THE IMPACT OF YOUTH FRIENDLY HEALTH SERVICES ON PREGNANCY RISK AMONG ADOLESCENT GIRLS AND YOUNG WOMEN IN LILONGWE, MALAWI

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ABSTRACT

Lauren A. Graybill: The Impact of Youth Friendly Health Services on Pregnancy Risk among Adolescent Girls and Young Women in Lilongwe, Malawi
(Under the direction of Daniel Westreich)

In 2020, approximately 22 million adolescent girls and young women aged 15-24 (AGYW) in sub-Saharan Africa (SSA) became pregnant, 45% of which were unintended. Interventions that enhance contraceptive use in this population may reduce risk of early and unintended pregnancy. Using rigorous epidemiologic methods, we investigated if—and how—access to youth-friendly health services (YFHS) shaped pregnancy risk among participants in the Girl Power study.

In 2016, Girl Power assigned four government-run health clinics in Lilongwe, Malawi, to offer either standard of care (SOC; n=1) or YFHS (n=3). Each clinic enrolled 250 AGYW and followed them for 12 months. In Aim 1, we used longitudinal data on sexual activity and contraceptive use to evaluate the impact of YFHS on the probability of sustained pregnancy protection. Sustained pregnancy protection, defined as sustained use of contraception or abstinence over 12 months, was more common under YFHS than under SOC (45.7% vs 38.5%; RD: 7.2%, 95% CI: -2.6%, 17.0%). The effect of YFHS was concentrated among participants who were married and those with children, and was driven by greater sustained use of non-barrier methods of contraception among participants with access to YFHS than those in the SOC.

In Aim 2, we leveraged longitudinal data on pregnancy (based self-report and results from urine pregnancy tests) to evaluate the impact of YFHS on the 12-month probability of pregnancy among study participants. Because of missing pregnancy test results, we used

multiple imputation to correct for outcome misclassification in self-reported pregnancy status. After correcting for outcome misclassification, the probability of pregnancy was lower under the YFHS model of service delivery than under the SOC (15.8% vs. 23.2%; RD: -7.3%, 95% CI: -15.5%, 0.8%). Pregnancies were concentrated among participants who did not sustain pregnancy protection over the 12-month study period.

Overall, our findings suggest that YFHS can improve contraceptive behaviors and decrease pregnancy risk, supporting ongoing efforts to introduce and expand access to YFHS in SSA. Future research is needed to identify interventions that enhance demand for contraception among unmarried and nulliparous AGYW, and to identify effective strategies for bringing YFHS to scale in SSA.

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LIST OF ABBREVIATIONS

AGYW	Adolescent Girls and Young Women
BI	Behavioral Intervention
CI	Confidence Interval
CCT	Conditional Cash Transfer
cRCT	Cluster Randomized Trial
DHS	Demographic and Health Survey
DREAMS	Determined, Resilient, Empowered, AIDS-free, Mentored and Safe
HTS	HIV Testing Services
ICPD	International Conference on Population and Development
IUD	Intrauterine Device
LAM	Lactational Amenorrhea Method
MICE	Multiple Imputation by Chained Equations
MIME	Multiple Imputation for Measurement Error
NAFCI	National Adolescent Friendly Clinic Initiative
OCP	Oral Contraceptive Pills
PCA	Principal Component Analysis
PS	Propensity Score
RD	Risk Difference
RR	Risk Ratio
SD	Standard Deviation
SDM	Standard Days Method
SOC	Standard of Care
SRH	Sexual and Reproductive Health
SSA	sub-Saharan Africa
STI	Sexually Transmitted Infections

UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nation Population Division
UPT	Urine Pregnancy Test
WHO	World Health Organization
YFHS	Youth Friendly Health Services

CHAPTER 1: BACKGROUND

In this chapter, we first provide background information on adolescents and young adults, describe the burden and consequences of early and unintended pregnancy in the sub-Saharan Africa, and summarize the main proximate causes of early and unintended pregnancy among adolescent girls and young women in the region. Next, we use a social ecological framework to introduce determinants of contraceptive use among adolescent girls and young women, drawing on qualitative work conducted from across sub-Saharan Africa. Then, we introduce youth friendly health services and summarize existing evidence relating these models of service delivery to contraceptive use and pregnancy outcomes among adolescent girls and young women in the region, highlighting important limitations and research gaps in the existing evidence base. Throughout this chapter, information specific to Malawi is emphasized when possible.

1.1. Adolescents and young adults

1.1.1. Terminology

The World Health Organization (WHO) defines *adolescents* as individuals aged 10 to 19, *youths* as individuals aged 15 to 24, and *young people* as the composite of these two overlapping age groups (10 to 24). The 10 to 24 age range is often deconstructed into *early adolescence* (10 to 14 years), *late adolescence* (15 to 19 years), and *young adulthood* (20 to 24 years) to reflect the biological changes and social-role transitions that have historically defined the adolescent and young adult period. For consistency with the parent study that contributed data to this dissertation, we use the phrase *adolescent girls and young women (AGYW)* to refer to the female youth (those aged 15 to 24 years old) population in this dissertation.

1.1.2. Population dynamics

An estimated 1.8 billion young people aged 10 to 24 accounted for approximately one quarter of the global population in 2019 (1). While gains in life expectancy have contributed to a decline in the proportion of the global population comprised of young people, the absolute size of the adolescent and young adult population remains on an upwards trajectory due to improvements in child survival and high fertility rates observed in many regions of the world (1). Under the United Nation Population Division's (UNDP) medium-variate projections, the absolute size of the global population of young people is expected to peak at just over two billion during the second half of the 21st century, with the vast majority of growth occurring in low- and lower-middle-income countries (1). Such dynamics are expected to shift the concentration of the world's population of young people from Asia to sub-Saharan Africa (SSA), and by 2050 approximately 30% of the world's population of young people will reside in SSA (up from 19% in 2020) (1).

Population trends in Malawi are similar to the overall patterns observed in SSA. Between 2000 and 2019, the infant mortality rate in Malawi declined substantially, from 100 to 31 infant deaths per 1000 live births, while the total fertility rate declined from 6.1 to 4.2 total births per woman (2). As a result of these dynamics, the size of the adolescent and young adult population in Malawi grew from 3.5 million in 2000 to approximately 6.5 million in 2020 (1). Under the medium-variant projections, which assume continued gains in child survival and total fertility rates persistently above replacement levels, UNDP projection models predict that the size of the adolescent and young adult population in Malawi will continue to grow throughout the 21st century, doubling by the early 2070s (1).

The social, economic, and political impact of the growing population of young people in Malawi will be significant, and investments in health are necessary in order to help this population realize their full potential. In Malawi, where first sexual intercourse, first union (cohabitation or marriage), and first birth typically occur during adolescence (3), addressing the

sexual and reproductive health (SRH) needs of AGYW is a pressing public health priority. In the short term, improved SRH during adolescence will enable the accumulation of resources and capital necessary for AGYW to successfully transition to adulthood (4). In the long term, improved SRH during adolescence plays a central role in determining adult health trajectories, and has profound implications for the health and wellbeing of future generations (4). From this perspective, addressing SRH needs of AGYW in Malawi will bring a triple dividend of benefits: for the immediate health of the youth population today, for the future health of the adults they will become, and for promoting the health of the next generation.

1.2. The burden of early and unintended pregnancy among AGYW in SSA

Using population and age-specific fertility rates estimated by the UNDP (1), the estimated regional abortion rate of 27 per 1000 women in SSA (5), and the assumption that 20% of births and 10% of abortions end in miscarriage (6), we estimate that approximately 22 million AGYW in SSA experienced a pregnancy in 2020. Critically, over the next several decades, the absolute number of pregnancies to AGYW in the region is projected to increase as a result of persistently high age-specific fertility rates and the rapidly growing population of 15 to 24-year-olds. Fertility rates among adolescent girls aged 15 to 19 and young women aged 20 to 24 in Malawi are among the highest in the world (87 and 154 births per 1,000 women, respectively), and approximately 60% of Malawian women experience a first birth during adolescence (1, 3). A large proportion of these births are the result of pregnancies that were mistimed or unwanted.

Using direct retrospective recall methods, the most recent Demographic and Health Survey (DHS) for Malawi estimated that 41% of births to adolescent girls and 35% of births to young women were either mistimed or unwanted (3). Importantly, these estimates of intention likely represent a lower bound for the true burden of unintended pregnancy experienced by AGYW in Malawi. Live births underestimate pregnancies by omitting conceptions that did not end in a live birth (~30% due to natural causes and ~15% due to induced abortions) (5-8), and

direct retrospective recall methods are subject to *ex post* rationalization biases that typically overestimate the proportion of pregnancies which were desired at the time of conception (9). Assuming that 45% of pregnancies are unintended (10), we estimate that four million adolescent girls aged 15 to 19 in SSA, and six million young women aged 20 to 24 in SSA, experienced an unintended pregnancy in 2020.

Early pregnancy (i.e. pregnancy before age 18) and unintended pregnancy (i.e. pregnancies that were mistimed or unwanted) have important immediate health consequences. Pregnancy-related complications are a leading cause of morbidity and mortality among AGYW in SSA, accounting for 1.7 million disability-adjusted life years lost and 17% of all deaths in the population in 2019 (11). Adolescents—particularly those younger than 18 years of age—experience are at high risk of several adverse obstetric events including: hypertensive disorders (pre-eclampsia and eclampsia), hemorrhage, prolonged and obstructed labor, puerperal endometritis, and sepsis (12-19). In SSA, where comorbidities like malnutrition, HIV, and malaria are common, the consequences of these adverse obstetric events can be fatal.

Post-abortion complications contribute to morbidity and mortality among AGYW in SSA, and approximately half of all unintended pregnancies in Malawi are believed to end with an induced abortion (6). While legal abortions are one of the safest medical procedures in contemporary medical practice, abortions are only legal in Malawi if performed to save a woman's life (20). As a result, AGYW in Malawi who seek to terminate their pregnancy will often obtain clandestine procedures that are performed by persons lacking necessary skills, or in environments that do not meet minimum medical standards, or both (21). In such contexts, post-abortion complications requiring medical attention are common (22), but stigma and misinformation surrounding the procedure often leads to delays in seeking medical care, increasing the risk of more severe complications and/or death (23). In addition to abortion, unintended pregnancy may increase risk of mental health disorders, including depression and anxiety (24-28), and may increase risk of poor medication adherence among women living with

HIV (29), a particular concern for countries like Malawi where over 10% of women over the age of 15 are living with HIV (30).

Beyond immediate health concerns, early and unintended pregnancies also have deleterious effects on individual socioeconomic outcomes. Adolescent pregnancy increases the risk of school dropout and decreases overall educational attainment (31-34), events that limit economic opportunities, negatively impact earning potential, and impede long term human capital accumulation (34-39). Moreover, women who become pregnant during adolescence often have more births over their lifetime than women who delay childbearing (37), which often corresponds to less labor force participation, larger family sizes, and a greater strain on limited household resources (38, 39). Critically, these socioeconomic consequences are linked to health outcomes across the life course (4).

There are also important intergenerational consequences of early and unintended pregnancy. Births to adolescent girls are more likely to be preterm, low birthweight, and small for gestational age than births to women in their twenties (12, 40, 41), and there is some evidence that adolescent pregnancy may increase risk of hospitalizations and infant death in the first twelve months postpartum (40-43). There are several plausible biological mechanisms for these relationships. Physiological immaturity may contribute to a higher risk of preterm birth (i.e. due to a short cervix and small uterine volume) (44), and among adolescents who are still growing or who experience nutrient deficiencies, the theory of feto-maternal nutrient competition may explain lower birth weights as well as increased risk of preterm birth (45). In addition, adolescent girls who become pregnant are often socioeconomically disadvantaged and may be less likely to receive adequate prenatal or postnatal care, heightening the risk of negative birth outcomes. Following birth, children of adolescent mothers may experience a greater risk of impaired health (43, 46), developmental delays (47, 48), and lower educational attainment (49, 50), which are hypothesized to relate to a lower cognitive readiness to parent among adolescent mothers (48).

Several studies have found that women who experience an unintended pregnancy are less likely to breastfeed than women whose pregnancies were intended, and that infants from unintended pregnancies are less likely to have received all recommended immunizations by 12 months of age than infants from pregnancies that were intended (51-55). In addition, some studies have reported associations between pregnancy intention and infant mortality and undernutrition (54, 56, 57), and adverse psychological and developmental outcomes among children (58-62). However, difficulties accurately ascertaining pregnancy intention, challenges with selection bias, and unmeasured confounding make it difficult to interpret these associations causally (54).

In summary, early and unintended pregnancy in Malawi is common, and pregnancy-related complications are a leading cause of morbidity and mortality among AGYW, who account for over 20% of maternal deaths in SSA each year. Beyond immediate health concerns, early and unintended pregnancies to AGYW can compromise educational attainment, endanger future economic opportunities, and have intergenerational consequences that impact the health and future wellbeing of offspring. From this perspective, identifying interventions to reduce the risk of early and unintended pregnancy in Malawi are a public health priority.

1.3. Proximate causes of early and unintended pregnancy among AGYW in SSA

1.3.1. Marriage

Marriage before age 18 is common in SSA and many early pregnancies in the region occur in the context of marriage (10). Social conventions regarding childbearing in SSA are often linked to marital status, and a common expectation in the region is that pregnancy should occur soon after marriage. In contexts where pregnancy and motherhood define a woman's status in society, married AGYW may perceive significant benefits to childbearing (63). A qualitative study on fertility preferences in Malawi and South Africa highlighted the relationship between marital status and childbearing, and described pressures that newly married women experience regarding conception, feelings of guilt and shame associated with not becoming

pregnant, and the enthusiasm and support received following a pregnancy (63). Similar feelings were expressed by adolescents interviewed in Uganda, who described a culturally vetted sequence of expected life events: marriage around the age of 18, and pregnancy shortly thereafter (64).

In Malawi, approximately 46% of women are married by 18 years of age. In 2017, however, the Malawian Government amended the national constitution to make marriage before the age of 18 illegal and removed a provision that allowed children to marry at age 15 with parental consent. As a result, most pregnancies in the context of marriage in Malawi now occur among AGYW who are 18 years of age or older, when the risk of adverse obstetric outcomes is lower.

1.3.2. Unmet need for modern methods of contraception

Modeling conducted by researchers at the Guttmacher Institute suggest that 77% of all unintended pregnancies globally occur among women with unmet need for modern methods of contraception (65). Women with an unmet need for modern contraception are those who wish to delay or prevent a pregnancy but who are not using a modern method of contraception (65). There is no standard definition of modern methods of contraception. The United Nations Department of Economic and Social Affairs (UNDESA) defines modern methods to include: female and male sterilization, intrauterine devices (IDU), subdermal implants, injectables, oral contraceptive pills (OCP), contraceptive patches, vaginal rings, emergency contraceptive pills, female and male condoms, vaginal barrier methods (including diaphragms, cervical caps, and sponges), and lactational amenorrhea method (LAM) (66). The Guttmacher Institute's definition of modern methods includes all those listed above, as well as two fertility awareness-based methods (the standard days method (SDM) and the TwoDay Method) (65), while the WHO's definition of modern methods builds upon the Guttmacher Institute's definition to include two other fertility awareness-based methods (basal body temperature and symptothermal method)

(67). As a result, estimates of unmet need for modern methods of contraception vary according to source.

Using the DHS's definition of a modern method of contraception, which largely aligns the Guttmacher Institute's definition, only 65% of AGYW in Malawi who want to prevent a pregnancy use a modern method of contraception (3). In comparison, nearly 75% of women over the age of 25 in Malawi who want to prevent a pregnancy use modern methods of contraception (3). These trends are consistent with estimates generated by UNDESA, which illustrate lower levels of modern methods use among AGYW compared to older women globally (66). Notably, estimates from UNDESA suggest that AGYW in SSA experience considerably more unmet need for modern methods of contraception than their counterparts in almost every other region in the world (66).

1.3.3. Preference for less effective methods of contraception

Modeling conducted by the Guttmacher Institute suggests that contraceptive failure accounts for nearly one-quarter of unintended pregnancies globally (65). Contraceptives differ in their effectiveness, particularly in real-world settings where some methods can be used inconsistently or incorrectly. The most effective methods of contraception are long-acting methods, including female and male sterilization, subdermal implants, and IUDs. For these methods, the 12-month risk of pregnancy under typical use is less than one percent (68). In contrast, the 12-month risk of pregnancy when using short-acting hormonal methods of contraception (i.e. injectables, OCPs, vaginal rings, and patches) ranges from six to nine percent under typical use, while the 12-month risk of pregnancy when using barrier methods (i.e. diaphragm, female and male condoms, cervical caps, and sponges) ranges from 12% to 24% under typical use (68). Fertility awareness-based methods and spermicides are the least effective contraceptive methods, with 12-month risks of pregnancy ranging from 24% to 28% under typical use (68). Notably, the risk of method-specific contraceptive failure is typically greater among AGYW than among older women (69-73).

Most AGYW in Malawi who use contraception rely on condoms or injectables. However, there are striking differences in contraceptive preferences according to marital status (3). Among married AGYW who report using a method of contraception, most (69%) report using injectables, followed by implants (20%), OCPs (4%) and condoms (4%). Among unmarried sexually active AGYW who report using a method of contraception, most report using condoms (50%), followed by injectables (30%), implants (12%), and OCPs (4%). Among both married and unmarried AGYW, subdermal implants are more commonly used by young women aged 20 to 24 than by adolescent girls aged 15 to 19. Notably, IDUs and traditional methods, defined by the DHS as rhythm methods, withdrawal, or—vaguely—"other traditional methods," are rarely used by AGYW in Malawi.

1.3.4. Challenges with contraceptive adherence and continuation

When used correctly, the effectiveness of short-acting hormonal methods of contraception for preventing pregnancy is similar to the effectiveness of long-acting methods (68). Early contraceptive discontinuation (i.e. discontinuing for reasons other than wanting a child or no longer needing protection) and challenges with using contraceptive methods as intended are the primary reasons why the such methods of contraception are less effective than long-acting methods in real-world settings. Challenges with contraceptive adherence and continuation also reduce the effectiveness of barrier methods, fertility awareness-based methods, and spermicides, which, even under perfect use, are generally less effective than long-acting methods under typical use or short-acting methods under perfect use.

In Malawi, the 12-month probability of discontinuation is highest among AGYW (74), and is more common among women who use OCPs (62%), male condoms (62%), and injectables (41%), than among women who use subdermal implants (8%) (3). While some degree of contraceptive discontinuation is expected over time (i.e. due to changes to fertility preferences), an estimated 32% of contraceptive users in SSA stop using contraception for reasons other than wanting a child (75), and these women contribute approximately 25% of unintended births in the

region (76). The adverse consequences of early discontinuation can be averted by promptly switching to an alternative method, but contraceptive switching in SSA is uncommon. In Malawi, more than 70% of women who discontinued a modern method of contraception while still at risk of an unintended pregnancy remained at risk of an unintended pregnancy three months after discontinuation (77). Unsurprisingly, incidence of pregnancy following contraceptive discontinuation in Malawi is high (>30%), and the majority of these pregnancies are considered mistimed or unwanted (73).

1.3.5. Summary

In light of legislative changes that made marriage before age 18 illegal, unmet need for modern methods of contraception and suboptimal patterns of use (e.g., less effective methods, inadequate adherence, and early discontinuation) are the primary sources of early and unintended pregnancy among AGYW in Malawi.

1.4. Determinants of contraceptive use among AGYW in SSA

Myriad modifiable factors are associated with an adolescent girl or young women's decision to use, or not use, contraception. Bronfenbrenner's socioecological theory provides a helpful framework for understanding how individual behaviors and decision-making processes are shaped within the broader social and physical environment (78). Figure 1.1 is an adaption of Bronfenbrenner's socioecological model and depicts four levels of influence (intrapersonal, interpersonal, structural, and societal) related to contraceptive behaviors (i.e. uptake, adherence, continuation, and method preference) among AGYW in SSA.

The *intrapersonal* level of the framework shown in Figure 1.1 represents the individual's own attitudes, beliefs, and knowledge, and how these factors influence contraceptive behaviors. The *interpersonal* level focuses on how interactions with family members, peers, and intimate partners shape contraceptive behaviors. The *structural* level of the socioecological model considers how features of the environment influence behaviors related to contraceptive

behaviors. Finally, the *societal* level considers how social, cultural, and political features of the broader environment relate to an individual's contraceptive behaviors.

1.4.1. Intrapersonal level

A desire to prevent pregnancy is the primary individual motivator for contraceptive use among women. Among AGYW in SSA, however, there is often an incongruence between pregnancy intentions and current contraceptive behaviors. Studies conducted among AGYW in Kenya, South Africa, and Malawi, for example, have found that fewer than half of AGYW with a self-reported desire to avoid pregnancy use contraceptives (79-81). Attitudes towards childbearing may be one explanation for these discordant findings. Attitudes towards childbearing go beyond stated intent and capture feelings and emotions regarding the possibility of becoming pregnant or becoming a mother (82). While attitudes are often related to pregnancy intention, they can also be in conflict with one another. For example, a study conducted among women in Burkina Faso, Ghana, and Kenya, found that more than a quarter of women who stated they wanted to delay or limit childbearing also reported that it would not be a big problem if they became pregnant soon (83). Ambivalent attitudes towards childbearing are common among AGYW in Malawi, where approximately 40% of AGYW expressed childbearing ambivalence at least once during an eight-wave panel study conducted between 2009 and 2011 (84). Critically, ambivalent attitudes towards childbearing have been associated with lower uptake and adherence to contraception (85-88).

Discordance between pregnancy intentions and contraceptive behaviors may also be explained by inadequate knowledge about *when* one should use contraception and *where* one can access contraception are common barriers to contraceptive uptake. Some AGYW are unaware they can get pregnant from a single intercourse event (64), and cite infrequent or uncommon intercourse as a reason for not using contraception (89). Knowledge of the fertile period among AGYW in Malawi is low (only 13% of adolescents and 18% of young women know that the fertile period occurs midway between menstrual periods) (3), suggesting that

many of the AGYW who cite infrequent sexual intercourse may be at risk of an unintentional pregnancy. In addition, not knowing where to access contraception is somewhat common among AGYW in Malawi, particularly younger adolescents, and may contribute to unmet need (90).

Inadequate knowledge about *how* modern methods of contraception work is another prominent barrier to uptake, adherence, and continuation of contraception. In a qualitative study conducted among South African AGYW, dissatisfaction with the quality of information received when seeking contraceptive services emerged as a key theme (91). Interviews with participants suggested that healthcare providers did not fully explain the different contraceptive options available at the clinic, how the different methods of contraception worked, what side effects to expect, and what advantages or disadvantages were associated with each method. Importantly, poor contraceptive counseling contributes to incorrect use of user-dependent methods of contraception.

> *"The woman inserts it (pill in the vagina) so that she doesn't get pregnant"*
> *– Kenyan AGYW (92)*

> *"I take a pill when I know my boyfriend is coming and we are probably going to make love. I sometimes forget to take it before we make love so I take it after we make love."*
> *– South African AGYW (93)*

In addition, inadequate knowledge about contraception also contributes to the proliferation of myths and misconceptions regarding their side effects, resulting in negative attitudes towards contraception. A study conducted among women in Kenya, Senegal, and Nigeria reported that the vast majority of study participants believed in at least one myth related to modern methods of contraception. The three most common misconceptions endorsed by participants were "people who use contraceptives end up with health problems" (48% to 74% reported believing in this myth), "contraceptives are dangerous to women's health" (47% to 72% reported believing in this myth), and "contraceptives can harm your womb" (37% to 62% reported believing in this myth) (94). Qualitative work conducted among AGYW from Malawi,

South Africa, Uganda, Kenya, and Mali also highlight common fears regarding future infertility, prolonged bleeding, long term health consequences like cancer, and birth defects.

> *"[Contraception] is not good for someone who has not given birth, it can bring you problems in future, and sometimes you can even not give birth, apparently it freezes you and causes infertility."*
> *– Malawian AGYW (95)*

> *"Some say contraceptives are going to ruin their wombs and, in the future, they will not be able to have kids, so they decide not to use contraceptives because they would like to have kids in the future"*
> *– South African AGYW (93)*

> *"The pills pile up where the child is supposed to be formed."*
> *– Malian AGYW (96)*

> *"People say that when you get the injection and if it does not work well for you, you bleed. You will bleed until you cannot get pregnant again and give birth. You will just be bleeding and bleeding, there are people who bleed for many months because of those injections."*
> *– Kenyan AGYW (97)*

> *"People are saying that it [family planning] is not safe…let's say for example I decide to use family planning and yet I have never gotten pregnant, so people say that maybe I can end up being barren… I have never been pregnant even for one day, so I don't know whether I can get pregnant or not. So you should use after you have gotten pregnant."*
> *– Kenyan AGYW (79)*

> *"They say you can get cancer or it [contraception] can damage your uterus and you fail to get pregnant."*
> *– Ugandan AGYW (64)*

> *"You hear that someone was pregnant and they got pregnant while using the pills and then you start worrying if you will give birth to a normal child or you will give a child without hands."*
> *– Kenyan AGYW (92)*

A qualitative study conducted in Malawi tabulated method-specific misconceptions reported by male youths, female youths, and parents of youths, and found similarities in beliefs across the three groups (98). Oral contraceptives were commonly believed to clog up the abdomen (female youths and parents), injectables were commonly believed to cause permanent sterility and weaken male libido (female and male youths and parents), and implants

were commonly believed to cause permanent sterility and damage internal organs (female and male youths).

Misconceptions and myths fuel negative attitudes towards contraception, and contribute to low modern method uptake, low demand for modern methods, and discontinuation of modern methods (99). An analysis of DHS surveys conducted between 2006 and 2013 in 31 countries in Africa, for example, found that 28% of women with unmet need for contraception reported side effects and fear of health problems as the primary reason for not using contraception (89). In a study conducted by Gueye and colleagues, a one-point increase in the number of myths believed by a woman was associated with a substantial decline in the odds of using modern contraception among women in Kenya, Senegal, and Nigeria (94). Similarly, a study from Egypt illustrated that women who believed in the rumors that oral contraceptives made people weak, were more likely to report that oral contraceptives were harmful and were less likely to use oral contraceptives in the future (100), while a study conducted in Uganda illustrated that women who strongly agreed that contraception impacted future fertility were considerably less likely to start using contraception over follow-up than those who strongly disagreed that contraception impacted future fertility (101). The Ugandan study also found that contraceptive discontinuation over 12 months of follow-up was more common among women who reported that it was not acceptable to use contraception before having children at baseline than among women who believed it was acceptable.

Anticipated or internalized stigma also shapes AGYW attitudes towards contraception. Social norms in SSA often frame premarital sex as immoral and unmarried women who use contraception as promiscuous. Qualitative work from Kenya and Ghana suggest these narratives can be internalized by unmarried AGYW, who often express fear that they may be labeled as “bad” or “spoilt” girls if they use hormonal methods of contraception (79, 102). Critically, these perceptions can influence contraceptive use behaviors. Using the Adolescent Sexual and Reproductive Health Stigma Scale, a study from Ghana found that higher scores—

which corresponded to greater perceived stigma—were inversely associated with ever using contraception in a cohort of 1,080 AGYW (103). Similar findings were reported in a smaller study conducted in Ethiopia, where AGYW who agreed with at least one item on an anticipated stigma scale were more likely to have an unmet need for contraception than those who did not (104).

Beyond individual attitudes, knowledge, and beliefs towards contraception and childbearing, contraceptive self-efficacy is hypothesized to relate to patterns of contraceptive use among AGYW. The concept of self-efficacy is nested within sociocognitive theory and refers to one's confidence in their own ability to perform a given outcome. Much of the literature on contraceptive use self-efficacy among AGYW in SSA is focused on condom use among individuals at risk of HIV. Cross-sectional studies typically report a positive correlation between condom use self-efficacy and condom use behaviors (105). A study conducted among South Africa adolescents, for example, found that both condom use at last sexual encounter and consistent condom use was more commonly reported among AGYW with high compared to low condom use self-efficacy (last sexual encounter: 65% vs 42%; consistent condom use: 46% vs. 20%) (106). However, evidence on the effect of condom use self-efficacy on future condom use behaviors is mixed, and positive effects are typically limited to male adolescents and young adults (105).

1.4.2. Interpersonal level

Parental influence on adolescent behavior is commonly acknowledged in developmental and health behavior theory, and there are four main pathways through which parents are believed to influence adolescent SRH: monitoring behaviors, modeling behaviors, communicating about behaviors, and disapproving of behaviors (107). Of these pathways, parent-adolescent communication about SRH appears most influential. A meta-analysis of 52 studies conducted primarily in the United States found a small, positive association between

SRH communication and the adoption of safe sex behaviors, particularly among adolescent girls (108).

Three studies included in this meta-analysis were conducted among adolescent populations in SSA. Low parental monitoring was associated with increased risk of sexual activity in the previous twelve months in a nationally-representative cross-sectional study conducted among adolescent girls in Burkina Faso, Ghana, Malawi, and Uganda (109). This same study reported an association between parent-adolescent communication about sex-related matters and contraceptive use among adolescents in Ghana and Uganda but not among adolescents in Burkina Faso or Malawi. There was no association between parent-adolescent communication about contraception and contraceptive behaviors. Notably, contraceptive communication between parents and children in this study was low; < 25% of adolescents in Burkina Faso, Ghana, Malawi, and Uganda reported their parents ever provided them with information about contraceptive methods. While parent-adolescent communication was not associated with sexual activity or consistent condom use in a South African study either (110), it was associated with condom use at last sex among adolescent girls in Kenya (111).

In addition to these three studies, a recent cross-sectional study conducted in Malawi suggest contraceptive communication with older women in the family was associated with use of non-barrier methods among unmarried/nulliparous AGYW, but not among married or unmarried/parous AGYW (112). However, contraceptive communication with older women may also negatively impact contraceptive behaviors among AGYW. Qualitative work from Kenya illustrated that mothers often advised their [female] children against using non-barrier methods of contraception due to concerns about side effects, and that these beliefs often sway contraceptive decision making (79).

> *"…Sometimes maybe we are sitting in the house, our mother usually advises us to abstain from sex and not go for family planning citing that family planning spoils young girls. She normally advises us, especially me, she really advises me because I am the youngest in our house that I should not start using those things [FP methods] now. I*

should not even think of using them…If I start using now, in the future when I will want to have children it will be very hard for me to conceive…"
– Kenyan AGYW (79)

Conversations with female peers may also influence contraceptive behaviors. Heightened sensitivity to peers during adolescence is hypothesized to influence adolescent health-related behavior by normalizing behaviors and sharing information within social networks (113, 114), and the influential role of social networks on contraceptive use behaviors may be greater in communities where cultural norms and taboos limit dialogue about sex and sexuality between adolescents and their parents/community elders (115). In Malawi, contraceptive communication with peers, and the perception that close friends were using contraception, was associated with use of non-barrier methods of contraception among unmarried AGYW regardless of parity (112). However, if peers propagate community narratives regarding contraceptive risks, the influence of peers on contraceptive behaviors may be negative (79).

Finally, relationship characteristics play a significant role in contraceptive use behaviors among AGYW. Contraceptive communication with intimate partners is associated with increased contraceptive uptake and reduced risk of discontinuation (112, 116-118). However, women often avoid discussing family planning with partners for fear of causing conflict. In many parts of SSA, contraception, particularly condoms, are associated with promiscuity and HIV, and suggesting them may cause violence and/or relationship dissolution:

"I do not talk to my partner because most men have a negative attitude towards family planning methods, especially towards girls who have never given birth before. They say family planning is not good because it damages you somehow."
– Malawian AGYW (95)

"I am afraid that if I talk to him [my partner] about that I may give him ideas that I have a relationship with another person and he would be angry"
– Malawian AGYW (95)

"He doesn't know I am [using a] contraceptive method because if I can tell him, he can be thinking that I have other partners besides him."
– Malawian AGYW (95)

"With the pills they [men] are very… much against it and they feel that with the pills their women can have extra marital affairs knowing that they will not get pregnant"
– Kenyan AGYW (92)

"In short it means untrustworthiness because you cannot get pregnant, … so maybe you will be having sex with someone or feel free to have sex anyhow and thereby infecting your partner with sexual diseases"
– Kenyan young male (97)

Relationship power in SSA is often skewed in favor of the male partner, especially in age-disparate relationships, and male preferences regarding fertility and contraception often supersede those of the female partner (119). Power dynamics within relationships may also limit access to and use of reproductive health services by determining who controls financial resources (119).

1.4.3. Structural level

Several structural features of the health system are barriers to uptake, adherence, and consistent use of contraception among AGYW in SSA. Inconsistent availability of contraception, limited method mix, and difficulties getting to healthcare facilities, are problems that many women seeking contraception in SSA experience, but may be particularly burdensome to AGYW who face additional barriers to SRH care seeking (120). For example, provider-imposed eligibility restrictions on the basis of age, marital status, and parity are pervasive and prevent many AGYW from accessing modern methods of contraception. A large study of 676 service providers at 273 health care facilities in five Kenyan cities found that more than half of providers imposed minimum age restrictions on one or more methods of contraception, and approximately 40% would not provide one or more methods of contraception to nulliparous women (121). In this study, minimum age restrictions were most common for oral contraceptives, injectables, implants, and IUDs (mean minimum age reported by providers ranged from 19 to 20 – several years above average age of sexual debut in Kenya), while restrictions on parity were the most common for injectables, IUDs, and implants.

Another study conducted in Senegal found that over 40% of public sector providers applied minimum age barriers to oral contraceptives, injectables, and implants, and approximately 25% of public sector providers applied minimum age barriers to condoms and emergency contraception (122). Age, parity, and marital restrictions are common in Nigeria, with most providers restricting the provision of injectables and IUDs (93% of providers reported minimum age restrictions, 65% reported minimum parity restrictions, and 73% reported marital restrictions) (123). Similar levels of provider-imposed restrictions have been reported in Ghana, Tanzania, and Uganda (124-126). In addition to outright refusal, providers across SSA may employ other methods to deter AGYW from using certain forms of contraception. Small studies from Ghana and Uganda reported that over one-third of providers required consent from a parent or spouse prior to providing contraception to adolescents under the age of 18 (125, 126). Work in Ghana and Malawi also found that medically contraindicated and expensive laboratory tests and/or proven menstruation or negative pregnancy tests was required prior to the provision of certain methods of contraception (126-129).

> *"[Before Girl Power], I wanted to be on a family planning method. They said we should test for pregnancy first, and I had to pay MK500 (approximately USD70 cents). I did not have that MK500. I was sent back. I ended up getting an unwanted pregnancy."*
> *– Malawian AGYW (129)*

Difficulties getting certain methods of contraception may contribute to misinformation spread in the community. An analysis of data from DHS in 52 low- and middle-income countries found that 11% of AGYW with unmet need for contraception cited "not married" (as opposed to "infrequent/no sex") as the primary reason for not using contraception (89).

Medically contraindicated provider-imposed eligibility restrictions are driven by personal judgements about premarital sexual activity, social and cultural norms regarding fertility and marriage, and misinformation about the long-term effects of non-barrier method use. Qualitative work conducted among healthcare providers in South Africa, Ghana, Kenya, and Uganda suggest that providers may be uncomfortable giving contraception to young and/or unmarried

AGYW because they do not want to promote pre-marital sexual activity, while misinformation regarding the long-term side effects of non-barrier methods of contraception largely influenced provider decisions to restrict certain methods to parous women only (125, 126, 130-132).

Misconceptions and concerns regarding contraceptive-related infertility are widespread among providers in some communities, and a common theme across much of the qualitative work conducted in SSA suggests that providers frequently feel that contraception is only appropriate for women who are "mothers." In addition to restricting access, such beliefs contribute to suboptimal contraceptive counseling and low levels of contraceptive knowledge among AGWY. Several adolescent participants in Mystery Client studies designed to evaluate adolescent friendliness of health services, for example, reported that the information they received regarding contraceptive options, method use, and side effects was insufficient, and that providers sometimes made decisions without consulting their opinion (133, 134).

> *"She said I should take the injection and that we shouldn't go into the other methods. When I asked why, she recommends the injection she asked how old I am and said that they don't recommend pills for young people because they are careless."*
> – *Benin, Mystery Client* (134)

Related to provider-imposed eligibility restrictions are the judgmental provider attitudes that many AGYW experience when seeking contraceptive information and services. Adolescents participating in Mystery Client studies conducted in South Africa, Tanzania, Ghana, Uganda, and Senegal often report dismissive, judgmental, or negative provider attitudes (133, 134). Additionally, some participants in these studies report they received unsolicited advice from providers, such as "you should abstain until marriage" or "you should spend your time with your studies not with boys." Qualitative studies from the region also document nurses publicly scolding AGYW, saying they are too young to have sex, lecturing them on why they should not have sex, and loudly questioning why they need contraception in spaces with other clients present (93, 129, 130). Unfriendly staff and negative clinical experiences dissuade AGYW from

seeking information about contraception, and may contribute to low uptake of contraceptives, as well as contraceptive discontinuation.

> *"A nurse will utter something that will be so hurtful, when you speak and tell them you are here to get contraceptives, they won't speak to you privately in a room instead they will loudly say why are you here for contraceptives in front of people and you can imagine how many people are at the clinic. They will make noise and say why are you here for contraceptives when you are so young, why?"*
>
> *– South African AGYW (93)*

> *"…When I started to explain my need of [contraception] s/he asked me twice, Family planning? So, are you married?"*
>
> *– Tanzania, Mystery Client (134)*

> *"So some women could laugh at us saying, 'girls coming for Depo [a contraceptive injection], what for?' so I was disappointed because of what people were saying, hence I stopped coming there again."*
>
> *– Malawian AGYW (129)*

In addition to negative interactions with healthcare providers, fears regarding lack of confidentiality contribute to low SRH care-seeking among AGYW. A study designed to explore the relative importance of various components of service provision among adolescent boys and girls in Kenya and Zimbabwe found that the majority of participants (93%) reported confidential services were the most important quality of service provision (90). However, as illustrated in some of the Mystery Client literature, lack of privacy and/or confidentiality are common experiences (134). Public sector healthcare facilities across much of SSA are crowded, wait times are long, and services are often provided behind a medical screen instead of a private room. AGYW seeking contraceptive services at facilities located in their community risk being recognized by community members and having their SRH care-seeking disclosed to parents and/or guardians. In Malawi, male and female youths report that both health providers and community members have reported youths seen at clinics to their parents, resulting in fear of accessing SRH services (98, 129).

> *"We do this [get an implant] because we don't want to go to the hospital. When we go to the hospital the whole world knows… we are using these contraceptives. So when girls show up to the hospital, they feel ashamed."*
>
> *– Malawian AGYW (98)*

"When they see someone going for contraceptives, it becomes a big issue which is why youths are scared to use contraceptives. When someone has been seen going to such facilities, it becomes an issue at home… so the youths are very scared and if it is known that youths are on contraceptives, they would be resented by their parents."
– Malawian parent (98)

"… let's say you are suffering from an STI and you go to the [SOC clinic] and in the consultation room you find as many as four or five people entering at the same time, and you look around. There are your friends from school, neighbors or relatives. How can you be free to explain your illness? Here [Girl Power clinic] we enter one at a time, and there is one doctor to whom you can explain your illness. If it were more than one person, it would be hard for us to be free."
– Malawian AGYW (129)

As a result, AGYW often choose to utilize clinics farther away from their communities for SRH needs, increasing costs related to care seeking, or may frequent pharmacies, where a less comprehensive range of methods are available at greater expense with greater discretion (135).

Finally, information from adolescents on preferences regarding the service delivery environment also highlight the desire for short waiting times and "one-stop-shopping" (i.e. the ability to obtain all services at one site) (90). In Malawi, waiting times at public sector facilities are long, and services are not integrated. This means that AGYW who require multiple SRH services (i.e. contraception and HIV testing and STI treatment) are required to wait in multiple queues with older adults from their communities for each service, which is expected to adversely affect SRH care-seeking. Structural features of the healthcare environment are particularly burdensome for AGYW currently enrolled in school. Public sector facilities in Malawi operate during regular business hours and are closed during the weekends, excluding school-going AGYW from accessing services.

1.4.4. Societal level

The effect of the broader sociocultural environment on individual behaviors related to contraceptive use has largely been described in previous sections. Briefly, social norms related to premarital sex creates an atmosphere of silence, where unmarried AGYW in sexually intimate relationships may feel embarrassed, ashamed, or afraid to seek SRH services or even talk about sex. A study conducted in Burkina Faso, Ghana, Malawi, and Uganda, for example, found

that feeling afraid, embarrassed, or shy was the most common barrier to obtaining contraception among sexually active adolescent girls and boys between the ages of 12 and 19 (136). Norms and expectations related to sex, marriage, and childbirth influence how parents/elders communicate with adolescents, influence where AGYW get information from, and how providers interact with young, unmarried, and nulliparous clients, shaping individual knowledge, attitudes, and beliefs regarding SRH, in general, and contraception specifically.

Beyond social norms and cultural expectations, national policies influence contraceptive availability and cost. Although the Malawian Government provides free contraception at all public sector health facilities, contraceptive stock outs and other supply chain issues contribute to suboptimal method mix availability at facilities. Moreover, insufficient training of providers and lack of a robust sexual health curriculum in schools contributes to the spread of misinformation regarding the side-effects of non-barrier methods of contraception in communities and social networks.

1.4.5. Summary

Myriad modifiable factors are associated with AGYW contraceptive use behaviors. While awareness about contraception is high, many AGYW in Malawi lack the necessary information needed to make informed choices regarding their SRH. As a result, many choose not to use contraception, or use methods of contraception that are not the most appropriate for their personal needs, increasing risk of early and unintended pregnancy. Youth-friendly health services may address several barriers to contraceptive uptake, adherence, and continuation among AGYW in SSA.

1.5. Youth-friendly health services

1.5.1. Overview

Three decades of research illustrating barriers young people face in accessing SRH services gave rise to the WHO's call in 2002 for the development and evaluation of youth-

friendly health services (YFHS) (137). The WHO describes YFHS as healthcare services that are equitable, accessible, acceptable, appropriate, and effective for young people:

1. *Equitable services* are those that do not restrict the provision of health care on any terms and are staffed by providers who treat all patients with equal care and respect.
2. *Accessible services* are those that provide free or affordable healthcare to all young people, have convenient hours of operation, are easily located, and are staffed by providers who are able to provide comprehensive information and services. Accessible services also work within communities to generate support for the provision of health services to young people.
3. *Acceptable services* are those that address to the service delivery barriers young people experience when seeking healthcare services. They guarantee client confidentiality and privacy, have short waiting times, and are staffed by providers who are knowledgeable about the needs of youths, who are not judgmental, and who treat clients with respect.
4. *Appropriate services* are comprehensive and are able to deliver an essential package of services responsive to the needs of young clients. They also have policies and guidelines in place that enable the fulfillment of additional service needs through referral programs.
5. *Effective services* are those that have all the equipment and supplies necessary for the fulfillment of healthcare needs, are staffed by providers with a high level of medical competency who know how to communicate with young people without being patronizing, and where the provision of services is directed by technically sound protocols and guidelines.

The model of YFHS that the WHO recommends is comprised of three components: provider training and sensitization to the SRH needs of young people, modifications to the clinical environment to make it more youth-friendly, and community outreach activities to generate support for the provision of SRH services to young people (138). Such models of YFHS were originally conceptualized as an intervention to increase utilization of health services by addressing the barriers young people experience when interacting with the health system.

However, when implemented according to the standards described by the WHO, YFHS also address important individual barriers to contraceptive uptake, adherence, and continuation, and take steps towards addressing intrapersonal and broader societal barriers that shape AGYW contraceptive behaviors. As a result, YFHS are hypothesized to promote modern method uptake in the short term, improve contraceptive adherence and continuation in the medium term, and reduce risk of early and unintended pregnancy in the long term.

The first two components of YFHS address the structural barriers AGWY experience when seeking contraception-related information and services. They ensure that providers are knowledgeable about the needs of young clients, able to provide comprehensive, unbiased, counseling and clinical services, are non-judgmental, and are able to treat young clients with respect. By offering young people integrated SRH services in private spaces with extended clinical hours, they also address common concerns regarding the lack of confidentiality, long wait times, and inconvenient clinic hours, while also addressing the desire for “one-stop-shopping”. By improving access to equitable, accessible, acceptable, appropriate, and effective SRH services, YFHS are also hypothesized to address several of the individual barriers to contraceptive uptake, adherence, and continuation.

Comprehensive high-quality counseling can improve knowledge about when one should use contraception, how different methods of contraception work, and what side-effects to expect when using contraception. In this way, YFHS may increase acceptability of contraception by addressing common beliefs around who should use contraception, what methods of contraception are appropriate for young people, and the long-term consequences of contraceptive use. Expanding access to comprehensive high-quality counseling may also improve knowledge on how to correctly use different methods of contraception, enhancing contraceptive self-efficacy and typical use effectiveness of user-dependent methods of contraception. Additionally, open and non-judgmental conversations between providers and clients may empower AGYW to select methods of contraception that are most appropriate given

their reproductive goals and life circumstances. Finally, by improving the overall care-seeking experience, YFHS may facilitate contraceptive continuation by encouraging AGYW to return to the clinic for contraceptive refills, or in the event they want to switch to a different method of contraception.

The third component of YFHS—community outreach activities to build support for the provision of SRH services to young people—is designed to enhance community awareness regarding the benefits of offering SRH services to young people and awareness of where YFHS are located. While a step towards addressing the intrapersonal and broader social barriers AGYW experience when seeking contraception-related information and services, the overall impact of this component on AGYW contraceptive behaviors is expected to vary according to the comprehensiveness of the community approach adopted. Critically, WHO guidance on community outreach activities for YFHS only emphasizes the importance of meeting with key community stakeholders to explain the rational for providing SRH services to young people (138). Such approaches may not be as effective at addressing the important intrapersonal and broader social barriers to AGYW contraceptive use as multilevel community-based interventions designed to shift sociocultural norms regarding sex, marriage, and fertility, and tackle harmful community narratives related to AGYW sexuality and contraceptive use.

Finally, the WHO guidelines for YFHS assume that facilities offering YFHS have all the equipment and supplies necessary for the fulfillment of healthcare needs. Stock-outs and limited method mix may negatively impact contraceptive uptake, adherence, and continuation among AGYW, even in the context of YFHS. While not designed to address broader supply-chain issues, WHO recommendations regarding the implementation of YFHS include specific actions at the national level, district level, and service delivery point design to strengthen supply chains and commodity redistribution plans.

1.5.2. Impact of youth-friendly health services

Facility-based models of YFHS that integrate provider training and sensitization with clinic modifications that make the service delivery environment more youth-friendly and community outreach activities have been implemented in a variety of SSA contexts. Here, we summarize the current evidence base relating these models of YFHS to contraceptive behaviors and pregnancy outcomes among AGYW in SSA.

Relevant literature was initially identified by reviewing published literature reviews that summarized evidence on the effect of YFHS on young people's SRH service utilization, SRH behaviors, and SRH outcomes in SSA (139-141). A total of nine publications included in these reviews evaluated the impact of five unique YFHS interventions that integrated provider training with clinic modifications and community outreach activities using outcomes related to contraceptive behaviors or pregnancy (142-150). Since three of the five YFHS interventions were implemented as part of large-scale programmatic efforts (Programa Geração Biz in Mozambique, Top Réseau in Madagascar, and the African Youth Alliance initiative in Botswana, Ghana, Tanzania, and Uganda), we conducted a Google search for additional information on these efforts to supplement findings reported in the identified publications. This strategy returned seven additional sources that reported relevant information (151-157).

In addition to identifying relevant literature from published literature reviews, we conducted our own literature search using the following search string in PubMed: *((((Youth friendly) OR (Adolescent friendly)) AND ((Health services) OR (Service delivery))) AND (((Contraception) OR (Family Planning) OR (Pregnancy) OR (Condom)))) AND (sub-Saharan Africa [MeSH Terms]) AND (2015:2023[pdat])*. This search strategy returned 136 publications, which we reviewed for relevance. Four of the publications identified through this search strategy evaluated four unique YFHS interventions that integrated provider training with clinic modifications and community outreach activities, and quantified impact using outcomes related to contraceptive behaviors or pregnancy (158-161). Since two of the four YFHS interventions

were implemented as part of large-scale programmatic efforts (the National Adolescent Friendly Clinic Initiative in South Africa and the Tunza Family Heath Network in Malawi), we conducted a Google search for additional information. This effort returned two additional sources that reported relevant information (162, 163).

Overall, the 22 included publications evaluated a total of nine different models of YFHS that were implemented in nine countries in SSA (Botswana, Ghana, Madagascar, Malawi, Mozambique, Senegal, South African, and Tanzania, and Uganda). All models of YFHS were integrated within existing healthcare infrastructure that was modified to be more youth-friendly, were staffed by providers who received training on the SRH needs of young clients, and included community outreach activities. However, there were notable differences in the types of modifications made to the clinical environment and the types of outreach activities conducted in communities (Table 1.1).

While all models of YFHS offered clinical services in private spaces, only four provided youth-dedicated spaces. Peer educators were available in five models to assist with clinical navigation, provide education, and assess SRH needs. Six models of YFHS offered integrated SRH services, and five offered convenient clinic hours. Other clinic modifications included: youth-friendly clinic branding (n=6), discreet physical locations (n=1), subsidized healthcare costs (n=4), the availability of youth-targeted health promotion materials at the clinic (n=3), and the introduction of extracurricular activities at the clinic (e.g. games, videos; n=1).

All models of YFHS conducted community sensitization meetings with key stakeholders. Other strategies (many of which overlapped at a single implementation site) included mass media campaigns (n=6), community-based peer education, adolescent champions, and/or edutainment initiatives (n=5), information, education, and communication campaigns at community events (n=5), and open house days for parents at the clinic (n=1). In addition to YFHS, three programs implemented school-based SRH education initiatives, and two offered recreational spaces for youths. One implemented a small group empowerment session with and

without a conditional cash transfer at a subset of sites offering YFHS, and one used a peer-referral system with a small non-cash incentive.

The impact of these models of YFHS were quantified using numerous outcomes related to individual knowledge and attitudes towards contraception (n=9), service utilization (n=8), use of contraception (n=11), and pregnancy (n=4) (Table 1.2). Most evaluations quantified impact using at least one endpoint that reflected contraceptive prevalence (i.e. at first sex, at last sex, or currently) or service utilization (i.e. aggregate number of visits, ever received condoms, ever received hormonal contraception). While such endpoints are related to pregnancy, the outcome policymakers ultimately wish to intervene upon, they do not reflect sustained behavioral changes necessary to reduce risk of pregnancy. Notably, only two evaluations quantified impact using a measure of pregnancy, two measured consistent condom use, and no evaluation explored how provision of YFHS shaped contraceptive behaviors among AGYW longitudinally.

Several different approaches were used to generate estimates of effect. The weakest evaluations were those that used a one-group pretest-posttest study design and quantified impact by comparing outcomes before and after the intervention. This approach was used to evaluate the impact of Programa Geração Biz, Top Réseau, and the Tunza Family Heath Network. Results from these evaluations suggested that all three models of YFHS had a considerable impact on service utilization. In Mozambique, the annual number of clinic visits at implementation sites increased from just over 1,000 at the start of Programa Geração Biz to over 164,824 seven years later (144), while in Madagascar, the annual number of family planning services delivered to youths increased from <1,000 at the start of Top Réseau to over 60,000 ten years later (153). Similar trends were observed in the Tunza Family Heath Network (160). While neither Top Réseau nor the Tunza Family Health Network reported on other endpoints, Programa Geração Biz reported greater awareness of contraception among young people and considerable increases in the proportion of young people reporting contraceptive use at first sex, condom use at first sex, condom use at last sex, and consistent condom use

(144). Data from the DHS also showed declines in adolescent birth rates that some have hypothesized are the result of expanding Programa Geração Biz program nationally (145). However, this may have been a function of other secular trends.

Results from studies that evaluated the impact of a YFHS intervention using a two-group posttest-only design are also challenging to interpret causally. In Uganda, YFHS were implemented at four Level IV health centers (142). Seventeen months after implementation, a Knowledge, Attitudes, and Practice study was conducted among adolescent girls receiving care at the health centers offering YFHS and among adolescent girls receiving care from four health centers not offering YFHS. Adolescent girls at health centers that offered YFHS were more aware of contraception (85% vs. 69%), were more likely to have ever received contraceptive services (69% vs. 21%), were more likely to have ever used a method of contraception (69% vs. 53%), and were more likely to be currently using a method of contraception (66% vs. 47%) than adolescent girls at health centers not offering YFHS. While control health centers were also Level IV facilities, and were comparable in terms of catchment size and population characteristics at end-line, the possibility of baseline differences between intervention and control health centers make it challenging to distinguish between treatment and selection effects (specifically, the authors state that health facilities offering YFHS were selected because they had adequate staffing levels and offered SRH services prior to study implementation).

While initially intended to be a two-group pretest-posttest evaluation, differences in the expected versus actual coverage of the African Youth Alliance initiative resulted in no comparable baseline data between intervention and control groups. As a result, the final evaluation of this model of YFHS was based only on post-intervention data collected from newly sampled households in intervention and control communities. In three sites (Ghana, Tanzania, and Uganda), a greater proportion of sexually active AGYW aged 17 to 22 reported using condoms at first sex, using condoms at last sex, ever using condoms, always using condoms with their current partner, using modern methods of contraception at first sex, and using modern

methods of contraception at last sex (149). Results of a per-protocol analysis, which compared outcomes among AGYW from intervention communities in Uganda who reported participating in three or more components of the intervention to all other AGYW in Uganda, suggested a greater impact of the intervention than the intention-to-treat analysis (150). While efforts were made to ensure that control communities in all countries were similar to intervention communities at end-line, differences between intervention and control communities at baseline are possible and could introduce bias into analyses.

A two-group pretest-posttest study design was used to evaluate a YFHS intervention implemented in Senegal (143). A household survey was conducted in the three regions (one control, two intervention) prior to intervention implementation. Fifteen months after the intervention was implemented, a second household survey was conducted in the same three regions. The impact of the intervention was quantified using within-group comparisons and an informal between-group comparison (where the results from the within-group analysis were qualitatively compared between exposure groups). In intervention regions, there were increases in the proportion of adolescent girls who knew about contraception, who knew how to use condoms and OCPs, who ever visited a health facility reproductive health services, and who believed unmarried adolescents can use contraception. However, improvements in contraceptive awareness and use of reproductive health services were also observed in the control region, making it difficult to attribute improvements seen in the intervention regions to the intervention alone.

Branson and colleagues conducted a difference-in-difference analysis to evaluate the impact of the NAFCI accreditation program on adolescent childbearing in South Africa (159). After geo-linking data on the timing and location of NAFCI rollout to birth histories recorded in nationally representative household survey data, they found that living within 1km of a NAFCI accredited clinic during adolescence resulted in a 6-percentage point reduction in the risk of childbirth by aged 17 and an 8-percentage point reduction in the risk of childbirth by age 18. The

key assumption for a difference-in-difference analysis however, is that, in the absence of treatment, the difference between the treatment and control groups is constant over time (164-166). Since the NAFCI program targeted clinics in high-needs communities and was implemented during a period of substantial investment in the healthcare system (167), observed declines in adolescent childbearing may be attributed to more than just the presence of NAFCI-accredited clinics.

Finally, two studies randomly assigned health facilities to offer either standard of care (SOC) or an intervention that included YFHS. A pilot cluster randomized trial in Malawi—the source data for this dissertation—assigned four comparable government-run health clinics to offer either a standard (n=1) or a youth-friendly (n=3) model of service delivery (158). After adjusting for baseline differences in the distribution of covariates between exposure groups, AGYW who enrolled at clinics offering YFHS were more likely than their counterparts who enrolled at the clinic offering SOC to have received condoms (83% vs. 26%) or hormonal methods of contraception (54% vs. 10%) at least once over follow-up. AGYW with access to YFHS were also more likely to report using condoms or hormonal methods of contraception than their counterparts with access to SOC six months (47% vs. 19%) and twelve months (44% vs. 24%) after enrollment. This was the only study that explored whether populations that experience greater barriers to SHR care-seeking also benefited from access to YFHS.

In a large cluster randomized trial implemented in 126 BlueStar Network Clinics in Uganda, clinics that were randomized to offer the peer-referral plus YFHS intervention provided services to an average of seven more adolescent clients per month during the intervention period than clinics randomized to offer SOC services (161). Notably, the effect of the peer-referral plus YFHS intervention on the number of adolescent visits was greater than the effect of the peer-referral only intervention, which provided services to an average of three more adolescent clients per month during the intervention period than the SOC clinics.

1.5.3. Summary

Though several evaluations were limited by suboptimal study design, models of YFHS recommended by the WHO (i.e. those that integrate provider training, clinic modifications, and community outreach activities) have shown promise towards increasing knowledge about contraception, acceptability of contraception, uptake of contraceptive services, and use of contraception among AGYW in SSA. However, it remains unknown if—or how—access to such models of YFHS shape contraceptive behaviors among AGYW over time. Few evaluations have quantified the impact of YFHS using measures related to pregnancy, and those that have were unable to isolate the effect of YFHS from other contemporaneous trends. In light of known challenges with contraceptive adherence and high rates of early discontinuation among AGYW in SSA, these are important gaps in the YFHS literature.

1.6. Tables and Figures

Figure 1.1. Socioecological model of contraceptive behaviors among AGYW in SSA

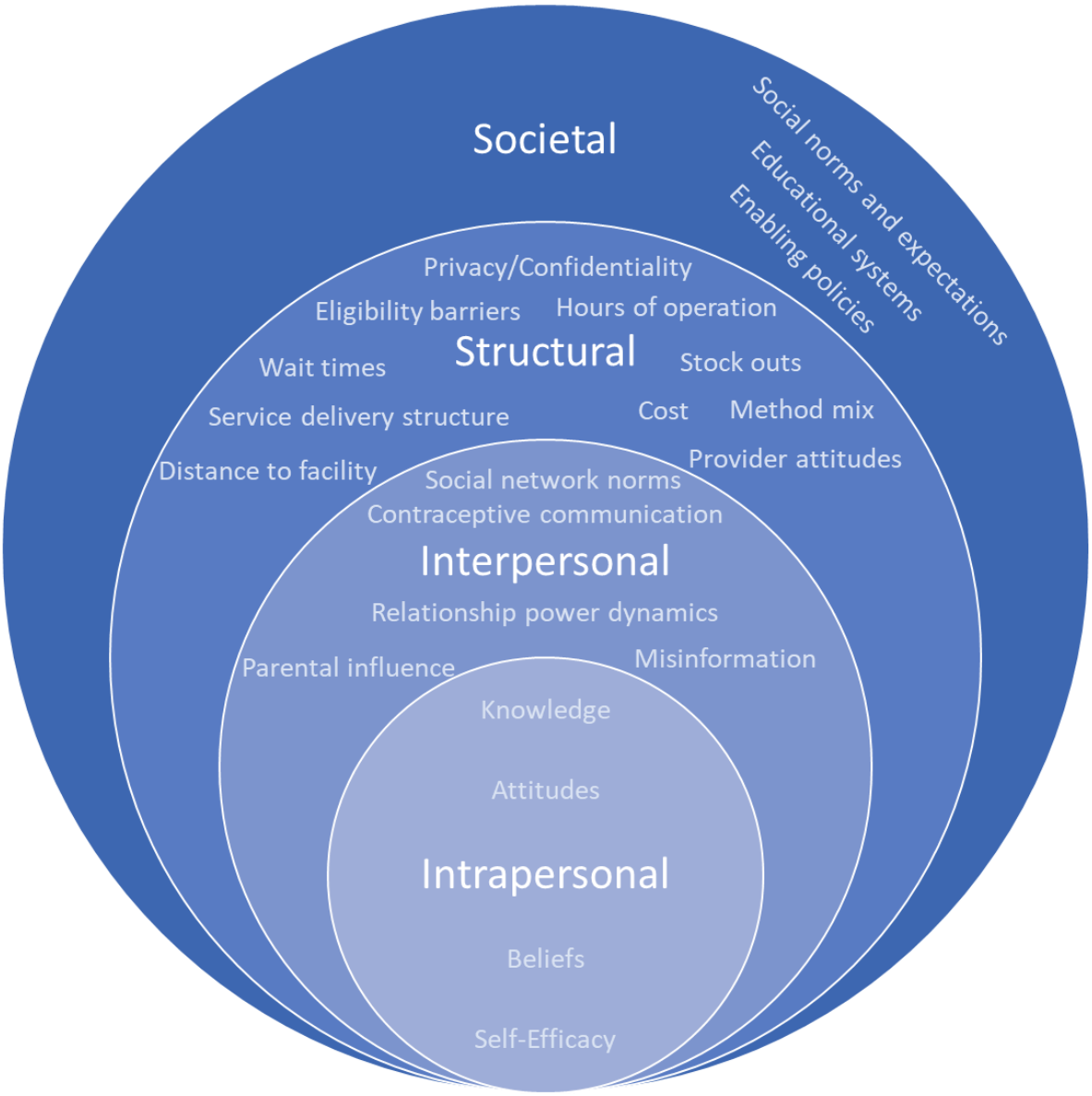


Table 1.1. Characteristics of facility-based models of YFHS implemented in SSA

		Uganda Pilot Initiative (142)	Senegal Pilot Initiative (143)	Programa Geração Biz (145, 151, 152)	Top Réseau (146, 147, 153)	Adolescent and Youth Alliance (149, 150, 154-157)	National Adolescent Friendly Clinic Initiative (159, 162, 163)	Girl Power-Malawi (158)	Tunza Family Heath Network (160)	Uganda cRCT (161)
Clinic Modifications	Youth-friendly clinic branding			X	X		X	X	X	X
	Discreet physical locations				X					
	Youth-dedicated spaces		X	X			X	X		
	Private space to receive services	X	X	X	X	X	X	X	X	X
	Peer Educators		X	X		X	X	X		
	Integrated SRH services	X		X	X	X	X	X		
	Convenient clinic hours			X	X	X	X	X		
	Subsidized healthcare costs			X	X			X		X
	Extracurricular activities	X								
	Health promotion materials			X			X			X
	Classes on SRH		X							
Community Activities	Community sensitization meetings	X	X	X	X	X	X	X	X	X
	Open house days at facilities	X								
	Mass media campaign		X	X	X	X	X		X	
	Community-based peer education		X	X	X	X	X			
	IEC activities at community events		X	X	X	X	X			
Additional interventions			One community with YFHS also offered school-based SRH education	School-based SRH education; Youth Centers	-	School-based SRH education; Livelihood Training Programmes	Youth "chill rooms"	Two clinics offered monthly empowerment sessions. One also offered a conditional cash transfer	-	Peer referral system with wristband incentive

Table 1.2. Outcomes used to quantify impact of facility-based YFHS interventions implemented in SSA

		Uganda Pilot Initiative	Senegal Pilot Initiative	Programa Geração Biz	Top Réseau	Adolescent and Youth Alliance*	National Adolescent Friendly Clinic Initiative	Girl Power-Malawi	Tunza Family Heath Network	Uganda cRCT
		(142)	(143)	(145, 151, 152)	(146, 147, 153)	(149, 150, 154-157)	(159, 162, 163)	(158)	(160)	(161)
Knowledge and attitudes	Aware of any method of contraception	X	X							
	Aware of any modern method of contraception			X						
	Aware of condoms as a contraceptive method		X	X						
	Aware of OCPs as a contraceptive method		X	X						
	Aware of sexual abstinence as a contraceptive method			X						
	Able to explain how to use a condom correctly		X							
	Able to explain how to use OCPs correctly		X							
	Belief that contraception can be used by married adolescents		X							
	Belief that contraception can be used by unmarried adolescents									
	Aware of health facilities offering YFHS		X							
Service utilization	Number of clinical visits (aggregate)			X				X		
	Number of condoms distributed (aggregate)			X				X		
	Number of family planning visits (aggregate)							X	X	
	Number of family planning services delivered (program-level)				X			X		X
	Ever visited a health facility for reproductive health services		X					X		
	Ever received family planning services	X						X		

	Received condoms						X
	Received hormonal contraception						X
	Number of times receiving condoms						X
	Number of times receiving hormonal contraception						X
Contraceptive use	Used protection at first sex		X				
	Used protection at last sex						
	Used condoms at first sex			X			
	Used condoms at last sex			X			
	Ever used condoms			X			
	Consistent condom use		X	X			
	Ever used contraception	X	X				X
	Used modern contraception at first sex			X			
	Used modern contraception at last sex			X			
	Currently using a method of contraception	X					X
	Currently using condom						X
	Currently using hormonal contraception						X
Pregnancy	Adolescent birth rate		X				
	Birth by age 17				X		
	Birth by age 18				X		

* Evaluation not conducted in Botswana

CHAPTER 2: SPECIFIC AIMS

In 2020, an estimated 22 million AGYW in SSA experienced a pregnancy (1, 5, 6), 10 million of which were unintended (10). The implications of early and unintended pregnancy are profound. It is well established that pregnancy-related complications are a leading cause of morbidity and mortality among AGYW in SSA, and AGYW account for a disproportionate proportion of maternal deaths in the region each year (11). Moreover, pregnancies to AGYW can compromise educational attainment (31-34), endanger future economic opportunities (34-39), and negatively impact the future health and wellbeing of children (40-43, 46-62). As described in Chapter 1, persistently high unmet need for modern contraception (66), high failure rates (69), and early discontinuation (75, 76), are the primary causes of early and unintended pregnancy among AGYW in the region. Interventions that improve contraceptive behaviors among AGYW in SSA are therefore expected to bring a triple dividend of benefits: for the immediate health of the youth population today, for the future health of the adults they will become, and for promoting the health of the next generation.

When implemented according to the standards described by the WHO (138), facility-based models of YFHS that integrate provider training with youth-friendly clinic modifications and community outreach activities address many of the barriers to contraceptive uptake, adherence, and continuation among AGYW in SSA. Access to such models of YFHS have improved knowledge about contraception, acceptability of contraception, and use of contraceptives in this population (142-150, 158-161). While promising, contraceptive use among AGYW in SSA is characterized by preferences towards less effective methods of contraception and early contraceptive discontinuation—behaviors that ultimately increase risk of early and unintended pregnancy (74, 168). Critically, there are no evaluations of sustained behavioral

changes following the implementation of facility-based models of YFHS, and past assessments that quantified the effect of such models of YFHS using pregnancy-related outcomes suffered from design limitations (145, 159).

This dissertation addressed these important gaps in the literature using data from Girl Power-Malawi, a pilot cluster randomized trial that assigned four comparable public health clinics in Lilongwe, Malawi to provide standard of care services (SOC, n=1) or a comprehensive model of YFHS that included integrated service provision, provider training, clinic modifications, and community outreach activities (n=3) (169). In Girl Power-Malawi, 250 AGYW were enrolled in each clinic and followed for 12 months. Leveraging longitudinal data on sexual activity, contraceptive use, and pregnancy, we sought to provide a more nuanced understanding of the relationships between YFHS, contraceptive behaviors, and probability of pregnancy among AGYW in SSA by addressing the following specific aims:

Aim 1: To evaluate the impact of YFHS on the probability of sustained pregnancy protection. We used inverse probability of exposure weighted linear and log binomial models to compare the 12-month probability of sustained pregnancy protection between AGYW with access to YFHS and those with access to SOC, and evaluated whether the effect of YFHS was modified by age, marital status, or parity. Secondarily, we leveraged the longitudinal study design to determine whether the effect of YFHS on sustained pregnancy protection changed over follow-up, and to explore patterns in contraceptive use under both a youth-friendly and standard model of service delivery.

This study was innovative for several reasons. First, our outcome—sustained pregnancy protection—is novel in the YFHS literature and reflects the importance of sustained behavioral changes for preventing early and unintended pregnancy. Second, few studies have explored whether YFHS actually benefit those who experience the greatest barriers to care seeking (141). By evaluating effect measure modification by age, marital status, and parity, our analyses provide critical information on whether facility-based models of YFHS are effective at reaching

populations who typically exhibit poor care-seeking behaviors and have high unmet need for contraception. Finally, we used novel data visualizing techniques to illustrate the dynamic nature of contraceptive behaviors over time. This offered new insights into longitudinal contraceptive preferences and behaviors under two different models of service delivery.

<u>Aim 2:</u> To estimate the effect of YFHS on the 12-month probability of pregnancy. At each study visit, participants in Girl Power-Malawi self-reported their current pregnancy status (expected to be measured with error) and received a urine pregnancy test (UPT; the gold-standard test to confirm pregnancy). Due to site operational challenges, UPTs were not consistently administered and the UPT-based measure of pregnancy was missing for nearly half of participants. Because of this, we used multiple imputation for measurement error (MIME) to correct for potential outcome misclassification in self-reported pregnancy (170, 171), and then applied the parametric g-formula on the corrected data to adjust for confounding and estimate effects of interest (172).

This study was also innovative for several reasons. By capitalizing on a controlled environment with a well-defined cohort and intervention, results from this analysis are more robust than existing evaluations that quantified impact of YFHS using metrics related to pregnancy. Additionally, our analytic approach in this aim is novel. Our main analysis is performed with the parametric g-formula, and we apply multiple imputation for measurement error correction in self-reported pregnancy, as well as bootstrapping to estimate standard errors. This analysis is one of the first to use MIME in non-simulated data, and, to our knowledge, the first to integrate both these approaches into an application of the g-formula.

These two aims are complementary and offer the first comprehensive assessment of how facility-based models shape downstream reproductive health behaviors and outcomes among AGYW in SSA. Such information is timely. Despite limited evidence on the long-term impact of YFHS on SRH outcomes, facility-based models of YFHS have been included as a key intervention in numerous national strategic plans to improve SRH outcomes among young

people in SSA (173-178), feature prominently in the Global Fund's priorities for investment (179), and are a core component of the multi-billion-dollar DREAMS (Determined, Resilient, Empowered, AIDS-free, Mentored and Safe) initiative aiming at reducing risk of HIV and pregnancy among AGYW in SSA (180). Our results therefore have the potential to inform national policies and strengthen ongoing initiatives to introduce and expand access to YFHS across the region.

CHAPTER 3: METHODS

These dissertation aims are an ancillary component of the Girl Power-Malawi study. In this section, we describe the Girl Power-Malawi intervention and study procedures, and summarize findings from the primary Girl Power-Malawi analysis. Subsequently, we describe the methodological approach for each aim of this dissertation, including a description of the study population, measurement and operationalization of exposures, outcomes, and covariates, analytic approach, and sensitivity analyses.

3.1. Parent study

3.1.1. Study design

Both aims of this dissertation use data from Girl Power, a pilot cluster randomized trial that was implemented in Lilongwe, Malawi and Cape Town, South Africa between 2016 and 2017. Due to differences in study design, intervention design, and data collection between Malawian and South African sites, this dissertation is restricted to the Malawian sites. Girl Power-Malawi was a pilot cluster randomized trial designed to evaluate three combinations of evidence-based interventions implemented at the clinic level—clinical, behavioral, and structural—with one another and with SOC, in order to identify the combination of services that maximized sexual risk-reduction and SRH care-seeking among AGYW aged 15-24 in Lilongwe, the capital city of Malawi (169).

The study was implemented in four comparable public sector health clinics in the greater Lilongwe catchment area (Appendix A). Selected sites were all located on a main road, had antenatal volumes >200 clients per month, and reported an antenatal HIV prevalence of > 5%. As public sector health facilities, all sites offered free HIV testing services (HTS), syndromic

management of sexually transmitted infections (STIs), condoms, and contraception, but did not provide these clinical services in an integrated format. While AGYW were able to receive care at each clinic before Girl Power-Malawi was implemented, none of the sites offered youth-friendly spaces, providers were not sensitized to AGYW SRH needs, and clinics were typically open only during weekday mornings. At the start of the Girl Power-Malawi study, each site was randomly assigned to one of the following models (Table 3.1):

- Clinic 1: SOC
- Clinic 2: YFHS
- Clinic 3: YFHS + Small Group Behavioral Intervention (BI)
- Clinic 4: YFSH + BI + Conditional Cash Transfer (CCT)

SOC: Clinic 1 offered AGYW the standard set of clinical services, including free HTS, syndromic management of STIs (medications required payment), and free contraception, including condoms. No modifications were made to the mode of service delivery; Clinic 1 was not modified to be more youth-friendly with regards to hours, clinical navigation, service integration, or youth-dedicated space, and providers were not trained on the provision of SRH services to AGYW.

YFHS: Clinics 2-4 offered AGYW the same package of clinical services as Clinic 1 but modified the way these services were delivered. In Clinics 2-4, services were integrated and provided in youth-dedicated spaces away from the general population. Two peer outreach workers/navigators were present at each clinic to welcome participants, help assess SRH needs, and assist with clinical navigation. Healthcare providers at Clinics 2-4 received additional training that equipped them to more appropriately respond to the SRH needs of AGYW. Finally, Clinics 2-4 offered extended clinical hours in order to give AGYW the opportunity to receive services after school and on select Saturdays.

BI: In addition to the YFHS model of service delivery, AGYW receiving care from Clinics 3-4 had the opportunity to attend a monthly series of 12 small group, facilitator-led, interactive sessions that addressed sexual health topics, relationships, social issues, and financial literacy, and helped AGYW develop cross-cutting skills such as problem-solving and communication. This BI was motivated by the theories of gender and power and social cognitive theory (181, 182), and sought to address gender-based inequities and disparities contributing to adverse SRH outcomes among AGYW through female empowerment.

CCT: Finally, in addition to YFHS model of service delivery and the BI, AGYW who received services from Clinic 4 were eligible to receive a monthly CCT of MKW 4,000 (~USD $5.50) for attending each BI session. AGYW enrolled at Clinic 4 could receive up to 12 CCTs over one year, immediately after each session. While there were no restrictions on how the money could be spent, it was intended to support investment in small businesses, help reduce transactional sex, and encourage AGYW to remain in school.

3.1.2. Study population

At each of the four clinics, 250 AGYW were recruited through a combination of community outreach, self-referral, and participant referral. Recruitment of young women already attending the clinic was discouraged. Community outreach activities were conducted by peer outreach workers/navigators who visited higher risk parts of their catchment area to promote clinic services and distribute study participation invitations (community referral). Village chiefs were oriented before outreach activities began to cultivate community support. Interested AGYW who presented to a Girl Power-Malawi clinic, with or without an invitation card, were screened for eligibility by a female research assistant of similar age. Those who were eligible and provided informed consent were enrolled and provided three invitations to invite friends to participate in the study (participant referral). AGYW who heard about the study through other channels were also eligible to enroll (self-referral).

To be eligible for participation, AGYW had to be female, aged 15 to 24, be presently living in the clinic's catchment area, be willing to provide locator information, and be willing to participate in a research study for 12 months. While sexual activity was not a formal requirement for Girl Power-Malawi, the study purposefully recruited AGYW who had experienced sexual debut.

AGYW aged 18-24 who met Girl Power-Malawi's eligibility requirements were able to provide informed consent and enroll in the study. AGYW aged 15-17 who met Girl Power-Malawi's eligibility requirements were able to provide assent, but were required to have a parent, guardian, or authorized representative with them to provide informed consent. Given that parental consent was considered a barrier to care seeking, the Malawian National Health Sciences Research Committee recommended that each of the Girl Power-Malawi clinics establish community clubs of individuals ≥ 18 years to serve as authorized representatives for AGYW < 18 years old. Girl Power-Malawi organized these community clubs and ensured that one person was available to act as an authorized representative during all clinic hours.

3.1.3. Study procedures

At all four clinics, study visits occurred at baseline and at six and 12 months after study enrollment. During these study visits, study research procedures were implemented: participants were administered a detailed behavioral survey in Chichewa by a trained young female research assistant, and received a small transportation reimbursement (MKW 1,500, ~USD $2.00). The behavioral survey included questions on demographics, socioeconomic status, reproductive history, current and previous contraceptive utilization, care-seeking behaviors, sexual history, and psychosocial outcomes.

Girl Power-Malawi implemented a series of intensive tracing procedures in all clinics to promote study retention. At baseline participants provided detailed locator information that could be used to trace them if they missed a study visit. Tracing for missed study visits was initiated the day after a missed study visit, and included a combination of phone calls and community

visits in unmarked vehicles by peer outreach workers/navigators. Tracing continued until either 12-month study procedures were conducted, or the study had a final disposition on non-retained participants. Participants who were lost to follow-up at six months remained eligible for their twelve-month study visit unless they withdrew their consent or died. Participants who missed their 12-month study visit and who were traced in the community were eligible to have study procedures conducted in the community.

As a result of these tracing efforts, retention in Girl Power-Malawi was high. In addition, missed visits did not differ by clinic. Ninety-two percent of participants had at least one study visit after enrollment, and 79% of participants attended both six- and 12-month study visits (Table 3.2). Primary reasons for non-retention included: leaving the catchment area (52%), being unable or unwilling to complete the study visit (25%), and being non-locatable (18%).

The same contraceptives services were available at all four clinics. Following national guidelines, AGYW seeking contraception received a pregnancy assessment, free contraceptives (condoms, oral contraceptive pills, injectables, implants, or intrauterine devices), counseling on correct use of selected contraceptive methods, and information on the importance of dual-method use for the prevention of pregnancy and STIs (183). Pregnancy assessments should have included a qualitative assessment of pregnancy status, and a pregnancy test if a pregnancy could not be ruled out (183). However, due to frequent stock-outs and affordability challenges, pregnancy testing was inconsistently conducted until Girl Power-Malawi began supplying pregnancy tests to all clinics in August 2016. At this time, pregnancy tests were administered to all participants at six- and twelve-month study visits, and Clinics 2-4 started providing pregnancy tests to participants who required testing between study visits.

3.1.4. Clinical environment

While the same contraceptive options were available in all four clinics, the delivery of this package was considerably different in the clinic offering the standard model of service delivery than in the clinics offering the youth-friendly model of service delivery.

In the clinic offering SOC, the lack of youth-dedicated spaces meant that AGYW seeking contraception often had to wait for services while standing in long queues with older adults from their communities, and that pregnancy assessments and contraceptive counseling were often provided in rooms with other clients present. In addition, healthcare providers were not sensitized to the SRH needs of AGYW, and there were no peer outreach workers/navigators to help evaluate the SRH needs of participants, or to explain the various contraceptive options available at the clinic. AGYW who enrolled at the clinic offering SOC were therefore responsible for identifying a need for contraception and advocating for it by themselves.

In contrast, youth-dedicated spaces in the clinics offering YFHS meant that AGYW seeking contraceptive services did not need to stand in queues with older adults while waiting to see a healthcare provider. When a participant arrived at the clinic, she was welcomed by a peer outreach worker/navigator who helped identify SRH needs, and described the types of contraception available at the clinic. All contraceptive services were provided in a private room by a nurse who received a five-day training on long acting methods of contraception, and a two-day training on medical and psychosocial support for adolescents and young adults. When a participant requested contraception, nurses conducted a pregnancy assessment, recommended the method(s) that matched the pregnancy intentions of the participant, and provided detailed counseling on the contraceptive method selected by the participant, including the importance of dual method use if a non-barrier method of contraception had been selected.

Over follow-up all clinical services provided at each clinical encounter were documented on participant-specific clinic cards. Each card had four sections (general information, HTS, STI, contraception) that were completed by different clinic staff depending on what services were provided. Peer outreach workers/navigators documented general information about the participant each time they presented for services. HIV diagnostic assistants completed HTS sections, and nurses completed STI and contraception sections. The contraception section of

the card included information about pregnancy test results, current contraceptive use, and contraceptives provided during the visit.

3.1.5. Primary results

The primary objective of Girl Power-Malawi was to estimate the effect of YFHS on utilization of SRH services over twelve months of follow-up. Results from the main analysis have been previously published (158); a summary of these results is presented in Chapter 1. Briefly, of 1109 potential participants screened for eligibility, 97% were eligible and 1000 enrolled (250 per clinic). The population of AGYW who enrolled at clinics offering YFHS were older, more likely to be married, more likely to have a child, and more likely to have a history of using non-barrier methods of contraception than their counterparts who enrolled at the clinic offering SOC. Compared to those who enrolled at the clinic offering SOC, those who enrolled at clinics offering YFHS were more likely to receive condoms (83% vs. 26%; adjusted RD: 57%, 95% CI: 50%, 63%) and non-barrier methods of contraception (54% vs. 10%; adjusted RD: 39%, 95% CI: 34, 45%) over follow-up. Additionally, compared to participants who enrolled at the clinic offering SOC, those who enrolled at clinics offering YFHS and were more likely to report currently using condoms and non-barrier methods of contraception at both six months (condoms: 68% vs. 54%; non-barrier contraception: 47% vs. 19%) and 12 months (condoms: 78% vs. 55%; non-barrier contraception: 44% vs. 24%).

3.2. Present work

This work described in this dissertation builds on results from the primary analysis to explore whether access to a model of YFHS that increased SRH service utilization and contraceptive point prevalence also resulted in sustained behavioral changes and decreased the probability of pregnancy. Below, we describe the study population, measures, analytic approach, and sensitivity analyses for each aim. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).

3.2.1. Analytic population

For both aims, we restricted our analysis to the subset of Girl Power-Malawi participants who reported not being pregnant at the time of enrollment. This restriction was important since pregnant participants would not be at risk of either outcome until after the pregnancy (and, if a live birth, exclusive breastfeeding) ended, and we lacked the necessary information over follow-up to determine if and when these events occurred.

3.2.2. Exposure measurement

For both aims, our exposure of interest was access to YFHS. Exposure was time fixed. AGYW who enrolled at the YFHS clinics (clinics 2, 3, and 4) were classified as exposed while those who enrolled at the clinic offering SOC (clinic 1) were classified as unexposed. The four study clinics served unique catchment areas located ≥7km apart to minimize risk of between-clinic cross-over.

3.2.3. Outcome measurement

Aim 1: Our primary outcome of interest was sustained pregnancy protection. We generated this outcome using information on sexual activity and use of contraception reported at the six- and 12-month study visits (Table 3.3). Table 3.4 illustrates how we used these data to classify participants as having sustained or not sustained pregnancy protection for each six-month period (i.e. enrollment to six months, and six to 12 months). For each six-month period, participants who reported not having vaginal sex during the period, or reported having vaginal sex and using condoms consistently, or reported having vaginal sex and using a non-barrier method of contraception for the full period between study visits, were classified as having sustained pregnancy protection. Participants who were sexually active during the period and either reported never using condoms or reported not using condoms consistently, and either reported never using a non-barrier method of contraception or reported using a non-barrier method of contraception for only part of the time between study visits, were classified as not having sustained pregnancy protection. Participants with sustained pregnancy protection for

both six-month periods—either using the same or different approaches—were classified as having sustained protection for 12 months. All other participants were classified as not having sustained protection for 12 months.

To explore trends in contraceptive behaviors over follow-up, we generated two, eight-level categorical variables that corresponded to the method used for the period between enrollment and six months, and the method used for the period between six and 12 months. For each period, participants who reported no sexual activity were classified as group 1. For participants who were sexually active, we further categorized them according to use of condoms only (group 2), condoms plus a non-barrier method (i.e. dual methods; group 3), OCPs only (group 4), injectables only (group 5), subdermal implants only (group 6), IUDs only (group 7), or sexually active without protection for some or all of the six-month period (group 8). There was no implied ordering of these categories in terms of effectiveness for pregnancy prevention.

Aim 2: Our outcome of interest, pregnancy, was measured in two ways. At six and 12 months, participants reported their current pregnancy status on an interviewer-administered questionnaire. Participants who reported being pregnant at either study visit were classified as having an incident pregnancy; those who reported not being pregnant at both study visits were classified as not having an incident pregnancy. Our second measure of pregnancy was generated using results from urine pregnancy tests (UPT) conducted at the six- and 12-month study visits. Participants with positive UPT at either study visit were classified as having an incident pregnancy while participants who tested negative on a UPT at both study visits were classified as not having an incident pregnancy.

3.2.4. Covariate measurement

Although clinics were randomly assigned to provide either a standard or youth-friendly model of service delivery, a prior analysis of Girl Power-Malawi reported imbalances in the distribution of baseline covariates between exposure groups (158). These imbalances were not unexpected given the small number of clinics randomized in Girl Power-Malawi, and the

relatively small number of participants enrolled at each clinic (184, 185). Critically, imbalances in the distribution of baseline covariates between exposure groups may introduce bias into our analyses. We therefore constructed causal diagrams to identify potential confounders for the relationship between YFHS and sustained pregnancy protection (Figure 3.1), and for the relationship between YFHS and pregnancy (Figure 3.2) (186).

Aim 1: The minimally sufficient adjustment set for our Aim 1 analysis included baseline measures of age, marital status, cohabitation, number of living children, history of using non-barrier methods of contraception, perceived chance of pregnancy in the next 12 months, multiple partners in the previous 12 months, socioeconomic status, and school enrollment. A prior analysis illustrated that the distribution of these variables differed according to exposure groups (158), and these variables are hypothesized to be independently associated with sustained pregnancy protection. In addition to our minimally sufficient adjustment set, we included baseline measures of condom use and current sexual activity (defined as sexual activity in the past 30 days) in our models. While the distribution of these variables were similar between exposure groups, we expected they would predict our outcome of sustained pregnancy protection.

Aim 2: The minimally sufficient adjustment set for our Aim 2 analysis was the same as the adjustment set as Aim 1. However, due to challenges with model convergence, we were unable to include our measure of cohabitation in our analytic models. This variable was highly collinear with marital status ($r > 0.9$), and the theoretical basis for including marital status in our models was stronger than the theoretical basis for including cohabitation. In addition, due to challenges with model convergence, we were unable to include variables not related with exposure but expected to predict pregnancy in our analytic models (history of condom use and current sexual activity).

All covariates were measured using self-reported data collected on the behavioral survey administered at the participant's enrollment visit. Below, we describe why each variable

in our minimally sufficient adjustments set was expected to be associated with our outcomes of sustained pregnancy protection and pregnancy, and describe how the variable was operationalized for our analyses.

- **Age:** Human brain imaging studies demonstrate differential development of the prefrontal cortex (i.e. the site of executive control function) and limbic system (i.e. the site that governs reward processing and pleasure seeking) during adolescence and young adulthood (187, 188), with the greatest disparity in maturation of the two sites occurring during middle adolescence (189). This asynchronous pattern of brain development reorients the brain's processing systems to favor socioemotional and reward-based learning over rational decision making, which may contribute to increased risk-taking behaviors (for example, and most relevant to this work, unprotected sex) during adolescence (187-189). In addition, as described in Chapter 2, younger age may correspond to a lower propensity to adopt or continue contraception for a variety of individual, interpersonal, structural, and sociocultural reasons. In both aims, we modeled age using restricted cubic splines with knots placed at the 5^{th}, 50^{th}, and 95^{th} percentiles.
- **Marital status:** As described in Chapter 2, social norms related to premarital sex creates an atmosphere of silence, where unmarried AGYW in sexually intimate relationships may feel embarrassed, ashamed, or afraid to seek SRH services or even talk about sex. Moreover, provider-imposed eligibility barriers have been documented across southern Africa, with providers refusing to provide contraceptive information or services to unmarried AGYW. Among women who are married or in stable relationships, partner fertility preferences, power dynamics with the relationship, and social norms related to marriage and childbearing, may also influence use of contraception. In both aims, we modeled marital status using a binary variable (married vs. not married).
- **Cohabitation:** In SSA, condom use is uncommon among AGYW in stable relationships (190), and we hypothesized that cohabitation may increase the regularity of sexual

intercourse. We operationalized cohabitation using a binary variable (lives with husband/boyfriend vs. does not live with husband/boyfriend).

- **Number of living children:** As described in Chapter 2, misconceptions regarding the side-effects of modern contraception, including future infertility, are ubiquitous across the region. In contexts where motherhood defines a woman's status in society and infertility is viewed as a female issue, like Malawi, such misconceptions can result in provider biases and may lower demand for modern contraception among AGYW who have no living children. In both aims, we modeled number of living children using a binary variable (any living children vs. no living children).
- **History of using non-barrier contraception:** As with many behaviors, historical patterns of contraceptive use, including current use at study enrollment, may predict future patterns of contraceptive use. In both aims, we modeled history of using non-barrier methods of contraception using a binary variable (ever used non-barrier methods of contraception vs. never used non-barrier methods of contraception), where we defined non-barrier methods of contraception as OCPs, injectables, subdermal implants, or IUDs only.
- **History of condom use:** As with many behaviors, historical patterns of condom use, including current use at study enrollment, may predict future patterns of condom use. This variable was only included in Aim 1. We operationalized history of condom use using a binary variable (ever used condoms vs. never used condoms).
- **Perceived chance of pregnancy:** We hypothesized that perceptions regarding an individual's own chance of becoming pregnant in the next twelve months would serve as a proxy for several unmeasured variables expected to be associated with contraceptive use and abstinence (i.e. personal fertility preferences, contraceptive self-efficacy, partner fertility preferences and attitudes towards contraception, and expected frequency of

sexual activity). At baseline, all participants were asked what they believed their chances of becoming pregnant would be in the next 12 months. Responses included: No chance, some chance, or a very high chance. Since few participants felt they had a very high chance of pregnancy in the next 12 months, we collapsed the latter two categories together to generate a binary variable that we used in both aims (some risk vs. no risk).

- **Multiple partnerships:** In SSA, condom use is more common in casual contacts than with a steady partner, and individuals with multiple concurrent partners use condoms more frequently than those with a single partner (190). In both aims, we modeled multiple partnerships using a binary variable (> 1 sex partner in the previous 12 months vs. ≤ 1 sex partner in the previous 12 months).
- **Current sexual activity:** We hypothesized that current sexual activity may be related to future sexual activity. This variable was only included in Aim 1. We modeled current sexual activity as a binary variable (had sex in the past 30 days vs. did not have sex in the past 30 days).
- **Socioeconomic status:** Prominent socioeconomic disparities in unmet need for contraception exist in Malawi, with women in the lowest wealth quintile typically reporting highest levels of unmet need and greatest gaps between wanted and actual fertility, while women in the highest wealth quintiles reporting the lowest levels of unmet need and lowest gaps between wanted and actual fertility (3). In both aims, socioeconomic status was measured using information on the presence of plumbing in the place of residence, the presence of water in the place of residence, and durable goods ownership. In Aim 1, plumbing and electricity were operationalized as a binary variable (yes/no), while principal component analysis (PCA) was used to combine information on durable goods ownership into a single score, which we then modeled using restricted cubic splines with knots at the 5^{th}, 50^{th}, and 95^{th} percentiles. In Aim 2, we used PCA to combine information on durable good ownership and presence of utilities in home

(plumbing and electricity) into a single score, which we then modeled using restricted cubic splines with knots at the 5th, 50th, and 95th percentiles. Following guidance in the literature (191-194), we used the first principal component from PCA as our score in both aims.

- **School enrollment:** School attendance has been shown to decrease risk of unprotected intercourse among AGYW in South Africa (195, 196). School attendance provides structure and supervision during the day, which may reduce opportunities for sexual activity (197). In addition, school attendance may promote contraceptive communication with peers and encourage the creation of social networks with high social capital, both of which may influence contraceptive use behaviors (112). Finally, there is evidence that school attendance reduces risk of age-disparate relationships (196), which may introduce power dynamics into the relationship that make it difficult to negotiate contraceptive use. Since some participants had completed secondary school, we used information on school enrollment and highest grade completed to generate a binary variable that was used in both aims (12+ years of education completed or < 12 years of education completed and enrolled in school vs. < 12 years of education completed and not enrolled in school).

3.2.5. Aim 1 approach

Our primary objective in Aim 1 was to estimate the effect of the Girl Power-Malawi model of YFHS on the 12-month probability of sustained pregnancy protection, and to evaluate whether the effect of YFHS was modified by age, marital status, and parity. Secondarily, we leveraged the longitudinal nature of the study to evaluate whether the effect of YFHS on sustained pregnancy protection changed over time, and to explore patterns in contraceptive use over follow-up. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).

Missing data: While most participants (>98%) had complete data on baseline covariates, only 78% of participants had all outcomes fully observed. Because missingness was non-monotonic, we imputed missing covariate and outcome data using multiple imputation by chained equations (MICE) (198). We generated 25 imputed datasets based on guidance that the number of imputations should be similar to the percentage of incomplete cases (198). Following best practices (198), our imputation model included our outcome variables, all variables from our minimally sufficient adjustment set, interaction terms between exposure and age, marital status, and parity, and auxiliary variables from the behavioral survey and clinic card expected to predict missing outcomes.

Briefly, MICE is a robust imputation approach that uses a series of regression models—one for each variable with missing values—to impute missing data (198). Initially, all missing values in all variables are filled in by random draws of observed data. Then, the first variable with missing data, v_1, is regressed on all variables specified in the v_1 model, restricted to only individuals for whom v_1 is observed. The missing values of v_1 are filled in by draws from the resulting posterior predictive distribution of v_1. This process is repeated for each variable that has missing data. To stabilize results, the whole process is repeated for several cycles (we used 20 burn-in iterations) to produce a single dataset with imputed values. The MICE algorithm is then repeated M times to generate M imputed datasets, within which analyses are conducted.

We selected MICE over other imputation algorithms given its ability to model each variable with missing data according to its distribution (198). As all variables with missing data in our analysis were binary or nominal, we used the default imputation method for categorical data (discriminate function) in our MICE algorithm (199). This method assumes a multivariate normal distribution of covariates with means that vary across levels of the categorical variable and within-category covariance matrices that are approximately constant over categories (199). In each imputation, category-specific means, a pooled covariance matrix, and prior probabilities of group membership are drawn from the corresponding posterior distributions and used to predict

the probability of membership in each group. The group with the highest probability of membership is imputed as the missing value (199).

To evaluate the performance of our imputation model, we compared the distributions of observed data and imputed data to ensure imputed data were logical and conducted a leave-one-out cross-validation assessment for a random sample of participants with observed data (200). Briefly, to implement leave-one-out cross-validation, we selected a random 10% of participants for whom outcomes were observed. Iteratively, we deleted a single observed outcome and then fit the imputation model to the entire dataset and predicted all missing outcomes, including the outcome that had been deleted. Once all iterations were complete, we evaluated the performance of the imputation model by summarizing the discrepancies between observed and predicted outcomes.

Analytic approach: For our primary analysis, we used linear and log-binomial models to estimate the effect of the Girl Power-Malawi model of YFHS on the 12-month probability of sustained pregnancy protection. Secondarily, we used generalized estimating equations with an exchangeable correlation matrix to estimate the marginal effect of YFHS on sustained pregnancy protection between enrollment and six months, and between six and twelve months. In both analyses, we accounted for confounders using inverse probability of exposure weights stabilized by the marginal probability of exposure (201), and thus estimated marginal rather than conditional risk differences (RD) and risk ratios (RR).

Briefly, the application of inverse probability of exposure weights to a study population standardizes the distribution of covariates within each exposure group to be the same as the distribution of covariates in the full study population (202). This is achieved by up-weighting participants with a low probability of receiving the exposure they actually received, while down-weighting participants with a high probability of receiving the exposure they actually received. In the “pseudo-population” obtained by weighting participants by the inverse probability of receiving the exposure they actually received, exposure is (or at least, should be) independent

of measured baseline covariates. This facilitates the estimation of marginal effects that are adjusted for confounding. Under key assumptions of consistency, conditional exchangeability, positivity, and no model misspecification (202), weighted estimates of effect can be interpreted as the causal effect of YFHS on the 12-month probability of sustained pregnancy protection.

Given limited missingness in baseline covariates, we generated our model for exposure weights using complete cases. The numerator of the weight was estimated using a logistic regression model for exposure status without covariates. The denominator of the weight was estimated using a logistic regression model for exposure status that included our minimally sufficient adjustment set. Predicted probabilities from these models were used to generate inverse probability of exposure weights. If A denotes access to YFHS, Z denotes the minimally sufficient adjustment set plus predictors of the outcome, the inverse probability of exposure weight for participants in the YFHS and in the SOC are calculated as:

Weight for YFHS participants: $\widehat{\Pr}(A_i = 1)/\widehat{\Pr}(A_i = 1 \mid Z_i)$

Weight for SOC participants: $(1 - \widehat{\Pr}(A_i = 1))/(1 - \widehat{\Pr}(A_i = 1 \mid Z_i))$

We evaluated the performance of our exposure weights with descriptive statistics (mean and range of the weights), and examined balance of measured covariates between exposure groups using standardized mean differences before and after weighting (201). To improve balance, we added statistical interaction terms to the weight model. The final models for our exposure weights was applied within each imputed dataset and used to generate imputation-specific estimates of effect (203). We averaged across imputations to generate the marginal RDs and RRs for the effect of the YFHS on the probability of unprotected sex.

Confidence intervals (CI) around our estimates of effect were constructed using a nonparametric bootstrap. For the primary analysis, bootstrap resamples were selected from the original population with replacement. For the secondary analysis, the bootstrap needed to accommodate repeated measures on participants (204). Therefore, if a participant was selected

for the bootstrap sample, she contributed both visits to the sample (204). We incorporated multiple imputation into our bootstrap using the Boot-MI algorithm (205).

In Boot-MI, B bootstrap resamples are drawn (with replacement) with missing data and each is imputed M times. In this analysis, $B = 200$ and $M = 25$. Within each imputed dataset, the analytic approach described above was used to obtain imputation-specific RDs and RRs. The standard deviation (SD) of the 200 RDs and 200 RRs served as the standard errors used to derive the confidence intervals around estimates of effect generated in the original data. For the RD, the confidence interval was simply the RD from the original data +/- 1.96 times the SD of the RDs from the 200 bootstrap resamples. For the RR, the confidence interval was constructed in the same way, but the natural log of the RR was used to generate the bounds, which were then exponentiated.

To describe trends in contraceptive use over follow-up, we generated stacked bar charts to illustrate method use used for the period between enrollment and six months, and method used for the period between six and 12 months, stratified according to exposure group. Within exposure groups, we added Sankey-style overlays to provide a visual depiction of the magnitude of flow between methods over follow-up (206). For each of these analyses, we tabulated weighted frequencies within each imputed dataset and used the average of the weighted frequencies to generate figures.

Effect measure modification: We compared stratum-specific estimates of effect and corresponding 95% CIs to determine if the effect of YFHS on the 12-month probability of unprotected sex varied according to age (15 to 19 vs. 20 to 24), marital status (not married vs. married), and parity (no children vs. at least one child). Age, marital status, and parity were assessed separately. Secondarily, we explored whether these factors modified the contraceptive methods used by participants between visits. Given limited sample size, this second analysis was only possible after collapsing across exposure groups. For both analyses,

the inverse probability of exposure weights were stabilized by the probability of exposure given the modifier to enhance precision (202).

Sensitivity analyses: We conducted two sensitivity analyses. First, we explored the sensitivity of our results to random nonpositivity using weight truncation and weight trimming. For weight truncation, weights below the 1st and above the 99th percentile were reset to the 1st and 99th percentile values, respectively (207). For weight trimming, we restricted our study population to only AGYW with a predicted probability of exposure that was greater than the 1st percentile of the exposed propensity score distribution and below the 99th percentile of the unexposed propensity score distribution (208). Note that propensity scores were generated by the model used to estimate the denominator of the inverse probability of treatment weights in the main analysis. In addition to enhancing precision, these analyses can reduce unmeasured confounding that is often present in the tails of the propensity score distributions. Following best practices, we re-estimated weights within the restricted sample.

Finally, to isolate the effect of YFHS from potential effects of the BI and the CCT, we restricted our analysis to only AGYW who enrolled at Clinics 1 and 2. Since the distribution of covariates in the restricted sample (Clinics 1 and 2) differed considerably from the distribution in the full analytic sample (Clinics 1-4), the models used to estimate our inverse probability of exposure weights in the primary analysis performed poorly in this restricted population. Because of this, we re-estimated the weights using a different model that included all the same main effects as the main analysis, but different interaction terms. We used the same strategies described above to assess performance of the exposure weights in this restricted sample.

3.2.6. Aim 2 approach

Our primary objective in Aim 2 was to estimate the effect of the Girl Power-Malawi model of YFHS on the 12-month probability of pregnancy. Because our gold-standard measure of pregnancy was missing for nearly half of participants, we used a two-step approach to estimate the effect of YFHS on the 12-month probability of pregnancy. First, we used multiple imputation

for measurement error (MIME) to correct for potential outcome misclassification in self-reported pregnancy (170, 171). Following this correction, we applied the parametric g-formula on the corrected data to adjust for confounding and estimate effects of interest (172). We also applied the parametric g-formula directly on observed data to compare estimates of effect generated using each of the three measures of pregnancy (i.e. the corrected measure, the self-reported measure, and the pregnancy test-based measure).

Measurement error correction: Our outcome of interest, pregnancy, was measured using both self-reported data and results from UPTs (defined previously as urine pregnancy tests). Our self-reported measure of pregnancy was available for most participants but was expected to be measured with error due to social desirability bias, fertility preferences, and challenges with identifying early pregnancy. Our UPT measure was considered the gold standard test to confirm pregnancy status. However, UPTs were inconsistently administered at study visits due to site operational challenges, including inconsistent access to bathrooms and busy providers. Additionally, UPTs were not conducted if the 12-month study visit occurred in the community.

Overall, 46% of participants had both measures of pregnancy recorded. This group formed a validation cohort in which our possibly misclassified, self-reported, measure of pregnancy (W) could be related to our UPT-based measure of pregnancy (D), facilitating the use of multiple imputation to correct for outcome misclassification (170, 171). To implement the MIME correction, we used a logistic regression model with Firth's correction to estimate the probability of D given W and A (our exposure: access to YFHS) in the validation cohort. The model for the predictive values included an interaction term between W and A, to flexibly model outcome misclassification between exposure groups, and all variables from our minimally sufficient adjustment set described earlier (Z):

$$\widehat{\Pr}(D = 1 \mid W, A, Z) = \frac{\exp(\beta_0 + \beta_1 W + \beta_2 A + \beta_3 (W \times A) + \beta_4 Z)}{(1 + \exp(\beta_0 + \beta_1 W + \beta_2 A + \beta_3 (W \times A) + \beta_4 Z)}$$

We drew 40 sets of regression coefficients from the resulting posterior predictive distribution of parameters and used these values to impute the MIME-corrected outcome, D_k, where k indexes each of the $k = 40$ imputations. For participants with our UPT-based measure of pregnancy observed, $D_k = D$ for all imputations. For participants with only our self-reported measure of pregnancy observed, D_k was imputed based on a random draw from a Bernoulli distribution with probability, p_k, generated using regression coefficients estimated in the validation subgroup from the k^{th} draw:

$$\widehat{p_k} = \frac{exp(\hat{\beta}_0^k + \hat{\beta}_1^k W + \hat{\beta}_2^k A + \hat{\beta}_3^k (W \times A) + \hat{\beta}_4^k Z)}{\left(1 + exp\left(\hat{\beta}_0^k + \hat{\beta}_1^k W + \hat{\beta}_2^k A + \hat{\beta}_3^k (W \times A) + \hat{\beta}_4^k Z\right)\right.}$$

Within each imputed dataset, we used the parametric g-formula to adjust for confounding and estimate risk differences (RD) and risk ratios (RR) comparing the 12-month probability of pregnancy between participants with and without access to YFHS:

$$\widehat{RD} = \frac{1}{n}\sum_{i=1}^{n}\left(\widehat{\Pr}(D_k|A = 1, Z_i) - \widehat{\Pr}(D_k|A = 0, Z_i)\right)$$

$$\widehat{RR} = \frac{1}{n}\sum_{i=1}^{n}\left(\widehat{\Pr}(D_k|A = 1, Z_i)/\widehat{\Pr}(D_k|A = 0, Z_i)\right)$$

Parametric g-formula: The parametric g-formula is a powerful causal inference approach used to estimate missing counterfactual observations for all participants (172). This is achieved by modeling the outcome in the observed data and then using the relationships between the exposure, covariates and outcome in the observed data to predict the probability of the outcome for each participant under all exposure scenarios. Averaging predicted probabilities according to exposure scenario produces standardized means that are weighted to reflect the distribution of covariates in the overall study population. This facilitates the estimation of marginal effects that are adjusted for confounding. Under key assumptions of consistency, conditional exchangeability, positivity, and no model misspecification (202), estimates of effect

generated by the parametric g-formula can be interpreted as the causal effect of YFHS on the 12-month probability of pregnancy.

To implement the parametric g-formula (172), we used a logistic regression model to predict the probability of pregnancy for each participant under a scenario where all clinics offered YFHS and under a scenario where all clinics offered SOC. Our prediction model adjusted for the minimally sufficient adjustment set described earlier and interaction terms between access to YFHS and age, marital status, living children, and history of using of non-barrier contraception. We averaged predicted probabilities according to exposure scenario and used these averages to estimate marginal RDs and RRs corrected for confounding. Confidence intervals were constructed as the effect estimate +/-1.96 times the standard deviation from 200 bootstrap resamples. For our MIME-corrected analysis, we incorporated multiple imputation into our bootstrap using the Boot-MI algorithm, with 40 imputed datasets per resample (205). The Boot-MI process was described previously, as part of our Aim 1 approach.

For each endpoint (i.e. the corrected measure of pregnancy, the self-reported measure of pregnancy, and the UPT-based measure of pregnancy), we evaluated the performance of the model used to predict the probability of pregnancy by comparing the observed probability of pregnancy to the predicted probability of pregnancy estimated under the natural course (i.e. under the scenario where all participants received the exposure they were assigned). While alignment of the two proportions is neither necessary nor sufficient to confirm correct model specification, similar proportions provide some confidence in the model specification.

Effect measure modification: To ascertain whether the effect of YFHS differed according to age, we averaged predicted probabilities according to exposure status and age group (AGYW aged 15-19 and AGYW aged 20-24), and compared stratum-specific effect estimates and CIs. Given limited sample size, we were unable to conduct this evaluation for other modifiers of interest (i.e. marital status and parity).

Bridging Aim 1 and Aim 2: In a post-hoc exploratory analysis, we tabulated our MIME-corrected measure of pregnancy according to our measure of sustained pregnancy protection from Aim 1. We did this within each of the 40 imputations and then averaged the resulting cross-tabulations across the 40 imputations to explore the distribution of our MIME-corrected measure of pregnancy according to our measure of sustained pregnancy protection. This analysis was only conducted among participants for whom our MIME-corrected measure of pregnancy and our measure of sustained pregnancy protection were available.

Sensitivity analyses: To isolate the effect of YFHS from potential effects of the BI and the CCT, we restricted our analysis to only AGYW who enrolled at Clinics 1 and 2 and implemented the same analyses described above.

3.4. Tables and Figures

Table 3.1. Description of services provided at each Girl Power-Malawi clinic

	Clinic 1	Clinic 2	Clinic 3	Clinic 4
	SOC	**YFHS**	**YFHS+BI**	**YFHS+BI+CCT**
Clinical services offered				
Non-barrier contraception offered	X	X	X	X
HIV testing offered	X	X	X	X
STI management offered	X	X	X	X
Condoms offered	X	X	X	X
Mode of service delivery				
Integrated clinical care		X	X	X
Youth-dedicated spaces		X	X	X
Extended hours of operation		X	X	X
Privacy from older adults		X	X	X
Youthful peer outreach workers/navigators and HIV testers		X	X	X
Youth-friendly trainings and sensitizations of clinic staff		X	X	X
Behavioral intervention				
12 monthly sessions			X	X
Conditional cash transfer				
12 payments				X

SOC = standard of care; YFHS = youth-friendly health services; BI = behavioral intervention; CCT = conditional cash transfer

Note. This table was adapted with permission from “Comparing Youth-Friendly Health Services to the Standard of Care Through “Girl Power-Malawi”: A Quasi-Experimental Cohort Study,” by N. E. Rosenberg *et al. JAIDS,* 2018;**79**(4), 458-466. Copyright 2018 by Wolters Kluwer Health, Inc.

Table 3.2. Retention at study visits according to clinic of enrollment

	Clinic 1	Clinic 2	Clinic 3	Clinic 4
	SOC	**YFHS**	**YFHS+BI**	**YFHS+BI+CCT**
Baseline	250	250	250	250
6 months	213 (85%)	207 (83%)	209 (84%)	215 (86%)
12 months	210 (84%)	222 (89%)	222 (89%)	213 (85%)

SOC = standard of care; YFHS = youth-friendly health services; BI = behavioral intervention; CCT = conditional cash transfer

Table 3.3. Measures from the Girl Power-Malawi behavioral survey used to construct Aim 1 outcomes

Variable Name	Survey Question	Assessment points	Response options
Ever use of OCPs	Have you ever used birth control pills?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Current use of OCPs	Are you currently using birth control pills?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Duration of OCP use	How long have you been using birth control pills (months)?	Baseline 6 Months 12 Months	Integer
Ever use of injectables	Have you ever used depo provera?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Current use of injectables	Are you currently using depo provera?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Duration of injectable use	How long have you been using depo provera (months)?	Baseline 6 Months 12 Months	Integer
Ever use of subdermal implants	Have you ever used a contraceptive implant?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Current use of subdermal implant	Are you currently using a contraceptive implant?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Duration of subdermal implant use	How long ago did you have this implant placed (months)?	Baseline 6 Months 12 Months	Integer
Ever use of IUD	Have you ever used an IUD?	Baseline 6 Months 12 Months	Yes No Don't Know No response

Current use of IUD	Are you currently using an intrauterine device?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Duration of IUD	How long ago did you have this device placed (months)?	Baseline 6 Months 12 Months	Integer
Ever use of male condoms	Have you ever used male condoms?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Current use of male condoms	Are you currently using male condoms?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Consistent use of male condoms	Do you use male condoms always or sometimes?	Baseline 6 Months 12 Months	Always Sometimes No response
Ever use of female condoms	Have you ever used female condoms?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Current use of female condoms	Are you currently using female condoms?	Baseline 6 Months 12 Months	Yes No Don't Know No response
Consistent use of female condoms	Do you use female condoms always or sometimes?	Baseline 6 Months 12 Months	Always Sometimes No response
Abstinence	In the past six months, have you had vaginal sex, anal sex, both, or neither?	6 Months 12 Months	Vaginal sex Anal sex Both Neither No response

OCP = Oral contraceptive pills; IDU = Intrauterine device

Table 3.4. Description of how data on sexual activity and contraceptive use was used to construct the primary outcome in Aim 1

Outcome	**Abstinence**		**Condom use (male and female)**				**Use of on-barrier methods (OCP, injectable, implant, and IUD)**				
Sustained pregnancy protection	No vaginal sex in the past six months	-	-			-	-				
	Vaginal sex in the past six months	AND	Use condoms consistently			AND EITHER	Never used any non-barrier methods	OR	Not currently using a non-barrier method	OR	Current use of a non-barrier method for < 100% of the period between study visits
	Vaginal sex in the past six months	AND EITHER	Never used condoms	OR	Does not use condoms consistently	AND	Current use of a non-barrier method for ≥ 100% of the period between study visits				
	Vaginal sex in the past six months	AND	Use condoms consistently			AND	Current use of a non-barrier method for ≥ 100% of the period between study visits				
Did not sustain pregnancy protection	Vaginal sex in the past six months	AND EITHER	Never used condoms	OR	Does not use condoms consistently	AND EITHER	Never used any non-barrier methods	OR	Not currently using a non-barrier method	OR	Current use of a non-barrier method for < 100% of the period between study visits

OCP = Oral contraceptive pills; IDU = Intrauterine device

Figure 3.1. Causal diagram for the relationship between YFHS and sustained pregnancy protection

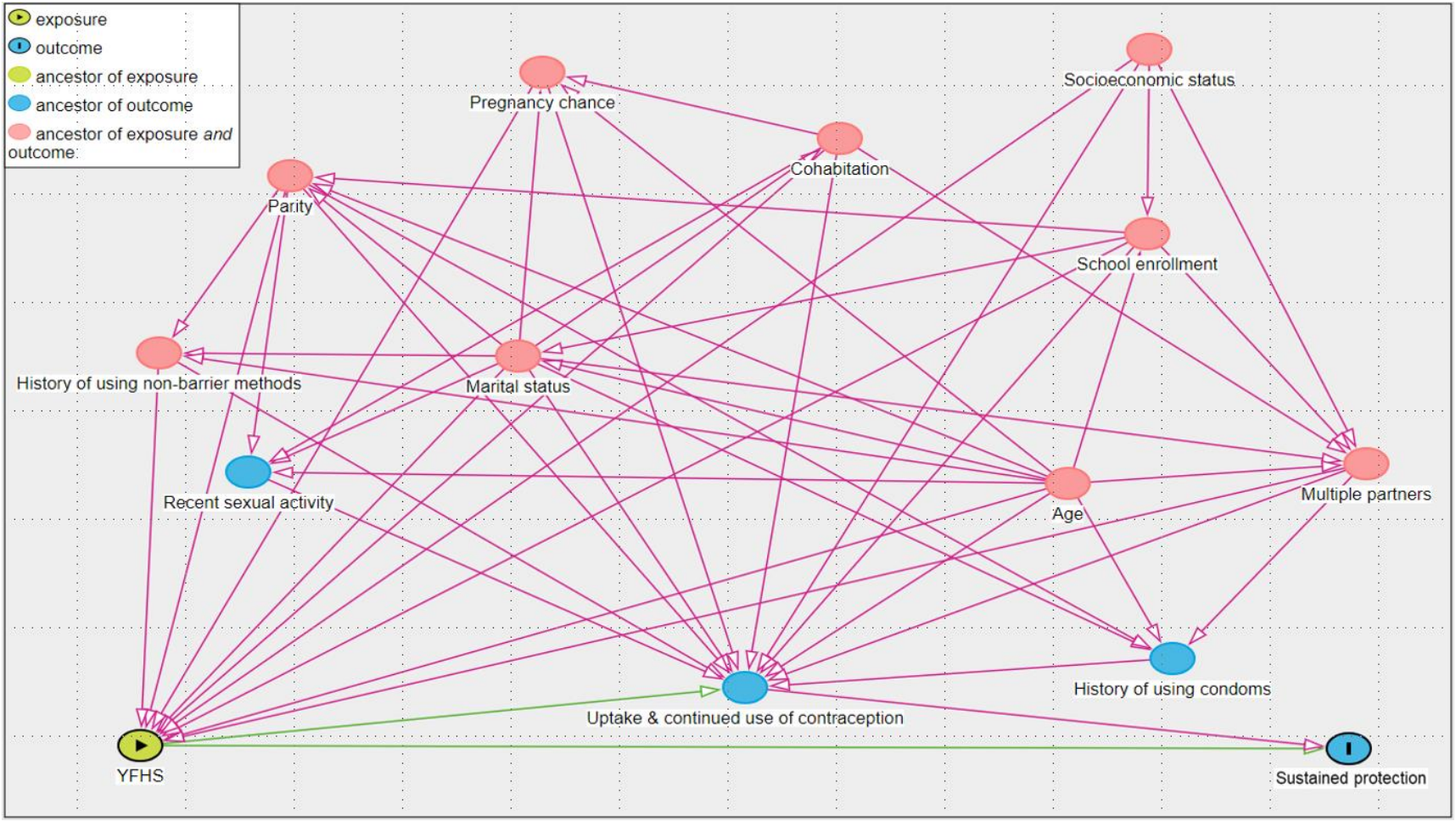
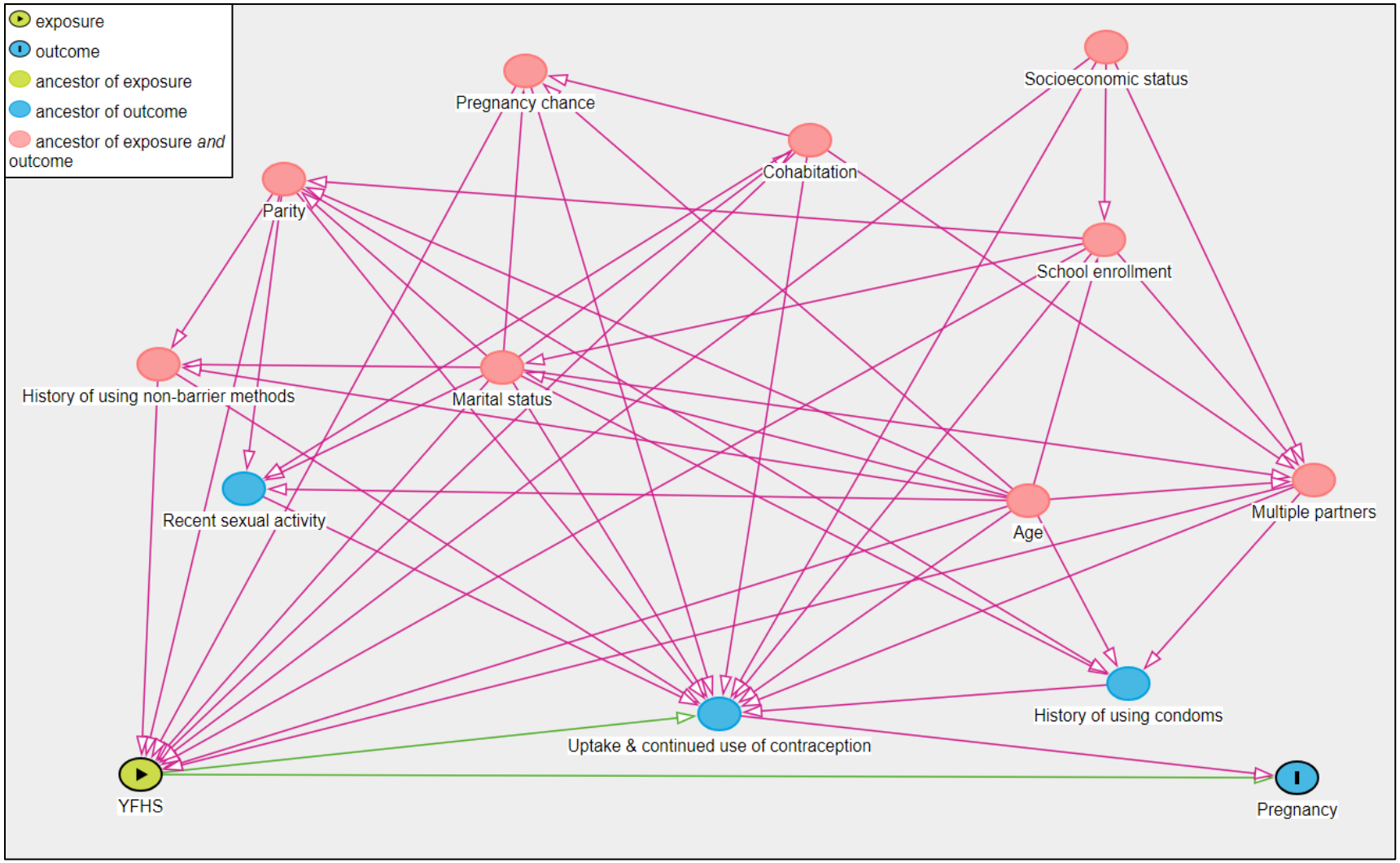


Figure 3.2. Causal diagram for the relationship between YFHS and pregnancy



CHAPTER 4: THE EFFECT OF A YOUTH-FRIENDLY MODEL OF SERVICE DELIVERY ON SUSTAINED PREGNANCY PROTECTION AMONG ADOLESCENT GIRLS AND YOUNG WOMEN IN LILONGWE MALAWI

4.1. Introduction

In 2020, an estimated 22 million adolescent girls and young women aged 15 to 24 years (AGYW) in sub-Saharan Africa (SSA) experienced a pregnancy (1, 5, 6), 45% of which were unintended (10). Globally, the majority of unintended pregnancies occur among women who want to avoid a pregnancy but who are not using a modern method of contraception (65). While efforts to expand access to contraception over the last three decades have decreased unmet need among AGYW in SSA (66), contraceptive discontinuation in this population is common, particularly among those using short-acting methods (74, 77, 209, 210). When unresolved, contraceptive discontinuation increases risk of unintended pregnancy, and an estimated 25% of unintended pregnancies in SSA are attributed to early discontinuation of modern methods (76). To maximize downstream reproductive health impact, interventions designed to increase uptake of contraception among AGYW must also facilitate sustained use of contraceptives.

Youth friendly health services (YFHS) that integrate provider training with clinic modifications and community outreach activities are an effective supply-side intervention that have facilitated greater uptake of contraception among AGYW in SSA relative to standard models of service delivery (142, 144, 149, 150, 158, 159). Whether access to such models of YFHS also increases the probability of sustained use of contraception is unknown. Multiple theories of behavior change maintenance emphasize the importance of motivation, self-regulation, access to resources, habits, and broader contextual factors for sustained changes in health behaviors (211). By making the service delivery environment more responsive to the

needs of young clients (138), YFHS enhance access to physical resources needed for sustained contraceptive use. Factors outside the health system, however, including pregnancy ambivalence (85-88), sporadic sexual activity (89), gendered power dynamics (63, 79, 212), social norms (63, 79, 213), and community narratives regarding the safety of contraception (94, 214, 215), may influence motivations to sustain use of contraception among AGYW. Understanding if—and how—YFHS shape contraceptive behaviors over time is necessary to strengthen ongoing efforts to expand access to YFHS across SSA (173-180).

The Girl Power study offers a unique opportunity to explore contraceptive use over time under both a youth-friendly and standard model of service delivery. Girl Power, which assigned government-run health clinics to offer YFHS or standard of care (SOC), reported considerably greater uptake of condoms and non-barrier methods of contraception among AGYW with access to YFHS compared to those in the SOC (158). Using longitudinal measures of sexual activity and contraceptive use collected in Girl Power, we evaluated whether access to YFHS also increased the probability of sustained pregnancy protection relative to SOC and compared longitudinal contraceptive behaviors under the youth-friendly and standard models of service delivery.

4.2. Methods

4.2.1. Study design

The Girl Power study (2016-2017) was designed to evaluate the effect of four different models of service delivery on uptake of sexual and reproductive health (SRH) services among AGYW in Lilongwe, Malawi and in Western Cape, South Africa (169). Due to differences in the intervention between countries, this analysis is restricted to the Malawi component alone (i.e., Girl Power-Malawi).

In Girl Power-Malawi four comparable government-run health clinics were randomized to offer a standard (n=1) or a youth-friendly model of service delivery (n=3). All four clinics provided free HIV testing, free contraception, free condoms, and syndromic management of

sexually transmitted infections. At the clinic offering standard of care (SOC; Clinic 1), services were not integrated and were delivered in a typical, adult-oriented clinical environment. At clinics offering YFHS (Clinics 2-4), services were integrated and delivered in private youth-dedicated spaces by providers who attended a two-day training on medical and psychosocial support for young people and a five-day training on long-acting reversable contraception. Clinics 2-4 also offered extended hours, and employed peer educators who provided information on available SRH services, helped assess SRH needs, and assisted with clinical navigation. An optional socio-behavioral intervention that addressed topics related to sexual health, relationships, social issues, and finances was offered with and without a cash transfer at Clinics 3 and 4, respectively. The four clinics served unique catchment areas located ≥7km apart to minimize risk of between-clinic cross-over.

4.2.2. Study population and procedures

Each clinic used a combination of community outreach activities, self-referral, and referral from enrolled participants, to recruit and enroll 250 AGYW who were 15 to 24 years old and lived in the clinic's catchment area. While not a formal eligibility requirement, the study preferentially enrolled AGYW who had experienced sexual debut. For the present study, we restricted our analysis to the subset of Girl Power-Malawi participants who reported not being pregnant at the time of enrollment.

Once enrolled, participants were followed for 12 months, with study visits at enrollment, six months, and 12 months. At these visits, participants responded to questions on a behavioral survey that was administered in Chichewa by a young female research assistant, and received a travel reimbursement (~$2 USD). The survey included questions about sociodemographics, socioeconomic status, past and present care-seeking behaviors, contraceptive use, and sexual partnerships. At any point during the 12-month follow-up period, participants were eligible to receive SRH services at their clinic of enrollment. Services provided at clinical encounters were documented on individual clinic cards.

4.2.3. Measures

Our exposure of interest was access to YFHS. AGYW who enrolled at the clinics offering YFHS (clinics 2-4) were classified as exposed while those who enrolled at the clinic offering SOC (clinic 1) were classified as unexposed.

Our primary outcome of interest was sustained pregnancy protection. We generated this outcome using information on sexual activity and contraceptive use reported at the six- and 12-month study visits. For each six-month period (enrollment to six months, and six to twelve months), participants were classified as having sustained protection if they reported no sexual activity during the period, reported sexual activity and consistent condom use, or reported sexual activity and use of a non-barrier method of contraception for the full period between study visits. Participants who were sexually active during the period and reported not using condoms consistently, or reported not using a non-barrier method of contraception for the full period between study visits, were classified as not having sustained pregnancy protection. Participants who sustained protection during both six-month periods—either using the same approach or different approaches—were classified as having sustained protection for 12 months. All other participants were classified as not having sustained protection over 12 months.

To explore patterns in contraceptive behaviors over follow-up, we generated two, eight-level categorical variables that corresponded to the contraceptive method used for the period between enrollment and six months, and the contraceptive method used for the period between six and 12 months. For each period, participants who reported no sexual activity were classified as group 1. For participants who were sexually active, we further categorized them according to use of condoms only (group 2), condoms plus a non-barrier method (i.e., dual methods; group 3), oral contraceptive pills (OCPs) only (group 4), injectables only (group 5), subdermal implants only (group 6), intrauterine devices (IUDs) only (group 7), or sexually active without protection

for some or all of the six-month period (group 8). There was no implied ordering of these categories in terms of effectiveness for pregnancy protection.

Although clinics were randomly assigned to provide either a standard or youth-friendly model of service delivery, a prior analysis of Girl Power-Malawi reported imbalances in the distribution of baseline covariates between exposure groups (158). We therefore constructed a causal diagram to identify potential confounders of the relationship between access to YFHS and sustained pregnancy protection (216). The minimally sufficient adjustment set for our analysis included baseline measures of age, marital status, cohabitation, living children, history of condom use, history of using non-barrier methods of contraception, perceived risk of pregnancy in the next 12 months, sexual activity in the 30 days prior to enrollment, multiple partners in the previous 12 months, school enrollment, presence of electricity or plumbing home, and socioeconomic status.

4.2.4. Missing data

While nearly all participants (>98%) had complete data on baseline covariates, only 78% of participants had all outcomes fully observed. Because missingness was non-monotonic, we imputed missing covariate and outcome data using multiple imputation by chained equations (198, 199). We generated 25 imputed datasets since the number of imputations should be similar to the percentage of incomplete cases (198). Our imputation model included our exposure, all outcome variables, all variables from our minimally sufficient adjustment set, and auxiliary variables from the clinic card expected to predict missing outcomes (e.g., uptake of a particular contraceptive method over follow-up). To evaluate the performance of our imputation model, we conducted a leave-one-out cross-validation assessment for a random sample of participants with observed data (200).

4.2.5. Analytic approach

For our primary analysis, we used linear and log binomial models to estimate the effect of YFHS on the 12-month probability of sustained pregnancy protection. Secondarily, we used

generalized estimating equations with an exchangeable correlation matrix to estimate the marginal effect of YFHS on sustained pregnancy protection between enrollment and six months, and between six and twelve months. In both analyses, we accounted for confounders using inverse probability of exposure weights stabilized by the marginal probability of exposure (201), and thus estimated marginal rather than conditional risk differences (RDs) and risk ratios (RRs). Given limited missingness in baseline covariates, we generated our model for exposure weights using complete cases. The numerator of the weight was estimated using a logistic regression model for exposure status without covariates. The denominator of the weight—a simple function of the propensity score (PS)—was estimated using a logistic regression model that included our minimally sufficient adjustment set.

We evaluated the performance of our exposure weights with descriptive statistics (mean and range of the weights), and examined balance of measured covariates between exposure groups using standardized mean differences before and after weighting (201). To improve balance, we added interaction terms to the weight model. The final models for our exposure weights was applied within each imputed dataset and used to generate imputation-specific estimates of effect (203).

In all analyses, confidence intervals (CI) were constructed as the effect estimate +/-1.96 times the standard deviation of point estimates generated in 200 bootstrap resamples. For our primary analysis (the effect of YFHS on sustained pregnancy protection over 12 months), bootstrap resamples were selected from the original population with replacement. For our secondary analysis (the effect of YFHS on sustained pregnancy protection over each six month period), the bootstrap needed to accommodate repeated measures on participants (204). Therefore, if a participant was selected for the bootstrap sample, she contributed both visits to the sample (204). We incorporated multiple imputation into our bootstrap using the Boot-MI algorithm with 25 imputations per resample (205).

To describe trends in contraceptive use over follow-up, we generated weighted stacked bar charts to illustrate method use used for the period between enrollment and six months, and method used for the period between six and 12 months, stratified according to exposure group. Within exposure groups, we added Sankey-style overlays to provide a visual depiction of the magnitude of flow between methods over follow-up (206). For each of these analyses, we tabulated weighted frequencies within each imputed dataset and used the average of the weighted frequencies to generate figures.

4.2.6. Effect measure modification

We assessed effect measure modification of the YFHS intervention sustained pregnancy protection over 12 months according to age (15 to 19 vs. 20 to 24), marital status (not married vs. married), and parity (no children vs. at least one child) by comparing stratum-specific estimates of effect and corresponding CIs. Secondarily, we explored whether these factors modified contraceptive methods used over follow-up.

4.2.7. Sensitivity analyses

We conducted two sensitivity analyses. First, to isolate the effect of YFHS from potential effects of the other interventions, we restricted our analysis to only AGYW who enrolled at Clinics 1 and 2. Second, we explored the sensitivity of our results to random nonpositivity using weight truncation (weights below the 1st and above the 99th percentile were reset to the 1st and 99th percentile values respectively) and weight trimming, where we restricted our analysis to only AGYW with a PS that was greater than the 1st percentile of the exposed PS distribution and below the 99th percentile of the unexposed PS distribution (207, 208). Following best practices, we re-estimated weights within the restricted samples.

4.2.8. Ethics

The Girl Power-Malawi study received approval from the University of North Carolina Institutional Review Board (Chapel Hill, NC, USA) and the Malawi National Health Sciences Research Committee (Lilongwe, Malawi). All study participants were fully informed of the study

procedures. Participants aged 18 to 24 provided written informed consent. Participants aged 15 to 17 provided written informed asset and permission by a parent, guardian, or authorized representative.

All statistical analyses were conducted with SAS version 9.4 software (SAS Institute, Cary, North Carolina).

4.3. Results

Of the 1,000 AGYW who enrolled in Girl Power-Malawi, 38 were excluded because they reported a current pregnancy at enrollment, resulting in an analytic sample of 962. In this sample, the median age at enrollment was 19 years (interquartile range: 17 to 21) and most participants (>99%) had already experienced sexual debut. At enrollment, approximately 20% of participants reported a current marriage, 36% reported a living child, and 72% reported sexual intercourse in the past 30 days.

Table 4.1 illustrates the distribution of baseline covariates according to exposure group. Before weighting, participants with access to YFHS were older and more likely to be married, have a child, and have a history of using non-barrier methods of contraception than those in the SOC. Participants with access to YFHS were also less likely to believe they would become pregnant in the next 12 months than those in the SOC. After weighting, the distribution of baseline characteristics between exposure groups were similar, and standardized mean differences suggested good balance in covariate distributions between exposure groups (Figure 4.1).

Retention was similar between participants with access to YFHS and those in the SOC at both six (84% vs. 85%) and 12 months (88% vs. 84%). Missed visits, however, contributed to missingness in the outcome variables: 14% of participants (n=139) were missing the primary outcome sustained pregnancy protection over 12 months, 16% (n=157) were missing information on the contraceptive method used between enrollment and six months, and 13% (n=128) were missing information on the contraceptive method used between six and twelve

months. Imputed outcomes appeared reasonable (Table 4.2). In leave-one-out cross-validation, the imputation model correctly predicted the deleted observation 100% of the time for our measure of sustained pregnancy protection over 12 months (Figure 4.2), and exhibited strong performance for predicting the contraceptive method used between enrollment and six months (Figure 4.3) and between six and 12 months (Figure 4.4).

4.3.1. Effect of YFHS on the probability of sustained pregnancy protection

Overall, an estimated 44.4% (95% CI: 41.2%, 47.7%) of participants sustained pregnancy protection for all 12-months of follow-up. In the unweighted analysis, the 12-month probability of sustained protection was 48.3% (95% CI: 44.3%, 52.2%) among AGYW with access to YFHS and 33.1% (95% CI: 27.1%, 39.0%) among those in the SOC (RD: 15.2%, 95% CI: 8.4%, 22.0%). In the weighted analysis, the expected 12-month probability sustained protection under the scenario where all clinics offered YFHS was 45.7% (95% CI: 41.4%, 49.9%) compared to 38.5% (95% CI: 29.2%, 47.7%) under the scenario where all clinics offered SOC (RD: 7.2%, 95% CI: -2.6%, 17.0%). The effect of YFHS was concentrated among AGYW who reported at least one living child and among those who were married (Table 4.3).

Results were similar when weights were truncated and when the study population was trimmed according to the distribution of PS (Table 4.4). When restricted to only AGYW who enrolled at Clinics 1 or 2, the overall effect of YFHS on the 12-month probability of sustained protection was greater than estimates generated within the full analytic sample (RD: 15.3%, 95% CI: 1.9%, 28.7%). Notably, AGYW in Clinics 1 and 2 were older, more likely to be married, and more likely to have a child than the full analytic population (Table 4.5).

Approximately 57.7% (95% CI: 54.3%, 61.0%) of participants sustained pregnancy protection between enrollment and six months and 57.8% (95% CI: 54.5%, 61.0%) sustained protection between six and 12 months. In the unweighted analysis, the probability of sustained protection between enrollment and six months was greater among AGYW with access to YFHS than among those with access to SOC (61.4% vs. 46.7%; RD: 14.6%, 95% CI: 7.9%, 21.3%).

Similar differences in the probability of sustained protection were observed between six and twelve months (61.2% vs. 47.7%; RD: 13.5%, 95% CI: 6.6%, 20.3%). In weighted analyses, estimates were attenuated between enrollment and six months (RD: 6.3%, 95% CI: -3.7%, 16.3%) and between six and twelve months (RD: 3.2%, 95% CI: -6.5%, 12.9%).

4.3.2. Contraceptive methods used over follow-up

At both time points and under both models of service delivery, condoms were the most common method of contraception used among participants (Figure 4.5). Sustained use of non-barrier methods of contraception (including dual methods) was more common under the youth-friendly model of service delivery than under the SOC between enrollment and six months (23.8% vs. 15.1%) and between six and twelve months (29.6% vs. 20.6%). Young women, those who were married, and those with at least one living child were more likely to sustain use of non-barrier methods of contraception than adolescent girls, those who were unmarried, and those without children (Table 4.6). Collapsing over exposure groups, we observed distinct differences in contraceptive preferences according to age (Figure 4.6), marital status (Figure 4.7), and parity (Figure 4.8). Condoms—alone or alongside non-barrier methods—were rarely used by married AGYW, and non-barrier methods were uncommon among AGYW without children.

As illustrated in Figures 4.9 and 4.10, a large proportion of AGYW under both exposure scenarios were sexually active without sustained protection for both six-month periods (23.6% and 29.3% under YFHS and SOC, respectively). Among women who did sustain protection, the proportion of sustained protection attributed to non-barrier method use was greater between six and twelve months than between enrollment and six months under both YFHS (51.0% vs. 38.6%) and SOC (37.7% vs. 28.3%). Under the youth-friendly model of service delivery, this trend was driven by uptake and sustained use of non-barrier methods among those who were either sexually active without sustained protection or sexually active and using condoms between enrollment and six months. In the SOC, this trend was driven only by uptake and

sustained use of non-barrier methods among those who were sexually active without sustained protection between enrollment and six months. While contraceptive switching was uncommon in the SOC, nearly 20% of AGYW with access to YFHS used two different approaches to maintain protection over 12 months. In this group, the most common transition was from abstinence to consistent condom use, followed by the switch from condoms only to non-barrier methods (with or without condoms) and the switch from non-barrier methods (with or without condoms) to condoms only.

4.5. Discussion

In this secondary analysis of Girl Power-Malawi, we examined how provision of YFHS shaped contraceptive use among AGYW over a 12-month period. Our findings showed an increase in the probability of sustained pregnancy protection when AGYW were offered YFHS than when they were offered SOC, with effects concentrated in married and parous subgroups. This trend was driven by greater sustained use of non-barrier methods of contraception under the youth-friendly model of service delivery than under the SOC. However, even under the scenario where all clinics offered YFHS, a large proportion of AGYW were at risk of unprotected sex during at least one of the six-month periods between study visits.

Our outcome, which reflects sustained contraceptive use, is novel and meaningful. Early contraceptive discontinuation is estimated to account for one-quarter of unintended pregnancies in SSA each year (76). We demonstrate that that access to a model of YFHS that integrated provider training with clinic modifications and community outreach increased the proportion of AGYW who sustained pregnancy protection over the 12-month period. Notably, the effect of the Girl Power-Malawi model of YFHS on *sustained protection* was smaller than the effect of the same model of YFHS on *uptake* or *current use* of contraception (158). A prior analysis in this population found that AGYW with access to YFHS were more likely to receive condoms (83% vs. 26%) and non-barrier methods of contraception (54% vs. 10%) at least once over 12 months than their counterparts in the SOC. They were also more likely to report currently using

condoms and non-barrier methods of contraception at six months (condoms: 68% vs. 54%; non-barrier contraception: 47% vs. 19%) and 12 months (condoms: 78% vs. 55%; non-barrier contraception: 44% vs. 24%) (158). Our results illustrate that uptake and current use do not reflect the extent to which contraceptive use is maintained, a finding with important implications for future research.

The effect of YFHS on the probability of sustained pregnancy protection was concentrated among AGYW who were married and among those who reported at least one living child. Impact in these subgroups is meaningful, particularly in contexts like Malawi where marriage and first birth often occur during adolescence (3). However, married and parous AGYW typically experience fewer barriers to contraceptive use than those who are unmarried or nulliparous (98, 99, 103, 120, 121, 123, 133, 134, 136), and our findings suggested a weaker effect of YFHS on sustained protection in these subgroups. Differences in motivations and perceived costs of initiating and sustaining contraception may explain these findings. Social norms regarding premarital sex, for example, may lower motivations and increase perceived costs of using contraception outside of marriage (63, 79, 213), while fears about long-term side effects may lower motivations and increase perceived costs of using contraception before having a child (94, 214, 215). Differences in method preference may also contribute to observed effect measure modification. Non-barrier methods of contraception typically require less active self-regulation to sustain use than condoms, and were more likely to be used by married and parous AGYW than those who are unmarried or nulliparous.

Access to YFHS resulted in greater sustained used of non-barrier methods of contraception among AGYW compared to SOC. However, even under the youth-friendly model of service delivery, condoms remained the predominant contraceptive method used by sexually active participants. Condoms are an effective method of contraception that can considerably decrease the 12-month risk of pregnancy and provide protection against sexually transmitted infections including HIV (68). However, 12-month typical-use failure rates are considerably

higher among condom users than among users of OCPs, injectables, implants, and IUDs (68, 69). Understanding the reasons why unmarried and nulliparous AGYW with access to YFHS select condoms over more effective methods of contraception is an important step towards identifying contextually-relevant interventions to facilitate sustained use of more effective non-barrier methods of contraception among AGYW in SSA (217, 218).

In contexts where early contraceptive discontinuation is common, an important strategy for reducing risk of unintended pregnancy is contraceptive switching (75). Our results suggest that an adolescent girl or young women's ability to promptly switch contraceptive methods may be enhanced under a youth-friendly model of service delivery compared to the SOC. Nevertheless, even with access to YFHS, nearly 20% of AGYW transitioned from sustained protection to being at risk of unprotected sex over follow-up. While discontinuation—and contraceptive nonuse—may reflect fertility preferences, these decisions may also reflect pregnancy ambivalence (85-88), sporadic sexual activity (89), gendered power dynamics (63, 79, 212), social norms related to sex, marriage, and fertility (63, 79, 213), myths and misconceptions regarding side effects of contraception (94, 214, 215), and method-related dissatisfaction (219-221). Future work is needed to better understand the extent to which contraceptive discontinuation and nonuse in the context of YFHS reflect free, full, and informed choices (222, 223).

Results of this study should be interpreted in light of the following limitations. First, our outcomes were generated using self-reported data on sexual activity and contraceptive use. While Girl Power-Malawi took several steps to ensure high quality data, these data are vulnerable to social desirability and recall bias (224, 225). Second, we were unable to align outcomes with fertility intentions. By standardizing the distribution of covariates within each exposure group to the distribution of covariates in the full study population, the proportion of unprotected sex attributed to a desire to conceive was likely similar between exposure groups. As a result, we expect estimates of effect were attenuated, though residual confounding is

possible. Third, participants who did not use a method of contraception for the full 12 months but whose contraceptive use was aligned with intermittent sexually activity during follow-up were misclassified as having unprotected sex. Since the YFHS intervention increased access to contraception, we expect this would attenuate our effect estimates. Fourth, our results rely on the assumption that missing data were missing at random condition on covariates included in the imputation model (198). While not testable, we parameterized our imputation model with numerous behavioral and clinical variables to make this assumption more plausible. Finally, as sexually active AGYW were purposefully recruited for enrollment, the generalizability of our results outside our study population is uncertain.

Addressing high levels of early contraceptive discontinuation among AGYW in SSA is an urgent public health priority. We demonstrate that making the service delivery environment more responsive to the needs of young clients does increase the probability of sustained pregnancy protection, especially among AGYW who are married, and parous. While these results support ongoing efforts to introduce and expand access to YFHS throughout SSA, weaker effects of YFHS on sustained protection among unmarried and nulliparous AGYW highlight the importance of implementing YFHS alongside interventions that address important sociocultural barriers that limit demand for—and agency to use—contraception among AGYW in SSA. To maximize the downstream reproductive health impact of YFHS, implementation science research is needed to identify barriers to sustained pregnancy protection among AGYW in communities served by YFHS, develop interventions to address those barriers, and guide implementation strategies to identify best practices for adopting, expanding, and sustaining high-quality YFHS in SSA.

4.5. Tables and Figures

Table 4.1. Baseline characteristics according to exposure group

		Crude		Weighted	
		YFHS (n=719)	SOC (n=243)	YFHS (n=712)	SOC (n=248)
Age	Median (Q1, Q3)	19 (18, 21)	18 (16, 20)	19 (17, 21)	19 (17, 21)
	15-19 years of age	390 (54%)	171 (70%)	413 (58%)	133 (54%)
	20-24 years of age	329 (46%)	72 (30%)	298 (42%)	115 (46%)
Married	Yes	157 (22%)	31 (13%)	140 (20%)	48 (19%)
Cohabitating with a male partner	Yes	152 (21%)	33 (14%)	137 (19%)	46 (19%)
Any living children	Yes	283 (39%)	65 (27%)	255 (36%)	86 (35%)
Perceived chance of pregnancy*	No risk in next 12 months	595 (83%)	104 (43%)	522 (73%)	183 (74%)
	Some risk in next 12 months	124 (17%)	139 (57%)	189 (27%)	65 (26%)
History of using non-barrier methods of contraception^	Never used non-barrier methods	423 (59%)	176 (72%)	445 (62%)	154 (62%)
	Prior or current user of non-barrier methods	296 (41%)	67 (28%)	267 (38%)	95 (38%)
History of using condoms	Never used condoms	136 (19%)	45 (19%)	132 (19%)	43 (17%)
	Prior or current user of condoms	583 (81%)	198 (81%)	580 (81%)	205 (83%)
School enrollment*	12 or more years of education or less than 12 years and currently enrolled	428 (60%)	171 (71%)	441 (62%)	151 (61%)
	Less than 12 years of education and not currently enrolled	291 (40%)	72 (29%)	270 (38%)	98 (39%)
Socioeconomic status	Quartile 4 (highest SES)	189 (26%)	41 (17%)	180 (25%)	60 (24%)
	Quartile 3	156 (22%)	76 (31%)	166 (23%)	58 (23%)
	Quartile 2	186 (26%)	67 (28%)	186 (26%)	58 (23%)
	Quartile 1 (lowest SES)	188 (26%)	59 (24%)	179 (25%)	72 (29%)
Water in home	Yes	334 (46%)	88 (36%)	320 (45%)	107 (44%)
Electricity in home*	Yes	299 (42%)	68 (28%)	278 (39%)	89 (36%)
Sexually active in past 30 days	Yes	520 (72%)	171 (70%)	512 (72%)	183 (74%)
Multiple partners in past 12 months*	Yes	136 (19%)	68 (28%)	149 (21%)	65 (26%)

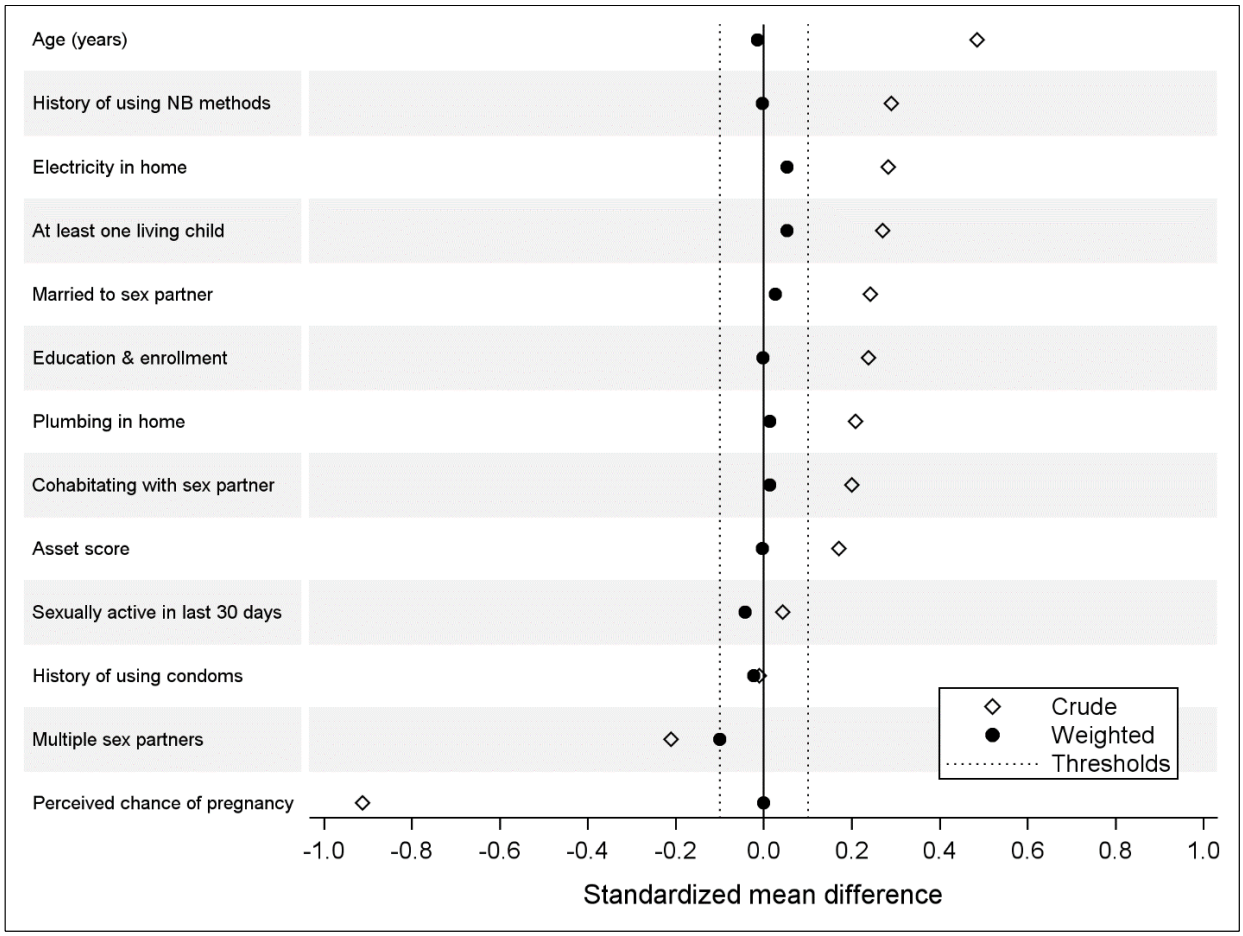
Q1 = 25th percentile; Q3 = 75th percentile; SES = Socioeconomic status; SOC = Standard of care; YFHS = Youth friendly health services

Data were averaged over the 25 imputations.

* Imputed data: perceived chance of pregnancy (one missing observation), school enrollment (10 missing observations), electricity in home (two missing observations), and multiple partnerships (five missing observations)

^ Non-barrier methods include: oral contraceptive pills, injectables, subdermal implants, and intrauterine devices.

Figure 4.1 Standardize mean differences in unweighted and weighted study populations



NB = non-barrier method of contraception, which we defined as oral contraceptive pills, injectables, contraceptive implants, and intrauterine devices.

Table 4.2. Comparison of observed and imputed outcomes

	Observed Data		Imputed Data			
	n	**Proportion**	**n**	**Proportion**	**(95% CI)**	**Min, Max**
Sustained protection between enrollment and Month 6	805	59.6%	157	56.4%	(44.1%, 68.8%)	(47.1%, 65.6%)
Sexually active without sustained protection	805	40.4%	157	43.6%	(31.2%, 55.9%)	(34.4%, 52.9%)
Not sexually active	805	13.4%	157	13.8%	(4.6%, 23.0%)	(9.6%, 22.9%)
Sexually active with consistent condom use	805	23.1%	157	22.9%	(12.4%, 33.4%)	(14.0%, 29.9%)
Sexually active with 100% coverage (OCP)	805	1.9%	157	1.2%	(-1.9%, 4.4%)	(0.0%, 5.7%)
Sexually active with 100% coverage (Injectable)	805	11.9%	157	9.8%	(3.4%, 16.2%)	(5.7%, 15.3%)
Sexually active with 100% coverage (Implant)	805	4.7%	157	6.2%	(2.0%, 10.3%)	(4.5%, 8.3%)
Sexually active with 100% coverage (IUD)	805	0.0%	157	0.0%	-	-
Sexually active with 100% coverage (Dual methods)	805	1.4%	157	2.5%	(-2.2%, 7.3%)	(0.0%, 8.3%)
Sustained protection between Month 6 to Month 12	833	59.8%	129	46.2%	(31.9%, 60.5%)	(37.2%, 58.1%)
Sexually active without sustained protection	833	40.2%	129	53.8%	(39.5%, 68.1%)	(41.9%, 62.8%)
Not sexually active	833	3.5%	129	6.8%	(-0.7%, 14.3%)	(0.8%, 13.2%)
Sexually active with consistent condom use	833	26.8%	129	20.2%	(8.7%, 31.8%)	(11.6%, 28.7%)
Sexually active with 100% coverage (OCP)	833	4.1%	129	1.4%	(-1.4%, 4.3%)	(0.0%, 4.7%)
Sexually active with 100% coverage (Injectable)	833	13.7%	129	7.4%	(1.5%, 13.4%)	(3.9%, 10.9%)
Sexually active with 100% coverage (Implant)	833	4.8%	129	5.3%	(0.9%, 9.7%)	(3.1%, 7.0%)
Sexually active with 100% coverage (IUD)	833	0.1%	129	0.0%	-	-
Sexually active with 100% coverage (Dual methods)	833	2.8%	129	5.0%	(-2.7%, 12.7%)	(0.0%, 13.2%)
Sustained protection between enrollment and Month 12	823	41.1%	139	64.3%	(54.3%, 74.3%)	(58.3%, 69.8%)

CI = Confidence interval; OCP = Oral contraceptive pills; IDU = Intrauterine device

Figure 4.2. Predictive ability of the imputation model for the primary outcome of sustained pregnancy protection over 12 months

The x-axis corresponds to the participant selected on the i^{th} draw whose observed outcome was deleted and then imputed. The blue triangles correspond to the participant's observed outcome, whereby the probability of sustained protection for participants who did not sustain protection is 0, while the probability of sustained protection for participants who did sustain protection is 1. The orange circles correspond to the mean value of the 25 imputed outcomes for the participant.

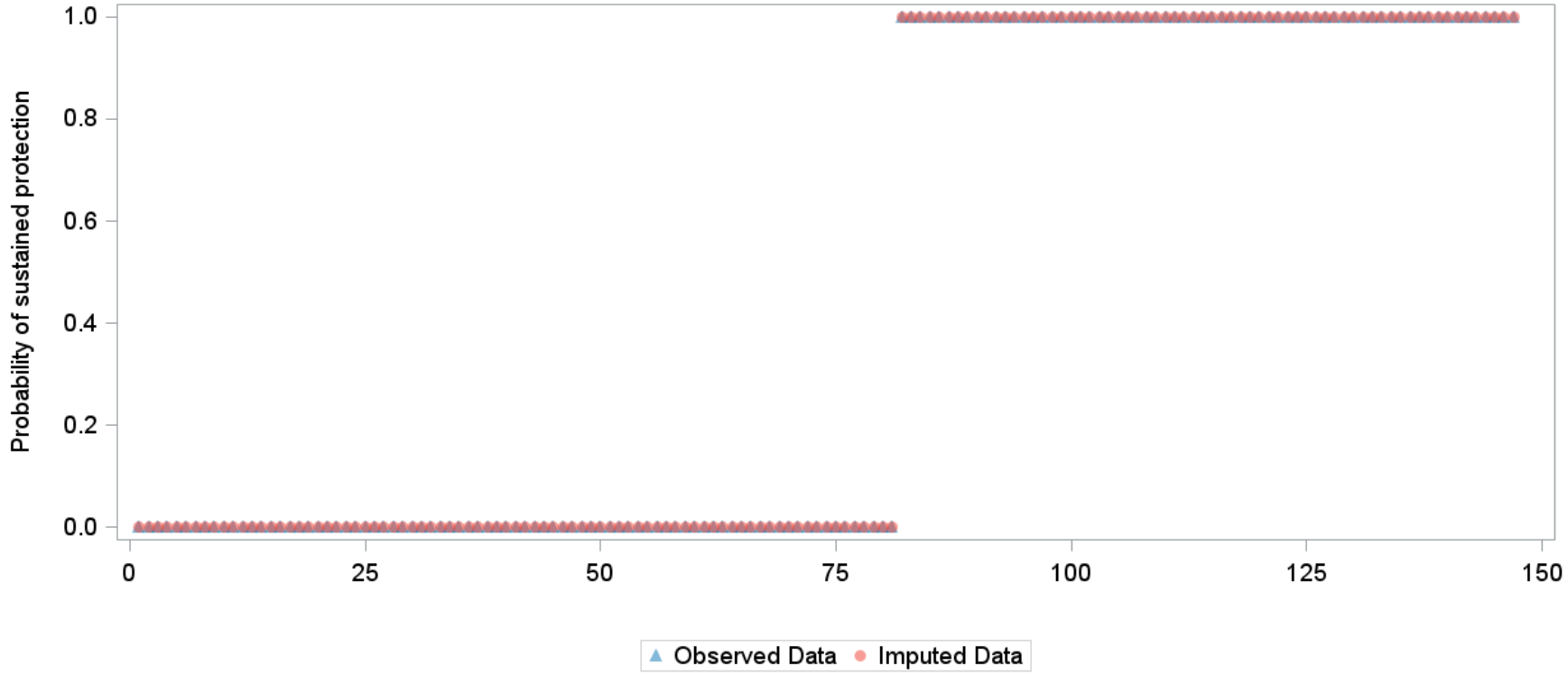


Figure 4.3. Predictive ability of the imputation model for the contraceptive method used between enrollment and six months

Each data point on this figure corresponds to a participant whose observed outcome was deleted and then imputed. Participants were selected randomly from those with the outcome observed. Data are grouped according to contraceptive method used by the selected participant between enrollment and six months. The orange circles reflect the proportion of imputations that correctly imputed the contraceptive method used by each participant.

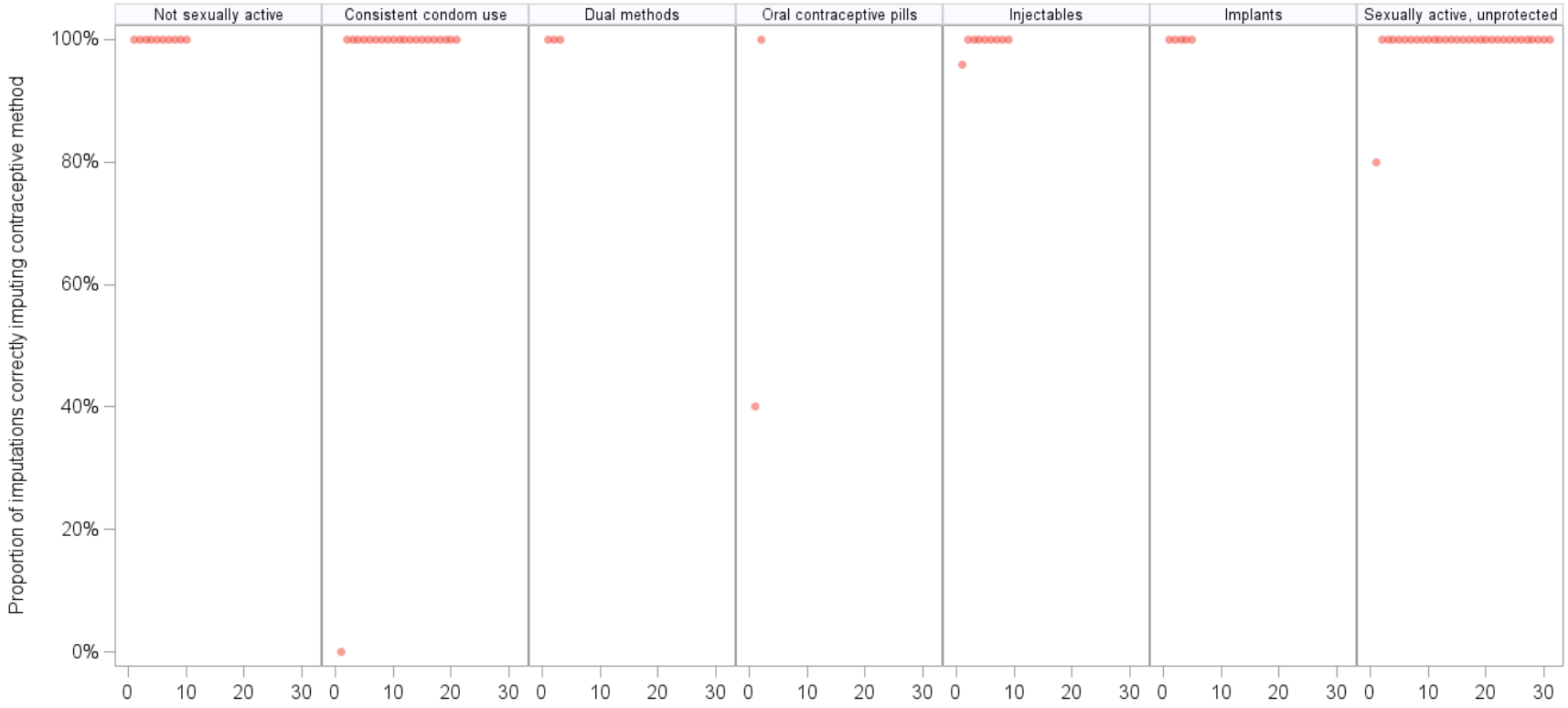


Figure 4.4. Predictive ability of the imputation model for the contraceptive method used between six and 12 months

Each data point on this figure corresponds to a participant whose observed outcome was deleted and then imputed. Participants were selected randomly from those with the outcome observed. Data are grouped according to contraceptive method used by the selected participant between six and 12 months. The orange circles reflect the proportion of imputations that correctly imputed the contraceptive method used by each participant.

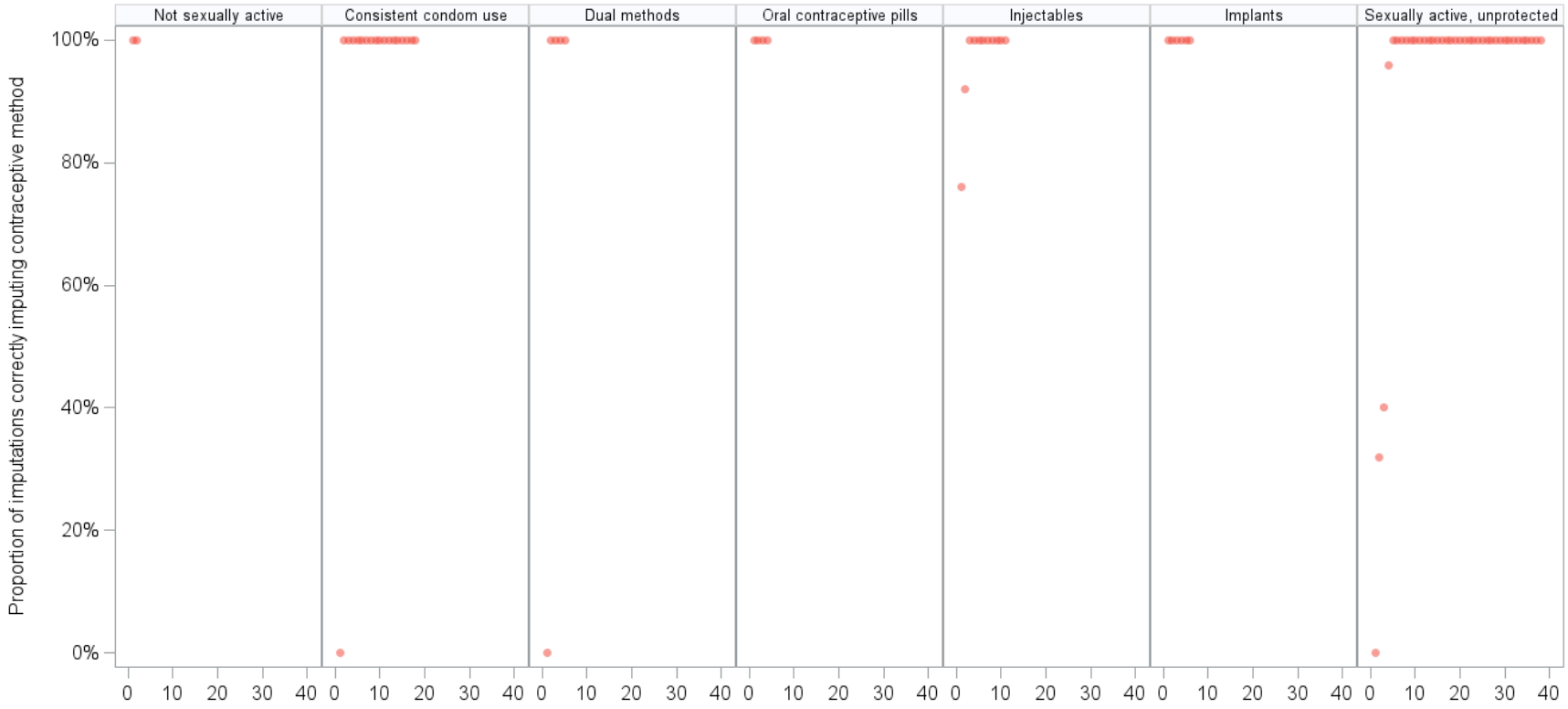


Table 4.3. The effect of youth-friendly health services on the 12-month probability of sustained pregnancy protection

	Probability (YFHS)	Probability (SOC)	Risk Difference (CI)	Risk Ratio (CI)
Unweighted Analysis				
Overall	48.3% (44.3%, 52.2%)	33.1% (27.1%, 39.0%)	15.2% (8.4%, 22.0%)	1.46 (1.21, 1.76)
Age Group				
Adolescents (15-19)	43.9% (38.5%, 49.4%)	31.9% (24.6%, 39.2%)	12.1% (3.4%, 20.8%)	1.38 (1.08, 1.77)
Young Women (20-24)	53.4% (48.3%, 58.6%)	35.9% (25.1%, 46.8%)	17.5% (5.6%, 29.4%)	1.49 (1.08, 2.06)
Marital Status				
Not married	44.9% (40.4%, 49.5%)	32.5% (26.0%, 39.0%)	12.4% (4.9%, 20.0%)	1.38 (1.12, 1.71)
Married	60.3% (53.0%, 67.5%)	37.2% (20.2%, 54.1%)	23.1% (5.0%, 41.2%)	1.62 (1.01, 2.62)
Parity				
No living children	41.7% (36.5%, 46.9%)	29.5% (22.1%, 36.9%)	12.2% (3.5%, 20.9%)	1.41 (1.08, 1.85)
At least one living child	58.3% (52.4%, 64.2%)	42.8% (30.6%, 54.9%)	15.6% (2.3%, 28.8%)	1.37 (1.01, 1.85)
Weighted Analysis				
Overall	45.7% (41.4%, 49.9%)	38.5% (29.2%, 47.7%)	7.2% (-2.6%, 17.0%)	1.19 (0.93, 1.52)
Age Group				
Adolescents (15-19)	40.9% (35.0%, 46.9%)	36.1% (26.0%, 46.1%)	4.9% (-6.6%, 16.3%)	1.14 (0.84, 1.54)
Young Women (20-24)	52.2% (47.0%, 57.4%)	41.2% (24.3%, 58.2%)	11.0% (-7.0%, 28.9%)	1.27 (0.80, 2.01)
Marital Status				
Not married	42.4% (37.4%, 47.4%)	39.2% (28.4%, 49.9%)	3.3% (-8.1%, 14.6%)	1.08 (0.81, 1.44)
Married	58.9% (51.5%, 66.4%)	35.4% (16.4%, 54.4%)	23.5% (3.6%, 43.4%)	1.67 (0.93, 3.00)
Parity				
No living children	38.9% (33.3%, 44.6%)	37.7% (25.5%, 50.0%)	1.2% (-11.6%, 14.0%)	1.03 (0.74, 1.44)
At least one living child	57.7% (51.7%, 63.7%)	39.9% (26.0%, 53.8%)	17.8% (3.0%, 32.7%)	1.45 (1.00, 2.11)

CI = 95% Confidence interval; SOC = Standard of care; YFHS = Youth friendly health services

Table 4.4. Sensitivity of results to random non-positivity

	Probability (YFHS)	Probability (SOC)	Risk Difference (CI)	Risk Ratio (CI)
Truncated Analysis (n=962) *				
Overall	45.8% (41.6%, 50.0%)	38.2% (30.2%, 46.3%)	7.6% (-1.2%, 16.3%)	1.20 (0.96, 1.50)
Age Group				
Adolescents (15-19)	41.1% (35.2%, 46.9%)	36.2% (27.0%, 45.4%)	4.8% (-5.9%, 15.6%)	1.13 (0.86, 1.50)
Young Women (20-24)	52.2% (47.0%, 57.4%)	40.8% (26.1%, 55.4%)	11.5% (-4.2%, 27.1%)	1.29 (0.86, 1.92)
Marital Status				
Not married	42.6% (37.6%, 47.5%)	38.8% (29.7%, 47.9%)	3.8% (-6.2%, 13.8%)	1.10 (0.85, 1.42)
Married	58.9% (51.5%, 66.4%)	35.5% (16.9%, 54.2%)	23.4% (3.9%, 42.9%)	1.66 (0.94, 2.93)
Parity				
No living children	39.1% (33.4%, 44.7%)	37.1% (26.9%, 47.3%)	1.9% (-9.2%, 13.1%)	1.05 (0.78, 1.42)
At least one living child	57.7% (51.7%, 63.7%)	40.1% (26.4%, 53.7%)	17.6% (3.1%, 32.2%)	1.44 (1.00, 2.07)
Trimmed Analysis (n=847) ^				
Overall	46.5% (42.3%, 50.6%)	39.0% (29.2%, 48.8%)	7.5% (-3.0%, 17.9%)	1.19 (0.92, 1.55)
Age Group				
Adolescents (15-19)	41.9% (36.0%, 47.8%)	37.8% (26.4%, 49.2%)	4.1% (-8.9%, 17.1%)	1.11 (0.79, 1.55)
Young Women (20-24)	52.5% (46.7%, 58.3%)	40.5% (23.9%, 57.0%)	12.0% (-5.5%, 29.6%)	1.30 (0.83, 2.06)
Marital Status				
Not married	43.3% (38.3%, 48.3%)	39.7% (28.0%, 51.4%)	3.6% (-8.9%, 16.0%)	1.09 (0.80, 1.49)
Married	57.9% (50.4%, 65.4%)	36.2% (17.7%, 54.6%)	21.8% (2.1%, 41.4%)	1.60 (0.92, 2.81)
Parity				
No living children	39.4% (33.6%, 45.2%)	38.2% (24.8%, 51.6%)	1.1% (-13.3%, 15.6%)	1.03 (0.71, 1.51)
At least one living child	57.4% (51.3%, 63.4%)	40.3% (26.6%, 54.0%)	17.1% (2.3%, 31.8%)	1.43 (0.99, 2.06)

CI = 95% Confidence interval; SOC = Standard of care; YFHS = Youth friendly health services

* Weights below the 1st and above the 99th percentile were reset to the 1st and 99th percentile values, respectively.

^ We restricted our study population to only AGYW with a predicted probability of exposure that was greater than the 1st percentile of the exposed propensity score distribution and below the 99th percentile of the unexposed propensity score distribution.

Table 4.5. Comparison of baseline characteristics between the full analytic sample and AGYW who enrolled at Clinics 1 and 2 only

		Full Sample (Clinics 1-4) (n=962)	Restricted Sample (Clinics 1-2) (n=472)
Age	Median (Q1, Q3)	19 (17, 21)	19 (17, 21.5)
	15-19 years of age	561 (58%)	270 (57%)
	20-24 years of age	401 (42%)	202 (43%)
Married	Yes	188 (20%)	142 (30%)
Cohabitating with a male partner	Yes	185 (19%)	141 (30%)
Any living children	Yes	348 (36%)	218 (46%)
Perceived chance of pregnancy*	No risk in next 12 months	699 (73%)	286 (61%)
	Some risk in next 12 months	263 (27%)	186 (39%)
History of using non-barrier methods of contraception^	Never used non-barrier methods	599 (62%)	272 (58%)
	Prior or current user of non-barrier methods	363 (38%)	200 (42%)
History of using condoms	Never used condoms	181 (19%)	128 (27%)
	Prior or current user of condoms	781 (81%)	344 (73%)
School enrollment*	12 or more years of education or less than 12 years and currently enrolled	560 (62%)	248 (53%)
	Less than 12 years of education and not currently enrolled	362 (38%)	224 (47%)
Socioeconomic status	Quartile 4 (highest SES)	230 (24%)	64 (14%)
	Quartile 3	232 (24%)	108 (23%)
	Quartile 2	253 (26%)	146 (31%)
	Quartile 1 (lowest SES)	247 (24%)	154 (33%)
Water in home	Yes	422 (44%)	127 (27%)
Electricity in home*	Yes	367 (38%)	120 (25%)
Sexually active in past 30 days	Yes	691 (72%)	348 (74%)
Multiple partners in past 12 months*	Yes	204 (21%)	92 (20%)

Q1 = 25th percentile; Q3 = 75th percentile; SES = Socioeconomic status

Data were averaged over the 25 imputations.

* Imputed data: perceived chance of pregnancy (one missing observation in both the full analytic sample and restricted sample), school enrollment (10 missing observations in full analytic sample and three missing observations in restricted sample), electricity in home (two missing observations in both the full analytic sample and restricted sample), and multiple partnerships (five missing observations in full analytic sample and three missing observations in restricted sample)

^ Non-barrier methods include: oral contraceptive pills, injectables, subdermal implants, and intrauterine devices.

Figure 4.5. Contraceptive methods used by participants, stratified by period and model of service delivery

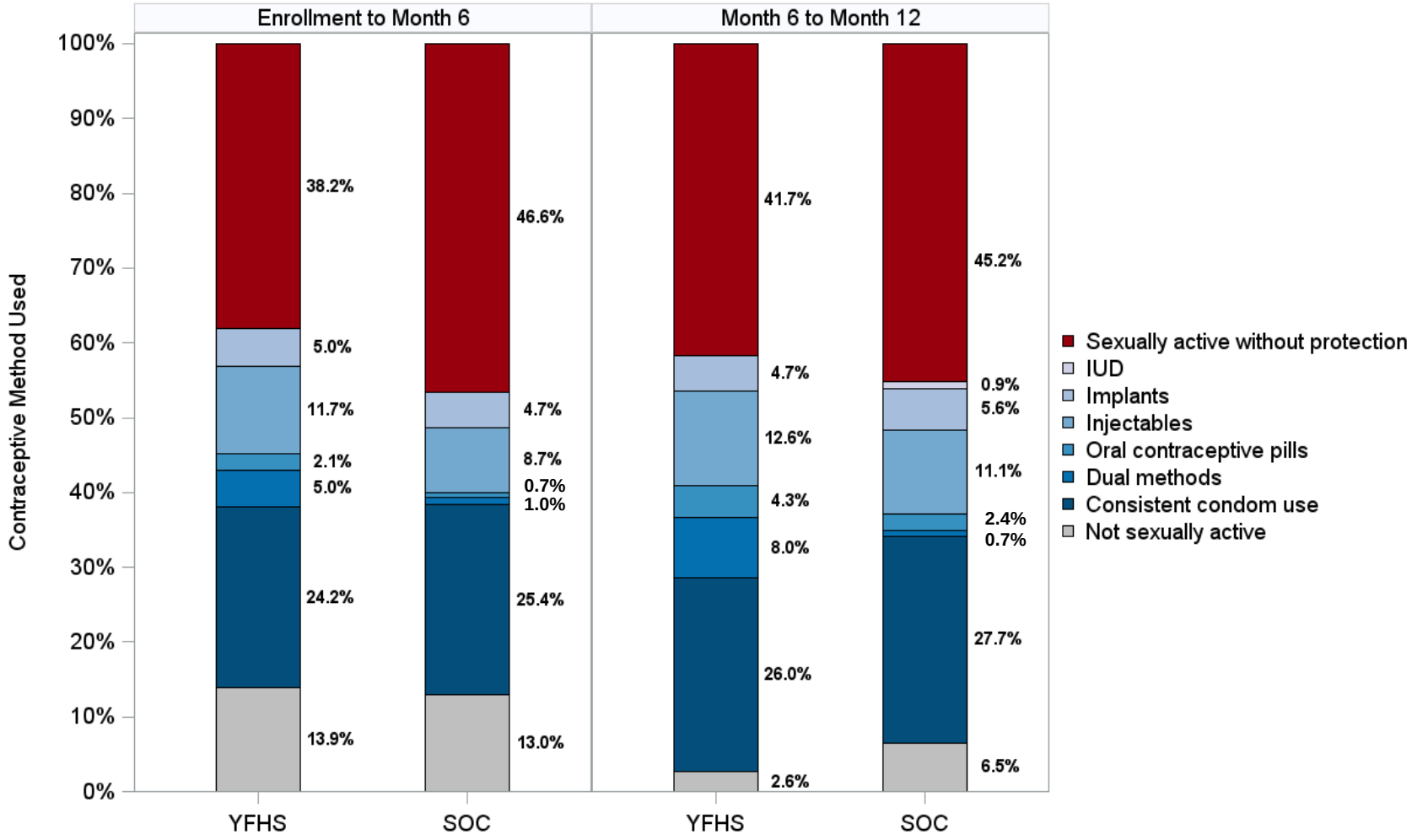


Table 4.5. Sustained use of non-barrier methods, stratified by period and model of service delivery

	Probability (YFHS)	Probability (SOC)	RD (CI)
Enrollment to Month 6			
Overall	23.8% (20.5%, 27.2%)	15.1% (10.5%, 19.7%)	8.7% (3.1%, 14.3%)
Age Group			
Adolescents (15-19)	14.6% (10.8%, 18.3%)	11.1% (5.7%, 16.5%)	3.4% (-3.1%, 9.9%)
Young women (20-24)	36.6% (31.0%, 42.3%)	19.7% (12.1%, 27.3%)	16.9% (7.6%, 26.3%)
Marital Status			
Not married	15.0% (11.8%, 18.1%)	6.4% (3.0%, 10.0%)	8.5% (3.8%, 13.2%)
Married	60.1% (51.6%, 68.5%)	51.5% (35.8%, 67.4%)	8.6% (-9.4%, 26.6%)
Parity			
No living children	7.0% (4.6%, 10.1%)	0.3% (0.0%, 1.2%)	7.0% (4.1%, 9.9%)
At least one living child	53.3% (47.0%, 59.6%)	43.1% (31.8%, 54.5%)	10.2% (-2.6%, 23.0%)
Month 6 to Month 12			
Overall	29.7% (26.1%, 33.3%)	20.6% (15.4%, 25.8%)	9.1% (2.7%, 15.5%)
Age Group			
Adolescents (15-19)	18.1% (14.1%, 22.0%)	15.2% (8.8%, 21.6%)	2.9% (-4.7%, 10.5%)
Young women (20-24)	45.8% (39.9%, 51.8%)	26.9% (18.7%, 35.2%)	18.9% (8.7%, 29.1%)
Marital Status			
Not married	21.4% (17.8%, 25.0%)	13.7% (8.8%, 18.6%)	7.7% (1.5%, 13.9%)
Married	63.6% (55.1%, 72.0%)	49.7% (34.4%, 65.0%)	13.9% (-3.7%, 31.5%)
Parity			
No living children	13.0% (9.7%, 16.4%)	3.7% (0.8%, 6.6%)	9.3% (4.9%, 13.7%)
At least one living child	59.5% (53.1%, 65.9%)	52.7% (40.7%, 64.7%)	6.8% (-7.0%, 20.6%)

SOC = Standard of care; YFHS = Youth friendly health services

Figure 4.6. Contraceptive methods used, stratified by period and age group

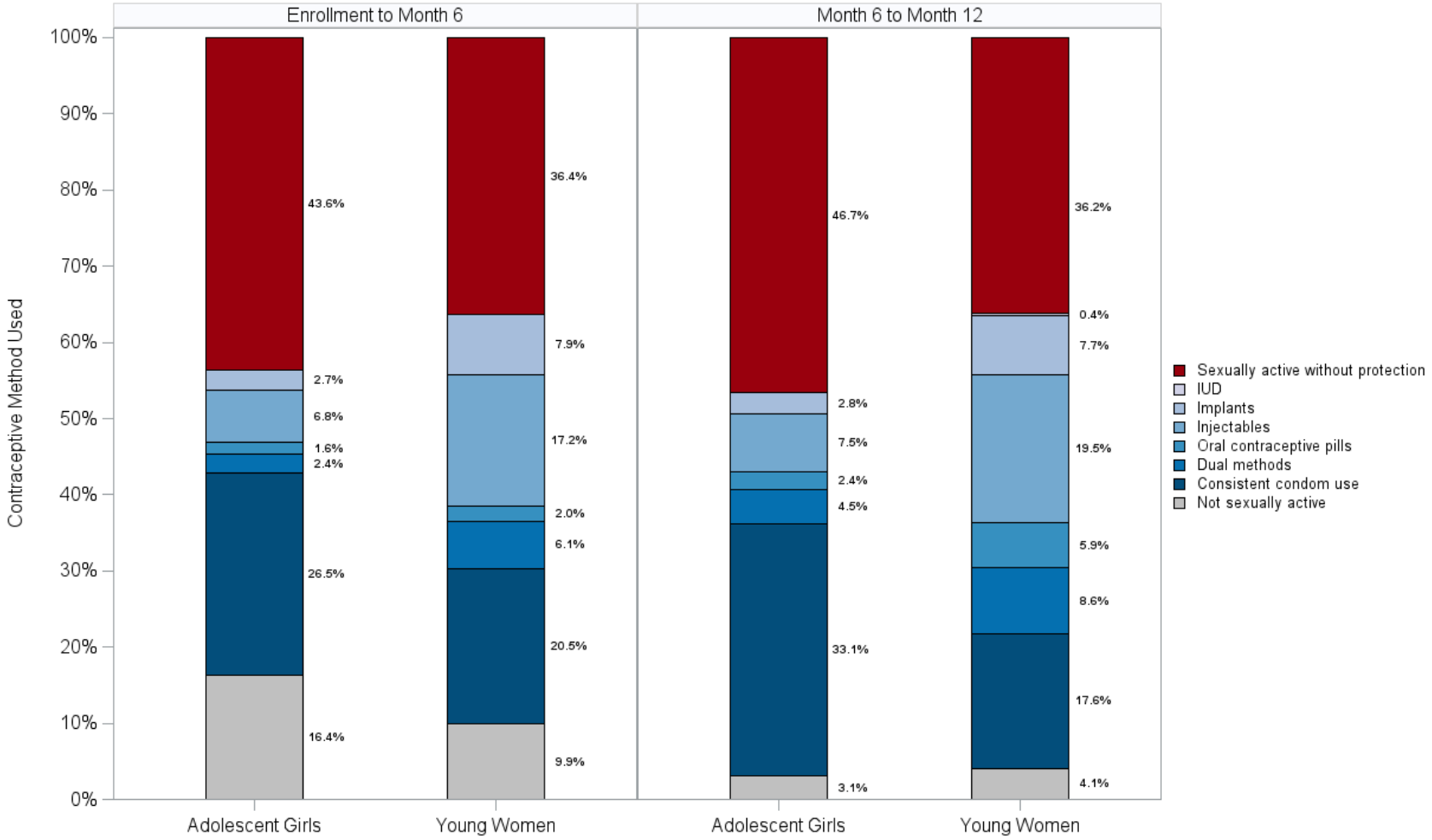


Figure 4.7. Contraceptive methods used, stratified by period and marital status

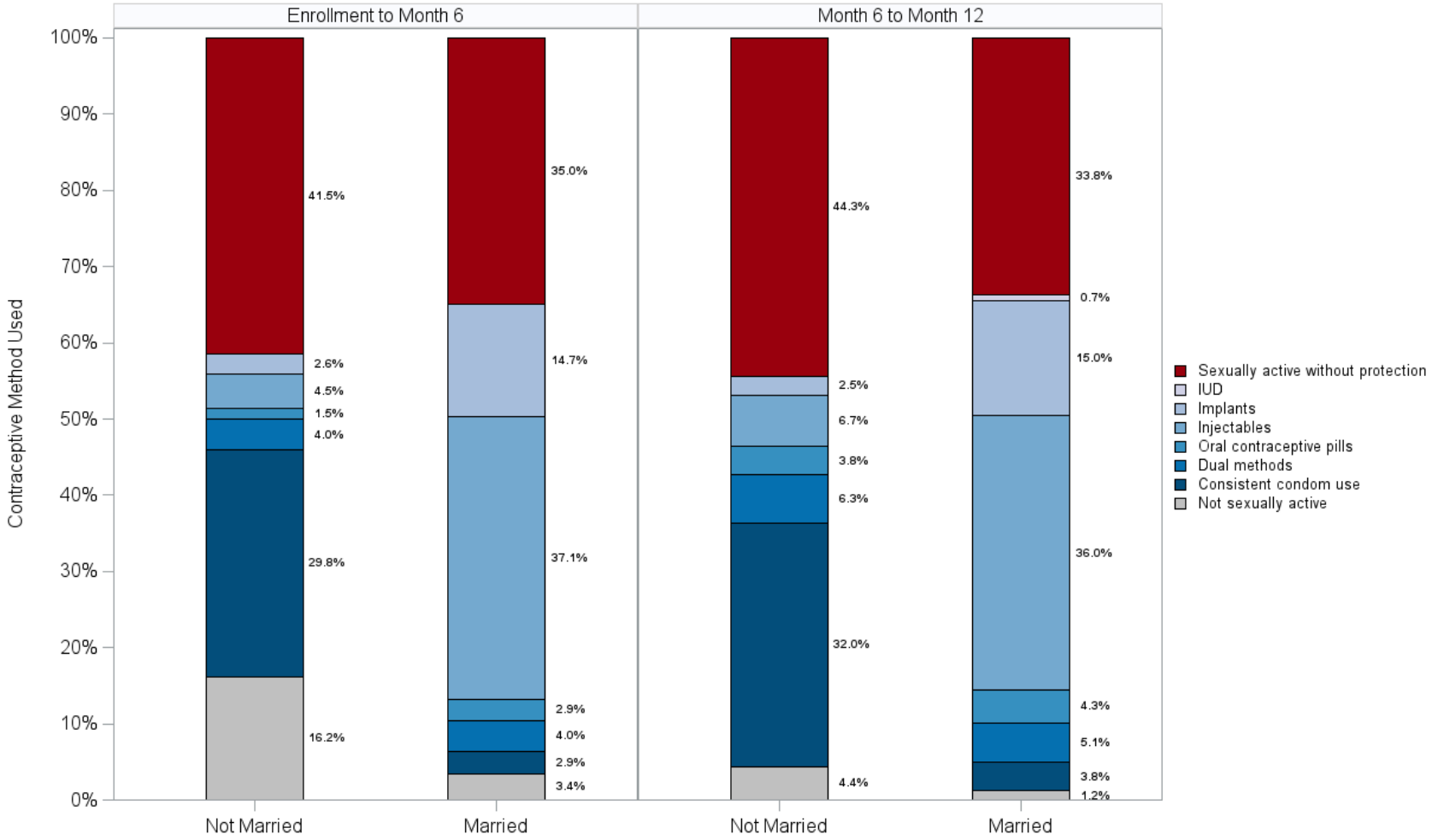


Figure 4.8. Contraceptive methods used, stratified by period and parity

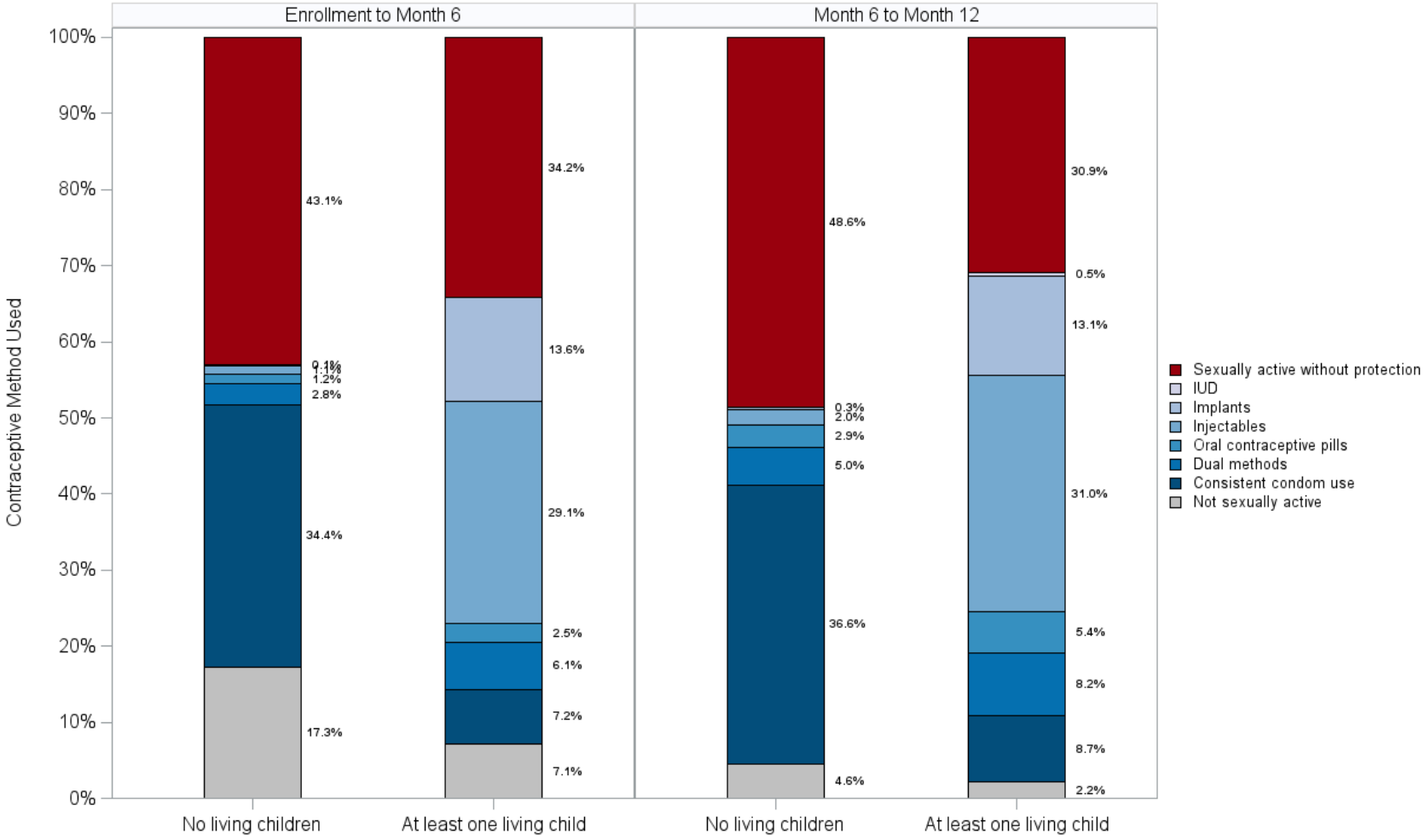


Figure 4.9. Longitudinal patterns in contraceptive use under a scenario where all clinics offered a youth-friendly model of service delivery

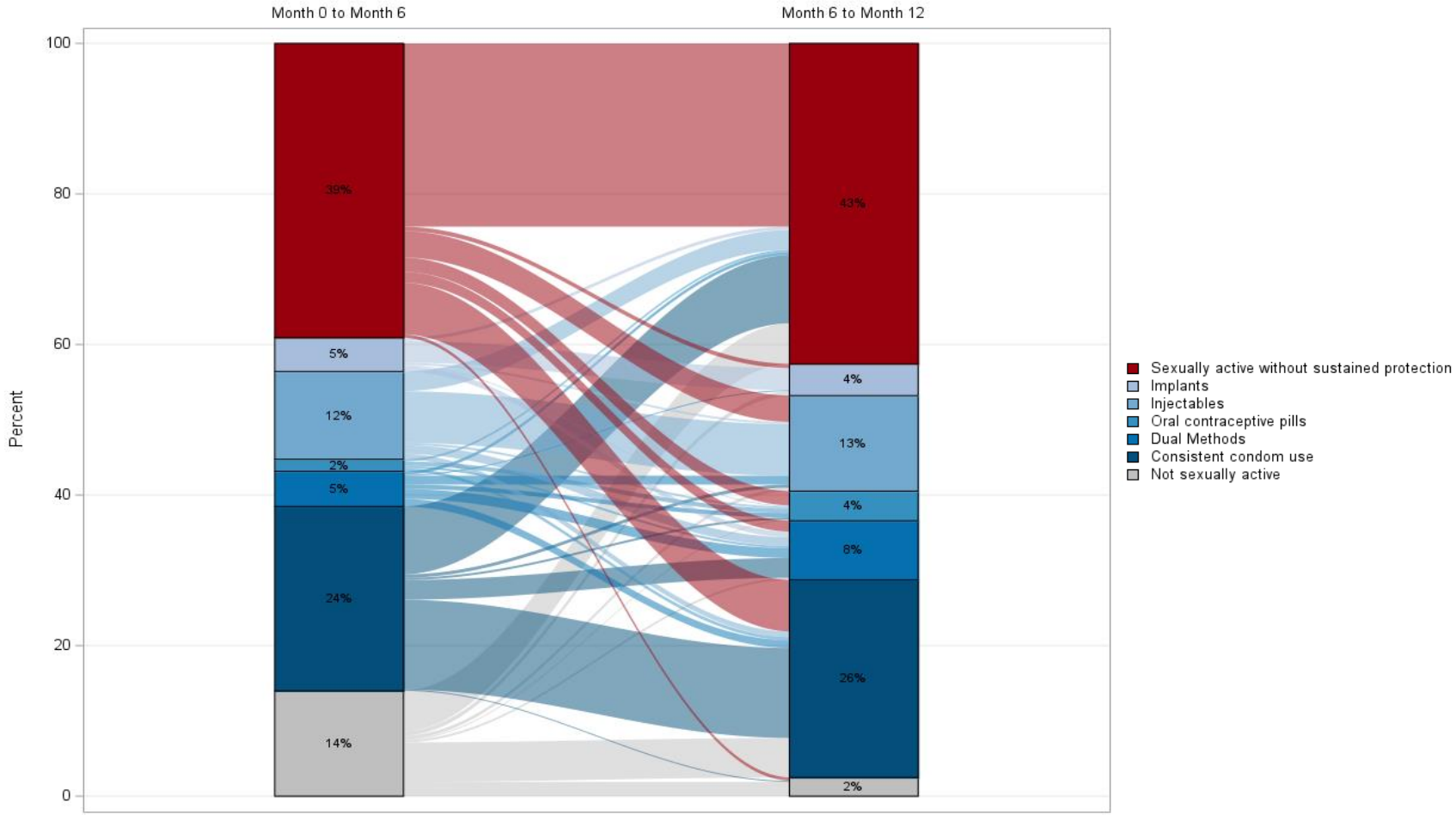
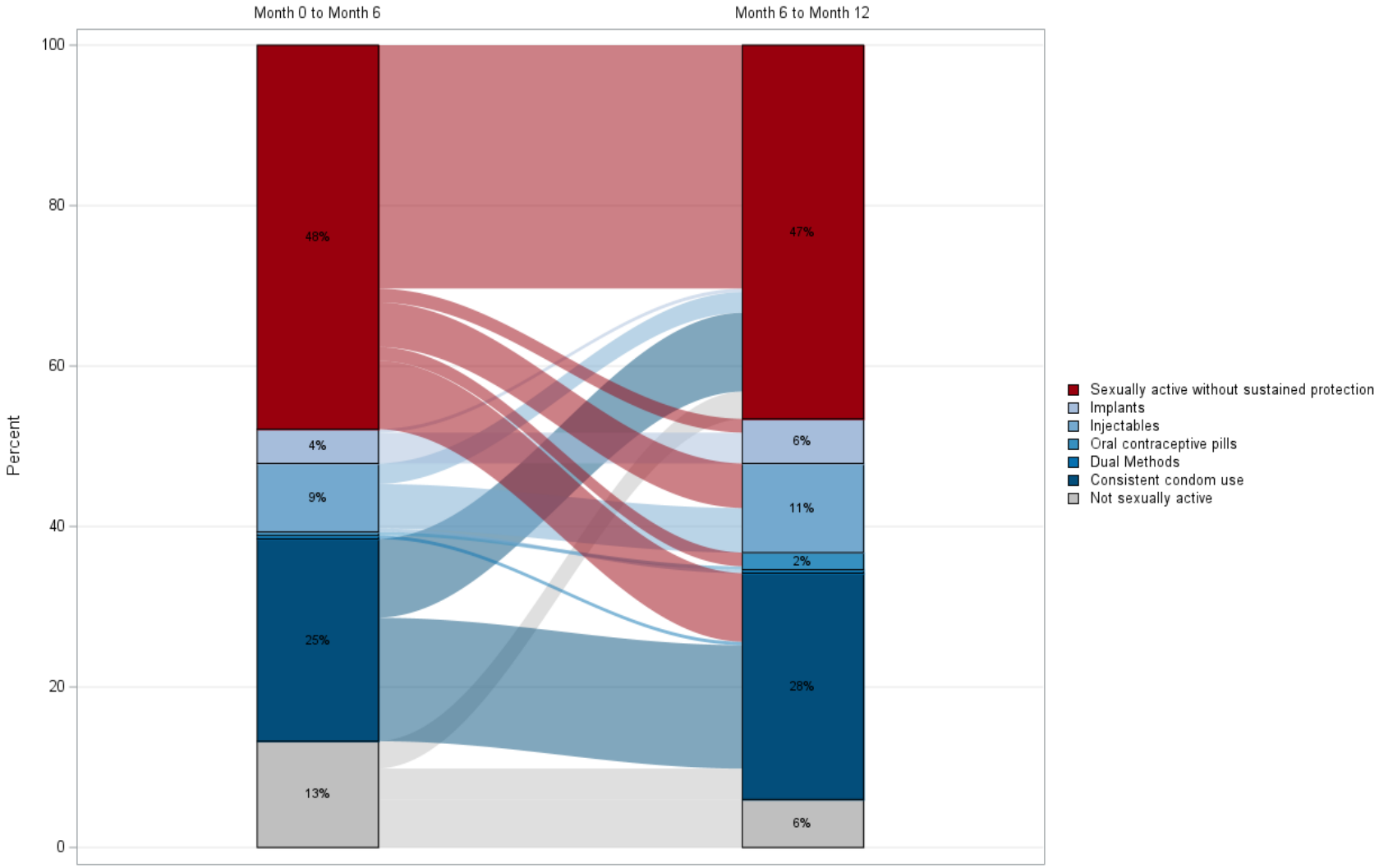


Figure 4.10. Longitudinal patterns in contraceptive use under a scenario where all clinics offered the standard model of service delivery



CHAPTER 5: THE EFFECT OF YOUTH-FRIENDLY HEALTH SERVICES ON THE PROBABILITY OF PREGNANCY AMONG ADOLESCENT GIRLS AND YOUNG WOMEN ENROLLED IN GIRL POWER-MALAWI

5.1. Introduction

Early and unintended pregnancies are common in sub-Saharan Africa (SSA), where the age-specific fertility rate among adolescents is more than twice the global average (1), and approximately 42% of all pregnancies are unplanned (5). Pregnancy complications are a leading cause of morbidity and mortality among adolescent girls and young women aged 15-24 (AGYW) in SSA. In 2019, 1.7 million disability-adjusted life years lost and 17% of all deaths in this population were attributed to maternal conditions (11). Early and unintended pregnancy can also compromise educational attainment, reduce future economic opportunities, and negatively impact the health and wellbeing of children (4).

High unmet need for contraception and suboptimal contraceptive utilization contribute to the high risk of early and unintended pregnancy among AGYW in SSA (65). Structural features of the health system, including provider-imposed contraceptive eligibility restrictions (226), judgmental provider attitudes (130, 134), inadequate privacy and confidentiality (98, 134), long wait times (227, 228), and inconvienent clinic hours (228, 229) are ubiquitous across the region and contribute to low levels of contraceptive use in this population. Youth-friendly health services (YFHS) that address these barriers may decrease the probability of pregnancy by increasing contraceptive use.

Facility-based models of YFHS that integrate provider training with youth-friendly clinic modifications are recommended by the World Health Organization (WHO) as a strategy to increase use of sexual and reproductive health (SRH) services among young people (139). While such approaches have increased acceptability and uptake of contraceptives among

AGYW across SSA, little is known about their impact on pregnancy (141). The single study examining this relationship in SSA reported a reduction in adolescent childbearing following implementation of the National Adolescent Friendly Clinic Initiative (NAFCI) in South Africa, but was unable to isolate intervention effects from other contemporaneous trends (159).

The Girl Power study offers a unique opportunity to evaluate the effect of a facility-based model of YFHS on the probability of pregnancy among AGYW in a more controlled environment. This study, which assigned health clinics to provide SRH services using a standard or youth-friendly model of service delivery, reported considerably greater uptake of contraception among AGYW with access to YFHS compared to those without (158). Using information on self-reported pregnancy status and results from pregnancy tests, we assessed whether access to YFHS also decreased the 12-month probability of pregnancy relative to the SOC.

5.2. Methods

5.2.1. Study design

Girl Power—a multisite study implemented in Lilongwe, Malawi and Western Cape, South Africa (2016 – 2017)—was designed to compare uptake of SRH services among AGYW under four different models of service delivery (169). Given differences in intervention design and outcome ascertainment between countries, we restricted the present analysis to Malawi, where four comparable government-run health clinics were randomized to offer SOC (n=1) or YFHS (n=3).

In Girl Power-Malawi, the SOC health center (Clinic 1) provided free HIV testing, free contraception, and syndromic management of sexually transmitted infections in a typical, adult-oriented, clinical environment. Clinics offering YFHS (Clinics 2-4) provided the same set of services as Clinic 1, but used a youth-friendly model of service delivery. Services at Clinics 2-4 were integrated, provided in youth-dedicated spaces, available in the afternoons and on select Saturdays, and delivered by healthcare providers who received training on medical and psychosocial support for young clients. Clinics 2-4 also employed peer navigators to help

assess SRH needs and assist with clinical navigation. In addition, a socio-behavioral intervention consisting of monthly, facilitator-led sessions with and without a cash transfer, was offered at Clinics 3 and 4, respectively. Since clinics served catchment areas located ≥7km apart, risk of between-clinic crossovers was minimal.

Details on recruitment and study procedures have been published previously (169). Briefly, community leaders from each health center's catchment area were informed about Girl Power-Malawi prior to implementation. Each health center enrolled 250 AGYW aged 15-24 years. While current sexual activity was not an eligibility requirement, sexually active AGYW were preferentially recruited. Participants were followed for 12 months with study visits at baseline, six, and 12 months. At each visit, participants received an interviewer-administered questionnaire and a small research incentive (~$2 USD). Participants were also asked to provide a urine sample for pregnancy testing at six and 12 months.

The Girl Power-Malawi study received approval from the University of North Carolina Institutional Review Board and the Malawi National Health Sciences Research Committee. All study participants were fully informed of the study procedures. Participants aged 18 to 24 provided informed written consent. Participants aged 15 to 17 provided informed written asset and permission by a parent, guardian, or legally authorized representative.

5.2.2. Analytic sample

For the present study, we restricted our analysis to the subset of participants who reported not being pregnant at the time of enrollment with no missing data on baseline covariates.

5.2.3. Measures

Our exposure of interest was access to YFHS. Participants enrolled at the SOC clinic were considered unexposed while participants enrolled at the YFHS clinics were considered exposed.

Our outcome of interest, pregnancy, was measured in two ways. At six and 12 months, participants reported their current pregnancy status on an interviewer-administered questionnaire. Participants who reported being pregnant at either study visit were classified as having an incident pregnancy; those who reported not being pregnant at both study visits were classified as not having an incident pregnancy. This self-reported measure of pregnancy was available for most participants and was expected to be measured with error due to social desirability bias, fertility preferences, and challenges with identifying early pregnancy.

Our second measure of pregnancy was generated using results from urine pregnancy tests (UPT) conducted at the six- and 12-month study visits. We considered UPTs as the gold-standard test to confirm pregnancy status (183). Participants with positive UPT at either study visit were classified as having an incident pregnancy while participants who tested negative on a UPT at both study visits were classified as not having an incident pregnancy. UPTs were inconsistently administered at study visits due to site operational challenges, including inconsistent access to bathrooms and busy providers. Additionally, UPTs were not conducted if the 12-month study visit occurred in the community. As a result, our UPT-based measure of pregnancy was only available for 52% of participants.

Although Girl Power-Malawi randomly assigned health clinics to different models of service delivery, a previous analysis reported imbalances in the distribution of baseline covariates between AGYW who enrolled at the SOC clinic and those enrolled at the YFHS clinics (158). We constructed a causal diagram to identify potential confounders of the relationship between access to YFHS and pregnancy. The minimally sufficient adjustment set for this analysis included baseline measures of age, socioeconomic status (constructed using principle components analysis on durable good ownership and presence of utilities in home) (191), school enrollment, multiple partners in the last year, marital status, living children, history of using non-barrier contraception, and perceived chance of pregnancy in the next year. Continuous covariates—age and socioeconomic status—were modeled using restricted cubic

splines with knots at the 5th, 50th, and 95th percentiles (230). All other covariates were structured as dichotomous variables.

5.2.4. Analytic approach

Because our gold-standard measure of pregnancy was missing for nearly half of participants, we used a two-step approach to estimate the effect of YFHS on the 12-month probability of pregnancy. First, we used multiple imputation for measurement error (MIME) to correct for potential outcome misclassification in self-reported pregnancy (170, 171). Following this correction, we applied the parametric g-formula on the corrected data to adjust for confounding and estimate effects of interest (172). We also applied the parametric g-formula directly on observed data to compare estimates of effect generated using each of the three measures of pregnancy (i.e. the corrected measure, the self-reported measure, and the UPT-based measure). These steps are described in detail below.

Measurement error correction: While most participants had our self-reported measure of pregnancy observed, only a subset of these participants also had our UPT-based measure of pregnancy observed. This formed a validation subgroup in which our possibly misclassified, self-reported, measure of pregnancy (W) could be related to our UPT-based measure of pregnancy (D), and facilitated the use of multiple imputation to correct for outcome misclassification (170, 171). To implement the MIME correction, we used a logistic regression model with Firth's correction to estimate the probability of D given W and A (our exposure: access to YFHS) in the validation subgroup. The model for the predictive values included an interaction term between W and A, to flexibly model outcome misclassification between exposure groups, and all variables from our minimally sufficient adjustment set described above (Z; Equation 1).

(1) $$\widehat{\Pr}(D = 1 \mid W, A, Z) = \frac{\exp(\beta_0 + \beta_1 W + \beta_2 A + \beta_3 (W \times A) + \beta_4 Z)}{(1 + \exp(\beta_0 + \beta_1 W + \beta_2 A + \beta_3 (W \times A) + \beta_4 Z)}$$

We drew 40 sets of regression coefficients from the resulting posterior predictive distribution of parameters and used these values to impute the MIME-corrected outcome, D_k, where k indexes each of the $k = 40$ imputations. For participants with our UPT-based measure of pregnancy observed, $D_k = D$ for all imputations. For participants with only our self-reported measure of pregnancy observed, D_k was imputed based on a random draw from a Bernoulli distribution with probability, p_k, generated using regression coefficients estimated in the validation subgroup from the k^{th} draw (Equation 2).

(2) $\widehat{p_k} = \frac{exp(\widehat{\beta}_0^k + \widehat{\beta}_1^k W + \widehat{\beta}_2^k A + \widehat{\beta}_3^k (W \times A) + \widehat{\beta}_4^k Z)}{(1 + exp(\widehat{\beta}_0^k + \widehat{\beta}_1^k W + \widehat{\beta}_2^k A + \widehat{\beta}_3^k (W \times A) + \widehat{\beta}_4^k Z)}$

Within each imputed dataset, we used the parametric g-formula to adjust for confounding and estimate risk differences (RD) and risk ratios (RR) comparing the 12-month probability of pregnancy between participants with and without access to YFHS (Equation 3 and 4).

(3) $\widehat{RD} = \frac{1}{n}\sum_{i=1}^{n}\left(\widehat{\Pr}(D_k|A = 1, Z_i) - \widehat{\Pr}(D_k|A = 0, Z_i)\right)$

(4) $\widehat{RR} = \frac{1}{n}\sum_{i=1}^{n}\left(\widehat{\Pr}(D_k|A = 1, Z_i)/\widehat{\Pr}(D_k|A = 0, Z_i)\right)$

G-formula: To implement the parametric g-formula (172), we used a logistic regression model to predict the probability of pregnancy for each participant under a scenario where all clinics offered YFHS and under a scenario where all clinics offered SOC. Our prediction model adjusted for the minimally sufficient adjustment set and interaction terms between access to YFHS and age, marital status, living children, and history of using of non-barrier contraception. We averaged predicted probabilities according to exposure scenario and used these averages to estimate marginal RDs and RRs corrected for confounding. Confidence intervals (CI) were constructed as the effect estimate +/-1.96 times the standard deviation from 200 bootstrap resamples. For our MIME-corrected analysis, we incorporated multiple imputation into our bootstrap using the Boot-MI algorithm, with 40 imputed datasets per resample (205).

To ascertain whether the effect of YFHS differed according to age, we averaged predicted probabilities according to exposure status and age group (AGYW aged 15-19 and AGYW aged 20-24), and compared stratum-specific effect estimates and CIs.

All statistical analyses were conducted with SAS version 9.4 software (SAS Institute, Cary, North Carolina).

5.2.5. Sensitivity analysis

To isolate the effect of YFHS from potential effects of the socio-behavioral intervention and cash transfer, we restricted our analysis to only AGYW enrolled at Clinics 1 and 2 and implemented the same analysis described above.

5.2.5. Exploratory analysis

In a post-hoc exploratory analysis, we tabulated our MIME-corrected measure of pregnancy according to our measure of sustained pregnancy protection from Aim 1. We did this within each of the 40 imputations and then averaged the resulting cross-tabulations across the 40 imputations to explore the distribution of our MIME-corrected measure of pregnancy according to our measure of sustained pregnancy protection. This analysis was only conducted among participants for whom our MIME-corrected measure of pregnancy and our measure of sustained pregnancy protection were available.

5.2.6. Ethics

The Girl Power-Malawi study received approval from the University of North Carolina Institutional Review Board (Chapel Hill, NC, USA) and the Malawi National Health Sciences Research Committee (Lilongwe, Malawi). All study participants were fully informed of the study procedures. Participants aged 18 to 24 provided written informed consent. Participants aged 15 to 17 provided written informed asset and permission by a parent, guardian, or authorized representative.

5.3. Results

Of the 1000 AGYW who enrolled in Girl Power-Malawi, 962 reported not being pregnant at enrollment. Nineteen participants (2%) were excluded due to missing baseline covariate information, resulting in an analytic sample of 943. Nearly all participants had experienced sexual debut (>99%), and 75% reported sexual activity in the 30 days prior to enrollment. Participants who enrolled at YFHS clinics were older, more likely to be married, more likely to have a child, more likely to have used non-barrier methods of contraception, and less likely to believe they would become pregnant in the next year than those who enrolled at the SOC clinic (Table 5.1).

Overall, 794 (84.2%) participants completed a six-month visit and 818 (86.7%) participants completed a 12-month visit. Retention was similar between AGYW who enrolled at YFHS clinics and those enrolled at the SOC clinic at six (84% vs. 85%) and 12 months (88% vs. 84%).

Two hundred and forty-eight participants (26.2%) had pregnancy measured by self-report only, 55 (5.8%) by pregnancy test only, and 434 (46.0%) by both self-report and pregnancy testing. Of the 682 participants with our self-reported measure of pregnancy observed, 119 (17.4%) reported being currently pregnant at either the six- or 12-month study visit. Participants who enrolled at a YFHS clinic were somewhat less likely to report a current pregnancy (85 of 513; 16.6%) than participants who enrolled at the SOC clinic (34 of 169; 20.1%). Participants at YFHS clinics were also somewhat less likely to test positive for pregnancy at the six- or twelve-month study visit (55 of 355; 15.5%) than their counterparts at the SOC clinic (23 of 134; 17.2%).

We observed some differences in the distribution of baseline covariates between the validation subgroup—i.e. the 434 participants for whom both measures of pregnancy were available—and those who only had our self-reported measure of pregnancy (Table 5.2). Within the validation subgroup, the diagnostic accuracy of self-reported pregnancy was reasonably

high and comparable between exposure groups (Table 5.3). The proportion of the validation subgroup who reported a pregnancy (17.7%) or tested positive for pregnancy (16.6%) was similar to the full analytic sample.

After correcting for outcome misclassification, the expected 12-month probability of pregnancy under the scenario where all clinics offered YFHS was 15.8% (12.5%, 19.2%) compared to 23.2% (16.0%, 30.4%) under the scenario where all clinics offered SOC (RD: -7.3%, 95% CI: -15.5%, 0.8%). This represents a 31% decrease in the 12-month probability of pregnancy relative to the standard model of service delivery (RR: 0.69, 95% CI: 0.46, 1.01). The effect of YFHS was smaller among adolescent girls aged 15-19 than among young women aged 20-24, though confidence intervals overlapped considerably (Figure 5.1). For all analyses, the effect of YFHS on pregnancy risk was attenuated when pregnancy was measured using either the observed self-reported or UPT-based measures of pregnancy in place of the imputed, MIME-corrected, measure of pregnancy. Nearly all pregnancies (89%) occurred among AGYW who did not sustain pregnancy protection for 12 months.

Restricting our analytic sample to only AGYW enrolled at Clinics 1 and 2 returned a smaller interventional effect, though estimates were considerably less precise due to the smaller sample size. After correcting for outcome misclassification, the 12-month probability of pregnancy under the scenario where both clinics provided YFHS was 18.4% (11.7%, 25.0%) compared to 24.2% (16.4%, 32.0%) under the scenario where both clinics offered SOC (RD: -5.8%, 95% CI: -16.7%, 5.0%; RR: 0.76, 95% CI: 0.45, 1.28).

Pregnancies in Girl Power-Malawi were concentrated among participants who did not sustain pregnancy protection (defined in Aim 1) over the 12-month period (Table 5.4). Whereas fewer than 5% of participants who sustained protection became pregnant over follow-up, more than one quarter of participants who did not sustain protection became pregnant over the 12-month study period.

5.4. Discussion

In this secondary analysis, we evaluated the effect of a facility-based YFHS intervention on the risk of pregnancy among AGYW in Lilongwe, Malawi. The 12-month probability of pregnancy among AGYW enrolled in Girl Power-Malawi was high. Our findings were generally consistent with a decrease in the 12-month probability of pregnancy when AGYW were offered a model of YFHS that included provider training and clinic modifications relative to SOC. Our results also demonstrated that self-reported pregnancy is prone to measurement error and may introduce bias into analyses.

Overall, we observed trends towards a positive impact of YFHS on downstream reproductive health outcomes among AGYW in SSA. Prior evidence regarding the effect of such interventions have largely focused on process indicators or upstream SRH outcomes (141, 231). One observational study from South Africa did find that living within one kilometer of a NAFCI-accredited clinic during adolescence resulted in an 8-percentage point reduction in the risk of childbirth by age 18 (159). However, since the NAFCI program was implemented during a period of substantial investment in the healthcare system (167), observed declines may be attributed to more than just the presence of NAFCI-accredited clinics (164-166). By capitalizing on a controlled environment with a well-defined intervention that enhanced care seeking experiences relative to SOC (232), our findings provide more direct evidence that expanding access to YFHS likely reduces the probability of pregnancy among AGYW in SSA.

Such evidence is timely in light of DREAMS (Determined, Resilient, Empowered, AIDS-free, Mentored, and Safe), a multi-billion-dollar initiative designed to reduce the risk of HIV, pregnancy, and violence among AGYW in 14 sub-Saharan African countries (180). To increase uptake of SRH services, DREAMS supports the establishment and expansion of YFHS within existing healthcare infrastructure (180). Our results suggest this component of DREAMS may decrease pregnancy risk, though impact may differ according to the model of YFHS implemented and the availability of contraception. Siloed funding mechanisms have contributed

to frequent stockouts of contraception within DREAMS (233), which we expect would limit overall impact.

Under current SOC, we estimate that nearly one in four AGYW would have become pregnant over follow-up. This is likely an underestimate of incidence owing to pregnancy losses between study visits (6), which we expect would be similar between exposure groups. Expanding access to the Girl Power-Malawi model of YFHS could decrease this risk by approximately 30%. While noteworthy, access to YFHS did not eliminate adolescent pregnancy. Moreover, prior work in Malawi suggests that >50% of pregnancies are unintended (6, 234), which exceeds the estimated interventional effect. To enhance effectiveness, future research should consider layering interventions that generate demand for, and agency to use, contraception, alongside YFHS (217). Vocational and life-skills training, socioeconomic asset building, educational subsidies, and community mobilization have reduced the probability of pregnancy among AGYW in some SSA contexts (235, 236). Aligning combination strategies with local contextual factors may have an even greater influence on early and unintended pregnancy.

Whereas existing evidence on interventions to prevent pregnancy among AGYW in SSA have relied on self-reported measures of pregnancy (235-237), Girl Power-Malawi collected self-reported and UPT-based measures of pregnancy. These measures had complementary strengths and weaknesses. Our self-reported measure was available for more participants, but our UPT-based measure was a more valid measure of current pregnancy status. To maximize precision and minimize bias, we capitalized on the presence of an internal validation subgroup in which our self-reported measure of pregnancy could be related to our UPT-based measure, and used multiple imputation to account for outcome misclassification in self-reported pregnancy (170, 171). This approach assumes that our UPT-based measure is missing at random conditional on observed covariates. We included all measured predictors of inclusion in the validation subgroup in our imputation model, and results were robust to the addition of other

measured sociodemographic and behavioral characteristics. Our results illustrate that errors in self-reported pregnancy can introduce bias into analyses, a finding with important implications for future research.

This secondary analysis used data from a study designed to compare uptake of SRH services under different models of service delivery. The small number of clinics in the parent study limited our ability to account for cluster-level effects, and the relatively small number of participants enrolled at each clinic contributed to imbalances in baseline covariates between exposure groups. While we included all measured confounders in our analysis, unmeasured and residual confounding remain possible. Additionally, as the parent study was not powered to definitively detect differences in the probability of pregnancy between exposure groups, our estimates lacked precision; nevertheless, results demonstrate clear trends towards a decrease in pregnancy risk. Finally, because pregnancy tests were not administered at enrollment, prevalent pregnancies may have been misclassified as incident pregnancies. Given differences in the distribution of age and marital status at baseline, we expect this risk is somewhat higher among AGYW enrolled at clinics offering YFHS than those enrolled at the SOC clinic, biasing effect estimates towards the null.

Preventing early and unintended pregnancy is an urgent public health priority in SSA that is expected to bring a triple dividend of benefit: for the immediate health of AGYW today, for the future health of the adults they will become, and for the health of the next generation. Facility-based models of YFHS that integrate provider training and youth-friendly clinic modifications are effective for delivering SRH services to young people (141). In this evaluation, we show that access to such models of YFHS may also improve downstream reproductive health outcomes relative to standard models of service delivery in SSA. Adopting, expanding, and sustaining access to high-quality, facility-based, models of YFHS is an important step towards protecting—and promoting—health and wellbeing within this large, and growing, population in the region.

5.5. Tables and Figures

Table 5.1. Baseline characteristics of non-pregnant adolescent girls and young women enrolled in Girl Power-Malawi

		YFHS *n*=707	SOC *n*=236
Age	15-17 years of age	154 (22%)	117 (50%)
	18-20 years of age	310 (44%)	67 (28%)
	21-24 years of age	243 (34%)	52 (22%)
School enrollment	Completed 12 years of school or enrolled in school	419 (59%)	167 (71%)
	Completed less than 12 years of school and not enrolled in school	288 (41%)	69 (29%)
Socioeconomic status	Quartile 4 (highest SES)	196 (28%)	40 (17%)
	Quartile 3	162 (23%)	80 (34%)
	Quartile 2	175 (25%)	61 (26%)
	Quartile 1 (lowest SES)	172 (24%)	55 (23%)
Number of partners in the past 12 months	Zero partners	46 (7%)	16 (7%)
	One partner	530 (75%)	154 (65%)
	More than one partner	131 (19%)	66 (28%)
Sexually active in the past 30 days	Yes	525 (74%)	174 (74%)
History of risky alcohol consumption	Yes	92 (13%)	34 (14%)
Currently married	Yes	156 (22%)	30 (13%)
Any living children	Yes	279 (39%)	63 (27%)
Perceived chance of pregnancy in next year	No chance	583 (82%)	101 (43%)
	Some chance	124 (18%)	135 (57%)
History of using non-barrier methods of contraception †	Never used non-barrier methods	414 (59%)	170 (72%)
	Prior or current user of non-barrier methods	293 (41%)	66 (28%)
History of using condoms	Never used condoms	129 (18%)	45 (19%)
	Prior or current user of condoms	578 (82%)	191 (81%)

SOC, standard of care; YFHS, youth-friendly health services

* Missing for two participants.

† Includes oral contraceptive pills, injectables, implants, and intrauterine devices.

Table 5.2. Comparison of baseline characteristics between the validation subgroup and those with only the self-reported measure of pregnancy observed

		Validation subgroup (n=434)	Self-reported measure of pregnancy only (n=248)
Exposure	SOC	119 (27%)	50 (20%)
	YFHS	315 (73%)	198 (80%)
Age	15-17 years of age	131 (30%)	52 (21%)
	18-20 years of age	172 (40%)	104 (42%)
	21-24 years of age	131 (30%)	92 (37%)
Current school enrollment	Completed 12 years of school or currently enrolled in school	275 (63%)	141 (57%)
	Completed less than 12 years of school and not currently enrolled in school	159 (37%)	107 (43%)
Socioeconomic status	Quartile 4 (highest SES)	106 (24%)	51 (21%)
	Quartile 3	116 (27%)	56 (23%)
	Quartile 2	108 (25%)	70 (28%)
	Quartile 1 (lowest SES)	104 (24%)	71 (29%)
Number of partners in the past 12 months	Zero partners	40 (9%)	9 (4%)
	One partner	306 (71%)	192 (77%)
	More than one partner	88 (20%)	47 (19%)
Married	Yes	87 (20%)	61 (25%)
Any living children	Yes	156 (36%)	108 (44%)
Perceived chance of pregnancy in next 12 months	No chance	315 (73%)	182 (73%)
	Some chance	119 (27%)	66 (27%)
History of using non-barrier methods of contraception *	Never used non-barrier methods	274 (63%)	137 (55%)
	Prior or current user of non-barrier methods	160 (37%)	111 (45%)

SOC, standard of care; YFHS, youth-friendly health services

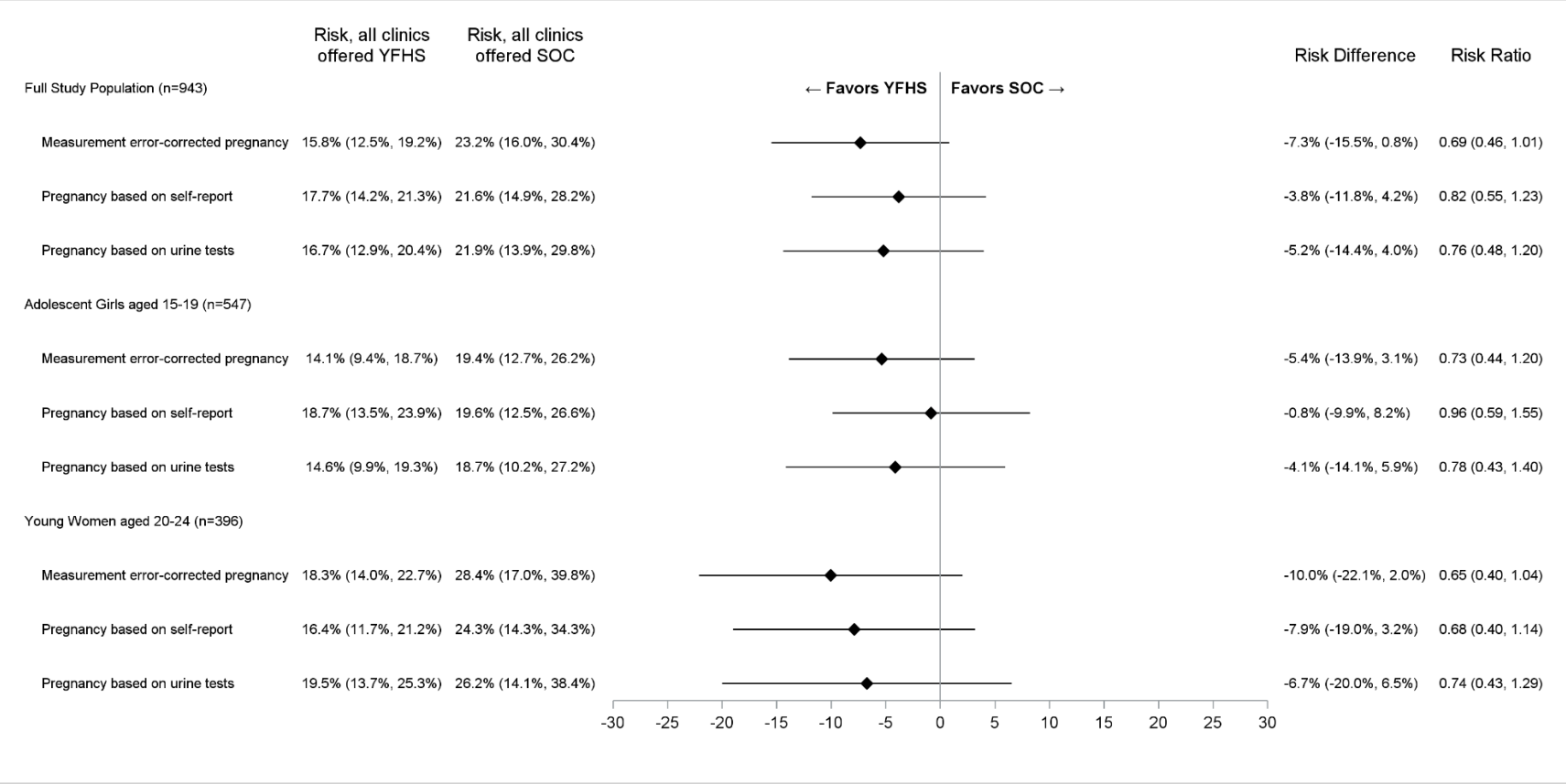
* Includes oral contraceptive pills, injectables, implants, and intrauterine devices.

Table 5.3. Diagnostic accuracy of self-reported pregnancy

	YFHS *n*=315	SOC *n*=119
Did not report a current pregnancy	259	98
Did not test positive on a urine pregnancy test	254	96
Tested positive on a urine pregnancy test	5	2
Reported a current pregnancy	56	21
Did not test positive on a urine pregnancy test	9	3
Tested positive on a urine pregnancy test	47	18
Sensitivity	0.90 (95% CI: 0.82, 0.98)	0.90 (95% CI: 0.77, 1.00)
Specificity	0.97 (95% CI: 0.94, 0.99)	0.97 (95% CI: 0.94, 1.00)
Positive predictive value	0.84 (95% CI: 0.74, 0.94)	0.86 (95% CI: 0.71, 1.00)
Negative predictive value	0.98 (95% CI: 0.96, 1.00)	0.98 (95% CI: 0.95, 1.00)

CI, confidence interval; SOC, standard of care; YFHS, youth-friendly health services

Figure 5.1. Impact of the youth-friendly health service intervention on the 12-month probability of pregnancy among adolescent girls and young women enrolled in Girl Power-Malawi



SOC: standard of care; YFHS: youth-friendly health services

Table 5.3. Associations between sustained pregnancy protection over 12 months and incident pregnancy

	Probability (Sustained protection)	**Probability (Did not sustain protection)**	**Risk Difference (CI)**	**Risk Ratio (CI)**
Pregnancy (MIME-Corrected)	4.3% (1.3%, 7.1%)	26.2% (21.6%, 30.7%)	-21.9% (-27.0%, -16.8%)	0.16 (0.08, 0.32)
Pregnancy (Self-Report)	4.1% (1.8%, 6.3%)	28.1% (23.6%, 32.6%)	-24.0% (-29.1%, -18.9%)	0.15 (0.08, 0.26)
Pregnancy (Urine Tests)	2.4% (0.4%, 4.5%)	26.9% (21.6%, 32.2%)	-24.5% (-30.2%, -18.8%)	0.09 (0.04, 0.22)

CI: confidence limit; MIME: multiple imputation for measurement error

CHAPTER 6: DISCUSSION

In this chapter, we summarize key findings, discuss the strengths and limitations of our analyses, and describe important future directions for research and practice.

6.1. Overview

During the landmark 1994 International Conference on Population and Development (ICPD), the importance of addressing the SRH needs of young people was first acknowledged by the global community as part of the ICPD's Programme of Action. Since then, considerable investments have been made to enhance AGYW SRH globally, contributing to marked declines in the adolescent fertility rate globally (66). Progress, however, has been uneven. In SSA, age-specific fertility rates among AGYW are more than twice the global average (1), and fewer than one in two AGYW who want to prevent a pregnancy use modern methods of contraception (66).

Unmet need for contraception, preferences towards less effective methods of contraception, and challenges with contraceptive adherence and continuation resulted in an estimated 10 million unintended pregnancies among AGYW in SSA in 2020. The consequences of early and unintended pregnancy are significant. As previously described, pregnancy-related complications are a leading cause of morbidity and mortality among AGYW, and pregnancies to AGYW can compromise educational attainment, endanger future economic opportunities, and adversely impact child health and development. Identifying interventions that facilitate sustained changes to contraceptive preferences and behaviors among AGYW are therefore a public health priority with benefits that extend far beyond the individual.

Facility-based models of YFHS that integrate provider training with youth-friendly clinic modifications and community outreach activities have improved knowledge, acceptability, and uptake of contraceptives among AGYW in SSA. While promising, these outcomes do not reflect

sustained changes necessary to reduce risk of early and unintended pregnancy among AGYW in the region. Moreover, existing evidence relating YFHS to pregnancy in SSA is limited by weak study designs. By enhancing our understanding of if—and how—access to YFHS shapes contraceptive behaviors and pregnancy risk, this dissertation offers insights that are critical for strengthening ongoing efforts to introduce and expand access to YFHS across the region.

6.2. Summary of findings

The first aim of this dissertation was to determine if access to YFHS resulted in sustained behavioral changes necessary to reduce risk of pregnancy among AGYW enrolled in Girl Power-Malawi. Our results were largely consistent with an increase in the 12-month probability of sustained pregnancy protection when AGYW were offered a youth-friendly model of service delivery relative to SOC; these effects were concentrated among those who were married and among those with children. Condoms were the most common method of contraception used by participants, with a similar proportion of AGYW using condoms consistently under both models of service delivery at both timepoints. At both time points, the proportion of sustained protection attributed to non-barrier method use was greater under the scenario where all clinics offered YFHS than under the scenario where all clinics offered SOC.

The second goal of this dissertation was to move beyond behavioral outcomes and determine whether access to YFHS decreased the probability of pregnancy—the outcome policymakers and communities ultimately want to influence. We used a novel approach to account for measurement error in self-reported pregnancy, and, by capitalizing on a controlled environment with a well-defined intervention, results from this analysis are more robust than prior evaluations (145, 159). Our findings were generally consistent with a decrease in the 12-month probability of pregnancy under a youth-friendly model of service delivery compared to SOC, with trends towards greater intervention impact among older compared to younger AGYW. This finding likely reflects the impact of marital status and parity—characteristics that are strongly related with age—on sustained pregnancy protection estimated in Aim 1. Notably,

the majority of pregnancies occurred among AGYW who did not sustain protection 12 months. Whereas fewer than 5% of participants who sustained protection became pregnant over follow-up, more than one quarter of participants who did not sustain protection became pregnant over the 12-month study period.

Overall, we observed a modest but meaningful impact on both sustained pregnancy protection and pregnancy among AGYW who enrolled in Girl Power Malawi, and illustrate that these outcomes and related. When considered together—and alongside results from the primary analysis (158)—our findings support ongoing efforts to introduce and expand access to YFHS across the region, while also highlighting opportunities to strengthen implementation. Our results suggest that access to facility-based models of YFHS that integrate provider training with clinic modifications and community outreach activities reduce overall pregnancy risk, with effects concentrated among those who were older, married and those with children. Interventional impact in these subgroups is meaningful. In much of SSA, where marriage and first birth often occur during adolescence, many AGYW are married and parous. Scaling up interventions that decrease pregnancy risk in these populations will therefore have considerable impact on the overall burden of early and unintended pregnancy among AGYW in the region by helping women space their pregnancies.

However, younger AGYW and those who are often unmarried and non-parous typically experience the highest levels of unmet need for modern methods of contraception (89), and findings from our analyses suggested a weaker effect of YFHS in these populations. In addition, even with access to a youth-friendly model of service delivery, most AGYW were at risk of unprotected sex during at least one of the six-month periods, and condoms remained the most popular method of contraception sustained by participants. Condoms are an effective method of contraception that can considerably decrease the 12-month risk of pregnancy and provide protection against sexually transmitted infections including HIV (68). Nevertheless, 12-month typical-use failure rates are considerably higher among condom users than among users of

OCPs, injectables, implants, and IUDs (68, 69). These findings suggest that factors outside the health system play a critical role in shaping contraceptive behaviors among AGYW in SSA, even when YFHS are available.

6.3. Strengths and limitations

The strengths and limitations of this dissertation are summarized according to key features of the study design and common threats to the internal and external validity of epidemiologic research.

6.3.1. Study design

As described in Chapter 1, inferences from prior evaluations of YFHS are generally limited by suboptimal study designs. Girl Power-Malawi offered a controlled environment, a meaningful comparison group, and a well-defined cohort that was followed longitudinally for 12 months. These features of the study design are a strength and enabled a nuanced exploration of how access to YFHS shaped pregnancy risk relative to SOC. However, as secondary outcomes, the design of Girl Power-Malawi was not optimized for our evaluations.

Girl Power-Malawi was not powered to definitively detect differences in the probability of sustained pregnancy protection or the probability of pregnancy between exposure groups and our estimates lacked precision. Nevertheless, results from both aims demonstrated clear, complementary, trends towards a decrease in pregnancy risk. The single control clinic in the parent study limited our ability to account for cluster-level effects, and the presence of other interventions in two of the three clinics offering YFHS made our exposure somewhat less well-defined. Similar trends in sensitivity analyses conducted among AGYW who enrolled at either the SOC clinic or the YFHS-only clinic, however, provide some reassurance that our overall findings are not driven by the addition of the BI or BI+CCT offered at two of the YFHS clinics.

Six-month gaps between study visits in Girl Power-Malawi had important implications for outcome ascertainment in both our aims. In Aim 1, it is possible that AGYW who did not use a method of contraception for the full period between study visits but whose contraceptive use

was aligned with intermittent sexual activity during follow-up were misclassified as not having sustained pregnancy protection. Since this was more likely among AGYW with access to YFHS than those in the SOC (i.e. because of reduced barriers to accessing contraception), we expect this limitation attenuated our estimates of effect in Aim 1. In Aim 2, six-month gaps between pregnancy assessments likely resulted in the under-ascertainment of pregnancy due to pregnancy losses between study visits (5-8). Because, access to YFHS was not expected to influence risk of miscarriage, and administration of pregnancy tests between study visits—an event we anticipated would occur among participants seeking an abortion—was similar between exposure groups, we expect this limitation attenuated our estimates of effect in Aim 2. Thus, the findings in both aims may underestimate the true effect of the YFHS intervention.

Finally, because Girl Power-Malawi did not routinely capture information on pregnancy intention, we were unable to incorporate intention into either analysis. As a result, a portion of unprotected sex in Aim 1 was likely the outcome of a rational decision to not use contraception, and a portion of pregnancies in Aim 2 were likely intended. It is worth noting, however, that pregnancy intention is hard to measure. Prospective measures of intention, typically ask women at baseline about their desire to continue (or start) childbearing. If participants respond affirmatively, they are then asked about the desired timing of their next (or first) pregnancy. This series of questions is then repeated at set points over follow-up, and any unprotected sex or pregnancies identified during follow-up can then be classified as intended or unintended according to desired timing from the most recent assessment. Critically, such classification relies on the assumption that intentions are stable between assessments, and there is considerable evidence demonstrating that pregnancy intentions are dynamic (238-241). In a longitudinal study conducted among AGYW in Malawi, for example, more than 50% of participants reported a change in the desired timing of childbearing at each four-month interval over the 18-month follow-up period (239). These changes were largely in response to changes

in life circumstances: having a child, starting a new relationship, or a change in household finances—events that occur with some regularity during adolescence and young adulthood.

Further complicating the ascertainment of pregnancy intention are the high levels of pregnancy ambivalence—strong simultaneous intentions in both directions—observed among AGYW in SSA. In Malawi, for example, approximately 40% of AGYW participating in an eight-wave panel study expressed childbearing ambivalence at least once during the 24 month study (84). In this study, childbearing ambivalence was defined as wanting a child as soon as possible but reporting a pregnancy in the next 30 days would be "neither good nor bad," "fairly bad," or "very bad," or wanting to delay having a child and reporting that a pregnancy in the next 30 days would be "neither good nor bad," "fairly good," or "very good."

Thus, while information on pregnancy intention at baseline and six-months would have been useful for classifying unprotected sex or pregnancies in the subsequent period as intended or not, a portion of these outcomes would still be misclassified.

6.3.2. Confounding

Although clinics in Girl Power-Malawi were randomly assigned to provide either a standard or youth-friendly model of service delivery, the small number of clinics in the study and the relatively small number of participants enrolled at each clinic contributed to imbalances in the distribution of covariates between exposure groups (184, 185). We used a causal diagram to identify confounders of the relationship between YFHS and each of our outcomes, and used rich baseline data collected on study participants to account for all measured confounders. However, it remains possible that AGYW who enrolled at a clinic offering YFHS differ in systematic ways from those who enrolled at the clinic offering SOC. For instance, we did not have information on baseline pregnancy intention or pregnancy ambivalence on study participants. While accounting for variables associated with these unmeasured factors (i.e. age, socioeconomic status, marital status, parity, and perceived chance of pregnancy) may reduce unmeasured confounding, residual confounding is possible.

Notably, the sophisticated analytic approaches we used in Aim 1 and Aim 2 facilitated the estimation of marginal effects adjusted for confounding. This is an important strength of our analyses since, under assumptions of conditional exchangeability with positivity, consistency, and no measurement error, marginal effects can be interpreted as effect that would have been observed if all participants had access to YFHS compared to if all participants had access to SOC (202). Such interpretation is more meaningful that conditional effect estimated using standard multivariate regression models and approaches a causal interpretation.

6.3.3. Positivity

While including numerous covariates in our analytic models was necessary to account for confounding, this resulted in sparse data. Because there were no structural reasons for non-positivity, using models to extrapolate over areas with sparse data is a valid approach (242).

6.3.4. Exposure consistency

Our primary exposure was access to YFHS, which we defined as clinic assignment to offer YFHS or SOC. Notably, two of the three clinics that offered YFHS also offered additional interventions. One clinic offered a BI (small-group empowerment sessions) and one clinic offered the BI plus a monthly cash transfer conditional on attending the BI. To evaluate the impact of these additional interventions on our outcomes—and thus, assess the plausibility of the consistency assumption—we reran our analyses in a restricted sample comprised of only AGYW who enrolled at either the SOC clinic or the YFHS-only clinic.

In Aim 1, the effect of YFHS on sustained pregnancy protection was greater in the restricted sample than in the full analytic population. We expect this is because participants in the restricted sample were older, more likely to be married, and more likely to have a living child than those in the full analytic population. In contrast with our primary Aim 1 results, however, the effect of YFHS on sustained protection appeared to be driven by greater condom use among AGYW with access to YFHS than those in with access to SOC. This may explain why the effect of YFHS on pregnancy in Aim 2 was somewhat attenuated in the restricted sample compared to

the full analytic population. While these results provide some reassurance that overall trends are not driven by the addition of the BI or BI+CCT, they do suggest that the addition of other interventions may have facilitated greater sustained use of non-barrier methods of contraception that just offering YFHS. This finding has important implications for ongoing efforts to introduce and expand access to YFHS in the region.

6.3.5. Measurement error

Challenges with measurement has been a theme throughout several of the prior sections in this discussion. Here, we focus on the quality of available data used to generate our outcomes of unprotected sex and pregnancy.

The availability of longitudinal data on sexual activity and contraceptive use facilitated a novel evaluation of how access to YFHS shaped contraceptive behaviors and preferences relative to SOC. Self-reported data on sexual activity and contraceptive use, however, is often measured with error due to social desirability biases and challenges with recall (224, 225). To minimize reporting bias, interviews were conducted in private spaces by trained female research assistants who were of similar age to participants. Decent alignment between our measure of sustained pregnancy protection and our MIME-corrected measure of pregnancy, as well as previous findings that highlighted concordance between clinical records and self-reported contraceptive behaviors (158), provided some reassurance regarding the quality of self-reported SRH behaviors. Nevertheless, the use of self-reported measures of sexual activity and contraceptive use may have introduced bias into our Aim 1 analysis. The impact of this bias on our results is difficult to discern. If measurement error were non-differential with respect to exposure, estimates of effect would be attenuated. However, if AGYW with access to YFHS were more likely to over-report contraceptive use than those with access to SOC our results would overestimate the impact of YFHS.

Self-reported data on pregnancy may have also been measured with error due to social desirability biases, fertility preferences, and challenges with identifying early pregnancy. The

availability of a UPT-based measure of pregnancy on a subset of study participants, however, facilitated the use of multiple imputation to account for outcome misclassification in self-reported pregnancy. This approach maximized precision while minimizing bias, but relied on the assumption that our UPT-based measure was missing at random conditional on observed covariates. We included all measured predictors of inclusion in the validation subgroup in our imputation model, and results were robust to the addition of other measured sociodemographic and behavioral characteristics.

As existing evidence on interventions to prevent pregnancy among AGYW in SSA have largely relied on self-reported measures of pregnancy and childbearing (235-237), the availability of results from UPTs in our study is novel, and our finding that errors in self-reported pregnancy can introduce considerable bias into analyses has important implications for interpreting existing evidence. While UPTs are the gold-standard measure for confirming pregnancy in Malawi (183), we acknowledge that UPTs have imperfect sensitivity and specificity. While longitudinal administration of UPTs enhanced sensitivity, more frequent testing would have been preferable to ensure that all pregnancies were captured.

6.3.6. Missing data

Robust tracing procedures resulted in high retention at study visits. However, missed study visits contributed to missing outcomes. We used rigorous epidemiologic methods to account for missing data. In Aim 1, we imputed missing outcomes using richly parameterized imputation models. Imputed outcomes appeared reasonable, and the imputation model exhibited strong performance for predicting outcomes in our leave-one-out cross-validation assessment. In Aim 2 we used the parametric g-formula to impute the probability of pregnancy for all participants regardless of whether their outcome was observed. The overall probability of pregnancy in the observed data was similar to the predicted probability of pregnancy under the natural course in our Aim 2 analyses, providing limited confidence in our model specification.

Both approaches used to account for missing data in this dissertation relied on the assumption that missing data were missing at random, conditional on measured covariates (243, 244). While not testable, we parameterized our imputation model in Aim 1 with numerous behavioral and clinical variables to make this assumption more plausible. Given the relatively small number of pregnancies in Aim 2, we were more limited in what variables we could include in our analytic models. Nevertheless, by including strong predictors of the outcome (i.e. age, marital status, parity, school enrollment, and perceived pregnancy chance), we believe the assumption that data are missing at random conditional on measured covariates is reasonable.

6.3.7. Generalizability

Results from research studies generalize to target populations when characteristics of the study population are similar to those in the target population (245). As Girl Power-Malawi primarily enrolled sexually active AGYW residing in—or close to—the city of Lilongwe, we expect our results will be most relevant for guiding programmatic decision-making in the greater Lilongwe municipality. Additional analyses would be required to estimate the effect of the Girl Power-Malawi model of YFHS on pregnancy risk in target populations where the distribution of age, marital status, and parity—effect measure modifiers in our analyses—is different from the distribution observed in our study population.

We note that implementation science research will be necessary to successfully introduce and expand access to YFHS in programmatic settings. Our results come from a rigorously conducted research study with considerable oversight, and findings from programmatic settings have illustrated challenges with implementing YFHS as part of routine services. In South Africa, for example, three evaluations of the national Youth Friendly Services Programme highlighted limited awareness of YFHS among youth (246) and limited implementation of YFHS at publicly-funded primary healthcare facilities (247, 248). Similar findings were reported in Malawi. Six years after the introduction of Malawi's National YFHS Programme in 2007, an evaluation conducted by Evidence for Action illustrated that most

surveyed facilitates were not implementing the standard elements of YFHS, and that only 13% of surveyed youths had ever received services at a clinic offering YFHS (249). In Tanzania, efforts to scale up the MEMA kwa Vijana Programme was limited by inadequate physical space healthcare facilities to ensure privacy and reduce wait times, a reliance on donor funding, overburdened human resources, and provider turnover (250, 251). Implementation science research will therefore be critical for guiding implementation efforts in programmatic settings.

6.3.8. Summary

In spite of the limitations, our work provides a valuable contribution to the literature and to practice. We use rigorous epidemiologic methods to overcome common threats to internal validity in epidemiologic research, including missing data, measurement error, and confounding, and capitalized on longitudinal measures of sexual activity, contraceptive use, and pregnancy in a well-defined cohort of AGYW to conduct a novel exploration of if—and how—access to YFHS shapes pregnancy risk. We found that access to YFHS increased the probability of sustained pregnancy protection, and decreased the probability of pregnancy, over 12 months, with effects concentrated among older, married, and parous AGYW. Such findings are especially important in light of considerable investments being made to expand access to YFHS across SSA.

6.4. Future directions

Overall, we observed a modest but meaningful impact on both sustained pregnancy protection and pregnancy among AGYW who enrolled in Girl Power Malawi. However, our results also highlighted opportunities for improvement. Specifically, we found that even when YFHS are available, a large proportion of sexually active AGYW—particularly younger AGYW, those who are not married, and those who do not have children—did not use contraception for all of the 12-month study period, increasing their risk of pregnancy. These findings reinforce calls for multi-level interventions to facilitate contraceptive uptake and continuation among AGYW in SSA (217). Identifying the underlying reasons for contraceptive nonuse and discontinuation when YFHS are available is an important first step.

Under the framework of contraceptive autonomy outlined by Senderowicz (222), contraceptive nonusers form two groups: those with a desire to use contraception and those without a desire to use contraception. This framework can easily be extended to include women who discontinue use: those with a desire to continue contraceptive use and those without a desire to continue contraceptive use. In communities served by YFHS, identifying barriers to contraceptive use and continuation among those with a desire to use contraception, is a clear step towards identifying interventions that make YFHS more accessible to all AGYW. Equally important, however, is understanding the motivations for nonuse and discontinuation. Such information can illustrate whether nonusers and discontinuers with access to YFHS made free, full, and informed decisions (i.e. a voluntary decision made without barriers or coercion, with access to a wide range of modern methods, and based on sufficient, unbiased information) (222), and offer insights into potential strategies to increase demand for—and agency to use—contraception. When implemented alongside YFHS, contextually-relevant multi-level interventions that improve access to YFHS and increase demand for contraception are expected to enhance uptake of contraceptive services within YFHS, resulting in greater downstream reproductive health impact.

Our results also suggested that even when YFHS are available, a large proportion of AGYW will select condoms as their preferred method of contraception. Compared to not using a method of contraception, condoms are highly effective and preventing pregnancy and also offer protection against STIs. However, condoms are one of the least effective modern methods of contraception, with 12-month typical-use failure rates above 10% (69). Among AGYW using YFHS, understanding the reasons for selecting condoms over more effective non-barrier methods of contraception is an important step towards determining the extent to which choices in the context of YFHS are free, full, and informed (222). Once again, such information can be used to strengthen implementation of YFHS and identify potential strategies to enhance uptake of more effective methods of contraception. However, such strategies must not be coercive and

must respect the individual AGYW's autonomy to select the contraceptive method she believes is most appropriate for her—or their autonomy to choose to not use contraception at all (252). To this end, community-based participatory approaches that engage AGYW, their parents, and their partners, may be especially effective for developing culturally-appropriate interventions to enhance uptake of more effective methods of contraception (253).

Finally—and relatedly—implementation science strategies are needed to bring YFHS to scale in SSA. As previously discussed, layering additional interventions alongside YFHS is expected to enhance acceptability of YFHS and adoption of YFHS by AGYW—two important implementation outcomes. Identifying strategies to strengthen other implementation outcomes (e.g. implementation fidelity, feasibility, and sustainability), however, is equally important for ensuring the downstream reproductive health impact of YFHS (254).

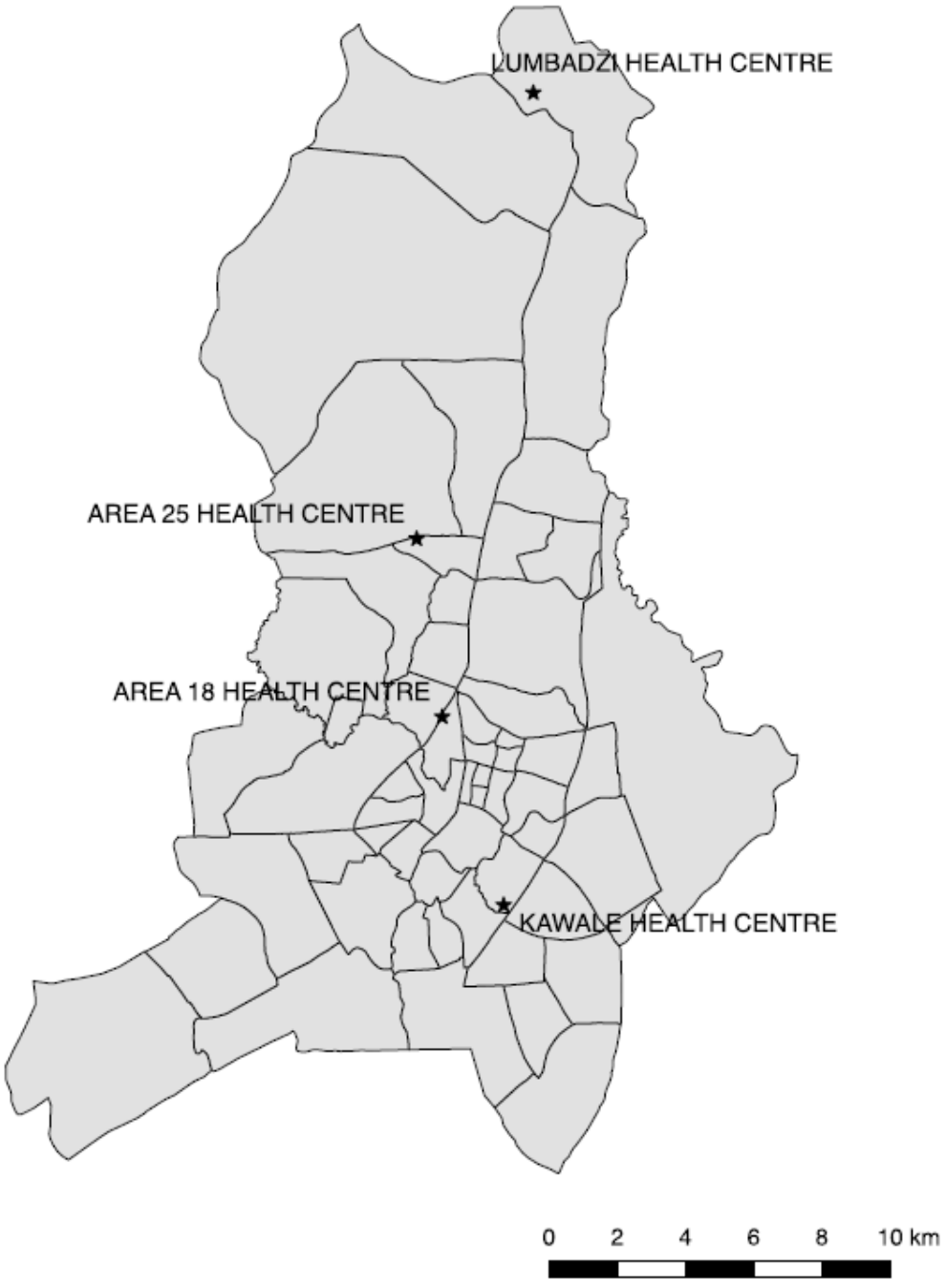
Mystery client evaluations of YFHS, for example, have identified challenges with implementation fidelity (134), while experiences scaling up YFHS as part of routine programming in South Africa, Malawi, and Tanzania have demonstrated challenges with feasibility, penetration, and sustainability (246-251). Integrating continuous quality improvement interventions may enhance implementation fidelity (255), while implementing systems analysis and improvement interventions at facilities offering YFHS may enhance feasibility and sustainability of YFHS within existing health infrastructure (256, 257). The impact of these—and other implementation strategies—should be evaluated to identify best practices for adopting, expanding, and sustaining high-quality YFHS across SSA.

6.5. Conclusion

Preventing early and unintended pregnancy is an urgent public health priority in SSA that is expected to bring a triple dividend of benefit: for the immediate health of AGYW today, for the future health of the adults they will become, and for the health of the next generation. Facility-based models of YFHS that integrate provider training, clinic modifications, and community outreach activities are effective for delivering SRH services to young people. In this

dissertation, we show that access to such models of YFHS may also improve downstream reproductive health outcomes relative to standard models of service delivery in SSA, with effects primarily concentrated among older AGYW, those who are married, and those with children. While these findings support ongoing efforts to introduce and expand access to YFHS throughout SSA, they also reinforce calls for multi-level interventions that tackle not only the supply-side barriers to contraceptive use, but also address important sociocultural barriers that limit demand for contraception among AGYW in SSA.

APPENDIX A: MAP OF GIRL-POWER MALAWI SITES



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