, A., ONO-KIHARA, M. & KIHARA, M. 2020. Factors associated with HIV testing and intention to test for HIV among the general population of Nonthaburi Province, Thailand. *PloS one,* 15**,** e0237393.

MYERS, J. E., EL-SADR, W. M., ZERBE, A. & BRANSON, B. M. J. A. 2013. Rapid HIV self-testing: long in coming but opportunities beckon. 27**,** 1687-1695.

NAA. 2015. *Cambodia Country Progress Report* [Online]. Phnom Penh: National AIDS Authority. Available: https://www.unaids.org/sites/default/files/country/documents/KHM_narrative_report_2015.pdf [Accessed April 12 2021].

NARIDDH, M. 1994. Myths about AIDS in Cambodia. *Aidscaptions,* 1**,** 20-21.

NATIONAL INSTITUTE OF PUBLIC HEALTH, N. I. O. S. C. A. O. M. 2006. Cambodia Demographic and Health Survey 2005. *In:* NATIONAL INSTITUTE OF PUBLIC HEALTH, N. I. O. S. A. O. M. (ed.). Phnom Penh, Cambodia and Calverton, Maryland, USA: National Institute of Public Health, National Institute of Statistics and ORC Macro.

NATIONAL INSTITUTE OF STATISTICS, D. G. F. H., AND ICF MACRO 2011. Cambodia Demographic and Health Survey 2010. *In:* NATIONAL INSTITUTE OF STATISTICS, D. G. F. H., AND ICF MARCO (ed.). Phnom Penh, Cambodia and Calverton, Maryland, USA: Phnom Penh, Cambodia and Calverton, Maryland, USA.

NATIONAL INSTITUTE OF STATISTICS, D. G. F. H., AND ICF MACRO 2015. Cambodia Demographic and Health Survey 2014. Phnom Penh, Cambodia, and Rockville, Maryland, USA: National Institute of Statistics, Directorate General for Health, and ICF International.

NCHADS 2008. Annual Report 2008. Phnom Penh: National Center for HIV/AIDS, Dermatology and STD.

NCHADS. 2012. *Annual Report 2021* [Online]. Phnom Penh: National Center for HIV/AIDS, Dermatology and STD. Available: https://www.nchads.org/wp-content/uploads/2020/11/Annual-report-2012en.pdf [Accessed May 23 2021].

NCHADS. 2017. *National Consolidated Guidelines on HIV Testing Services in Cambodia [Online]. Phnom Penh: National Centre for HIV/AIDS, Dermatology and STD.* [Online]. Phnom Penh: MoH/NCHADS. Available: https://www.aidsdatahub.org/sites/default/files/publication/Cambodia_National_Consolidated_on_Guidelines_on_HIV_Testing_Services_2017.pdf [Accessed May 7 2019].

NCHADS/NMCHC. 2013. *Standard Operating Procedure for Implementation of the Boosted Linked Response between HIVandSRH for Elimination of New Pediatric HIV Infections and Congenital Syphilis in Cambodia* [Online]. Phnom Penh: NCHADS/NMCHC. Available: https://www.nchads.org/wp-content/uploads/2021/02/boosted-LR-SOP_update_eng.pdf [Accessed April 12 2021].

NCHADS/NMCHC. 2018. *National Road Map for the elimination of Mother-to-Child Transmission of HIV and Congenital Syphilis (eMTCT) in Cambodia* [Online]. Phnom Penh: Ministry of Health. Available: https://www.aidsdatahub.org/resource/national-road-map-elimination-mother-child-transmission-hiv-and-congenital-syphilis-emtct [Accessed].

NMCHC. 2007. *PMTCT Joint Program Review Report* [Online]. Phnom Penh: Ministry of Health. Available: http://hismohcambodia.org/public/fileupload/PMTCT_EXTERNAL_JOINT_REVIEW_E_15_1__08.pdf [Accessed April 12 2021].

NMCHC 2016. National Guideline For the Prevention of Mother-to-Child Transmission of HIV and Syphilis. *In:* CENTER, N. M. A. C. H. (ed.). Phnom Penh: National Maternal and Child Health Center.

NMCHC 2020. PMTCT program database. Phnom Penh ed. Phnom Penh: National Maternal and Child Health Center.

NUNNALLY, J. C. 1994. *Psychometric theory 3E*, Tata McGraw-hill education.

ONGOLLY, F. K. & BUKACHI, S. A. 2019. Barriers to men's involvement in antenatal and postnatal care in Butula, western Kenya. *African journal of primary health care & family medicine,* 11**,** 1-7.

ONONOKPONO, D. N. & AZFREDRICK, E. C. 2014. Intimate partner violence and the utilization of maternal health care services in Nigeria. *Health care for women international,* 35**,** 973-989.

ONONOKPONO, D. N., ODIMEGWU, C. O., IMASIKU, E. & ADEDINI, S. 2013. Contextual determinants of maternal health care service utilization in Nigeria. *Women & health,* 53**,** 647-668.

ORNE-GLIEMANN, J., TCHENDJOU, P. T., MIRIC, M., GADGIL, M., BUTSASHVILI, M., EBOKO, F., PEREZ-THEN, E., DARAK, S., KULKARNI, S. & KAMKAMIDZE, G. 2010. Couple-oriented prenatal HIV counseling for HIV primary prevention: an acceptability study. *BMC public health,* 10**,** 1-11.

OSOTI, A. O., JOHN-STEWART, G., KIARIE, J., RICHARDSON, B., KINUTHIA, J., KRAKOWIAK, D. & FARQUHAR, C. 2014. Home visits during pregnancy enhance male partner HIV counseling and testing in Kenya: a randomized clinical trial. *AIDS (London, England),* 28**,** 95.

OSOTI, A. O., JOHN-STEWART, G., KIARIE, J. N., BARBRA, R., KINUTHIA, J., KRAKOWIAK, D. & FARQUHAR, C. 2015. Home-based HIV testing for men preferred over clinic-based testing by pregnant women and their male partners, a nested cross-sectional study. *BMC infectious diseases,* 15**,** 1-7.

PAL, K., NGIN, C., TUOT, S., CHHOUN, P., LY, C., CHHIM, S., LUONG, M.-A., TATOMIR, B. & YI, S. 2016. Acceptability study on HIV self-testing among transgender women, men who have sex with men, and female entertainment workers in Cambodia: a qualitative analysis. *PLoS One,* 11**,** e0166129.

PENEZA, A. K. & MALUKA, S. O. 2018. 'Unless you come with your partner you will be sent back home': strategies used to promote male involvement in antenatal care in Southern Tanzania. *Global health action,* 11**,** 1449724.

PERERA, R., HENEGHAN, C. & BADENOCH, D. 2011. *Statistics toolkit*, John Wiley & Sons.

PHILLIPS, K. A., MORRISON, K. R., ANDERSEN, R. & ADAY, L. A. 1998. Understanding the context of healthcare utilization: assessing environmental and provider-related variables in the behavioral model of utilization. *Health services research,* 33**,** 571.

POLIT, D. F. & BECK, C. T. 2009. *Essentials of nursing research: Appraising evidence for nursing practice*, Lippincott Williams & Wilkins.

POLLAHAN, A., THINKHAMROP, J., KONGWATTANAKUL, K., CHAIYARACH, S., SUTTHASRI, N. & LAO-UNKA, K. 2019. Rate of Couple HIV Testing in a Prenatal Care Clinic and Factors Associated with Refusal of Testing Among Male Partners. *HIV/AIDS (Auckland, NZ),* 11**,** 369.

PROJECT, P. 2003. *HIV/AIDS in the Mekong Region: Cambodia, Lao PDR, Thailand and Viet Nam: Current situation, future projections, socioeconomic impacts, and recommendations.* [Online]. Washington DC: POLICY Project. Available: http://www.policyproject.com/pubs/generalreport/ACF1B3.pdf [Accessed May 20 2021].

PULLUM, T. & ELKASABI, M. 2019. *Pooled data analysis from 25 countries* [Online]. The DHS Program User Forum. Available: https://userforum.dhsprogram.com/index.php?t=msg&th=7730&start=0&S=Google [Accessed: September 30th, 2020].

QIN, Y., HAN, L., BABBITT, A., WALKER, J. S., LIU, F., THIRUMURTHY, H., TANG, W. & TUCKER, J. D. J. A. 2018. Experiences using and organizing HIV self-testing. 32**,** 371-381.

REECE, M., HOLLUB, A., NANGAMI, M. & LANE, K. 2010. Assessing male spousal engagement with prevention of mother-to-child transmission (pMTCT) programs in western Kenya. *AIDS care,* 22**,** 743-750.

REN, R. 2004. *Note on DHS standard weight de-normalization* [Online]. Available: http://userforum.measuredhs.com/index.php?t=getfile&id=4& [Accessed: September 20th, 2020].

REVILLA, M. A., SARIS, W. E. & KROSNICK, J. A. 2014. Choosing the number of categories in agree–disagree scales. *Sociological Methods & Research,* 43**,** 73-97.

RICKETTS, T. C. & GOLDSMITH, L. J. 2005. Access in health services research: the battle of the frameworks. *Nursing outlook,* 53**,** 274-280.

SAKALA, D., KUMWENDA, M. K., CONSERVE, D. F., EBENSO, B. & CHOKO, A. T. 2021. Socio-cultural and economic barriers, and facilitators influencing men's involvement in antenatal care including HIV testing: a qualitative study from urban Blantyre, Malawi. *BMC Public Health,* 21**,** 1-12.

SANDELOWSKI, M. 1995. Sample size in qualitative research. *Research in nursing & health,* 18**,** 179-183.

SAPHONN, V., FUJITA, M., SAMRETH, S., CHAN, S., ROUET, F., KHOL, V., MAM, S., MOM, C., TUOT, S. & LE, L.-V. 2017. Cluster of HIV infections associated with unsafe injection practices in a rural village in Cambodia. *Journal of acquired immune deficiency syndromes (1999),* 75**,** e82.

SAPHONN, V., SOPHEAB, H., SUN, L. P., VUN, M. C., WANTHA, S. S., GORBACH, P. M. & DETELS, R. 2004. Current HIV/AIDS/STI epidemic: intervention programs in Cambodia, 1993–2003. *AIDS Education and Prevention,* 16**,** 64-77.

SASAKI, Y., ALI, M., SATHIARANY, V., KANAL, K. & KAKIMOTO, K. 2010. Prevalence and barriers to HIV testing among mothers at a tertiary care hospital in Phnom Penh, Cambodia. Barriers to HIV testing in Phnom Penh, Cambodia. *BMC Public health,* 10**,** 494.

SAU, M. S., BALAMANE, M., LURIE, M., HARWELL, J., WELLE, E., MEAN, C. & CU-UVIN, S. 2016. Assessment of prevention of mother-to-child transmission HIV services in the Bantey Meanchey Province in Cambodia. *Journal of the International Association of Providers of AIDS Care (JIAPAC),* 15**,** 345-349.

SCHATZ, E. 2005. 'Take your mat and go!': Rural Malawian women's strategies in the HIV/AIDS era. *Culture, health & sexuality,* 7**,** 479-492.

SEMRAU, K., KUHN, L., VWALIKA, C., KASONDE, P., SINKALA, M., KANKASA, C., SHUTES, E., ALDROVANDI, G. & THEA, D. M. 2005. Women in couples antenatal HIV counseling and testing are not more likely to report adverse social events. *AIDS (London, England),* 19**,** 603.

SIM, S., TUON, S., WELLE, E., SAMRETH, S., SUN, S., NGAUV, B., OUK, V., FUJITA, M., SENG, S. & MEAN, C. V. 2015. Implementation and operational research: scaling up the provision of the PMTCT services, using the linked response approach in Cambodia from 2008 to 2012. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 69**,** e66-e73.

SNIEHOTTA, F. F., PRESSEAU, J. & ARAÚJO-SOARES, V. 2014. Time to retire the theory of planned behaviour. Taylor & Francis.

STEIN, J. A., ANDERSEN, R. & GELBERG, L. 2007. Applying the Gelberg-Andersen behavioral model for vulnerable populations to health services utilization in homeless women. *Journal of health psychology,* 12**,** 791-804.

STEIN, J. A., ANDERSEN, R. M., ROBERTSON, M. & GELBERG, L. 2012. Impact of hepatitis B and C infection on health services utilization in homeless adults: a test of the Gelberg-Andersen Behavioral Model for Vulnerable Populations. *Health Psychology,* 31**,** 20.

STEINMETZ, H., KNAPPSTEIN, M., AJZEN, I., SCHMIDT, P. & KABST, R. 2016. How effective are behavior change interventions based on the theory of planned behavior? *Zeitschrift für Psychologie*.

STREINER, D. L. 2003. Starting at the beginning: an introduction to coefficient alpha and internal consistency. *Journal of personality assessment,* 80**,** 99-103.

TABER, K. S. 2018. The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education,* 48**,** 1273-1296.

THEURING, S., MBEZI, P., LUVANDA, H., JORDAN-HARDER, B., KUNZ, A. & HARMS, G. 2009. Male involvement in PMTCT services in Mbeya Region, Tanzania. *AIDS and Behavior,* 13**,** 92-102.

THEWES, B., RIETJENS, J. A., VAN DEN BERG, S. W., COMPEN, F. R., ABRAHAMS, H., POORT, H., VAN DE WAL, M., SCHELLEKENS, M. P., PETERS, M. E. & SPECKENS, A. E. 2018. One way or another: The opportunities and pitfalls of self-referral and consecutive sampling as recruitment strategies for psycho-oncology intervention trials. *Psycho-oncology,* 27**,** 2056.

THIRUMURTHY, H., MASTERS, S. H., MAVEDZENGE, S. N., MAMAN, S., OMANGA, E. & AGOT, K. 2016. Promoting male partner HIV testing and safer sexual decision making through secondary distribution of self-tests by HIV-negative female sex workers and women receiving antenatal and post-partum care in Kenya: a cohort study. *The lancet HIV,* 3**,** e266-e274.

TORNIKOSKI, E. & MAALAOUI, A. 2019. Critical reflections–The Theory of Planned Behaviour: An interview with Icek Ajzen with implications for entrepreneurship research. *International Small Business Journal,* 37**,** 536-550.

UNAIDS 1999a. Counselling and voluntary HIV testing for pregnant women in high HIV prevalence countries: elements and issues. *Counselling and voluntary HIV testing for pregnant women in high HIV prevalence countries: elements and issues.*

UNAIDS. 1999b. *Sexual behavioural changefor HIV:Where have theories taken us?* [Online]. Geneva: Joint United Nations Programme on HIV/AIDS (UNAIDS). Available: https://www.who.int/hiv/strategic/surveillance/en/unaids_99_27.pdf [Accessed April 14 2021].

UNAIDS. 2014. *90-90-90: An ambitious treatment target to help end the AIDS epidemic* [Online]. Geneva: Joint United Nations Programme on HIV/AIDS (UNAIDS). Available: https://www.unaids.org/sites/default/files/media_asset/90-90-90_en.pdf [Accessed May 23 2021].

UNAIDS. 2018a. *Country progress report - Cambodia* [Online]. Geneva: UNAIDS. Available: https://www.unaids.org/sites/default/files/country/documents/KHM_2018_countryreport.pdf [Accessed July 10 2019].

UNAIDS. 2018b. *UNAIDS warns that progress is slowing and time is running out to reach the 2020 HIV targets* [Online]. Geneva: World Health Organization/UNAIDS. Available: https://www.unaids.org/en/resources/presscentre/pressreleaseandstatementarchive/2018/july/miles-to-go [Accessed].

VERMEULEN, E., MILTENBURG, A. S., BARRAS, J., MASELLE, N., VAN ELTEREN, M. & VAN ROOSMALEN, J. 2016. Opportunities for male involvement during pregnancy in Magu district, rural Tanzania. *BMC pregnancy and childbirth,* 16**,** 1-9.

VON LENGERKE, T., GOHL, D. & BABITSCH, B. 2014. Re-revisiting the Behavioral Model of Health Care Utilization by Andersen: a review on theoretical advances and perspectives. *Health care utilization in Germany.* Springer.

VUN, M. C. 2016. Cluster of HIV infections attributed to unsafe injection practices—Cambodia, December 1, 2014–February 28, 2015. *MMWR. Morbidity and mortality weekly report,* 65.

WACHOLDER, S., MCLAUGHLIN, J. K., SILVERMAN, D. T. & MANDEL, J. S. 1992a. Selection of controls in case-control studies: I. Principles. *American journal of epidemiology,* 135**,** 1019-1028.

WACHOLDER, S., SILVERMAN, D. T., MCLAUGHLIN, J. K. & MANDEL, J. S. 1992b. Selection of controls in case-control studies: II. Types of controls. *American journal of epidemiology,* 135**,** 1029-1041.

WALMSLEY, S. 2003. Opt in or opt out: what is optimal for prenatal screening for HIV infection? *Cmaj,* 168**,** 707-708.

WEIHS, M., MEYER-WEITZ, A. & BAASNER-WEIHS, F. 2018. The influence of lotteries on employees' workplace HIV testing behaviour. *African Journal of AIDS Research,* 17**,** 9-21.

WHITE, J., DELVAUX, T., CHHEA, C., SARAMONY, S., OUK, V. & SAPHONN, V. 2013. The linked response: lessons emerging from integration of HIV and reproductive health services in Cambodia. *AIDS research and treatment,* 2013.

WHO. 2006. *Taking stock: HIV in children* [Online]. Geneva: World Health Organization. Available: chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/https://www.who.int/hiv/toronto2006/Children2_eng.pdf [Accessed April 11 2021].

WHO 2010. *Counselling for maternal and newborn health care: A handbook for building skills*, World Health Organization.

WHO 2012a. *Male involvement in the prevention of mother-to-child transmission of HIV*, World Health Organization.

WHO. 2012b. *Planning, implementing and monitoring home-based HIV testing and counselling: A practical handbook for Sub-Saharan Afric* [Online]. Geneva: World Health Organization. Available: https://www.who.int/hiv/pub/vct/home_based_care/en/ [Accessed May 25 2021].

WHO. 2014. *Joint review of the Cambodian national health sector response to HIV 2013* [Online]. Geneva: World Health Organization. Available: https://iris.wpro.who.int/bitstream/handle/10665.1/10423/9789290616641_eng.pdf [Accessed April 12 2021].

WHO. 2015a. *Consolidated guidelines on HIV testing services 2015* [Online]. Geneva: World Health Organization. Available: https://apps.who.int/iris/bitstream/handle/10665/179870/9789241508926_eng.pdf [Accessed April 12 2021].

WHO 2015b. The Kingdom of Cambodia health system review. Manila: WHO Regional Office for the Western Pacific.

WHO. 2016. *Supplement guidelines on HIV Self-testing and partner notification* [Online]. Geneva: World Health Organization. Available: http://apps.who.int/iris/bitstream/handle/10665/251655/9789241549868-eng.pdf?sequence=1 [Accessed August 28 2018].

WHO. 2017. *Health Topics: HIV/sexually transmitted infections* [Online]. Phnom Penh: World Health Organization Representative Office Cambodia. Available: http://www.wpro.who.int/cambodia/topics/hiv_sti/en/ [Accessed April 15 2021].

WHO. 2019a. *Consolidated guidelines on HIV testing services* [Online]. Geneva: World Health Organization. Available: https://www.who.int/publications/i/item/978-92-4-155058-1 [Accessed April 12 2021].

WHO. 2019b. *HIV self-testing* [Online]. Geneva: World Health Organization. Available: https://www.who.int/hiv/topics/self-testing/en/ [Accessed April 14 2021].

WHO. 2019c. *Prevention of mother-to-child transmission (PMTCT)* [Online]. Geneva: World Health Organization. Available: https://www.who.int/gho/hiv/epidemic_response/PMTCT/en/ [Accessed April 11 2021].

WHO. 2020. *HIV/AIDS* [Online]. Geneva: World Health Organization. Available: https://www.who.int/news-room/fact-sheets/detail/hiv-aids [Accessed April 15 2021].

WHO. 2021. *Mother-to-child transmission of HIV* [Online]. Geneva: World Health Organization. Available: https://www.who.int/hiv/topics/mtct/about/en/ [Accessed April 11 2021].

YANG, D., PLIANBANGCHANG, P., VISAVARUNGROJ, N., RUJIVIPAT, S. J. S. A. J. O. T. M. & HEALTH, P. 2004. Quality of pharmaceutical items available from drugstores in Phnom Penh, Cambodia. 35**,** 741-747.

YAYA, S., OLAREWAJU, O., OLADIMEJI, K. E. & BISHWAJIT, G. 2019. Determinants of prenatal care use and HIV testing during pregnancy: a population-based, cross-sectional study of 7080 women of reproductive age in Mozambique. *BMC Pregnancy and Childbirth,* 19**,** 354.

YEE, L. M., LEZIAK, K., JACKSON, J. & MILLER, E. S. 2020. Attitudes toward male partner HIV testing among low-income, minority pregnant women and their partners. *Sexual & Reproductive Healthcare,* 25**,** 100513.

YEGANEH, N., SIMON, M., MINDRY, D., NIELSEN-SAINES, K., CHAVES, M. C., SANTOS, B., MELO, M., MENDOZA, B. & GORBACH, P. 2017. Barriers and facilitators for men to attend prenatal care and obtain HIV voluntary counseling and testing in Brazil. *Plos one,* 12**,** e0175505.

ZHANG, C., LI, X., BRECHT, M.-L. & KONIAK-GRIFFIN, D. J. P. O. 2017. Can self-testing increase HIV testing among men who have sex with men: A systematic review and meta-analysis. 12**,** e0188890.

ZULU, E. M. & CHEPNGENO, G. 2003. Spousal communication and management of HIV/AIDS risk in rural Malawi. *Demographic Research S,* 1**,** 247-278.