

CONTRACEPTION METHODS AND CERVICAL CANCER PREVENTION:
OPPORTUNITIES OR UNINTENDED CONSEQUENCES?

by

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ABSTRACT

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Background: Patients may seek sexual and reproductive health care for a range of clinical services, including cervical cancer prevention through human papillomavirus (HPV) vaccination or screening with Pap and/or HPV testing, or pregnancy prevention through initiation or continuation of contraceptive methods. Recommendations for frequency of cervical cancer screening are clearly defined, but clinical surveillance for contraception varies significantly between methods. Despite the opportunities presented to complete preventive health care during clinical encounters for contraception, there are no existing analyses that explicitly consider the associations between contraceptive services and cervical cancer prevention and screening.

Methods: A secondary data analysis of the 2015-2019 National Survey of Family Growth (NSFG) was completed to investigate the association between past and current contraception use and (a) awareness of cervical cancer screening recommendations, (b) history of HPV vaccination, (c) maintenance of current cervical cancer screening, and (d) Pap testing interval. Special populations, including sexual minority women and rural residents, were also considered. Univariate and bivariate statistics were calculated and logistic regression was used to estimate odds ratios (OR) using STATA 17.0, guided by a theory-based model.

Results: Use of provider-surveilled contraception methods was associated with higher rates of HPV vaccination, increased odds of Pap testing prior to age 21, higher odds of current Pap testing, and lower odds of a >12 month Pap testing interval. There were no significant differences among contraception users in awareness of screening recommendations, nor were there differences in maintenance of current screening according to sexual orientation or place of residence.

Significance: While provider-surveilled contraception use was associated with protective behaviors, individuals may undergo excessive cervical cancer screening that could increase risk for physical, emotional, or financial consequences, while not providing additional protection against cervical cancer. Clinical interactions should emphasize evidence-based cervical cancer prevention counseling and screening, while public health campaigns and health policy enhance awareness of these measures and reimbursement for services, respectively. Further research is necessary to understand the consequences of excessive screening while developing interventions to reach those at risk for delayed screening.

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To Etta Marian,
and those who have helped nurture her so I could achieve my goals

TABLE OF CONTENTS

LIST OF FIGURES	ix
LIST OF TABLES	x
LIST OF ABBREVIATIONS.....	xi
ACKNOWLEDGEMENTS	xii
Chapter 1. Introduction.....	1
Cervical Cancer and Human Papillomavirus.....	3
Cervical Cancer Prevention Measures	4
Cervical Cancer Overscreening	6
Contraception and Cervical Cancer Prevention Services	7
Contraception and Cervical Cancer Prevention Inequities in Special Populations	9
Knowledge and Beliefs Regarding Cervical Cancer Prevention	13
Theoretical Framework	14
The Social Contextual Model of Health Behavior Change	14
Reproductive Health and Cervical Cancer Prevention: A Social Contextual Model.....	15
Definitions	16
Health Behavior Outcomes	16
Contraception	18
Sources of Knowledge About Contraception and Cervical Cancer Screening.....	20
Research Objectives.....	21
Chapter 2. Methodology	23
Study Design.....	23
Data Source	23
National Survey of Family Growth (NSFG)	23
Measures	25
Dependent Variables.....	25
Independent Variables	27
Other Variables	28
Approach.....	29
Aim 1	31
Aim 1 Study Population.....	31
Aim 1 Key Variables	31
Aim 1 Other Variables	32
Aim 1 Data Analysis	33
Aim 2	33
Aim 2 Study Population.....	33
Aim 2 Key Variables	33
Aim 2 Other Variables	33
Aim 2 Data Analysis	34

Aim 3	35
Aim 3a Study Population	35
Aim 3a Key Variables	35
Aim 3a Other Variables	35
Aim 3a Data Analysis	36
Aim 3b Study Population	37
Aim 3b Key Variables	37
Aim 3b Other Variables	37
Aim 3b Data Analysis	38
Aim 3c Study Population	39
Aim 3c Key Variables	39
Aim 3c Other Variables	39
Aim 4	40
Aim 4 Study Population	41
Aim 4 Key Variables	41
Aim 4 Data Analysis	41
Regression Modeling	41
Chapter 3. Results	43
Aim 1	43
Aim 1 Descriptive Statistics	43
Aim 1 Bivariate Statistics	46
Aim 1 Regression Analyses Results	48
Aim 2	55
Aim 2 Descriptive Statistics	55
Aim 2 Bivariate Statistics	56
Aim 2 Regression Analyses Results	58
Aim 3	60
Aim 3a Descriptive Statistics	60
Aim 3a Bivariate Statistics	60
Aim 3a Regression Analyses Results	63
Aim 3b Descriptive Statistics	65
Aim 3b Bivariate Statistics	67
Aim 3b Regression Analyses Results	68
Aim 3c Descriptive Statistics	72
Aim 3c Bivariate Statistics	73
Aim 3c Regression Analyses Results	75
Aim 4	77
Chapter 4. Discussion	78
Aim 1: Overestimation of Pap and HPV Testing Intervals	78
Aim 2: HPV Vaccination	80
Aim 3a: Contraception Use and Pap Testing Before Age 21	82
Aim 3b: Assessment of the Pap Testing Interval	84
Aim 3c: Maintenance of Current Cervical Cancer Screening	86
Applying the Social Contextual Model of Reproductive Health and Cervical Cancer Prevention	88
Race	90
Insurance Coverage	91

Rural Residence.....	92
History of Live Birth.....	93
Impact of the COVID19 Pandemic.....	93
Strengths & Limitations.....	94
Future Research.....	97
Chapter 5. Conclusion.....	99
Clinical Implications.....	99
Public Health Implications.....	102
Economic Impact.....	104
Policy Considerations.....	105
References.....	108

LIST OF FIGURES

Figure 1	A Social Contextual Model of Health Behavior Change	15
Figure 2	A Social Contextual Model of Reproductive Health and Cervical Cancer Prevention	16
Figure 3	Revised Social Contextual Model of Reproductive Health and Cervical Cancer Prevention	89

LIST OF TABLES

Table 1	Cervical Cancer Screening Guidelines for Average Risk Individuals	17
Table 2	Classification of Contraception Methods	19
Table 3	Analytical Approach According to Specific Aim	30
Table 4	Weighted descriptive statistics (percentages) by age group for Aim 1 examining overestimation of Pap and HPV testing frequency; 2015-2019 NSFG, female respondents aged 15-50 without history of abnormal Pap testing or cervical cancer	45-46
Table 5	Weighted bivariate statistics (percentages) for Aim 1 examining overestimation of Pap and HPV testing intervals, 2015-2019 NSFG, female respondents ages 21-50 without history of abnormal Pap testing or cervical cancer	47-48
Table 6	Weighted logistic regression estimates (OR, 95% CI) for Aim 1 predicting overestimation of Pap and HPV testing intervals, 2015-2019 NSFG, females aged 15-20 without history of abnormal cervical cancer screening	50-51
Table 7	Weighted logistic regression estimates (OR, 95% CI) for Aim 1 considering overestimation of Pap and HPV testing intervals, 2015-2019, females aged 21-29 without history of abnormal cervical cancer screening	51-53
Table 8	Weighted logistic regression estimates (OR, 95% CI) for Aim 1 examining overestimation of Pap and HPV testing intervals, 2015-2019 NSFG, females aged 30-50 without history of abnormal cervical cancer screening	53-54
Table 9	Weighted descriptive statistics for Aim 2 examining history of HPV vaccination; 2015-2019 NSFG, female respondents ages 15-24	55-56
Table 10	Weighted descriptive statistics for Aim 2 examining history of HPV vaccination; 2015-2019 NSFG, female respondents ages 15-24	57-58
Table 11	Weighted regression estimates for Aim 2 predicting receipt of the HPV vaccine ¹ ; 2015-2019 NSFG, females aged 15-24	59
Table 12	Weighted descriptive statistics for Aim 3a examining history of cervical cancer screening; 2015-2019 NSFG, non-pregnant females aged 15-20	61
Table 13	Weighted bivariate statistics (percentages) for Aim 3a examining history of cervical cancer screening; NSFG 2015-2019, females aged 15-20	62-63
Table 14	Weighted regression estimates for Aim 3a predicting history of cervical cancer screening; 2015-2019 NSFG, non-pregnant females aged 15-20	64
Table 15	Weighted descriptive statistics for Aim 3b examining cervical cancer screening interval; 2015-2019 NSFG, non-pregnant females aged 21-50 without history of hysterectomy or abnormal Pap test	65-66
Table 16	Weighted bivariate statistics (percentages) for Aim 3b according to Pap test interval (<1 year, 1-2 years, 2-3 years); NSFG 2015-2019, non-pregnant females aged 21-50 without history of hysterectomy	67-68
Table 17	Weighted ordinal regression estimates for Aim 3b predicting Pap testing interval (<1 year, 1-2 years, 2-3 years); NSFG 2015-2019, non-pregnant females aged 21-50 without history of hysterectomy	70-71
Table 18	Weighted descriptive statistics for Aim 3c examining being overdue for Pap testing; 2015-2019 NSFG, females aged 21-50 without history of hysterectomy	72-73
Table 19	Weighted bivariate statistics (percentages) for Aim 3c according to cervical cancer screening status (current versus overdue); NSFG 2015-2019, non-pregnant females aged 21-50 without history of hysterectomy	74-75
Table 20	Weighted logistic regression estimates for Aim 3c predicting being overdue for cervical cancer screening; NSFG 2015-2019, females age 21-50 without history of hysterectomy	76-77

LIST OF ABBREVIATIONS

ACA	Affordable Care Act
ACOG	American College of Obstetricians and Gynecologists
ACS	American Cancer Society
AIAN	American Indian and Alaska Native
ASCCP	American Society for Colposcopy and Cervical Pathology
ASCP	American Society for Clinical Pathology
BRFSS	Behavioral Risk Factor Surveillance System
CI	confidence interval
EMR	electronic medical record
FDA	Food and Drug Administration
HINTS	Health Information National Trends Survey
HPV	human papillomavirus
IUD	intrauterine device
LARC	long-acting reversible contraception
NBCCEDP	National Breast and Cervical Cancer Early Detection Program
NSFG	National Survey of Family Growth
MSA	metropolitan statistical area
OCP	oral contraceptive pill
OMB	Office of Management and Budget
OTC	over the counter
OR	odds ratio
Pap	Papanicolaou
SMW	sexual minority women
SRH	sexual and reproductive health care
STD	sexually transmitted disease
US	United States
USPSTF	United States Preventive Service Task Force

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Chapter 1. Introduction

Advancements in cervical cancer screening and prevention have led to dramatic declines in its incidence and mortality since the mid-20th century (Freeman & Wingrove, 2005; Saslow et al., 2012). Cervical cancer, still a leading cause of mortality in many developing countries (Bray et al., 2018), is projected to be responsible for less than 1.5% of new female cancer diagnoses in the United States in 2023 (American Cancer Society, 2023a) - a significant decrease credited to widespread uptake of Papanicolaou (Pap) testing, and which could be further improved through increased vaccination against human papillomavirus (HPV). The HPV vaccine, routinely administered as part of the standard vaccine schedule at age 11-12, is recommended for individuals aged 9-26 (Centers for Disease Control and Prevention, 2021a) and is highly effective against the virus attributed to nearly all cervical cancer cases (Walboomers et al., 1999). Current guidelines recommend that cervical cancer screening be initiated at age 21-25, and completed every 3-5 years until discontinuation at age 65 for average-risk individuals with an adequate, negative screening history (Curry et al., 2018; Fontham et al., 2020; Saslow et al., 2012). Despite these reliable opportunities for both primary and secondary prevention, however, these interventions require access to comprehensive health care. Specifically, sexual and reproductive health care (SRH) encompasses a range of clinical services aimed to promote well-being of the reproductive system (United Nations Population Fund, 2022); this may include addressing physical, mental, or social needs necessary to maintain a satisfying sex life, achieve or prevent pregnancy, or prevent infection or malignancy of reproductive organs. SRH further

acknowledges the important roles of human rights, bodily autonomy, education, gender equity, and access to care in achieving these goals.

In an effort to reliably prevent pregnancy, many individuals of childbearing potential may seek SRH services for contraception; between 2017-2019, nearly two-thirds of women aged 15-49 in the United States reported use of a contraceptive method (Daniels & Abma, 2020). For those utilizing a method that requires oversight by a health care provider, these clinical interactions present an optimal opportunity for receipt of preventive services such as cervical cancer screening. However, once a contraceptive method is initiated, visit requirements vary; contraceptive surveillance may range from quarterly office visits for injections to device replacement every 3 to 12 years. For this reason, although there are clear recommendations for when and how often to do so, the opportunity to offer HPV vaccination and cervical cancer screening may vary between patients dependent on their chosen contraceptive method. Further, the risk for excessive screening, including initiation of screening earlier than recommended or completing screening more frequently than recommended, must also be considered in relation to surveillance expectations for various contraceptive methods.

The impact of contraceptive surveillance intervals on patient education, HPV vaccine administration, and maintenance of Pap and/or HPV testing has not been substantially considered. The objective of this research is to consider how an individual's current and prior contraception use is associated with their awareness of cervical cancer screening recommendations, receipt of the HPV vaccine, maintenance of current Pap and/or HPV testing, and the corresponding screening interval. Using a

version of the Social Contextual Model of Health Behavior Change (Sorensen et al., 2003) modified to predict utilization of preventive health services and contraceptive use, the role of sociodemographic characteristics, intrapersonal conditions, and structural factors related to preventive care completion and SRH will also be considered.

Cervical Cancer and Human Papillomavirus

In the late 20th century, cervical cancer was the first malignancy to be attributed to a carcinogenic pathogen, human papillomavirus, which was then recognized as a necessary cause of 99.7% of cervical malignancies worldwide (Walboomers et al., 1999). This discovery has led to the development and enhanced reliability of both primary and secondary prevention measures and presents a remarkable public health opportunity to eradicate this avoidable condition. Despite this, it is projected that 13,960 new cases of invasive cervical cancer will be diagnosed in the United States in 2023, with 4,310 predicted to die from the condition (American Cancer Society, 2023a). While incidence and mortality have declined by more than 50% since the 1970s, incidence has remained stable in the last decade; rates of localized cervical cancer diagnoses are decreasing, but advanced diagnoses – which carry more intensive and less successful treatments, contributing to lower survival rates – are increasing, a phenomenon attributed to suboptimal vaccination and screening rates (American Cancer Society, 2022; Francoeur et al., 2022).

Despite the American Cancer Society's (2017) suggestion that cervical cancer rates may be approaching a lower limit, racial inequities in cervical cancer screening and outcomes persist (Newmann & Garner, 2005; Olusola et al., 2019). Cervical cancer mortality is 65% higher in Black than White populations, and Black individuals have a

lower 5-year survival rate (American Cancer Society, 2023a). Geography-based disparities are also apparent, as rural areas have higher age-adjusted incidence of cervical cancer across all stages (localized, regional, distant) of disease (Yu et al., 2019). The rural-urban disparity is especially apparent for rural-dwelling racial and ethnic minorities; here, 5-year survival rates are 50.8% and 57.8% in Black and Hispanic populations, respectively, compared to an overall survival rate of 71% in urban-dwelling non-Hispanic White individuals (Olusola et al., 2019). These racial and geographic inequities suggest that opportunities for improvement could exist if modifiable risk factors are further explored and addressed.

Cervical Cancer Prevention Measures

Persistent HPV infection that may lead to cervical cancer is potentially preventable through lifestyle measures, vaccinations, and screening that may facilitate early diagnosis and treatment. Despite incredible strides in the understanding of HPV and its role in both cervical and non-cervical cancers, tremendous opportunities exist to enhance the public's awareness of continuously-evolving guidelines in response to this knowledge (Thompson, Wheldon, et al., 2020). In addition to provider counseling regarding HPV transmission and prevention, health care providers should also ensure that vaccination status and maintenance of current screening are addressed in each SRH encounter.

Human Papillomavirus Vaccination

The first HPV vaccine was approved by the U.S. Food and Drug Administration in 2006. Widespread immunization could eradicate HPV-related disease (Beavis & Levinson, 2016; Garland, 2009). While a steep decline in cervical cancer incidence in

the United States among individuals aged 20-24 has been credited to HPV vaccination (American Cancer Society, 2023a), HPV vaccine uptake (68.1%) and completion (51.1%) remains significantly lower than the Healthy People 2020 goal of 80% coverage in both male and female adolescents (U.S. Department of Health and Human Services; Walker et al., 2018). The recommended vaccine series may include two or three doses depending on age (Centers for Disease Control and Prevention, 2021a), and completion is important to ensure that recipients have an optimal immune response to provide adequate protection from the virus.

Cervical Cancer Screening

The Pap test has been heralded for its success in dramatically reducing the incidence of cervical cancer in the United States, with over half of cases diagnosed in those who have never been screened (American Cancer Society, 2022). In 2012 the American Cancer Society (ACS), the American Society for Colposcopy and Cervical Pathology (ASCCP), and the American Society for Clinical Pathology (ASCP) released a consensus guideline recommending Pap testing every 3 years for individuals ages 21-29. Pap testing every 3 years is acknowledged as an acceptable screening approach for those aged 30-65, though the preferred screening method in this age group is “cotesting” with both Pap and HPV testing every 5 years (Saslow et al., 2012). Recognizing the increased sensitivity of HPV testing in detecting cervical dysplasia, the U.S. Preventive Service Task Force (USPSTF) updated screening guidelines in 2018 to include a third option, HPV testing alone (hereafter referred to as primary HPV testing) every 5 years, as an acceptable alternative to Pap only or cotesting for individuals aged 30-65 (Curry et al., 2018). Primary HPV testing was then endorsed by the American

Cancer Society as the preferred method of screening in 2020 and, due to a low disease burden in individuals under 25 years of age, the recommended age of screening initiation per ACS was delayed to 25 years (Fontham et al., 2020). This evolution in screening recommendations over the last decade illustrates tremendous strides in the understanding of cervical cancer development and progression, but both patients and health care providers have expressed discontent with or lack of awareness of the change. While adoption of current guidelines has expanded significantly (Cuzick et al., 2021), even several years after guideline revision over 40% of providers indicated that they were not utilizing HPV cotesting (Teoh et al., 2015). Further, patients have expressed concern regarding the risk of cancer developing during the expanded screening interval (Gerend et al., 2017). While more frequent Pap testing increases the likelihood of invasive diagnostic procedures and the psychological distress and physical discomfort associated with them (Saslow et al., 2012), provider confusion and/or skepticism regarding the guideline change is likely to contribute to completion of screening more frequently than the intervals recommended in national guidelines (Boone et al., 2016).

Cervical Cancer Overscreening

Excessive cervical cancer screening, or overscreening, may include (a) initiating screening earlier than recommended, (b) completing screening more frequently than recommended, or (c) continuing screening beyond the recommended age of discontinuation. Guidelines for screening initiation and discontinuation are largely based on age, with rare exceptions for individuals with limited life expectancy, immune suppression, or history of precancerous lesions (Curry et al., 2018; Fontham et al.,

2020; Saslow et al., 2012). There are no aspects of the individual's medical history, exposures, or behaviors that indicate that testing should be completed prior to age 21, a significant difference from the guidelines released in the last decade. Medicare coverage, which provides health insurance for people under 65 who have certain health conditions and disabilities and typically a need for higher health care utilization, was a significant predictor of unindicated cervical cancer screening in individuals under age 21 (Franklin et al., 2020), in addition to use of hormonal contraception, pregnancy, or completion of testing for sexually transmitted diseases (STDs) (Qin et al., 2020). Excessive screening of older adults (age 66+) has been documented more frequently in metropolitan areas and in those with better self-reported health, who are married, have an educational attainment beyond a high school diploma, and who are non-Hispanic Black and Hispanic (Moss et al., 2020).

In addition to discomfort associated with speculum exam and specimen collection, and potential for stress and anxiety associated with abnormal results and follow-up care, overscreening also poses a significant economic burden; the cost of excess screening in individuals ages 18-20 in a 2-year period was over \$35,000 in a single U.S. health system (Teoh et al., 2018). When multiplied across the hundreds of health systems in the country, this may account for millions of dollars in potentially unnecessary health care expenditures.

Contraception and Cervical Cancer Prevention Services

Among the 65% of individuals aged 15-49 using contraception between 2017-2019, the most commonly used methods included tubal sterilization (18.1%), oral contraceptive pills (14.0%), long-acting reversible contraception (10.4%), and penile

(outer) condoms (8.4%) (Daniels & Abma, 2020). Use of contraceptive methods varied among ethnic groups and by educational attainment, and increased with age, from 38.7% of women aged 15-19 to 74.8% of women aged 40-49 (Daniels & Abma, 2020). Considering that a number of contraceptive methods require insertion by or prescription from a health care professional, these patient-provider interactions may also present important opportunities to confer preventive health care such as anticipatory guidance, HPV vaccination, or cervical cancer screening. While associations between HPV vaccination and current Pap test completion have been documented (Guo et al., 2017), there are no existing analyses that explicitly consider the associations between contraceptive services and cervical cancer prevention and screening.

While patient-provider interactions for contraceptive services may present a convenient preventive care opportunity, 13% of women have reported difficulty obtaining a prescription or refill for hormonal contraception due to the clinician requiring a clinic visit, exam, or Pap smear (Grindlay & Grossman, 2016). In fact, some providers require that patients present annually to receive prescriptions for contraception – a practice that has been deemed unnecessary and a barrier to contraceptive care (American College of Obstetricians and Gynecologists, 2019). Dubbed “Pap Smear Ransom” (Marchand & Sainz, 2020), the denial of prescription refills until a patient completes a clinic visit increases risk for unintended pregnancy in patients unable to present for care according to arbitrary schedules imposed by prescribers. Once the individual presents to the office, patients may be subjected to invasive pelvic exams or unindicated collection of screening specimens. While expert opinion is that routine pelvic exam in the asymptomatic individual may result in early detection of vulvar or

vaginal cancers or offer the opportunity for open dialogue between the patient and provider regarding the patient's anatomy, it may also result in fear, embarrassment, or pain (American College of Obstetricians and Gynecologists, 2018). Due to limited data regarding both the benefits or harms of routine pelvic examination, the American College of Obstetricians and Gynecologists (ACOG) asserts that "a pelvic examination is not necessary before initiating or prescribing contraception, other than an intrauterine device" (2018, p. 175). That said, there are no national guidelines regarding the practice of undergoing screening for preventable cancers during visits meant to reduce the risk of unintended pregnancy; in fact, ACOG recommends that hormonal contraception be available over the counter (OTC), relying on the individual to self-screen to determine their eligibility (2019).

Contraception and Cervical Cancer Prevention Inequities in Special Populations

While the burden of cervical cancer in the United States has decreased significantly, the decline has not been equally distributed across all groups. Inequities in HPV vaccination, Pap and HPV testing, and cervical cancer incidence and mortality exist among racial and ethnic minority groups, the socioeconomically disadvantaged, in those with lower educational attainment, those residing in isolated areas, and in sexual minority women (Buskwofie et al., 2020; Harper et al., 2022; Locklar & Do, 2021; McDonald et al., 2022). Compromised access to care, quality of counseling and available services, and mistrust of providers fueled by historically racist practices, discrimination, and reproductive coercion are likely to contribute to differences in SRH utilization and subsequent vaccination and screening completion. Though the challenges to receipt of preventive services posed to each population are unique,

differences in uptake of these measures could ultimately influence morbidity and mortality across populations. Further, use of and/or access to contraception may present special considerations for each group.

Race

Non-Hispanic Black, Hispanic, and American Indian and Alaska Native (AIAN) populations have higher cervical cancer incidence and mortality than their non-Hispanic White counterparts (American Cancer Society, 2022). Similar self-reported Pap testing rates among racial and ethnic minorities compared to non-Hispanic Whites raise concerns regarding access to follow-up care and treatment completion (Buskwofie et al., 2020). Evidence of lower HPV vaccination rates and lower screening rates in young White women is also emerging, and is thought to contribute to increasing rates of advanced-stage diagnoses, especially in younger age groups (Francoeur et al., 2022).

Black and Hispanic individuals report lower overall rates of contraception use, including highly-effective methods such as LARC or sterilization (Daniels & Abma, 2020; Dehlendorf et al., 2014). Preferences regarding contraceptive features, including the ability to discontinue the method and conceive when desired, effects on menstrual cycles, and protection against sexually transmitted diseases, differ across racial groups (Jackson et al., 2016). Impaired access to SRH, including utilization of both contraception and fertility services, is most notable in Black and Hispanic individuals and attributed to cost prohibition, inadequate counseling, and discrimination (Beroukhim et al., 2022). Black individuals report personal, vicarious, and historical experiences of structural racism and reproductive coercion, resulting in invalidation, dismissal, and

absence of shared decision making, and inspire protective actions, such as avoiding the health care system or seeking intervention only when desperate (Treder et al., 2022).

Place of Residence

Rural patients, providers, and staff identify geographic barriers and distance to services as the most important obstacle to health care receipt (Buzza et al., 2011). Rural providers express concern that distance may reduce patient visit frequency (Khoong et al., 2014), increasing the likelihood the patients present for acute visits rather than for the receipt of preventive care services, such as cancer screenings or contraceptive care. Low patient volumes may limit clinic hours and availability of flexible appointment times. Further, public transportation services may be non-existent, cost-prohibitive, or have limited availability. Travel to both general and, often more significantly, specialty care, may require substantial time and resources.

It is unsurprising that variation in both contraception use and cervical cancer prevention efforts has been documented according to place of residence given the access required to utilize these services. Rural adolescents have lower rates of HPV vaccine initiation and series completion (Walker et al., 2019), though a convenience sample of patients aged 18-26 at a rural clinic showed that current use of hormonal contraception was protective against HPV vaccine refusal (Mills et al., 2011). Lower Pap and HPV testing rates have been noted in rural individuals (Casey et al., 2001; Coughlin et al., 2002; Harper et al., 2020; Larson & Correa-de-Araujo, 2006; Locklar & Do, 2021), potentially contributing to higher cervical cancer incidence and mortality rates in rural compared to urban individuals (Blake et al., 2017). There is significant variation (two- or threefold) in cervical cancer incidence and mortality across states (Siegel et al., 2020).

Contraceptive services may also be limited; a survey of 558 family planning clinics in the Great Plains and the Midwest found that 70% of isolated rural clinics lacked a practitioner trained to provide LARC (Martins et al., 2016). Availability of services may also ultimately influence known variation in fertility-related behavior among rural and urban individuals, including number of births and regional patterns of contraceptive use (Daniels et al., 2018).

Sexual Orientation

Sexual minority women (SMW; women who do not identify as exclusively heterosexual including queer, bisexual, or lesbian) are at heightened risk of sexual and reproductive health threats in both adolescence and adulthood, including increased rates of mistimed or unwanted pregnancy, pregnancy termination, higher number of sexual partners, earlier initiation of sexual activity, and increased likelihood of experiencing sexual violence (Everett et al., 2017; Tornello et al., 2014). These inequities illustrate the need for both comprehensive contraception and cervical cancer prevention services due to the risk for unwanted pregnancy and HPV transmission, respectively. Cervical cancer screening rates among SMW are lower than their heterosexual counterparts, with lesbian women exhibiting the lowest rates of recent Pap testing (Agénor et al., 2014; Agénor et al., 2017). Most SMW report experience with penile-vaginal intercourse (Diamond, 2008, 2016; Everett et al., 2019; Higgins et al., 2019) and comprise a substantial share – up to 1 in 3 – of clients seeking contraceptive services (Everett et al., 2018); however, SMW also face barriers to SRH access due to stigma within the health care system, exclusion from pregnancy-prevention messaging, and a struggle to reconcile contraceptive use with queer identity (Higgins et al., 2019).

While lesbian women are less likely to use any form of contraception, those currently using hormonal contraception report increased Pap test utilization rates (Charlton et al., 2014). Further, use of LARC is increasing across other sexual minority groups (Charlton et al., 2019). As contraception is a common entry point into SRH for many patients, lack of necessity may present unintended barriers to other services commonly offered in that setting, such as cervical cancer screening. While women who have sex exclusively with other women may not require contraception, they may also choose to utilize it for non-contraceptive benefits, including menstrual regulation or suppression.

Knowledge and Beliefs Regarding Cervical Cancer Prevention

Public dialogue regarding HPV and associated cancers has increased significantly in the last decade as a greater understanding regarding their long-term sequelae and preventable nature has developed. However, this information may not be equally disseminated among populations dependent on individual factors, such as one's personal risk profile or counseling offered during interactions with health care providers. While many adults in the United States are aware of HPV (72.9%) and HPV vaccination (67.1%), this knowledge is unevenly distributed across sexes, education levels, and according to cancer information-seeking behaviors (Thompson, Wheldon, et al., 2020). Place of residence also contributes to knowledge disparities, as rural adults are less likely than their urban peers to have heard of HPV or the vaccine that prevents it and less likely to believe that the virus causes cervical cancer or could be transmitted through sexual contact (Mohammed et al., 2018). This lack of awareness may contribute to population-level inequities in cervical and other HPV-related cancers, especially if recommendations for prevention or screening are not well understood.

Considering a greater than 80% lifetime risk of acquiring HPV (Chesson et al., 2014), it is crucial that the entire population has an understanding of its pathology and is thoroughly counseled not only on lifestyle measures to reduce the likelihood of transmission or persistent infection, but also routine screening to reduce associated morbidity and mortality.

Theoretical Framework

Despite dramatic advancements in the understanding of cervical cancer pathogenesis and prevention, individuals continue to be diagnosed with and die from the malignancy. While HPV and cervical cancer prevention, screening, and treatment efforts are safe and effective, awareness of and accessibility to them may be largely influenced by sociodemographic and reproductive health factors. For this reason, the effects of these influences on health behaviors and outcomes must also be considered when strategizing how to maximize the reach of vaccination and screening programs. To demonstrate how sociodemographic and reproductive health factors relate to HPV and cervical cancer prevention and screening behaviors, a multidisciplinary conceptual model will be adapted.

The Social Contextual Model of Health Behavior Change

Figure 1, the Social Contextual Model of Health Behavior Change (Sorensen et al., 2003) provides a conceptual framework valuable in evaluating how a sociodemographic characteristic may influence health outcomes. Inspired by the traditions of behavioral research, social epidemiology, and tenets of Social Cognitive Theory, the Transtheoretical Model, and the Theory of Reasoned Action, the multidisciplinary framework demonstrates how a characteristic may present conditions

that mediate or modify the relationship between that factor and a specific health outcome. This model will be used to present considerations regarding potential mechanisms influencing health behaviors, and adapted (Figure 2) to specifically illustrate the relationship between specific reproductive health factors and cervical cancer morbidity and mortality.

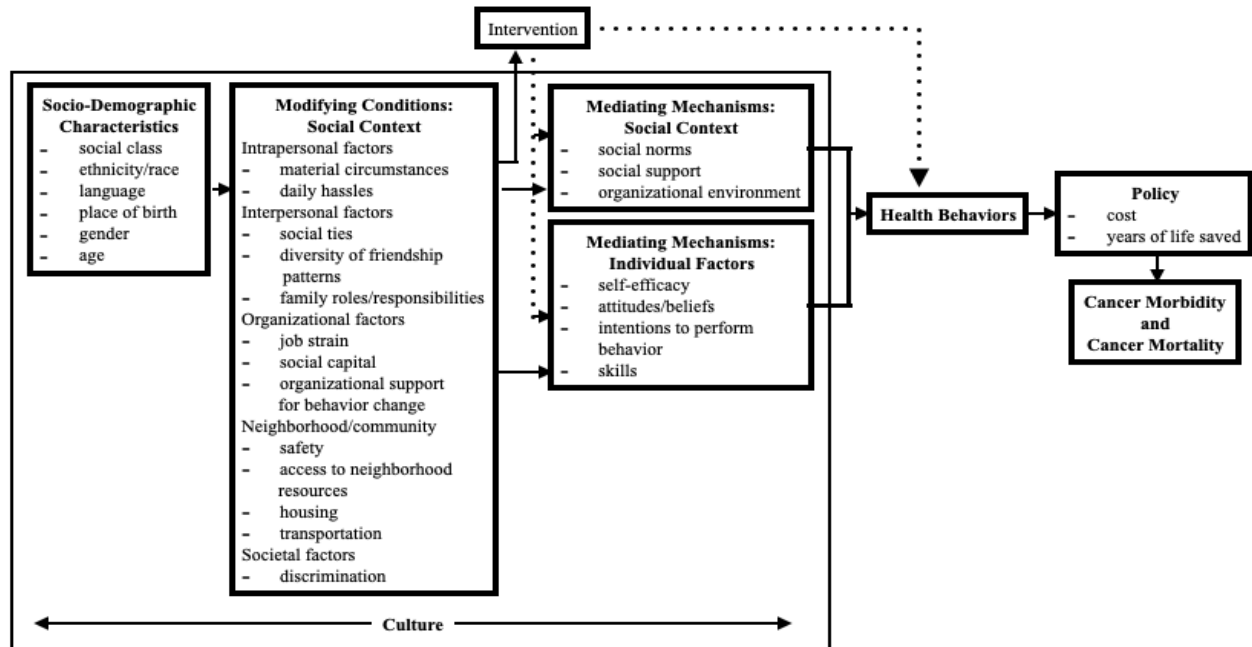


Figure 1. A Social Contextual Model of Health Behavior Change (Sorensen et al., 2003)

Reproductive Health and Cervical Cancer Prevention: A Social Contextual Model

The relationship between contraception use, SRH uptake, and cervical cancer prevention and screening is likely to be directly and indirectly influenced by a number of sociodemographic and intrapersonal factors. To illustrate these relationships, Figure 2 presents an adaptation of the Social Contextual Model of Health Behavior Change. Modifying conditions, including contraceptive method, independently influence the outcome by impacting the uptake or effectiveness of an intervention (Sorensen et al., 2003) - specifically receipt of sexual and reproductive health care.

The Social Contextual Model of Reproductive Health and Cervical Cancer Prevention presents a comprehensive, though not exhaustive, list of factors that may directly or indirectly influence an individual's uptake of or access to sexual and reproductive health

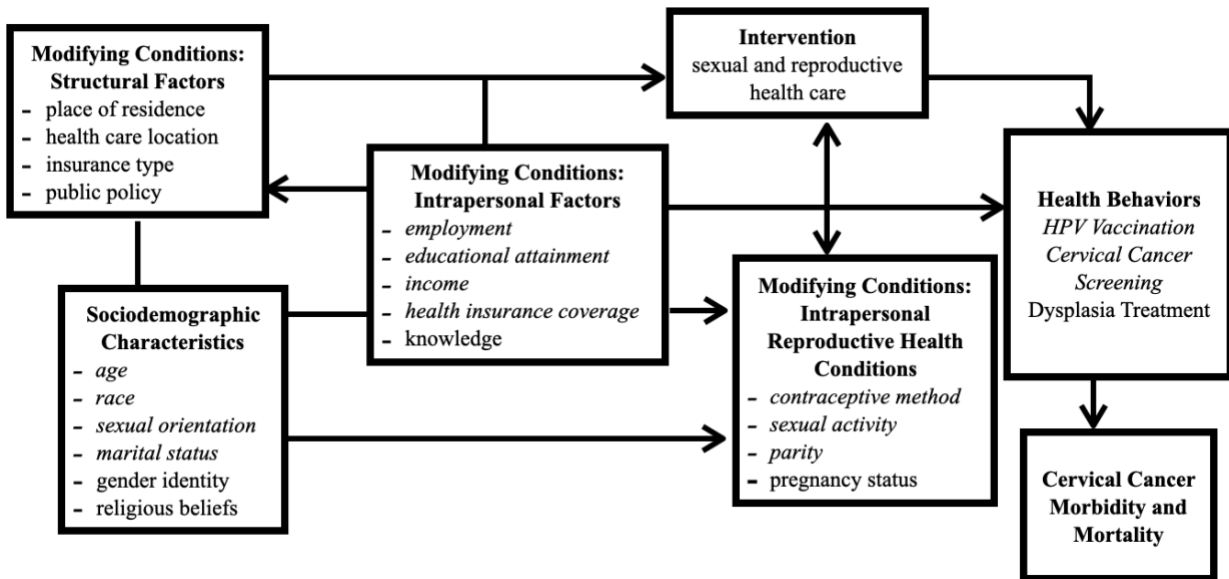


Figure 2. Social Contextual Model of Reproductive Health and Cervical Cancer Prevention (adapted from Sorensen et al., 2003)

care. This care may include counseling and interventions aimed to reduce the risk for cervical cancer morbidity and mortality, including HPV vaccination, cervical cancer screening, and treatment of cervical dysplasia. Analytical models utilized for the research objectives presented below will incorporate italicized variables. These include sociodemographic characteristics (*age*, *race*, *sexual orientation*), structural factors (*place of residence*), intrapersonal factors (*employment*, *educational attainment*, *income*, *health insurance coverage*) and reproductive health conditions (*contraceptive method*, *sexual activity*, *parity*).

Definitions

Health Behavior Outcomes

HPV Vaccination. The HPV vaccine is currently recommended for individuals ages 9 to 45 for the prevention of cervical cancer. This age range reflects an expanded group from the initial Food & Drug Administration (FDA) approval, as the recommendation was revised in 2020 from the original approval for natal females ages 9 to 26. The HPV vaccine series is routinely recommended at age 11 or 12 and, depending on the age of initiation, includes two (ages 9-14) or three doses (age 15-26) (Centers for Disease Control and Prevention, 2021a).

Cervical Cancer Screening. Table 1 presents current acceptable guidelines for cervical cancer screening from several national organizations. Updates from prior releases are italicized. In 2012 the American Cancer Society (ACS), American Society for Colposcopy and Cervical Pathology (ASCCP), and American Society for Clinical

Table 1. Cervical Cancer Screening Guidelines for Average Risk Individuals

Age	Cervical Cancer Screening Recommendation		
	2012 ACS, ASCCP, ASCP consensus (Saslow et al., 2012)	2018 USPSTF update (Curry et al., 2018)	2020 ACS update (Fontham et al., 2020)
<21	screening not indicated		
21-29	Pap alone within 3 years		<25: <i>screening not indicated</i>
			25-65: primary HPV testing every 5 years (<i>preferred</i>) cotesting every 5 years (acceptable) Pap alone every 3 years (acceptable)
30-65	cotesting every 5 years (<i>preferred</i>) Pap alone within 3 years (acceptable)	Pap alone every 3 years cotesting every 5 years <i>primary HPV testing every 5 years</i>	
>65	screening not indicated for those with adequate prior screening history		

Pathology (ASCP) released revised screening recommendations for the prevention and early detection of cervical cancer. While the ACS first acknowledged the role of HPV in cervical cancer pathogenesis in their 2003 screening guidelines, the 2012 release incorporated a systematic review of a decade's worth of evidence regarding HPV and included significant changes in age-related screening recommendations and management of abnormal results (Saslow et al., 2012). This included recommendations to initiate screening at age 21 with cytology (Pap) alone every 3 years until age 29, then the preferred method of adding HPV testing to Pap specimens (cotesting) every 5 years from ages 30-65. In 2018 the USPSTF released an updated guideline including acceptance of primary HPV testing every 5 years in the 30-65 age group (Curry et al., 2018). This was followed by an update from ACS in 2020, recommending that screening not be initiated until age 25 and continued through age 65 with primary HPV testing as the preferred mechanism.

Contraception

A number of hormonal and non-hormonal strategies exist for pregnancy prevention. There are many different ways in which contraceptive methods are categorized; drawing on the schema outlined by the data source and for the purposes of this research, these methods are categorized according to features of use in Table 2. In addition to pregnancy prevention, many hormonal formulations may also be used off-label for non-contraceptive benefits such as menstrual regulation or suppression. I define "provider-surveilled contraception" as methods that require prescriptions or procedures to initiate, continue, or discontinue. These methods include *long-acting reversible contraception* (LARC, including Nexplanon and intrauterine devices [IUDs]),

progestin injection (Depo Provera), and other *prescription* methods, including oral contraceptive pills (OCP), patch, or ring. LARC require office visits for insertion,

Table 2. Classification of Contraception Methods¹

Primary Contraception Class	Methods Included
PROVIDER-SURVEILLED CONTRACEPTION	
Long-Acting Reversible Contraception (LARC)	Nexplanon
	intrauterine devices (copper IUD and progestin IUDs)
Progestin injection	Depo Provera
Prescription	oral contraceptive pill (OCP)
	patch
	ring
OTHER CONTRACEPTIVE METHODS	
Permanent	tubal sterilization
	vasectomy
Over the Counter (OTC)	emergency contraceptive pills (may require prescription)
	diaphragm
	penile condom
	spermicides (jelly, creams, films)
Non-hormonal	fertility awareness methods
	withdrawal
Non-users (report penile-vaginal intercourse in the last 3 months, not actively seeking pregnancy)	do not report using any method

¹ “non-candidates” include those who are attempting pregnancy or deny penile-vaginal intercourse in the last three months

removal, or replacement, whereas progestin injections are administered quarterly and prescription methods may require regular scheduled renewal of a script according to prescriber and/or clinic policy. Other contraceptive methods include *permanent* (vasectomy or tubal sterilization), *over the counter* (OTC) methods (some emergency contraceptive pills, penile [outer] condom, vaginal [inner] condom, diaphragm, cream/jelly), or *non-hormonal* (fertility awareness methods, withdrawal) approaches. These methods can be accessed and utilized without provider oversight. Those attempting pregnancy or currently abstinent (no intercourse within 3 months) are non-candidates, and individuals not using contraception are classified as non-users.

Sources of Knowledge About Contraception and Cervical Cancer Screening

Extant literature regarding contraception use and its association with cervical cancer prevention and screening in the United States is sparse, and understanding this relationship requires information regarding a number of sensitive SRH topics. Medical records may offer the most reliable information regarding receipt of vaccinations, completion of screening tests, and the timing and use of provider-surveilled contraceptive methods; however, laborious review may be necessary to garner information regarding non-hormonal or behavioral practices used to avoid pregnancy, should these be formally documented at all. This also requires that records be current and comprehensive, as accuracy would be affected if vaccination or screening is completed within another health system. Especially considering the length of time between Pap test completion, relocation or insurance changes could contribute significantly to incomplete or inaccurate information.

Use of publicly available data gathered through conventional survey procedures is also limited due to the sensitivity of the data collected, especially when considering smaller populations such as sexual minorities and rural dwellers. The National Survey of Family Growth (NSFG) provides an important source of this data, collected through voluntary, confidential, in-person interviews of a nationally representative sample (National Center for Health Statistics, 2020). To enhance respondent confidentiality, answers to sensitive topics are answered privately through self-administration. The NSFG, discussed in Chapter 2, will be analyzed to answer the research questions developed in response to current gaps in the literature.

Research Objectives

To better understand the relationship between contraception use and cervical cancer screening and prevention, four specific aims were identified. Data from two rounds (2015-2019) of the NSFG were analyzed to illustrate relationships between key variables of interest (past and current contraception use, estimation of the recommended cervical cancer screening interval, HPV vaccination, and maintenance of cervical cancer screening and the associated interval), and the sociodemographic characteristics, structural factors, and intrapersonal modifying conditions presented in the Social Contextual Model of Reproductive Health and Cervical Cancer Prevention (Figure 2).

The aims of this study were to:

Aim One: examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency

Q1: Is current knowledge regarding age-specific cervical cancer screening recommendations associated with current contraception use?

Aim Two: document HPV vaccination rates among users of different contraceptive classes

Q2: Is provider-surveilled contraception use associated with HPV vaccine receipt?

Aim Three: examine how contraception use across the lifespan is associated with cervical cancer screening completion, the screening interval, or maintenance of current screening

Q3a: Among ages 15-20, how is risk for cervical cancer screening distributed across users of all contraceptive classes?

Q3b: Among ages 21-50, how is contraception use associated with an individual's cervical cancer screening interval?

Q3c: Are users of certain contraceptive classes more likely to be overdue for cervical cancer screening?

Aim Four: assess the association between contraception methods and maintenance of current cervical cancer screening among sexual minority women and rural dwellers

Q4a: Does maintenance of current cervical cancer screening vary among contraceptive users according to sexual orientation?

Q4b: Does maintenance of current cervical cancer screening vary among contraceptive users according to place of residence?

Chapter 2. Methodology

Study Design

This was a quantitative study using publicly-available survey data to examine the relationship between contraception use and cervical cancer prevention and screening behaviors across the lifespan. Two rounds (2015-2017, 2017-2019) of the National Survey of Family Growth were combined to produce a robust analytical sample while also limiting the study time frame to allow for consistency in national cervical cancer screening recommendations in place at the time of data collection. Descriptive statistics for each analytical sample were calculated after which bivariate analyses were performed to test hypotheses regarding associations between the independent and dependent variables of interest. Regression analyses were then used to estimate associations between outcomes of interest and key predictors while controlling for other sociodemographic characteristics according to the Social Contextual Model of Reproductive Health and Cervical Cancer Prevention.

Data Source

National Survey of Family Growth (NSFG)

The National Survey of Family Growth is conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics. Data are collected in four 12-week waves per year through in-person interviews with non-institutionalized, civilian individuals ages 15-50 living in the United States. Sampling is performed using probability-based, multistage methods to generate a nationally representative sample. In addition to information regarding family life, marriage and divorce, pregnancy, and infertility, the NSFG collects data on current and past contraceptive use (month-by-

month method recorded for the previous 3 years) and preventive services, including cancer screening and vaccination (National Center for Health Statistics, 2020). There are not currently questions in the NSFG regarding sex assigned at birth or current gender identification; respondents initially self-identify and are then classified as “male” or “female” with separate data files corresponding to each sex.² Between 2015-2019 82,000+ households were sampled with over 33,000 having at least one household member meet eligibility criteria; 21,441 total interviews were conducted in this time period (National Center for Health Statistics, 2021a). NSFG interviews are voluntary, confidential, and conducted by female interviewers; interviewees answer more sensitive questions privately using self-administration of the survey (National Center for Health Statistics, 2020). Participants who meet screening criteria and agree to the interview are provided an \$80 prepaid incentive. Mean length of interview time for female respondents from 2015-2019 was 74.8 minutes with a 66.2% total response rate (Centers for Disease Control and Prevention, 2021b).

NSFG data files are published for public use every 2 years. This research utilized a combined 2015-2019 dataset, which provided appropriately scaled and defined weights that reflect population characteristics at the midpoints of the span of years used (July 2017 for the 2015-2019 file combination). This combined file treats the two 2-year survey periods as a single survey period in order to avoid inflated or inaccurate population size estimates by using separate case weights (National Center for Health Statistics, 2021b). In 2015 the NSFG expanded interviews to include respondents ages 15-50; prior to 2015 surveys were completed through age 44. Due to compatibility of

² For this reason, respondents may be hereby referred to as “female”.

survey weights after this age range expansion, datasets released prior to 2015 were not able to be combined with the most recent (2015-2019) analytical samples. Regression analyses considered the complex survey design of the NSFG, utilizing survey (svy) methods in STATA that incorporate final post-stratified, fully adjusted case weights, specified strata and clusters, and present robust standard errors. Logistic regression coefficients are expressed as odds ratios (OR). Observations with missing data for key variables were excluded from analyses.

Measures

Dependent Variables

Each dependent variable described below represents a facet of HPV or cervical cancer awareness, prevention, or screening.

Overestimation of Recommended Screening Frequency. NSFG respondents without history of hysterectomy were asked “How often do you think you will need to have a Pap test for regular cancer screening?” and “How often do you think you will need to have an HPV test?” Participants’ responses for Pap and HPV testing frequency were compared to national guidelines in place at the time of the survey. Considering heterogeneity in demographic composition across age groups and significant differences in recommended screening frequency according to age, separate regression analyses were conducted for each age group. The majority of respondents across all age groups overestimated the recommended frequency for Pap and HPV testing. As excessive screening may incur excess cost and present physical and/or psychological discomfort for the patient, this was assigned as the dependent variable of interest in order to determine predictors of this potentially harmful overestimation. This was treated

as a binary outcome, with overestimation of the Pap and HPV testing frequency assigned with 1 and respondents who indicated the correct screening frequency, a less frequent interval, or that they did not know, were assigned a 0. Because respondents ages 30+ may either have Pap testing every 3 years or Pap with HPV cotesting every 5 years, a 3-5 year testing interval was considered an accurate response for this age group; less than 3 years was considered an overestimation. Hence, I developed two dependent variables to reflect Overestimation of Recommended Pap Testing Frequency and Overestimation of Recommended HPV Testing Frequency.

Receipt of the HPV Vaccination. NSFG data does not differentiate between receipt of one, two, or three doses of the HPV vaccine series; therefore, this was treated as a binary variable where any receipt (rather than completion of the series) was considered a positive response.

History of Pap Testing. This outcome was binary, with history of Pap testing at any time in the respondent's lifetime representing a positive response.

Pap Testing Interval. Categories for the respondent's Pap testing interval included <1 year, 1-2 years, and 2-3 years.

Overdue for Cervical Cancer Screening. Respondents were classified as being overdue for cervical cancer screening if they had never had cervical cancer screening or if their last screening was outside of the recommended timeframe according to 2012 ASCCP guidelines (Table 1); this includes Pap test within 3 years (ages 21-50) or Pap with HPV cotesting within 5 years (age 30+). For respondents ages 30+ in 2019, HPV testing without Pap test in the last 12 months fulfilled current screening guidelines

according to 2018 USPSTF guidelines; however, there were no observations meeting this criteria.

Independent Variables

The key independent variables each reflect the respondent's current or historical contraception use, as described below.

Current Contraception Method. Current method of contraception was defined as the method in use by the respondent at the time of the survey. This was classified into subcategories according to need and/or interval for in-person office visit (injection/prescription, LARC, permanent, OTC/other).

History of Provider-Surveilled Contraception Use. Users with history of LARC, injection, or prescription contraception at any time were combined into a binary "history of provider-surveilled contraception" group that served as the key predictor for the outcome of interest in Aims 2 and 3a. Respondents who indicated that they had never used IUD, Nexplanon, or a contraceptive pill, ring, patch, or injection were assigned to the comparison group.

Contraception Method at Time of Last Pap Test. Detailed month-by-month contraception use was reviewed to determine which contraceptive method(s) were utilized during the time frame (<1 year, 1-2 years, 2-3 years) in which the last Pap test was collected. If multiple methods were reported, the one requiring the most frequent provider oversight (1. injection/prescription, 2. LARC, 3. sterilization, 4. OTC/other) was assigned as the primary method.

Current Provider-Surveilled Contraception Use. Current use of a provider-surveilled contraception method included respondents who reported pill, patch, ring, injection, or LARC use at the time of the survey.

Other Variables

Other variables represent key factors related to cervical cancer prevention and screening as summarized in Figure 2.

Age. Age was a continuous variable for years 15-50 (four respondents were age 49 at the time of their screening interview, but had turned 50 at the time of their actual interview).

Race. Consistent with NSFG categorization, race was categorized as “non-Hispanic White” (reference category), “non-Hispanic Black,” “Hispanic or Latino,” and “other.”

Marital Status. The NSFG formal marital status categories include “married to a person of the opposite sex,” “never married,” “separated,” “divorced or annulled,” or “widowed.” “Separated” and “divorced or annulled” were combined into one “divorced or separated” category. The NSFG does not currently account for same-sex marriage or the non-binary nature of sex. The reference category was “married.”

Poverty Percentage. This was a categorical variable that assessed household income according to place of residence to determine the respondent’s percent of poverty level (<100%, 100-199%, 200-299%, 300-399%, 400-499%, >500% [reference]). Higher percentage of poverty level is consistent with and may hereafter be referred to as higher household income or lower poverty.

Place of Residence. Publicly available NSFG datasets offer information regarding place of residence relative to one's location in a metropolitan statistical area (MSA), defined by the US Office of Management and Budget (OMB). Respondents within the principal city of the MSA, in an MSA outside of the principal city, or outside of the principal city, will be classified as "urban," "suburban" (reference category), and "rural," respectively.

Education Level. Categories for education level included "less than a high school diploma," "high school diploma," "some college," or "college diploma" (reference category).

Insurance Coverage. This was a binary outcome, with any respondent reporting public or private health insurance coverage comprising the reference category.

Sexual Orientation. NSFG classifications include "heterosexual" (reference), "lesbian," "bisexual," "something else," or "not ascertained," the latter two of which were combined into an "other" category.

History of Live Birth. This was a binary outcome, satisfied by any history of live birth regardless of the number of living children.

History of Vaginal Intercourse with a Male Partner. A binary outcome with a positive response if the female respondent reported sexual intercourse with an opposite-sex partner. The NSFG does not acknowledge the non-binary nature of sex and does not inquire regarding history of sexual activity with a same-sex partner.

Approach

Study population, key variables, and the analysis strategy for each Aim are described below; a summary of this information is included in Table 3. In each

regression model the key independent variable reflected the respondent's current or past contraception use. The contraception classes considered included LARC, injection/prescription, permanent, and OTC/other as defined in Table 2. For the purpose

Table 3: Analytical Approach According to Specific Aim

	Population	Key Dependent Variable	Key Independent Variable	Strategy
Aim 1	respondents without abnormal Pap test in the last 3 years, history of cervical intraepithelial lesion, or history of cervical cancer	overestimation of recommended screening frequency for Pap and HPV	current contraception method	binary logistic regression
Aim 2	female respondents <25 years of age	receipt of HPV vaccine	history of provider-surveilled contraception use	binary logistic regression
Aim 3	3a non-pregnant female respondents aged 15-20	history of Pap test	history of provider-surveilled contraception use	binary logistic regression
	3b non-pregnant females aged 21-50 without history of abnormal Pap test or hysterectomy who underwent Pap test within three years	Pap test interval (<1, 2, 3 years)	contraception method at time of last Pap test	ordinal logistic regression
	3c female respondents aged 21-50 without history of hysterectomy	overdue for Pap test	current contraception method	binary logistic regression
Aim 4	female respondents aged 21-50 without history of hysterectomy	overdue for Pap test	current provider-surveilled contraception use	binary logistic regression, interaction terms for contraception + special populations

of these analyses, non-users were combined with OTC/other users as these categories do not require provider oversight. If respondents reported use of multiple methods of

contraception (i.e. current use of OCP in addition to a sterilization procedure), the method requiring the most frequent provider oversight was coded as the primary method (1. injection/prescription, 2. LARC, 3. sterilization, 4. OTC/other).

Aim 1

Aim 1 examined the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency.

Aim 1 Study Population

The analytical sample for Aim 1 was comprised of females aged 15-50 without history of hysterectomy. Respondent-reported estimates of recommended testing intervals were compared to national guidelines for each of three separate age groups consistent with current age-specific recommendations for cervical cancer screening (<21, 21-29, 30+). Respondents with a history of abnormal Pap within the last 3 years were excluded as recommendations regarding follow up may differ from routine screening guidelines.

Aim 1 Key Variables

The dependent variable for Aim 1 was Overestimation of Recommended Screening Frequency. The key independent variable was Current Contraception Method. Due to a small sample size for respondents under 21 relying on permanent contraception methods (n=11), these observations were excluded in the <21 analyses in Aim 1.

Aim 1 Other Variables

Age. Because Aim 1 analyses were divided into age-specific categories according to screening recommendations, this variable was not included in Aim 1 regression equations.

Race. Race was categorized as “non-Hispanic White” (reference), “non-Hispanic Black,” “Hispanic or Latino,” and “other.”

Marital Status. Marital status categories include “married” (reference), “never married,” “divorced or separated,” or “widowed.” Marital status was not included in analyses of the <21 age group for Aim 1 as the vast majority of respondents (99.3%) were never married.

Poverty Percentage. This was a categorical variable that assessed household income according to place of residence to determine the respondent’s percent of poverty level (<100%, 100-199%, 200-299%, 300-399%, 400-499%, >500% [reference]).

Place of Residence. Respondents within the principal city of the MSA, in an MSA outside of the principal city, or outside of the principal city, will be classified as “urban,” “suburban” (reference category), and “rural,” respectively.

Education Level. Categories for education level included “less than a high school diploma,” “high school diploma,” “some college,” or “college diploma” (reference).

Insurance Coverage. This was a binary outcome, with any respondent reporting public or private health insurance coverage comprising the reference category.

Sexual Orientation. This includes “heterosexual” (reference), “lesbian,” “bisexual,” or “other.”

History of Live Birth. This was a binary outcome, satisfied by any history of live birth regardless of the number of living children.

History of Vaginal Intercourse with a Male Partner. A binary outcome with a positive response if the female respondent reported sexual intercourse with an opposite-sex partner.

Aim 1 Data Analysis

Univariate and bivariate statistics were presented as means (continuous variables) and percentages (categorical variables). Binary logistic regression was then used to estimate odds ratios for overestimation of the recommended screening frequency. Regression modeling was done in a stepwise manner as described below.

Aim 2

Aim Two documented HPV vaccination rates among users of different contraceptive classes.

Aim 2 Study Population

Due to limitations in available NSFG data regarding receipt of the HPV vaccine, Aim 2 analyses were performed on all female respondents <25 years of age.

Aim 2 Key Variables

The dependent variable for Aim 2 was Receipt of the HPV Vaccination and independent variable of interest was History of Provider-Surveilled Contraception Use.

Aim 2 Other Variables

Age. Age was a continuous variable for years 15-24.

Race. Race was categorized as “non-Hispanic White” (reference), “non-Hispanic Black,” “Hispanic or Latino,” and “other.”

Marital Status. Marital status categories include “married” (reference), “never married,” “divorced or separated,” or “widowed.”

Poverty Percentage. This was a categorical variable that assessed household income according to place of residence to determine the respondent’s percent of poverty level (<100%, 100-199%, 200-299%, 300-399%, 400-499%, >500% [reference]).

Place of Residence. Respondents within the principal city of the MSA, in an MSA outside of the principal city, or outside of the principal city, were classified as “urban,” “suburban” (reference category), and “rural,” respectively.

Education Level. Categories for education level included “less than a high school diploma,” “high school diploma,” “some college,” or “college diploma” (reference).

Insurance Coverage. This was a binary outcome, with any respondent reporting public or private health insurance coverage comprising the reference category.

Sexual Orientation. This includes “heterosexual” (reference), “lesbian,” “bisexual,” or “other.”

History of Live Birth. This was a binary outcome, satisfied by any history of live birth regardless of the number of living children.

History of Vaginal Intercourse with a Male Partner. A binary outcome with a positive response if the female respondent reported sexual intercourse with an opposite-sex partner.

Aim 2 Data Analysis

Univariate and bivariate statistics were presented as means (continuous variables) and percentages (categorical variables). Binary logistic regression was then

used to estimate odds ratios for HPV vaccine receipt. Regression modeling was done in a stepwise manner as described below.

Aim 3

Aim 3 examines how contraception use across the lifespan is associated with cervical cancer screening completion, the screening interval, and maintenance of current screening.

Aim 3a

Aim 3a examined whether completion of Pap testing was associated with an individual's contraception history.

Aim 3a Study Population

The analytical sample for Aim 3a was comprised of non-pregnant female respondents aged 15-20. Pregnant respondents were excluded as the intent of the analysis was to consider screening rates among those receiving standard SRH services which may differ from obstetric care in visit frequency and insurance coverage.

Aim 3a Key Variables

The dependent variable for Aim 3a was History of Pap Testing and independent variable was History of Provider-Surveilled Contraception Use.

Aim 3a Other Variables

Age. Age was a continuous variable for years 15-20.

Race. Race was categorized as “non-Hispanic White” (reference), “non-Hispanic Black,” “Hispanic or Latino,” and “other.”

Marital Status. Marital status was not included in bivariate and regression analyses in Aim 3a as 99.2% of the analytical sample was never married.

Poverty Percentage. This was a categorical variable that assessed household income according to place of residence to determine the respondent's percent of poverty level (<100%, 100-199%, 200-299%, 300-399%, 400-499%, >500% [reference]).

Place of Residence. Respondents within the principal city of the MSA, in an MSA outside of the principal city, or outside of the principal city, were classified as "urban," "suburban" (reference category), and "rural," respectively.

Education Level. Categories for education level included "less than a high school diploma," "high school diploma," "some college," or "college diploma" (reference).

Insurance Coverage. This was a binary outcome, with any respondent reporting public or private health insurance coverage comprising the reference category.

Sexual Orientation. This includes "heterosexual" (reference), "lesbian," "bisexual," or "other."

History of Live Birth. This was a binary outcome, satisfied by any history of live birth regardless of the number of living children.

History of Vaginal Intercourse with a Male Partner. A binary outcome with a positive response if the female respondent reported sexual intercourse with an opposite-sex partner.

Aim 3a Data Analysis

Univariate and bivariate statistics were presented as means (continuous variables) and percentages (categorical variables). In Aim 3a, binary logistic regression was used to estimate odds ratios for history of Pap testing. An interaction term between history of provider-surveilled contraception use and history of vaginal intercourse with a

male partner was also introduced in this model, as it was hypothesized that differences in provider recommendations for cervical cancer screening may exist for respondents using contraception to avoid pregnancy rather than for off-label medical indications (i.e. menstrual management). A detailed regression modeling approach is described below.

Aim 3b

Aim 3b considered how contraception use among respondents ages 21-50 is associated with the individual's cervical cancer screening interval.

Aim 3b Study Population

The population for Aim 3b was non-pregnant females age 21-50 without history of abnormal Pap test or hysterectomy who underwent Pap test within three years. Considering that the most conservative recommendation for a Pap testing interval is three years, the majority of respondents reported Pap collection within that time frame, and detailed contraceptive history was only available for 36 months prior to the interview, analyses were restricted to individuals reporting Pap testing in this time period.

Aim 3b Key Variables

The dependent variable for Aim 3b was the Pap Testing Interval and independent variable was Contraception Method at Time of Last Pap Test.

Aim 3b Other Variables

Age. Age was a continuous variable for years 21-50.

Race. Race was categorized as “non-Hispanic White” (reference), “non-Hispanic Black,” “Hispanic or Latino,” and “other.”

Marital Status. Marital status categories include “married” (reference), “never married,” “divorced or separated,” or “widowed.”

Poverty Percentage. This was a categorical variable that assessed household income according to place of residence to determine the respondent’s percent of poverty level (<100%, 100-199%, 200-299%, 300-399%, 400-499%, >500% [reference]).

Place of Residence. Respondents within the principal city of the MSA, in an MSA outside of the principal city, or outside of the principal city, were classified as “urban,” “suburban” (reference category), and “rural,” respectively.

Education Level. Categories for education level included “less than a high school diploma,” “high school diploma,” “some college,” or “college diploma” (reference).

Insurance Coverage. This was a binary outcome, with any respondent reporting public or private health insurance coverage comprising the reference category.

Sexual Orientation. This includes “heterosexual” (reference), “lesbian,” “bisexual,” or “other.”

History of Live Birth. This was a binary outcome, satisfied by any history of live birth regardless of the number of living children.

History of Vaginal Intercourse with a Male Partner. A binary outcome with a positive response if the female respondent reported sexual intercourse with an opposite-sex partner.

Aim 3b Data Analysis

Univariate and bivariate statistics were presented as means (continuous variables) and percentages (categorical variables). Ordinal logistic regression was used

for Aim 3b to estimate predictors of the Pap testing interval (<1 year, 1-2 years, 2-3 years). A detailed regression modeling approach is described below.

Aim 3c

Aim 3c examined associations between contraceptive methods and maintenance of current cervical cancer screening.

Aim 3c Study Population

Aim 3c included all non-pregnant female respondents aged 21-50 without history of hysterectomy.

Aim 3c Key Variables

The dependent variable for Aim 3c was being Overdue for Cervical Cancer Screening and the key independent variable was Current Contraception Method.

Aim 3c Other Variables

Age. Age was a continuous variable for years 21-50.

Race. Race was categorized as “non-Hispanic White” (reference), “non-Hispanic Black,” “Hispanic or Latino,” and “other.”

Marital Status. Marital status categories include “married” (reference), “never married,” “divorced or separated,” or “widowed.”

Poverty Percentage. This was a categorical variable that assessed household income according to place of residence to determine the respondent’s percent of poverty level (<100%, 100-199%, 200-299%, 300-399%, 400-499%, >500% [reference]).

Place of Residence. Respondents within the principal city of the MSA, in an MSA outside of the principal city, or outside of the principal city, were classified as “urban,” “suburban” (reference category), and “rural,” respectively.

Education Level. Categories for education level included “less than a high school diploma,” “high school diploma,” “some college,” or “college diploma” (reference).

Insurance Coverage. This was a binary outcome, with any respondent reporting public or private health insurance coverage comprising the reference category.

Sexual Orientation. This includes “heterosexual” (reference), “lesbian,” “bisexual,” or “other.”

History of Live Birth. This was a binary outcome, satisfied by any history of live birth regardless of the number of living children.

History of Vaginal Intercourse with a Male Partner. A binary outcome with a positive response if the female respondent reported sexual intercourse with an opposite-sex partner.

Aim 3c Data Analysis

Univariate and bivariate statistics were presented as means (continuous variables) and percentages (categorical variables). Aim 3c used binary logistic regression to estimate predictors of being overdue for cervical cancer screening. A detailed regression modeling approach is described in the following section.

Aim 4

Aim 4 assessed the association between contraception methods and maintenance of current cervical cancer screening according to sexual orientation and

place of residence. Completion of Aim 4 is contingent on significant main effects of sexual orientation and place of residence in Aim 3c analyses.

Aim 4 Study Population

Aim 4 included all non-pregnant female respondents aged 21-50 without history of hysterectomy.

Aim 4 Key Variables

The dependent variable for Aim 4 was Overdue for Cervical Cancer Screening and independent variable was Current Use of Provider-Surveilled Contraception.

Aim 4 Data Analysis

The intention of Aim 4 was to expand on the binary logistic regression models analyzed in Aim 3c with the addition of interaction terms between contraception method and a) place of residence and b) sexual orientation. Given nuances related to SRH access and utilization among rural dwellers and sexual minority women, this sought to determine whether differential effects existed between these variables. However, results from the models analyzed in Aim 3c showed that the main effects of both place of residence and sexual orientation were not significant, so an interaction term was not tested.

Regression Modeling

Regression modeling was performed in a stepwise manner. First, the base model considered the crude association between the predictor contraception variable and cervical cancer prevention or screening outcome by adjusting only for age and race. Next, sociodemographic factors for which known associations between the outcome of interest have been documented were included into an expanded model; these included

education level, marital status, poverty percentile, place of residence, and insurance coverage for Aims 1, 3, and 4 considering HPV awareness and knowledge, screening completion, and the screening interval (Blake et al., 2015; Harper et al., 2020; Khoong et al., 2014; Limmer et al., 2014) and education level, poverty percentile, place of residence, and insurance coverage predicting HPV vaccine receipt in Aim 2 (Kessels et al., 2012; Pingali et al., 2021). Finally, additional sociodemographic factors hypothesized to contribute to contraception use and/or SRH utilization according to the Social Contextual Model of Reproductive Health and Cervical Cancer Prevention, including sexual orientation, history of live birth, and history of vaginal intercourse with a male partner, were incorporated into a fully integrated model.

Chapter 3. Results

I developed the objectives of this study to test hypothesized associations between an individual's contraception use and cervical cancer prevention behaviors, including awareness of cervical cancer screening guidelines, likelihood of HPV vaccination, and frequency of Pap testing. While most extant research has examined characteristics of those without history of Pap test or with prolonged screening intervals, the analyses performed also considered the risks associated with excessive (initiated at a younger age or completed more frequently than recommended screening). This chapter contains the results of the presented analyses, including descriptive and bivariate statistics for the analytical samples of interest and results of logistic regression, displayed as odds ratios.

Aim 1

Aim 1 was to examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency. As the majority of respondents across all age groups believed Pap and HPV testing to be indicated more frequently than supported by national guidelines (Table 1), unindicated or excessive screening incurs surplus cost, and screening collection may present physical and/or psychological discomfort for the patient, this was assigned as the dependent variable of interest.

Aim 1 Descriptive Statistics

Weighted descriptive statistics according to age group (<21, 21-29, 30+, according to cervical cancer screening guidelines) for female respondents without history of cervical cancer or abnormal cervical cancer screening in the last 3 years are

presented in Table 4. Population characteristics varied significantly across age groups; this, in addition to significant differences in screening recommendations according to age, drove the decision to conduct separate regression analyses according to age group. The total analytical sample was primarily non-Hispanic White, never married, with a college diploma, and residing in a suburban area. Of all respondents, 45.2% used an OTC/fertility awareness/other method of contraception, while 22.2% relied on permanent methods, 13.2% used LARC, and 19.5% used an injection or prescription method. Over half (53.5%) of respondents had a history of live birth and the majority (85.2%) reported history of vaginal intercourse with a male partner. While 15.5% of respondents accurately reported the recommended screening frequency for Pap testing, only 4.8% correctly estimated the recommended HPV testing frequency. Respondents under age 21 comprised the largest (10.1% and 11.5% for Pap and HPV testing, respectively) proportion of “don’t know”; more respondents reported not knowing HPV testing guidelines than they did those regarding Pap testing. There were no significant differences in racial composition across age groups; however, significant differences were found in each of the sociodemographic factors considered among those <21, 21-29, and 30+ years. Across all age groups, the majority of respondents overestimated the recommended Pap testing frequency (79.7%); 88.8% of respondents <21 years believed Pap testing was indicated, 76.2% of those ages 21-29 believed they needed a Pap more often than every 3 years, and 78.2% of respondents aged 30 and over believed that Pap was needed more often than every 3 years. Overestimation was also the majority response for HPV testing; 78.2% of the entire sample felt HPV testing was necessary more often than recommended (85.5% of those under 21 and 86.1% aged

21-29 believed this was routinely indicated, and 71.7% of those 30+ believed it to be necessary more frequently than every 5 years).

Table 4: Weighted descriptive statistics (percentages) by age group for Aim 1 examining overestimation of Pap and HPV testing frequency; 2015-2019 NSFG, female respondents aged 15-50 without history of abnormal Pap testing or cervical cancer

Aim One: examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency

	15-20 (n=1986)	21-29 (n=2507)	30-50 (n=4530)	ALL (n=9023)	P-value
Age (mean/SD)	17.5 (1.8)	24.9 (2.7)	39.3 (5.6)	31.3 (10.1)	
Race					.13
Non-Hispanic White	51.0	54.1	56.9	55.1	
Non-Hispanic Black	14.0	13.5	12.3	13.0	
Hispanic	24.8	22.3	20.3	21.7	
Other	10.3	10.1	10.5	10.3	
Current contraception method					<.001**
LARC	7.1	16.5	13.6	13.2	
Prescription/Injection	24.8	28.4	13.1	19.5	
Permanent	0.7	5.9	38.0	22.2	
OTC/other	67.4	49.2	35.3	45.2	
Marital status					<.001**
Married	0.6	21.9	58.5	37.6	
Never married	99.3	74.1	23.7	51.7	
Divorced/separated	0.1	3.9	16.6	10.0	
Widowed	0	0.2	1.3	0.7	
% Poverty level					<.001**
0-99%	30.5	25.5	19.3	23.1	
100-199%	28.3	23.3	20.5	22.7	
200-299%	17.1	18.3	16.5	17.1	
300-399%	8.6	10.1	11.2	10.4	
400-499%	7.5	9.1	13.5	11.2	
>500%	8.0	13.7	19.0	15.5	
Place of residence					<.001**
Urban	29.3	39.8	33.3	34.3	
Suburban	54.6	44.3	50.1	49.3	
Rural	16.1	15.9	16.7	16.4	
Education					<.001**
Did not graduate HS	57.9	5.4	9.8	17.6	
HS diploma	21.1	23.5	23.2	22.9	
Some college	19.6	31.5	17.2	21.6	
College diploma	1.4	39.6	49.8	37.9	
Uninsured	12.4	24.0	16.2	17.7	<.001**

Sexual orientation					
Heterosexual	81.6	83.0	92.2	87.7	<.001**
Lesbian	2.6	3.4	2.2	2.6	
Bisexual	13.7	11.6	4.2	8.0	
Other	2.2	2.0	1.4	1.7	
History of live birth	3.3	33.7	81	53.5	<.001**
History of sexual intercourse with a male	45.6	86.6	98.1	85.1	<.001**
Self-report of necessary Pap testing interval compared to current guidelines ¹					<.001**
More frequent	88.8	76.2	78.2	79.7	
Correct	1.1	16.4	20.1	15.5	
Less frequent	0	5.4	0.3	1.7	
Don't know	10.1	1.9	1.4	3.2	
Self-report of necessary HPV testing interval compared to current guidelines ²					<.001**
More frequent	85.5	86.1	71.7	78.2	
Correct	3.0	3.6	6.0	4.8	
Less frequent	0	0	8.2	4.4	
Don't know	11.5	10.3	14.1	12.6	

* $P < .05$; ** $P < .01$

¹ ever needing a Pap for age <21, Pap more often than 3 years for age 21-29, Pap more often than every 5 years for 30+

² ever needing HPV testing for age 15-29, or HPV testing more often than every 5 years for age 30+

Aim 1 Bivariate Statistics

Weighted percentages for respondents overestimating Pap and HPV testing intervals for variables of interest are presented in Table 5. Respondents <21, non-Hispanic Blacks, and those with less than a high school diploma or with higher poverty were more likely to overestimate Pap testing intervals. Respondents under 30, Hispanics, bisexual women, and those using prescription/injection contraception or without history of live birth were more likely to overestimate the HPV testing interval. Never married individuals overestimated both Pap and HPV testing intervals. Insurance status, place of residence, and history of vaginal intercourse with a male were not significant predictors of either Pap or HPV testing interval overestimation.

Table 5: Weighted bivariate statistics (percentages) for Aim 1 examining overestimation of Pap and HPV testing intervals, 2015-2019 NSFG, female respondents ages 21-50 without history of abnormal Pap testing or cervical cancer (n=9023)

Aim One: examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency

	Pap testing interval overestimated ¹ (%)	P-value	HPV testing interval overestimated ² (%)	P-value
Age group		<.001**		<.001**
<21	88.8		85.5	
21-29	76.2		86.1	
30+	78.2		71.7	
Race		<.001**		.003**
Non-Hispanic White	77.3		76.0	
Non-Hispanic Black	87.1		80.5	
Hispanic	83.5		82.8	
Other	74.8		77.4	
Current contraception method		.51		<.001**
LARC	78.9		80.1	
Prescription/Injection	80.6		83.1	
Permanent	78.1		69.6	
OTC/other	80.2		79.8	
Marital status		.02*		<.001**
Married	77.0		71.4	
Never married	81.8		84.1	
Divorced/separated	79.5		73.2	
Widowed	72.4		80.5	
% Poverty level		<.001**		.006**
0-99%	83.3		81.2	
100-199%	81.9		79.2	
200-299%	80.6		78.0	
300-399%	78.6		80.5	
400-499%	75.8		72.3	
>500%	73.4		75	
Place of residence		.85		.15
Urban	79.8		80.8	
Suburban	79.9		77.1	
Rural	78.7		76.1	
Education		<.001**		.05
Did not graduate HS	86.5		80.7	
HS diploma	82.7		77.2	
Some college	81.9		80.6	
College diploma	73.3		76.3	

Insurance status		.19		.10
Insured	79.2		77.6	
Uninsured	81.7		81.0	
Sexual orientation		.53		.01*
Heterosexual	79.8		77.7	
Lesbian	74.8		79.9	
Bisexual	81.1		85.1	
Other	78.9		78.2	
History of live birth		.75		<.001**
Yes	79.9		74.5	
No	79.4		82.5	
History of vaginal intercourse with a male		.63		.02*
Yes	79.5		77.4	
No	80.4		82.6	

* $P < .05$; ** $P < .01$

¹ ever needing a Pap for age <21, Pap more often than 3 years for age 21-29, Pap more often than every 5 years for 30+

² ever needing HPV testing for age 15-29, or HPV testing more often than every 5 years for age 30+

Aim 1 Regression Analyses Results

Weighted logistic regression estimates for overestimation of Pap and HPV testing interval recommendations among respondents aged <21 are presented in Table 6. In this age group, overestimation was consistent with the response that Pap or HPV testing was indicated at any time regardless of stated interval, as current guidelines do not support initiating screening until age 21. Respondents with a history of vaginal intercourse with a male partner had 60% higher odds of believing Pap testing was indicated (Model 1c, OR=1.60, 95% CI 1.04-2.48). Prescription or injection contraception use was associated with 45% lower odds of overestimating the HPV test interval (Model 2c, OR=0.55, 95% CI 0.33-0.91). Both of these were significant at $p=.05$ level. There were no other significant sociodemographic predictors of overestimation for either the Pap or HPV testing interval across any of the other models.

Table 7 contains weighted logistic regression estimates for overestimation of Pap and HPV testing interval recommendations among respondents aged 21-29. In the base

model, non-Hispanic Blacks had nearly double the odds of overestimating the Pap testing interval compared to non-Hispanic White respondents (Model 1d, OR=1.99, 95% CI 1.28-3.10); this was attenuated with the addition of other sociodemographic variables but remained significant at $p=.05$ level in the fully integrated model (Model 1f, OR=1.78, 95% CI 1.15-2.75). Respondents with history of live birth had 91% higher odds of overestimating the recommended HPV testing interval (Model 1f, OR=1.91, 95% CI 1.31-2.78) compared to nulliparous respondents. Those with less than a high school diploma also had significantly lower odds of overestimating the HPV testing interval (Model 2f, OR=0.31, 95% CI 0.17-0.56). There were no other significant associations in the 21-29 age group between the variables of interest and Pap or HPV overestimation.

Table 8 contains weighted logistic regression estimates for overestimation of Pap and HPV testing intervals for ages 30-50. Across all three models, non-Hispanic Black race was a significant predictor of overestimation of the recommended Pap testing interval (Model 1i, OR = 1.95, 95% CI 1.33-2.88) in this age group. Hispanics also had higher odds of overestimation for Pap testing interval; this remained significant at the 5% level in the final model (Model 1i, OR=1.57, 95% CI 1.07-2.29). Model 1i also predicted a significant association between history of vaginal intercourse with a male partner and nearly 4 times higher odds (OR=3.84, 95% CI 2.07-7.14) of overestimating the Pap testing interval. Hispanic respondents had significantly higher odds of overestimating the HPV testing interval (Model 2i, OR=1.71, 95% CI 1.21-2.42), as well as those who were never married (Model 2i, OR = 1.79, 95% CI 1.38-2.33).

Table 6: Weighted logistic regression estimates (OR, 95% CI) for Aim 1 predicting overestimation of Pap¹ and HPV² testing intervals, 2015-2019 NSFG, females aged 15-20 without history of abnormal cervical cancer screening (n=1986)

Aim One: examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency

	Pap Testing ¹			HPV Testing ²		
	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Current contraception method (ref: OTC/other ³)						
LARC	1.50 (0.63-3.60)	1.46 (0.61-3.51)	0.96 (0.38-2.45)	1.42 (0.77-2.59)	1.45 (0.75-2.80)	1.20 (0.55-2.60)
Prescription/Injection ⁴	1.01 (0.61-1.68)	0.92 (0.54-1.57)	0.76 (0.46-1.27)	0.67 (0.40-1.12)	0.62 (0.36-1.06)	0.55* (0.33-0.91)
Race (reference: NH White)						
Non-Hispanic Black	0.77 (0.41-1.47)	0.83 (0.40-1.71)	0.81 (0.46-1.43)	1.02 (0.64-1.61)	1.07 (0.67-1.71)	1.04 (0.65-1.65)
Hispanic	0.66 (0.44-1.00)	0.74 (0.47-1.17)	0.69 (0.44-1.09)	0.79 (0.51-1.24)	0.89 (0.57-1.39)	0.87 (0.55-1.38)
Other	0.52 (0.25-1.08)	0.55 (0.28-1.09)	0.54 (0.27-1.07)	0.95 (0.44-2.02)	0.96 (0.47-1.95)	0.93 (0.45-1.94)
% Poverty level (ref: >500%)						
0-99%						
100-199%		0.58 (0.26-1.30)	0.58 (0.26-1.27)		0.63 (0.28-1.45)	0.61 (0.27-1.39)
200-299%		0.51 (0.22-1.17)	0.52 (0.23-1.17)		0.50 (0.20-1.22)	0.48 (0.20-1.17)
300-399%		0.51 (0.18-1.39)	0.54 (0.21-1.35)		0.61 (0.26-1.42)	0.58 (0.25-1.36)
400-499%		0.87 (0.34-2.18)	0.86 (0.34-2.16)		1.50 (0.58-3.90)	1.50 (0.57-3.93)
		2.83 (0.96-8.35)	2.85 (0.99-8.26)		1.19 (0.41-3.44)	1.14 (0.39-3.36)
Place of residence (ref: suburban)						
Urban		0.87 (0.55-1.37)	0.81 (0.53-1.23)		0.99 (0.63-1.58)	0.96 (0.61-1.53)
Rural		1.14 (0.61-2.13)	1.10 (0.59-2.04)		0.94 (0.46-1.92)	0.95 (0.46-1.96)
Education (ref: college diploma)						
Less than high school		1.57 (0.33-7.36)	2.13 (0.47-9.70)		0.61 (0.15-2.47)	0.71 (0.17-2.97)
High school diploma		2.43 (0.52-11.33)	2.82 (0.62-13.15)		0.82 (0.20-3.42)	0.88 (0.21-3.75)

Attended college		2.73 (0.51-14.71)	3.35 (0.69-16.27)		0.87 (0.17-4.42)	0.92 (0.18-4.61)
Uninsured		1.24 (0.64-2.41)	1.24 (0.62-2.49)		0.84 (0.51-1.39)	0.81 (0.48-1.36)
Sexual orientation (ref: heterosexual)						
Lesbian			1.71 (0.54-5.38)			0.85 (0.29-2.45)
Bisexual			0.67 (0.37-1.21)			1.21 (0.75-1.96)
Other			0.24 (0.05-1.00)			1.01 (0.37-2.75)
History of live birth			2.16 (0.58-8.03)			0.99 (0.38-2.56)
History of vaginal intercourse with a male partner			1.60* (1.04-2.45)			1.36 (0.88-2.10)

* $P < .05$; ** $P < .01$

¹ ever needing routine Pap test

² ever needing routine HPV test

³ OTC and non-hormonal methods, non-candidates, and non-users

⁴ pill, patch, ring, progestin injection

Table 7: Weighted logistic regression estimates (OR, 95% CI) for Aim 1 considering overestimation of Pap¹ and HPV² testing intervals, 2015-2019, females aged 21-29 without history of abnormal cervical cancer screening (n=4530)

Aim One: examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency

	Pap Testing ¹			HPV Testing ²		
	Model 1d	Model 1e	Model 1f	Model 2d	Model 2e	Model 2f
Contraception method (ref: OTC/other ³)						
LARC	1.26 (0.75-2.14)	1.22 (0.72-2.08)	1.16 (0.68-1.98)	1.45 (0.80-2.65)	1.42 (0.77-2.64)	1.24 (0.65-2.35)
Prescription/Injection ⁴	1.18 (0.82-1.70)	1.24 (0.86-1.79)	1.22 (0.83-1.78)	1.62* (1.01-2.58)	1.57 (0.96-2.56)	1.64 (0.97-2.77)
Permanent ⁵	0.88 (0.46-1.69)	0.82 (0.44-1.53)	0.80 (0.41-1.55)	1.00 (0.59-1.70)	1.08 (0.60-1.95)	0.99 (0.48-1.70)
Race (reference: NH)						

White)						
Non-Hispanic Black	1.99** (1.28-3.10)	1.76* (1.13-2.76)	1.78* (1.15-2.75)	1.18 (0.70-1.98)	1.19 (0.71-1.99)	1.06 (0.64-1.76)
Hispanic	1.14 (0.79-1.63)	1.06 (0.72-1.57)	1.04 (0.70-1.54)	1.27 (0.81-1.99)	1.24 (0.79-1.97)	1.18 (0.75-1.85)
Other	0.99 (0.59-1.69)	1.02 (0.59-1.76)	1.03 (0.59-1.78)	1.27 (0.61-2.64)	1.16 (0.56-2.40)	1.13 (0.54-2.36)
Marital status (ref: married)						
Never married		1.09 (0.76-1.57)	1.16 (0.79-1.70)		0.74 (0.51-1.07)	0.94 (0.64-1.39)
Divorced/separated		1.47 (0.85-2.53)	1.52 (0.88-2.65)		1.06 (0.49-2.29)	1.01 (0.47-2.15)
Widowed		0.37 (0.05-3.03)	0.37 (0.05-2.90)		1.52 (0.16-14.32)	1.13 (0.12-10.26)
% Poverty level (ref: >500%)						
0-99%		1.05 (0.68-1.62)	1.05 (0.69-1.59)		1.21 (0.60-2.41)	1.08 (0.55-2.11)
100-199%		0.89 (0.56-1.39)	0.88 (0.56-1.40)		0.85 (0.40-1.80)	0.77 (0.37-1.63)
200-299%		1.34 (0.79-2.25)	1.34 (0.78-2.33)		1.34 (0.64-2.80)	1.30 (0.62-2.69)
300-399%		0.58* (0.35-0.95)	0.60* (0.37-0.99)		1.89 (0.87-4.11)	1.89 (0.87-4.11)
400-499%		0.59 (0.33-1.06)	0.62 (0.34-1.11)		0.71 (0.33-1.51)	0.70 (0.33-1.47)
Place of residence (ref: suburban)						
Urban		1.16 (0.85-1.60)	1.17 (0.85-1.61)		1.54* (1.01-2.36)	1.53 (1.00-2.34)
Rural		1.35 (0.87-2.09)	1.37 (0.88-2.11)		0.99 (0.49-1.97)	1.00 (0.50-2.03)
Education (ref: college diploma)						
Less than high school		1.69 (0.99-2.89)	1.73 (0.97-3.09)		0.44** (0.24-0.81)	0.31** (0.17-0.56)
High school diploma		1.19 (0.79-1.80)	1.19 (0.75-1.88)		0.77 (0.48-1.24)	0.60* (0.37-0.99)
Attended college		1.37 (0.97-1.94)	1.37 (0.96-1.95)		1.00 (0.64-1.57)	0.91 (0.57-1.44)
Uninsured		0.98 (0.68-1.41)	0.97 (0.67-1.40)		1.16 (0.76-1.79)	1.17 (0.76-1.82)
Sexual orientation (ref: heterosexual)						
Lesbian			0.78 (0.33-1.83)			2.05 (0.98-4.31)
Bisexual			1.09 (0.70-1.69)			1.75 (0.97-3.16)
Other			1.19 (0.46-3.04)			1.67 (0.57-4.85)
History of live birth			1.02 (0.69-1.50)			1.91** (1.31-2.78)

History of vaginal intercourse with a male			1.24 (0.74-2.07)			1.16 (0.68-1.98)
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* $P < .05$; ** $P < .01$

¹ routine Pap more often than 3 years

² ever needing routine HPV testing

³ includes OTC and non-hormonal methods, non-candidates, and non-users

⁴ pill, patch, ring, progestin injection

⁵ tubal sterilization or vasectomy

Table 8: Weighted logistic regression estimates (OR, 95% CI) for Aim 1 examining overestimation of Pap¹ and HPV² testing intervals, 2015-2019 NSFG, females aged 30-50 without history of abnormal cervical cancer screening (n=2507)

Aim One: examine the relationship between an individual's current contraceptive method and their knowledge regarding recommendations for cervical cancer screening frequency

	Pap Testing ¹			HPV Testing ²		
	Model 1g	Model 1h	Model 1i	Model 2g	Model 2h	Model 2i
Contraception method (ref: OTC/other ³)						
LARC	0.86 (0.64-1.17)	0.87 (0.65-1.17)	0.77 (0.57-1.04)	1.06 (0.74-1.51)	1.14 (0.80-1.63)	1.11 (0.76-1.61)
Prescription/Injection ⁴	1.00 (0.74-1.34)	1.06 (0.80-1.41)	1.00 (0.74-1.35)	1.32 (0.93-1.88)	1.37 (0.96-1.95)	1.34 (0.93-1.94)
Permanent ⁵	0.98 (0.74-1.29)	0.92 (0.70-1.22)	0.86 (0.65-1.15)	0.81 (0.62-1.05)	0.92 (0.70-1.21)	0.92 (0.69-1.22)
Race (ref: NH White)						
Non-Hispanic Black	2.44** (1.69-3.51)	2.19** (1.48-3.22)	1.95** (1.33-2.88)	1.34 (0.96-1.88)	1.14 (0.80-1.63)	1.07 (0.74-1.54)
Hispanic	2.13** (1.55-2.94)	1.67** (1.15-2.42)	1.57* (1.07-2.29)	1.85** (1.36-2.52)	1.78** (1.27-2.49)	1.71** (1.21-2.42)
Other	0.89 (0.63-1.27)	0.93 (0.65-1.33)	0.90 (0.64-1.28)	1.06 (0.76-1.47)	1.05 (0.74-1.50)	1.03 (0.71-1.50)
Education (ref: college diploma)						
Less than high school		1.50 (0.94-2.40)	1.36 (0.82-2.26)		0.69 (0.47-1.01)	0.73 (0.50-1.08)
High school diploma		1.43* (1.04-1.95)	1.54** (1.12-2.11)		0.76 (0.58-1.01)	0.81 (0.62-1.07)
Attended college		1.32 (0.98-1.77)	1.26 (0.93-1.70)		0.83 (0.63-1.10)	0.82 (0.61-1.09)
Marital status (ref: married)						
Never married		0.86 (0.64-1.16)	1.06 (0.77-1.45)		1.67** (1.27-2.19)	1.79** (1.38-2.33)
Divorced/separated		0.89 (0.62-1.28)	0.88 (0.61-1.27)		1.08 (0.77-1.52)	1.12 (0.80-1.58)

Widowed		0.64 (0.20-2.12)	0.60 (0.17-2.06)		1.73 (0.74-4.02)	1.68 (0.72-3.89)
% Poverty level (ref: >500%)						
0-99%						
100-199%		1.49 (0.87-2.53)	1.52 (0.90-2.57)		1.31 (0.87-1.97)	1.28 (0.85-1.94)
200-299%		1.61 (1.00-2.59)	1.65* (1.02-2.68)		1.35 (0.96-1.91)	1.34 (0.93-1.92)
300-399%		1.32 (0.91-1.90)	1.27 (0.88-1.84)		1.06 (0.74-1.53)	1.05 (0.73-1.52)
400-499%		1.62* (1.07-2.45)	1.51 (1.00-2.30)		1.16 (0.79-1.69)	1.17 (0.80-1.69)
		1.33 (0.96-1.83)	1.28 (0.91-1.79)		0.93 (0.64-1.34)	0.95 (0.66-1.37)
Place of residence (ref: suburban)						
Urban		0.88 (0.68-1.15)	0.94 (0.73-1.21)		1.03 (0.76-1.40)	1.05 (0.77-1.45)
Rural		0.71 (0.47-1.05)	0.70 (0.47-1.05)		0.94 (0.64-1.40)	0.93 (0.63-1.38)
Uninsured		1.15 (0.81-1.64)	1.07 (0.74-1.54)		1.16 (0.83-1.62)	1.14 (0.81-1.61)
History of live birth			1.27 (0.96-1.68)			1.05 (0.80-1.37)
History of vaginal intercourse with a male			3.84** (2.07-7.14)			1.13 (0.59-2.16)
Sexual orientation (ref: heterosexual)						
Lesbian			1.01 (0.53-1.90)			0.81 (0.43-1.52)
Bisexual			1.17 (0.72-1.90)			1.11 (0.68-1.79)
Other			1.11 (0.52-2.39)			0.64 (0.33-1.24)

* $P < .05$; ** $P < .01$

¹ routine Pap more often than every 5 years

² routine HPV testing more often than every 5 years

³ includes OTC and non-hormonal methods, non-candidates, and non-users

⁴ pill, patch, ring, progestin injection

⁵ tubal sterilization or vasectomy

Aim 2

Aim 2 was to document HPV vaccination rates among users of different contraceptive classes.

Aim 2 Descriptive Statistics

Weighted descriptive statistics for the analytical sample for Aim 2 are presented in Table 9. Mean age was 19.7 years. The population was primarily non-Hispanic White, never married, without a high school diploma, suburban dwelling, with a high poverty level, and heterosexual. Over half of the respondents reported history of vaginal intercourse with a male partner (63%) and history of provider surveilled contraception use (57.6%). 18% of the analytical sample did not have current health insurance coverage.

Table 9: Weighted descriptive statistics for Aim 2 examining history of HPV vaccination; 2015-2019 NSFG, female respondents ages 15-24 (n=3,341)

Aim Two: document HPV vaccination rates among users of different contraceptive classes

Variables	Mean (SD) or percent
Age	19.7 (3.0)
Race	
Non-Hispanic White	52.2
Non-Hispanic Black	14.3
Hispanic	23.3
Other	10.2
History of provider surveilled contraception use ¹	57.6
History of HPV vaccination ²	51.5
Marital status	
Married	6.2
Never married	92.9
Divorced/separated	1.0

Education	
Did not graduate HS	34.9
HS diploma	23.3
Some college	28.5
College diploma	13.3
% Poverty level	
0-99%	30.3
100-199%	26.9
200-299%	17.1
300-399%	9.7
400-499%	6.8
>500%	9.3
Place of residence	
Urban	33.7
Suburban	50.0
Rural	16.2
Uninsured	18.0
History of live birth	13.0
History of vaginal intercourse with a male partner	63.3
Sexual orientation	
Heterosexual	81.1
Lesbian	3.0
Bisexual	14.2
Other	1.8

¹ LARC, prescription (pill, patch, ring), or progestin injection use

² receipt of any number of doses of the HPV vaccine

Aim 2 Bivariate Statistics

Weighted percentages for female respondents under age 25 are presented in Table 10 according to HPV vaccination status. Non-Hispanic Whites and those with a college diploma, higher household income, insurance coverage, history of vaginal intercourse with a male partner, and history of provider surveilled contraception use were more likely to have received the HPV vaccine. There were no significant

differences in vaccination status across marital status, place of residence, history of live birth, or sexual orientation.

Table 10: Weighted percentages for Aim 2 according to receipt of the HPV vaccine; 2015-2019 NSFG, female respondents aged 15-24 (n=3,341)

Aim Two: document HPV vaccination rates among users of different contraceptive classes

	Received the HPV Vaccine ¹ (n=1664)	Did Not Receive the HPV Vaccine (n=1677)	P-value
Age (mean/SD)	20.0 (2.9)	19.3 (3.0)	
Race			
Non-Hispanic White	54.9	45.1	.02*
Non-Hispanic Black	47.5	52.5	
Hispanic	44.8	55.3	
Other	54.6	45.5	
History of provider surveilled contraception use ²			<.001**
Yes	59.8	40.2	
No	40.2	59.8	
Marital status			0.9
Married	52.5	47.5	
Never married	51.4	48.6	
Divorced/separated	48.4	51.6	
Education			<.001**
Did not graduate HS	44.7	55.3	
HS diploma	48.7	51.3	
Some college	56.0	44.0	
College diploma	64.4	35.6	
% Poverty level			.001**
0-99%	45.4	54.6	
100-199%	50.8	49.2	
200-299%	50.7	49.3	
300-399%	50.7	49.3	
400-499%	61.6	38.5	
>500%	67.8	32.2	
Place of Residence			.3
Urban	51.0	49.0	

Suburban	53.7	46.4	
Rural	45.8	54.4	
Insurance Coverage			<.001**
Yes	54.7	45.3	
No	37.9	62.1	
History of live birth			.5
Yes	49.8	50.2	
No	51.7	48.3	
History of sexual intercourse with a male			<.001**
Yes	56.6	43.4	
No	42.6	57.3	
Sexual orientation			.09
Heterosexual	51.2	48.8	
Lesbian	40.3	59.7	
Bisexual	57.6	42.4	
Other	40.0	60.0	

* $P < .05$; ** $P < .01$

¹ any number of doses of HPV vaccine

² LARC, prescription (pill, patch, ring), or progestin injection

Aim 2 Regression Analyses Results

Weighted logistic regression estimates for receipt of the HPV vaccine are presented in Table 11. Individuals with history of LARC, prescription, or injection contraception had nearly double the odds of HPV vaccine receipt (Model 3c, OR=1.91, 95% CI 1.42-2.57) than those who hadn't used provider-surveilled contraception in their lifetime. Compared to their suburban counterparts, rural dwellers had lower odds of HPV vaccine receipt (Model 3c, OR=0.63, 95% CI 0.40-0.97) as did those without health insurance coverage (Model 3c, OR=0.51, 95% CI 0.38-0.67). Education, race, history of live birth, sexual orientation, and history of vaginal intercourse with a male partner were not significant predictors of HPV vaccine receipt.

Table 11: Weighted regression estimates for Aim 2 predicting receipt of the HPV vaccine¹; 2015-2019 NSFG, females aged 15-24 (n=3341)

Aim Two: document HPV vaccination rates among users of different contraceptive classes

	Model 3a	Model 3b	Model 3c
Age	1.04* (1.00-1.08)	1.04 (0.98-1.10)	1.06 (0.99-1.14)
Race (reference: NH White)			
Non-Hispanic Black	0.77 (0.53-1.10)	0.83 (0.57-1.20)	0.83 (0.58-1.20)
Hispanic	0.78 (0.57-1.06)	0.86 (0.64-1.15)	0.87 (0.64-1.17)
Other	1.09 (0.75-1.60)	1.00 (0.70-1.43)	0.98 (0.69-1.40)
History of provider surveilled contraception use ²	1.97** (1.53-2.54)	2.01** (1.56-2.59)	1.91** (1.42-2.57)
Place of residence (ref: suburban)			
Urban		0.84 (0.67-1.06)	0.84 (0.68-1.05)
Rural		0.62* (0.40-0.96)	0.63* (0.40-0.97)
Education (ref: college diploma)			
Less than high school		0.74 (0.45-1.20)	0.86 (0.52-1.44)
High school diploma		0.71 (0.49-1.03)	0.78 (0.54-1.14)
Attended college		0.79 (0.54-1.16)	0.84 (0.58-1.22)
% Poverty level (ref: >500%)			
0-99%		0.56* (0.33-0.94)	0.57* (0.34-0.95)
100-199%		0.65 (0.41-1.04)	0.65 (0.41-1.02)
200-299%		0.63 (0.38-1.07)	0.64 (0.38-1.07)
300-399%		0.57* (0.34-0.95)	0.58* (0.34-0.97)
400-499%		0.88 (0.49-1.55)	0.87 (0.49-1.53)
Uninsured		0.51** (0.39-0.67)	0.51** (0.38-0.67)
History of live birth			0.75 (0.52-1.07)
History of vaginal intercourse with a male partner			1.16 (0.83-1.63)
Sexual orientation (ref: heterosexual)			
Lesbian			0.72 (0.35-1.46)
Bisexual			1.32 (0.98-1.76)
Other			0.76 (0.39-1.49)

* $P < .05$; ** $P < .01$

¹ any number of doses of HPV vaccine

² LARC, prescription (pill, patch, ring), or progestin injection

Aim 3

Aim 3 examines how contraception use across the lifespan is associated with cervical cancer screening completion, the screening interval, and maintenance of current screening.

Aim 3a

Aim 3a examines how history of cervical cancer screening is associated with an individual's contraception history.

Aim 3a Descriptive Statistics

Weighted descriptive statistics for the analytical sample for Aim 3a, which considers history of cervical cancer screening among non-pregnant females aged 15-20, are presented in Table 12. The average age was 17.5 years. The analytical sample was predominantly non-Hispanic White, never married, had not graduated high school, heterosexual, suburban dwelling, and with low household income. History of provider-surveilled contraception use was reported by 43.4% of respondents, and 16% had a Pap test. Nearly one out of eight respondents (13.1%) did not have health insurance coverage.

Aim 3a Bivariate Statistics

Bivariate statistics for female respondents aged 15-20 according to history of cervical cancer screening are presented in Table 13. Non-Hispanic Blacks and other races were more likely to report history of Pap test, as were those with a history of provider-surveilled contraception use, live birth, or vaginal intercourse with a male partner. Those with a high school diploma or higher education had higher Pap testing rates than their counterparts who hadn't graduated high school. There were no

Table 12: Weighted descriptive statistics for Aim 3a examining history of cervical cancer screening¹; 2015-2019 NSFG, non-pregnant females aged 15-20 (n=2088)

Aim 3a: examine how risk for cervical cancer screening among ages 15-20 is distributed across users of all contraceptive classes

Variables	Mean (SD) or Percent
Age (mean/SD)	17.5 (1.8)
Race	
Non-Hispanic White	50.9
Non-Hispanic Black	14.0
Hispanic	24.6
Other	10.6
History of provider-surveilled contraception use ²	43.4
History of Pap test ¹	16.0
Education	
Did not graduate HS	57.4
HS diploma	21.2
Some college	20.0
College diploma	1.3
% Poverty level	
0-99%	31.2
100-199%	28.0
200-299%	17.1
300-399%	8.6
400-499%	7.3
>500%	7.7
Place of residence	
Urban	29.3
Suburban	54.5
Rural	16.2
Marital status	
Married	0.7
Never married	99.2
Divorced/separated	0.1
Widowed	0
Uninsured	13.1
History of live birth	3.9
History of vaginal intercourse with a male partner	46.2
Sexual orientation	
Heterosexual	81.3
Lesbian	2.8
Bisexual	13.6
Other	2.3

¹ History of Pap test at any time in the respondent's lifetime

² History of LARC, prescription (pill, patch, ring), or injection contraception use

significant differences in completion of cervical cancer screening according to place of residence, poverty level, insurance coverage, or sexual orientation. Marital status was omitted from bivariate analysis as 99.2% of the sample was never married.

Table 13: Weighted bivariate statistics (percentages) for Aim 3a examining history of cervical cancer screening¹; NSFG 2015-2019, females aged 15-20

Aim 3a: examine how risk for cervical cancer screening among ages 15-20 is distributed across users of all contraceptive classes

	History of Pap test ¹	No history of Pap test	P-value
N	331	1757	
Age (mean/SD)	18.7 (1.4)	17.2 (1.7)	
Race			<.001**
Non-Hispanic White	13.8	86.2	
Non-Hispanic Black	27.3	72.8	
Hispanic	9.4	90.6	
Other	26.8	73.2	
History of provider-surveilled contraception use ²			<.001**
Yes	29.8	70.3	
No	5.4	94.6	
Education			<.001**
Did not graduate HS	7.9	92.1	
HS diploma	26.8	73.2	
Some college	26.9	73.1	
College diploma	27.8	72.2	
% Poverty level			.17
0-99%	18.8	81.2	
100-199%	13.4	86.6	
200-299%	15.1	84.9	
300-399%	18.4	81.7	
400-499%	7.9	92.1	
>500%	20.5	79.5	
Place of residence			.57
Urban	17.6	82.4	
Suburban	14.9	85.1	
Rural	16.6	83.4	
Insurance Coverage			.14
Yes	15.6	84.4	
No	20.4	79.6	

History of vaginal intercourse with a male partner			<.001**
Yes	31.4	68.6	
No	2.7	97.3	
History of live birth			<.001**
Yes	72.6	27.4	
No	13.7	86.3	
Sexual orientation			.13
Heterosexual	16.1	83.9	
Lesbian	6.3	93.7	
Bisexual	18.3	81.7	
Other	8.1	91.9	

* $P < .05$; ** $P < .01$

¹ History of Pap test at any time in the respondent's lifetime

² History of LARC, prescription (pill, patch, ring), or progestin injection use

Aim 3a Regression Analyses Results

Weighted regression estimates for history of Pap testing among non-pregnant females ages 15-20 are presented in Table 14. History of provider-surveilled contraception use remained a significant predictor of Pap testing across all three models, with those with history of LARC, prescription, or injection methods having over triple the odds of cervical cancer screening (Model 4c, OR=3.28, 95% CI 1.93-5.59) than their counterparts without history of provider-surveilled contraception use. Due to the need for pelvic exam with IUD insertion and increased potential for confusion related to specimen collection, analyses were also performed that omitted IUD users without significant differences in findings (results not shown). History of live birth (Model 4c, OR=7.58, 95% CI 3.58-16.08) and history of vaginal intercourse with a male partner (Model 4c, OR= 5.32, 95% CI 2.66-10.64) were also both positively associated with Pap testing. Each year of age increased the odds of having had Pap testing among those aged 15-20 (Model 4c, OR=1.47, 95% CI 1.14-1.88). Education, poverty level, insurance status, and sexual orientation were not significant predictors of Pap testing in

those <21 years of age. Marital status was omitted from the expanded and fully integrated models (4b,4c) as 99.2% of the analytical sample was never married. An

Table 14: Weighted regression estimates for Aim 3a predicting history of cervical cancer screening¹; 2015-2019 NSFG, non-pregnant females aged 15-20 (n=2088)

Aim 3a: examine how risk for cervical cancer screening among ages 15-20 is distributed across users of all contraceptive classes

	Model 4a	Model 4b	Model 4c
Age	1.70** (1.47-1.97)	1.89** (1.51-2.37)	1.47** (1.14-1.88)
Race (reference: NH White)			
Non-Hispanic Black	3.43** (1.93-6.08)	3.42** (1.86-6.26)	3.12** (1.68-5.80)
Hispanic	0.95 (0.60-1.50)	0.84 (0.51-1.38)	0.61 (0.36-1.03)
Other	2.83** (1.61-4.95)	2.90** (1.71-4.90)	3.13** (1.72-5.68)
History of provider-surveilled contraception use ²	6.19** (3.81-10.06)	6.16** (3.76-10.09)	3.28** (1.93-5.59)
Education (ref: college diploma)			
Did not graduate HS		1.88 (0.52-6.71)	1.33 (0.36-4.94)
HS diploma		2.26 (0.65-7.78)	1.85 (0.51-6.70)
Some college		1.30 (0.41-4.14)	1.34 (0.39-4.53)
% Poverty level (ref: >500%)			
0-99%		1.25 (0.59-2.65)	1.00 (0.44-2.29)
100-199%		0.83 (0.37-1.89)	0.73 (0.31-1.76)
200-299%		0.88 (0.40-1.98)	0.96 (0.41-2.25)
300-399%		0.80 (0.31-2.08)	0.84 (0.30-2.38)
400-499%		0.45 (0.16-1.24)	0.39 (0.13-1.17)
Place of residence (ref: suburban)			
Urban		0.86 (0.56-1.32)	0.74 (0.47-1.16)
Rural		0.70 (0.43-1.15)	0.56* (0.31-0.98)
Uninsured		1.12 (0.65-1.90)	1.05 (0.59-1.85)
History of live birth			7.58** (3.57-16.08)
History of vaginal intercourse with a male partner			5.32** (2.66-10.64)
Sexual orientation (ref: heterosexual)			
Lesbian			0.35 (0.06-1.92)
Bisexual			0.95 (0.50-1.80)
Other			0.38 (0.11-1.34)

* $P < .05$; ** $P < .01$

¹ History of Pap test at any time in the respondent's lifetime

² History of LARC, prescription (pill, patch, ring), or progestin injection use

interaction term for history of provider surveilled contraception use and history of vaginal intercourse with a male partner was tested in an additional model but not found to be significant (results not shown).

Aim 3b

Aim 3b considered how contraception use among respondents aged 21-50 is associated with the individual’s cervical cancer screening interval.

Aim 3b Descriptive Statistics

Weighted descriptive statistics for non-pregnant females aged 21-50 without history of abnormal Pap test or hysterectomy who reported a Pap test within 3 years are presented in Table 15. The analytical sample had a mean age of 34.8 years and was predominantly non-Hispanic White, married, heterosexual, with a college diploma, and living in a suburban area. 68.1% of the sample reported a Pap test within the last 12 months. History of live birth was reported by 68.5% of respondents, and 16.2% did not have health insurance coverage. Over a third of respondents (38.3%) used OTC or other contraception methods.

Table 15: Weighted descriptive statistics for Aim 3b examining cervical cancer screening interval¹; 2015-2019 NSFG, non-pregnant females aged 21-50 without history of hysterectomy or abnormal Pap test (n=6371)

Aim 3b: examine how contraception method at the time of last Pap is associated with the individual’s cervical cancer screening interval among ages 21-50

Variables	Mean (SD) or Percent
Age (mean/SD)	34.8 (8.0)
Race	
Non-Hispanic White	55.1
Non-Hispanic Black	14.3
Hispanic	20.6
Other	10.0
Years since last Pap test	
<1	68.1
1-2	20.0

2-3	11.9
Contraception method at time of last Pap test	
LARC	15.3
Injection/Prescription ²	24.9
Permanent ³	21.5
OTC/other ⁴	38.3
Education	
Did not graduate HS	8.1
HS diploma	22.8
Some college	21.0
College diploma	48.1
% Poverty level	
0-99%	20.2
100-199%	20.1
200-299%	16.7
300-399%	10.7
400-499%	12.8
>500%	19.4
Place of residence	
Urban	36.0
Suburban	48.2
Rural	15.9
Marital status	
Married	50.8
Never married	36.2
Divorced/separated	12.1
Widowed	0.9
Uninsured	16.2
History of live birth	68.5
History of vaginal intercourse with a male partner	97.8
Sexual orientation	
Heterosexual	90.3
Lesbian	2.1
Bisexual	6.3
Other	1.3

¹ <12 months, 1-2 years, 2-3 years since last Pap test

² prescription (pill, patch, ring) or progestin injection

³ tubal sterilization or vasectomy

⁴ OTC and non-hormonal methods, non-candidates, and non-users

Aim 3b Bivariate Statistics

Bivariate statistics for Aim 3a according to Pap testing interval (<1 year, 1-2 years, 2-3 years) are presented in Table 16. There were significant associations between the Pap testing interval and respondent race, contraception method at time of last Pap test, and insurance coverage. Non-Hispanic Black respondents were more likely to report a shorter Pap test interval (<1 year), as were those using prescription or injection contraception, or with current health insurance coverage. There were not significant differences in the Pap testing interval across education level, poverty level, place of residence, marital status, history of live birth, history of vaginal intercourse with a male partner, or sexual orientation.

Table 16: Weighted bivariate statistics (percentages) for Aim 3b according to Pap test interval (<1 year, 1-2 years, 2-3 years); NSFG 2015-2019, non-pregnant females aged 21-50 without history of hysterectomy

Aim 3b: examine how contraception method at the time of last Pap is associated with the individual's cervical cancer screening interval among aged 21-50

	Pap Test Interval			P-value
	<1 year	1-2 years	2-3 years	
N	4341	1263	768	
Age (mean/SD)	34.8 (8.2)	34.7 (7.5)	35.1 (7.6)	
Race				.001**
Non-Hispanic White	66.5	21.4	12.1	
Non-Hispanic Black	78.1	14.6	7.3	
Hispanic	66.8	19.7	13.5	
Other	65.5	19.9	14.6	
Contraception Method at Time of Last Pap Test				.002**
LARC	67.5	22.2	10.3	
Prescription/Injection ¹	74.8	15.6	9.6	
Permanent ²	68.2	19.2	12.6	
OTC/other ³	64.0	22.2	13.7	
Education				.57
Did not graduate HS	64.0	21.1	14.9	
HS diploma	66.8	21.7	11.6	
Some college	68.4	20.1	11.6	
College diploma	69.4	18.9	11.8	
% Poverty level				

0-99%	67.6	20.1	12.4	.98
100-199%	67.1	20.3	12.6	
200-299%	68.1	19.3	12.7	
300-399%	68.7	21.0	10.3	
400-499%	68.7	18.9	12.4	
>500%	69.1	20.2	10.8	
Place of residence				.80
Urban	68.8	19.7	11.5	
Suburban	67.9	19.6	12.6	
Rural	11.5	21.6	11.0	
Marital status				.05
Married	65.7	21.6	12.7	
Never married	70.2	18.7	11.2	
Divorced/separated	72.5	17.6	9.9	
Widowed	64.8	10.2	24.9	
Insurance coverage				.003**
Yes	69.2	19.8	11.0	
No	62.4	20.6	17.0	
History of live birth				.10
Yes	66.9	20.8	12.3	
No	70.8	18.1	11.1	
History of vaginal intercourse with a male partner				.52
Yes	68.2	20.0	11.8	
No	66.4	17.1	16.5	
Sexual orientation				.50
Heterosexual	68.0	19.9	12.1	
Lesbian	69.5	20.8	9.7	
Bisexual	69.7	23.2	7.1	
Other	70.4	14.4		

* $P < .05$; ** $P < .01$

¹ prescription (pill, patch, ring) or progestin injection

² tubal sterilization or vasectomy

³ OTC and non-hormonal methods, non-candidates, and non-users

Aim 3b Regression Analyses Results

Ordinal logistic regression (ordered logit) was used to estimate the odds of a longer Pap testing interval (less than one year, 1-2 years, 2-3 years). Weighted odds ratios are presented in Table 17. The odds of reporting high vs. combined middle/low Pap interval for Non-Hispanic Blacks were 48% lower than that for Whites. Prescription or injection contraception use was also associated with decreased odds of a longer Pap testing interval; those using a pill, patch, ring, or injection had 39% lower odds of a

longer Pap testing interval (Model 5c, OR=0.61, 95% CI 0.48-0.79). There were no significant differences in the Pap testing interval between OTC/other/non-users and LARC users or those relying on sterilization procedures. In the fully integrated model uninsured individuals (OR=1.44, 95% CI 1.14-2.83) had significantly increased odds of a longer screening interval. There were not significant associations detected between the Pap testing interval and place of residence, history of vaginal intercourse with a male partner, history of live birth, or sexual orientation.

Table 17: Weighted ordinal regression estimates for Aim 3b predicting Pap testing interval (<1 year, 1-2 years, 2-3 years); NSFG 2015-2019, non-pregnant females aged 21-50 without history of hysterectomy (n=6371)

Aim 3b: examine how contraception method at the time of last Pap is associated with the individual's cervical cancer screening interval among aged 21-50

	Model 5a	Model 5b	Model 5c
Age	0.99 (0.98-1.00)	1.00 (0.98-1.01)	0.99 (0.98-1.01)
Race (reference: NH White)			
Non-Hispanic Black	0.54** (0.43-0.68)	0.52** (0.41-0.67)	0.52** (0.40-0.68)
Hispanic	0.98 (0.79-1.21)	0.87 (0.69-1.09)	0.86 (0.68-1.08)
Other	1.04 (0.72-1.48)	1.05 (0.74-1.50)	1.07 (0.74-1.54)
Contraception method at last Pap test (ref: OTC/other/non-user ¹)			
LARC	0.81 (0.64-1.03)	0.83 (0.66-1.06)	0.84 (0.65-1.07)
Prescription/injection ²	0.58** (0.45-0.74)	0.60** (0.47-0.76)	0.61** (0.48-0.79)
Permanent ³	0.86 (0.68-1.09)	0.84 (0.67-1.06)	0.84 (0.66-1.06)
Education (ref: college diploma)			
Did not graduate HS		1.25 (0.92-1.69)	1.23 (0.89-1.68)
HS diploma		1.11 (0.88-1.40)	1.11 (0.87-1.41)
Some college		1.07 (0.84-1.37)	1.06 (0.83-1.35)
% Poverty level (ref: >500%)			
0-99%		1.11 (0.81-1.52)	1.03 (0.76-1.40)
100-199%		1.09 (0.79-1.51)	1.04 (0.74-1.45)
200-299%		1.09 (0.82-1.44)	1.05 (0.79-1.38)
300-399%		1.02 (0.72-1.40)	1.01 (0.74-1.39)
400-499%		1.03 (0.79-1.33)	1.02 (0.78-1.32)
Marital status (ref: married)			
Never married		0.87 (0.72-1.05)	0.93 (0.75-1.14)
Divorced/separated		0.73* (0.56-0.94)	0.77* (0.60-0.99)

Widowed		1.22 (0.37-3.97)	1.20 (0.34-4.16)
Uninsured		1.40** (1.10-1.77)	1.44** (1.14-1.83)
Place of residence (ref: suburban)			
Urban		0.99 (0.83-1.18)	0.99 (0.83-1.18)
Rural		0.98 (0.73-1.32)	0.99 (0.73-1.33)
History of live birth			1.14 (0.91-1.42)
History of vaginal intercourse with a male partner			0.76 (0.43-1.33)
Sexual orientation (reference: heterosexual)			
Lesbian			0.84 (0.44-1.60)
Bisexual			0.88 (0.66-1.17)
Other			0.89 (0.40-1.96)

Cut point 1: 0.22

Cut point 2: 1.49

* $P < .05$; ** $P < .01$

¹ OTC and non-hormonal methods, non-candidates, and non-users

² prescription (pill, patch, ring) or progestin injection

³ tubal sterilization or vasectomy

Aim 3c

Aim 3c examined associations between contraceptive methods and maintenance of current cervical cancer screening.

Aim 3c Descriptive Statistics

Descriptive statistics for Aim 3c are presented in Table 18. This analytical sample had a mean age of 34.2 years and was comprised of respondents who were primarily non-Hispanic White, college educated, residing in a suburban area, married, heterosexual, and using OTC/other contraception methods. In this sample, 19.2% respondents did not have health insurance, 65.0% had history of live birth, and 12.0% were overdue for Pap testing.

Table 18: Weighted descriptive statistics for Aim 3c examining being overdue for Pap testing¹; 2015-2019 NSFG, females aged 21-50 without history of hysterectomy (n=9022)

Aim 3c: determine whether users of certain contraceptive classes are more likely to be overdue for Pap test among ages 21-50

Variables	Mean (SD) or Percent
Age (mean/SD)	34.2 (8.1)
Race	
Non-Hispanic white	56.6
Non-Hispanic Black	13.2
Hispanic	20.3
Other	9.9
Current contraception method	
LARC	14.2
Prescription/Injection ²	19.0
Permanent ³	27.6
OTC/other ⁴	39.2
Overdue for Pap testing	12.0
Education	
Did not graduate HS	8.6
HS diploma	22.9
Some college	21.8
College diploma	46.7
% Poverty level	
0-99%	21.2

100-199%	21.7
200-299%	16.5
300-399%	10.3
400-499%	11.8
>500%	18.5
Place of residence	
Urban	35.8
Suburban	48.0
Rural	16.2
Marital status	
Married	46.5
Never married	39.9
Divorced/separated	12.8
Widowed	0.9
Uninsured	19.2
History of live birth	65.0
History of vaginal intercourse with a male partner	95.2
Sexual orientation	
Heterosexual	89.0
Lesbian	2.3
Bisexual	7.1
Other	1.6

¹ last Pap >3 years ago for age 21-29, last Pap >5 years ago for age 30+

² prescription (pill, patch, ring) or progestin injection

³ tubal sterilization or vasectomy

⁴ OTC and non-hormonal methods, non-candidates, and non-users

Aim 3c Bivariate Statistics

Bivariate statistics for non-pregnant females aged 21-50 without history of hysterectomy are presented in Table 19 according to currency of Pap testing. Non-Hispanic Blacks and those who were college educated, had high household income, and utilizing LARC or prescription/injection contraception birth were significantly more likely to have current Pap testing. History of live birth or vaginal intercourse with a male partner were also associated with current Pap testing. Among never married respondents, 19.5% did not have current cervical cancer screening. Heterosexual and bisexual respondents were more likely to report current Pap testing than respondents identifying as lesbian or other sexual orientation.

Table 19: Weighted bivariate statistics (percentages) for Aim 3c according to cervical cancer screening status (current versus overdue); NSFG 2015-2019, non-pregnant females aged 21-50 without history of hysterectomy (n=9022)

Aim 3c: determine whether users of certain contraceptive classes are more likely to be overdue for Pap test among ages 21-50

	Pap current ¹	Pap overdue ²	P-value
N	7938	1084	
Age (mean/SD)	34.7 (7.9)	31.0 (8.6)	
Race			<.001**
Non-Hispanic White	86.5	13.5	
Non-Hispanic Black	94.9	5.1	
Hispanic	85.3	14.7	
Other	84.6	15.4	
Current contraception method			<.001**
LARC	94.1	5.9	
Prescription/Injection ³	94.1	6.0	
Sterilization ⁴	90.0	10.0	
OTC/other ⁵	77.8	22.2	
Education			<.001**
Did not graduate HS	84.5	15.5	
HS diploma	85.6	14.5	
Some college	83.5	16.5	
College diploma	90.2	9.8	
% Poverty level			<.001**
0-99%	83.5	16.5	
100-199%	83.6	16.4	
200-299%	85.3	14.7	
300-399%	89.0	11.0	
400-499%	92.2	7.8	
>500%	93.1	6.9	
Place of residence			.20
Urban	88.1	11.9	
Suburban	87.1	12.8	
Rural	85.0	15.0	
Marital status			<.001**
Married	92.2	7.8	
Never married	80.5	19.5	
Divorced/separated	89.3	10.7	
Widowed	92.9	7.1	
Health insurance coverage			<.001**
Yes	89.8	10.3	

No	76.4	23.6	
History of live birth			<.001**
Yes	92.0	8.0	
No	78.2	21.8	
History of sexual intercourse with a male partner			<.001**
Yes	89.8	10.2	
No	35.9	64.2	
Sexual orientation			<.001**
Heterosexual	88.1	11.9	
Lesbian	74.5	25.5	
Bisexual	84.2	15.9	
Other	74.6	25.4	

* $P < .05$; ** $P < .01$

¹ Pap within three years for age 21-29, Pap within five years for age 30+

² last Pap >3 years ago for age 21-29, last Pap >5 years ago for age 30+

³ prescription (pill, patch, ring) or progestin injection

⁴ tubal sterilization or vasectomy

⁵ OTC and non-hormonal methods, non-candidates, and non-users

Aim 3c Regression Analyses Results

Binary logistic regression was performed to estimate predictors of overdue cervical cancer screening. Weighted odds ratios are displayed in Table 20. Compared to non-Hispanic Whites, non-Hispanic Blacks had significantly lower odds of being overdue for cervical cancer screening (Model 6c, OR=0.23, 95% CI 0.17-0.32). Prescription or injection contraception users had 76% lower odds of being due for Pap testing than those using OTC or other methods (Model 6c, 95% CI 0.01-0.35); this association was also significant across all three models for LARC users (Model 6c, OR=0.37, 95% CI 0.23-0.60). Likelihood of being overdue for cervical cancer screening decreased as income increased. Those without health insurance coverage had greater than 2 times higher odds of being overdue Pap testing than their insured counterparts (Model 6c, OR = 2.30, 95% CI 1.74-3.02). Those with history of live birth or vaginal

intercourse with a male partner were significantly less likely to be overdue for cervical cancer screening. Sexual orientation and place of residence were not significant predictors of being overdue for cervical cancer screening.

Table 20: Weighted logistic regression estimates (odds ratios) for Aim 3c predicting being overdue for cervical cancer screening¹; NSFG 2015-2019, females aged 21-50 without history of hysterectomy

Aim 3c: determine whether users of certain contraceptive classes are more likely to be overdue for Pap test among ages 21-50

	Model 6a	Model 6b	Model 6c
Age	0.93** (0.91-0.94)	0.96** (0.94-0.97)	0.98** (0.96-0.99)
Race (reference: NH White)			
Non-Hispanic Black	0.26** (0.20-0.36)	0.19** (0.13-0.26)	0.23** (0.17-0.32)
Hispanic	0.90 (0.68-1.19)	0.72* (0.54-0.96)	0.77 (0.57-1.04)
Other	0.92 (0.65-1.30)	1.02 (0.71-1.46)	1.10 (0.76-1.58)
Current contraception method (ref: OTC/other ²)			
LARC	0.21** (0.13-0.34)	0.23** (0.14-0.37)	0.37** (0.23-0.60)
Prescription/injection ³	0.17** (0.12-0.25)	0.19** (0.13-0.28)	0.24** (0.17-0.35)
Permanent ⁴	0.63** (0.49-0.82)	0.67** (0.52-0.87)	0.88 (0.66-1.17)
Marital status (ref: married)			
Never married		2.38** (1.81-3.13)	1.42* (1.04-1.93)
Divorced/separated		1.41* (1.02-1.94)	1.50* (1.08-2.09)
Widowed		1.06 (0.42-2.67)	1.05 (0.43-2.57)
Education (ref: college diploma)			
Did not graduate HS		1.11 (0.77-1.58)	1.69* (1.12-2.53)
HS diploma		1.06 (0.78-1.44)	1.27 (0.92-1.77)
Some college		1.26 (0.97-1.66)	1.50** (1.15-1.97)
% Poverty level (ref: >500%)			
0-99%		1.74** (1.18-2.58)	1.80** (1.20-2.72)
100-199%		1.74** (1.20-2.52)	1.89** (1.26-2.83)
200-299%		1.73** (1.21-2.46)	1.74** (1.19-2.55)
300-399%		1.26 (0.77-2.07)	1.31 (0.79-2.16)
400-499%		1.07 (0.63-1.84)	1.12 (0.65-1.92)
Place of residence (ref: suburban)			
Urban		0.81 (0.61-1.06)	0.79 (0.60-1.03)
Rural		1.16 (0.88-1.51)	1.20 (0.90-1.61)
Uninsured		2.15** (1.68-2.74)	2.30** (1.74-3.02)
History of live birth			0.41** (0.30-0.54)
History of vaginal intercourse			0.15** (0.11-0.22)

with a male partner			
Sexual orientation (ref: heterosexual)			
Lesbian			0.60 (0.31-1.19)
Bisexual			0.94 (0.68-1.31)
Other			1.53 (0.74-3.17)

* $P < .05$; ** $P < .01$

¹ >3 years since last Pap for age 21-29, >5 years since last Pap for age 30+

² OTC and non-hormonal methods, non-candidates, and non-users

³ prescription (pill, patch, ring) or progestin injection use

⁴ tubal sterilization or vasectomy

Aim 4

Aim 4 was to assess the association between contraception methods and maintenance of current cervical cancer screening among sexual minority women and rural dwellers. However, the models analyzed in Aim 3c showed that the main effects of both place of residence and sexual orientation on being overdue for cervical cancer screening were not significant; hence, an interaction term was not considered.

Chapter 4. Discussion

For this study I completed a secondary data analysis of the National Survey of Family Growth to explore associations between contraception use across the lifespan and cervical cancer screening and prevention. Guided by a theory-based model, I used logistic regression to examine relationships between current and prior contraception use, individual sociodemographic factors, and cervical cancer screening and prevention outcomes, including awareness of national screening guidelines, HPV vaccination, and Pap testing completion and frequency. Across four aims, I found several significant associations between contraception use across the lifespan and cervical cancer prevention and screening behaviors among NSFG respondents, particularly among those with prior or current use of a provider-surveilled contraception method. My findings suggest an unintended consequence of overscreening for cervical cancer in patients using provider-surveilled methods, while identifying protective associations between use of these methods and both HPV vaccination and maintenance of current Pap testing. Further, a predominant lack of awareness regarding current screening guidelines reveals opportunities for both clinicians and public health professionals to enhance education and counseling regarding cervical cancer screening. In this section I review and contextualize significant findings related to each outcome of interest, discuss strengths and limitations of this study, and propose recommendations for future research.

Aim 1: Overestimation of Pap and HPV Testing Intervals

It is discouraging that, across all age groups, the vast majority of respondents believed that Pap testing was indicated more frequently than recommended by national

guidelines in place at the time of the survey (hereafter referred to as overestimation). There were significant differences in overestimation according to age group, race, marital status, and poverty level in bivariate analyses, but regression models revealed few factors that independently predicted overestimation, and most findings were not consistent across models or age groups. There were no differences in overestimation across users according to their method of contraception class; considering the necessity of patient-provider interaction required for initiation and/or continuation of certain methods, the lack of awareness of current cervical cancer screening guidelines among users of provider-surveilled contraception raises concern regarding the counseling and anticipatory guidance offered in these clinical interactions.

While delayed or lack of screening compromises the opportunity for early diagnosis and treatment, the downstream effects of excessive cervical cancer screening must not be underestimated. The consequences of increased frequency of Pap testing across the lifespan were considered by Habbema et al. (2017), who compared screening practices and outcomes between the United States and the Netherlands in 2007. While HPV prevalence and cervical cancer incidence and mortality rates were similar between the two countries during the study period, the United States had far more intensive screening recommendations in place. Despite similar baseline risk, increased Pap testing rates were attributed to increased risk for biopsy, dysplasia treatment, preterm birth, and other health problems without improved cervical cancer incidence or mortality outcomes. The revised USPSTF (2018) cervical cancer screening guidelines acknowledge that screening more frequently than every 3 years “confers little additional benefit, with a large increase in harms” (p.678). Further, updated guidelines

from the American Cancer Society in 2020 recommend initiating screening at age 25 rather than age 21 in response to the risks of adverse outcomes and low disease burden in that age group. While patients' acceptance of – or even preference for – a 3- or 5-year Pap testing interval has increased over time, evidence suggests that many health care providers encourage shorter intervals (Cooper & Saraiya, 2018; Meissner et al., 2010). Considering that a provider's recommendation has a significant association with cancer screening (Peterson et al., 2016), it is possible that this clinical practice is driving beliefs regarding overestimation.

Aim 2: HPV Vaccination

Among respondents ages 15-24, I found that those who have used a provider-surveilled contraception method had nearly 2 times higher odds of HPV vaccine receipt compared to those who had never used a contraceptive pill, patch, ring, progestin injection, Nexplanon, or IUD. This finding is similar to those of Wei et al. (2013) and Mills (2011), which found that current use of hormonal contraception was associated with increased likelihood of HPV vaccine series initiation. HPV vaccination is a crucial primary preventive measure and, with sufficient uptake, has the potential to eradicate cervical cancer (Beavis & Levinson, 2016; Garland, 2009). HPV vaccination is also a predictor of future Pap testing (Guo et al., 2017; Silver & Kobrin, 2020).

Considering that increased health care utilization is associated with higher rates of HPV vaccination in adolescent females (Kessels et al., 2012), history of provider-surveilled contraception use may be a proxy for access to care in the models presented. However, while I found that respondents without insurance coverage were significantly less likely to have received the HPV vaccine, provider-surveilled contraception use

remained a significant predictor of HPV vaccination even after controlling for insurance coverage; this suggests that the SRH encounter may be more influential for uptake of services than the coverage itself. While vaccinations may be offered to individuals free of charge regardless of insurance coverage, the clinical encounter necessary for receipt of vaccine information from a health care provider – also a significant predictor of vaccine receipt (Kessels et al., 2012) – may present a financial burden. As health insurance coverage is a significant predictor of both HPV vaccination (Pingali et al., 2021) and cervical cancer screening (Harper et al., 2020; Locklar & Do, 2021), lower rates of both primary and secondary prevention in uninsured individuals expose serious equity concerns related to HPV-associated cancers. Barriers to health care, including access to both highly effective contraception methods and HPV vaccination in uninsured individuals, increase risk for both unintended pregnancy and preventable cancers in this population. Considering the association between preventive care and contraceptive services, my findings reinforce the importance of access to comprehensive SRH services across the lifespan, and policy must be modified to enhance their physical availability and financial accessibility.

I found that rural respondents had lower odds of HPV vaccination than their suburban-dwelling counterparts. Although I was unable to determine the number of vaccine doses that NSFG respondents received, rural-urban disparities in both series initiation and completion have persisted over time (Buskwofie et al., 2020; Pingali et al., 2021; Walker et al., 2019) and are speculated to contribute to higher rates of HPV-associated cancers in rural populations (Blake et al., 2017). Rural residents are also

less likely to report recommendations from health care providers to receive the HPV vaccine, a predictor of series initiation (Kessels et al., 2012).

There were no differences in HPV vaccination across racial and ethnic groups. Significant disparities in HPV vaccination between Black and Hispanic respondents and their White counterparts have been documented (Daniel-Ulloa et al., 2016; Gelman et al., 2013), but more recent research suggests a higher likelihood for Blacks, Hispanics, and Asians to initiate the HPV vaccine series (Walker et al., 2019), though with lower completion rates than Whites (Spencer et al., 2019). In these instances, more frequent contraceptive surveillance may offer the opportunity to not only initiate but also complete the series. Though this effect is unable to be discerned using NSFG data, it is a consideration for future research.

Aim 3a: Contraception Use and Pap Testing Before Age 21

I found that respondents who had used a provider-surveilled contraception method had over 3 times higher odds of having a Pap test prior to age 21. Initiation of Pap testing prior to age 21 is explicitly discouraged by the 2012 consensus guidelines (Saslow et al., 2012), yet my findings are consistent with those of Qin et al. (2020), which found significantly higher rates of Pap testing in those currently using an IUD (52.0%) or other hormonal contraception (35.5%) compared to those not currently utilizing a provider-surveilled method among NSFG respondents between 2011-2017. Mason et. al (2020) published similar findings on a smaller 2013-2015 NSFG sample; 75.9% and 46.9% of IUD and OCP users, respectively, had undergone Pap testing before age 21. However, it is encouraging that my analyses, conducted on a more

recent (2015-2019) sample, show lower overall rates of Pap testing in respondents under 21 years of age than literature examining earlier NSFG data releases.

I also found that individuals with history of vaginal intercourse with a male partner had over 5 times higher odds of completion of Pap testing prior to age 21. Two years after release of the consensus guidelines, a study investigating cervical cancer screening practices found that over 20% of providers continued to screen sexually active patients under age 21 for cervical cancer, while less than 3% reported screening those under age 21 who were not sexually active (Haas et al., 2016). Not only did the updated guidelines eliminate screening for those <21 years of age, but they removed conditions of screening related to sexual activity (Saslow et al., 2012). Rather than performing potentially unnecessary pelvic examinations and Pap collection in this age group, clinical encounters should focus on patient counseling consistent with patients' goals, such as pregnancy prevention, STI prevention and screening, or other health promotion behaviors. Further, though a small percentage (3.9%) of respondents aged 15-20 reported history of live birth, this group had over 7 times higher odds of Pap testing compared to their nulliparous peers. As pregnancy is not an indication for cervical cancer screening, this raises concern for the procedures performed as part of routine prenatal care.

Non-Hispanic Black and other race respondents in the aged 15-20 group had over 3 times higher odds of Pap testing than their non-Hispanic White counterparts. Considering disparities in infant mortality and associations between excessive screening and preterm birth (Habbema et al., 2017), the unintended effects of early initiation of Pap testing in young Black individuals must not be overlooked. In fact, risk

for preterm birth associated with dysplasia treatment is discussed as a factor in the most recent revision of the American Cancer Society guidelines for cervical cancer screening, recommending initiation of cervical cancer screening at age 25 (Fontham et al., 2020). Further research is necessary to examine the association between early cervical cancer screening, dysplasia treatment, and subsequent obstetric outcomes.

Aim 3b: Assessment of the Pap Testing Interval

The association between provider-surveilled contraception use and Pap testing extended to respondents aged 21-50, for whom those using prescription (pill, patch, ring) contraception or progestin injection at the time of their last Pap had significantly lower odds of a >12-month screening interval. Considering that the recommended screening interval ranges from 3-5 years and assuming that the timing of indication for repeat screening would be evenly distributed across the sample, this finding suggests that prescription or injection contraception users have higher likelihood of more frequent, potentially excessive, screening. Nonetheless, it is difficult to determine whether this association exists because providers are recommending or requiring Pap tests to maintain current contraception prescriptions, or patients are presenting to the office for contraception services and requesting screening.

Guo (2017) found that two-thirds of Pap tests between 2013-2015 were completed per provider recommendation, with the remaining one-third requested by the patient. The 2012 revision of cervical cancer screening guidelines invoked a degree of confusion and skepticism in health care providers (Boone et al., 2016), and despite the consensus of several national organizations (ACS, ASCCP, and ASCP) many providers acknowledged that they continued to screen for cervical cancer in excess of national

guidelines (Haas et al., 2016). In addition to provider practice favoring more frequent screening, Pap collection in excess of current guidelines may also be fueled by patient request; between 2008-2011, 74.1% patients expressed a preference for annual Pap testing (Silver et al., 2015). However, acceptance of an extended Pap testing interval is growing, as patient preference for a 3- or 5-year screening interval doubled between 2012 and 2015 (Cooper & Saraiya, 2018).

Here again, the role of the SRH provider in maintaining cervical cancer screening in accordance with national guidelines – including either completion or deferral of Pap or HPV testing – must not be overlooked. A positive association between patient-provider communication and cervical cancer screening completion has been well documented: “there is overwhelming evidence that provider recommendation significantly improves cancer screening rates” (Peterson et al., 2016, p. 4), a finding that was consistent across rural and urban populations, racial and ethnic groups, and geographic locations. Further, patients are significantly more likely to accept updated screening guidelines promoting primary HPV testing (Thompson, Galvin, et al., 2020) or extension of the Pap testing interval (Gerend et al., 2017; Silver et al., 2015) if a provider recommends they do so. However, given time constraints surrounding clinical encounters that may limit a provider’s opportunity to provide comprehensive counseling regarding HPV and cervical cancer screening, the effectiveness of alternative approaches to promote extension of the screening interval in accordance with current guidelines such as patient education materials, counseling from other members of the health care team, or public health campaigns, should also be considered.

Nearly 30 years ago, an international group of 72 recognized experts in the field released a consensus statement titled “Evidence-Guided Prescribing in Combined Oral Contraceptives” in an effort to reduce unnecessary barriers to OCP access (Hannafor & Webb, 1996). Despite their recommendation that safe provision of an OCP requires only an accurate blood pressure measurement and careful review of personal and family medical history inclusive of cardiovascular risk factors, a 2010 survey found that nearly one-third of physicians and almost half of advanced practice nurses in primary care still required a pelvic exam prior to prescribing an OCP (Henderson et al., 2010). My findings suggest that patients may still be undergoing unnecessary pelvic exam or Pap test collection as a condition of prescription initiation or maintenance. While ACOG discourages routine pelvic exam (American College of Obstetricians and Gynecologists, 2018), Pap Smear Ransom is still recognized as a frequent barrier to accessible contraception (Marchand & Sainz, 2020). This represents a stark contrast between evidence-based guidelines and clinical practice, and overlooks the financial, physical, and emotional consequences that unnecessary examination and testing may impose on a patient. This practice remains so pervasive that medical malpractice litigation has been proposed so that individuals who have experienced injury due to “pill hostage” (p.12) can recover damages while disincentivizing the practice (Barnes, 2021).

Aim 3c: Maintenance of Current Cervical Cancer Screening

I found that users of provider-surveilled contraception methods were significantly less likely than those relying on permanent, OTC, or other methods to be overdue for cervical cancer screening. This supports that LARC users, who may appreciate reliable contraception for 3-12 years depending on the device used (Baker & Creinin, 2022),

maintain current cervical cancer screening despite lacking a provider's expectation for contraceptive surveillance and refutes documented concerns that long-acting methods may decrease the likelihood of routine clinical follow up, reducing the number of opportunities to address other health issues (Kavanaugh et al., 2013).

Lack of health insurance coverage and greater poverty were also associated with increased odds of being overdue for Pap testing. This reinforces significant concern for health equity, as loss of life and well-being due to cervical dysplasia or cancer is disproportionately concentrated in the socioeconomically disadvantaged (Buskwofie et al., 2020). Those without health insurance are not only more likely to be unvaccinated against HPV, but also have lower Pap testing rates (Silver & Kobrin, 2020). I treated insurance coverage as a binary variable, disregarding type (public or private) as the Affordable Care Act (ACA) requires that preventive screenings, including Pap testing, be freely available to all patients (United States Preventive Services Task Force, 2014). Disparities related to insurance coverage are especially disheartening as robust state and federal programs exist that provide no- or low-cost screening, yet these programs are not widely utilized (Tangka et al., 2015). The National Breast and Cervical Cancer Early Detection Program (NBCCEDP), established in 1991, provides cervical cancer screening at no charge to low-income, uninsured, and underinsured individuals (Centers for Disease Control and Prevention, 2019). While the program has been instrumental in increasing screening rates in certain populations, such as AIAN women who receive care provided by local tribal organizations, about one-third of women who are eligible for the program have not been screened for cervical cancer (Tangka et al., 2015). Conversely, overuse of routine Pap testing has been documented in commercially

insured women (Wright et al., 2021), raising concerns for health care expenditures in addition to the potential physical and emotional harms associated with overscreening.

I found that Black respondents had significantly lower odds of being overdue for Pap testing than Whites. While this is consistent with extant literature (Buskwofie et al., 2020), Black women continue to be plagued by a 60% higher cervical cancer incidence than Whites, including a higher proportion of advanced stage diagnoses (Olusola et al., 2019), and lower 5-year survival rates (American Cancer Society, 2022). Additional research is necessary to better understand drivers of these disparities, including differences in treatments and subsequent outcomes across racial and ethnic groups.

I did not find differences in maintenance of current cervical cancer screening according to place of residence, as discussed in the next section, or sexual orientation. Recent literature supports lower rates of Pap and/or HPV testing among sexual minority women (McDonald et al., 2022; Suk et al., 2022). Detection of differences in screening rates between SMW and heterosexual respondents may be limited by a smaller sample size over a limited time frame in comparison to other published literature. Additional research is necessary to further understand the prevalence and potential consequences of lower screening rates among SMW.

Applying the Social Contextual Model of Reproductive Health and Cervical Cancer Prevention

My research questions and regression modeling were guided by a modified version of the Social Contextual Model of Health Behavior Change (Figure 1) (Sorensen et al., 2003). While the Social Contextual Model of Reproductive Health and Cervical Cancer Prevention (Figure 2) encompassed a range of sociodemographic

characteristics and modifying conditions, the factors that contribute to HPV infection and progression to cervical cancer are multi-faceted and are likely to extend well beyond the variables presented. Below, the Revised Social Contextual Model of Reproductive Health and Cervical Cancer Prevention (Figure 3) summarizes my research findings and outlines considerations for future research.

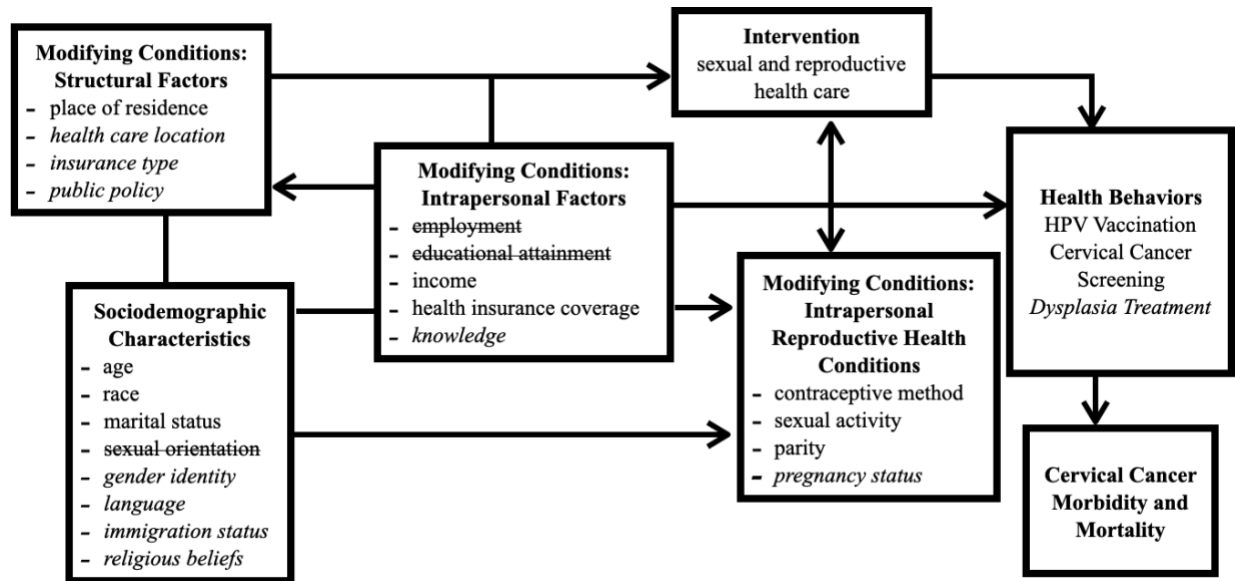


Figure 3. Revised Social Contextual Model of Reproductive Health and Cervical Cancer Prevention (adapted from Sorensen et al., 2003)

Strikethrough text includes hypothesized variables for which my analyses did not support a direct association with HPV vaccination and/or cervical cancer screening completion. Italicized variables represent those that were not included in my analyses, but present opportunities for future research. Independent of associations between contraception use and cervical cancer prevention and screening behaviors, I found that race, insurance coverage, place of residence, and parity had significant associations with HPV vaccination and maintenance of current Pap testing.

Race

It is important that HPV prevention and screening behaviors between racial groups are investigated as cervical cancer incidence and survival vary significantly according to race and ethnicity. I found that Black respondents aged 21-50 were significantly more likely to overestimate the recommended Pap testing frequency compared to non-Hispanic Whites. Further, non-Hispanic Black and other race respondents aged 15-20 had significantly higher odds of Pap testing than their non-Hispanic White counterparts. Black respondents also had significantly higher odds of a shorter Pap interval. There were no differences in HPV vaccination rates across racial groups.

There is mixed evidence regarding Pap testing rates according to race. While Hispanic and other race individuals may be less likely to have current Pap testing, extant literature supports that current screening rates are similar between Black and White individuals when controlling for other covariates (McDaniel et al., 2021) or perhaps higher in Black populations (Datta et al., 2022). Despite lack of evidence supporting disparate screening rates according to race and my findings suggesting that Black women may be at increased risk for excessive screening, racial inequities exist in cervical cancer incidence and mortality. Compared with Whites, AIAN individuals have 56% higher incidence of cervical cancer, and survival rates are significantly lower in Black individuals (American Cancer Society, 2022). It is possible that members of a population with a disproportionate burden of cervical cancer may have a higher likelihood to request or be offered more frequent or earlier screening; however, unindicated Pap testing may present negative physical, emotional, or financial

consequences. For those with abnormal screening results, further research is also necessary to better understand follow-up care as there is little information regarding completion and timing of diagnostic testing and dysplasia treatment among minority individuals. Finally, increased cervical cancer incidence and mortality in minority populations may instead be attributed to complete lack of, rather than overdue, screening as minority groups are more likely to have never undergone Pap testing (Datta et al., 2022). Considering that more than half of cervical cancer cases are diagnosed in those who have never been screened (American Cancer Society, 2022), it is crucial that this service is accessible and cost-effective for all health care consumers.

The negative effect of systemic racism on the health of minority populations must also be acknowledged. While perceived discrimination is negatively associated with cervical cancer screening uptake (Jacobs et al., 2014), conversely, lack of trust in providers or the health care system may prevent minority women from accepting less frequent screening. Initiatives to decrease cervical cancer disparities among specific ethnic groups should focus on culturally-tailored education, offered in appropriate languages and focused on behavioral strategies to reduce risk for HPV infection, including vaccination. The use of cultural and linguistic-matched patient navigators may also help coordinate care to ensure that early detection and treatment can be delivered.

Insurance Coverage

Despite robust state and federally-sponsored vaccination and screening programs and ACA-mandated coverage of cancer screening (United States Preventive Services Task Force, 2014), I found that lack of health insurance coverage was associated with lower odds of HPV vaccination, higher likelihood of a longer Pap testing

interval, and higher likelihood of being overdue for Pap testing. My findings are consistent with those from another large, nationally representative population, in which those without health insurance were not only more likely to be unvaccinated against HPV, but also had lower Pap testing rates (Silver & Kobrin, 2020). While lower rates of vaccination and being overdue for screening may increase risk for cervical cancer in uninsured individuals, previous findings of a longer interval (2.02 years in 2018 versus 3.88 years in 2018) between cervical cancer screenings in uninsured individuals receiving screening through the NBCCEDP were viewed as a reassuring sign that providers were completing screening consistent with current guidelines (Bartley et al., 2020).

Rural Residence

Consistent with existing data (Walker et al., 2019), I found that rural respondents had lower odds of HPV vaccination than their suburban-dwelling counterparts. However, my analyses did not detect associations between place of residence and the cervical cancer screening interval or odds of being overdue for Pap testing. While publications related to geographical differences in Pap or HPV testing rates have been somewhat limited since the major revision of national screening guidelines in 2012, existing literature suggests lower rates of Pap and/or HPV testing among rural women (Harper et al., 2020; Locklar & Do, 2021). My finding of similar screening rates across geographic locations may be attributed to the younger sample provided by the NSFG; individuals aged 50-64 have the lowest rates of cervical cancer screening of any age group (Harper et al., 2022), and a higher proportion of older adults reside in rural areas (Smith & Trevelyan, 2019).

History of Live Birth

Pregnant and recently postpartum respondents were intentionally omitted from the analytical samples used in my analyses, as my objective was to capture patterns related to clinical interactions for contraceptive surveillance or routine sexual and reproductive healthcare. However, parity was controlled for as a reflection of its influence on contraceptive choice and potential access to healthcare and/or usage. Though a small percentage (3.9%) of respondents aged 15-20 reported history of live birth, this group had over 7 times higher odds of Pap testing compared to their nulliparous peers. As pregnancy is not an indication for cervical cancer screening, this raises concern for the procedures performed as part of routine prenatal care. On the other hand, respondents ages 21-50 with history of live birth had significantly lower odds of being overdue for Pap testing. This may suggest that these respondents developed a relationship with a provider during the course of their prenatal care, which was maintained and transitioned to preventive care.

Impact of the COVID19 Pandemic

I found that nearly 1 in 8 NSFG respondents aged 21-50 were overdue for cervical cancer screening from 2015-2019. This statistic was undoubtedly further affected by the COVID19 pandemic; in April 2020, a 94% decrease in cervical cancer screening was documented (Gorin et al., 2021). Patients seeking both contraceptive services and cancer screenings experienced delayed access due to staffing shortages, supply chain disruptions, and fear of COVID19 transmission in health care settings (Aly et al., 2020). Further, in some institutions preventive care and contraception were not deemed essential services and access to them was suspended indefinitely. While

cervical cancer screening rates have rebounded to some extent, screening completion still remains below the pre-pandemic baseline (Burger et al., 2022). For individuals who had been adequately screened leading up to the pandemic, the effects of service disruptions are thought to be low, especially if HPV-based screening was performed. However, those who were overdue for screening and encountered further delays may be at increased risk for the development of symptomatic cervical cancer (Burger et al., 2022). These findings reinforce the importance of maintaining timely access to screening to minimize the negative effects of disruptions in preventive services.

While the COVID19 pandemic limited access to preventive care, it also inspired inventiveness by capitalizing on in-home screenings for preventable cancers. Although cervical cancer screening rates decreased abruptly between March and June 2020, there was a more modest decrease in home testing for colorectal cancer (Gorin et al., 2021). In addition to prepare for future disruptions in preventive care, home sampling kits for cervical cancer screening (currently under evaluation for FDA approval) may also enhance access to those using contraceptive methods that do not require clinical surveillance.

Strengths & Limitations

This study has several strengths. The NSFG offered a wealth of specific information regarding the variables of interest for a large, nationally representative sample. Nonetheless, the use of secondary data presents limitations in causal inference related to the cross-sectional study design and the features of the variables provided. While a detailed, month-by-month contraceptive history was available, the wider 12-month ranges for respondent report of Pap testing made it unfeasible to determine the

exact contraceptive method in use at the time Pap testing was collected. However, despite this limitation, previous research considering associations between HPV vaccination or Pap testing and contraception use considered only the contraceptive method in use at the time of data collection.

An additional limitation related to the use of survey data is recall error. Patients often fail to differentiate a pelvic exam from a Pap test (Howard et al., 2015) and, compared to medical record review, overestimate their participation in Pap testing (Howard et al., 2009). For this reason, medical record review – though more labor-intensive and requiring efforts to preserve patient confidentiality – may be a more reliable approach to assess HPV vaccination and Pap or HPV testing intervals. However, while this may provide more accurate insight to surgical histories for those with history of tubal sterilization or users of provider-surveilled contraceptive methods, those relying on a partner’s sterilization, OTC/other methods, or using multiple health systems would not be accurately reflected. Self-report of cancer screening behaviors may also be subject to social desirability bias (Johnson et al., 2005).

Use of cross-sectional data through the NSFG renders it impossible to determine whether HPV vaccination was received prior to, at the time of, or after initiating a provider-surveilled contraception method. Maintaining currency of other childhood vaccinations is a predictor of HPV vaccine receipt in adolescent females (Kessels et al., 2012) and, considering that the HPV vaccine can be initiated as early as age 9 (Centers for Disease Control and Prevention, 2021a), it is possible that HPV vaccine receipt occurred well before initiation of SRH and, thereby, may be associated with health care utilization rather than provider-surveilled contraception use. Further research may

consider longitudinal analyses to determine whether adolescent access to SRH increases HPV vaccination rates, or if those desiring of or agreeable to HPV vaccination are more likely to seek these services.

Despite its large overall sample size, small cohorts for special populations and those using certain contraception methods within specific age groups are noted in the NSFG. These groups were combined when appropriate, but the ability to do so was somewhat limited in order to maintain generalizability. The NSFG sample is also limited to self-identified male or female respondents. This classification overlooks the non-binary nature of gender identity and prevents researchers from gathering information that could advance the health of transgender individuals. Transgender men have less frequent Pap intervals and are more likely to be overdue for cervical cancer screening than cisgender females (Gatos, 2018). While Pap testing may expose non-binary or transgender patients to increased psychological stress due to gender dissonance (Dutton et al., 2008), comprehensive SRH may require periodic pelvic exam and completion of screening consistent with the anatomy present.

Due to availability of NSFG data, the upper age limit for my analyses was 50 years. However, the average age of cervical cancer diagnosis is 50 years (American Cancer Society, 2023b) and discontinuation of cervical cancer screening is not recommended until age at least age 65 (Curry et al., 2018; Fontham et al., 2020; Saslow et al., 2012). For this reason, an important population was overlooked as women ages 50-64 have lower cervical cancer screening rates than those less than age 50 (Harper et al., 2020; Harper et al., 2022). However, considering that the average age of menopause (when fertility ceases and contraception is no longer indicated) in the

United States is between 51 and 52 years, interactions between contraception practices and cervical cancer screening behaviors are less likely to influence screening – other than by potentially reducing clinical encounters and opportunities for continuation – in this age group.

Future Research

Relative to other cancers, cervical cancer is well understood, but questions remain regarding risk factors and how modifiable and non-modifiable risk factors may contribute to overall risk. While the risks of lack of or late cancer screening have been well documented, there is comparatively less information regarding the consequences of unindicated or excessive screening.

Above, I presented opportunities for future research including longitudinal analyses considering how provider-surveilled contraception use may influence HPV vaccine initiation or completion, consider how overscreening may increase likelihood of dysplasia treatment and subsequent obstetric outcomes, better understand drivers of racial inequities in cervical cancer outcomes for which screening differences cannot obviously account for, and understand the consequences of lower screening rates in SMW. Future research should also include careful consideration of cervical cancer prevention and screening in transgender men. Unfortunately, I was unable to include gender identity in my analyses as this is not currently assessed by the NSFG; however, it is reassuring that large, nationally-representative datasets, such as the Behavioral Risk Factor Surveillance System (BRFSS) and Health Information National Trends Survey (HINTS), are now including assessment of gender identity. Further, increasing participation in The U.S. Trans Survey will also provide researchers with a robust

dataset that may inform transgender-specific health care guidelines and interventions to reduce disparities in this population, such as those seen in HPV prevention counseling and cervical cancer screening (McDonald et al., 2022). Health care providers in all specialties must also be trained to provide transgender-specific care to enhance the quality of patient-provider interactions and reduce the stigma reported by transpeople seeking health services.

Chapter 5. Conclusion

In a secondary data analysis of the 2015-2019 National Survey of Family Growth, I found conflicting associations between cervical cancer prevention and screening behaviors and contraception use. Use of provider-surveilled contraception was associated with protective effects, such as HPV vaccination and decreased odds of being overdue for cervical cancer screening, while also predictive of increased odds of a shorter screening interval, which may represent excessive cervical cancer screening. These analyses were strengthened by the ability to access month-by-month contraception history for a large, nationally representative sample, and consider pregnancy prevention strategies that many medical records would fail to capture.

The implications of my findings extend from the individual level to a broader population perspective; opportunities range from maximizing counseling during patient-provider interactions in the health care setting to recognizing population patterns that can be leveraged to reduce the burden of preventable cancers. Initiating cancer screening at the appropriate age and completing at the recommended interval also offers the opportunity for considerable economic impact, which is likely to be further influenced by health policy.

Clinical Implications

As is true with most aspects of health care, sexual and reproductive health is a dynamic specialty. Practitioners must maintain awareness of current screening guidelines, familiarize themselves with new contraception methods and devices, and apply evidence-based care recommendations to physically and socially complex patient populations. As the SRH provider may be the only health care contact for many

individuals, the limited time spent in patient contact must be triaged. ACOG (2020) recommends that an initial sexual and reproductive health visit be completed between ages 13-15, with periodic follow-up to evaluate needs related to physical evaluation, vaccination, screening, and counseling (2018). It is further acknowledged that each of these services (for example, pelvic exam or Pap testing) may not be indicated on an annual basis. That said, it is imperative that clinicians are comprehensively assessing the needs of a patient by obtaining a detailed history, and using clinical judgment and shared decision making to determine which aspects of care should be prioritized. While screening completion and physical exam may not be indicated, the importance of routine preventive health care should be reinforced; the benefits of building a patient-provider relationship and offering comprehensive counseling with anticipatory guidance must not be overlooked. In fact, counseling regarding nutrition, physical activity, stress management, or other health-promoting behaviors may prove more beneficial than physical evaluation of the asymptomatic patient or completion of unindicated testing. On the contrary, team-based preventive care may be indicated to meet the needs of patients with broad or more complex health needs. As health care becomes more specialized and the supply of general practitioners is not forecasted to meet demand (Association of American Medical Colleges, 2020), it is important that those overseeing health maintenance offer referrals to providers who provide full-scope contraception care, comprehensive cervical cancer prevention counseling, and evidence-based screening and treatment procedures if personally unable to provide these services.

While contraception and cervical cancer prevention may seem to be independent pillars of SRH, several considerations require the attention of the clinician and inspire

patient counseling regarding the associations between these services. Individuals seeking contraceptive services to avoid pregnancy should be thoroughly counseled on another unintended risk of sexual activity: HPV transmission. Within two years of initiating sexual activity 50% of women will contract genital HPV (Krüger Kjaer et al., 2001), with lifetime risk of HPV estimated at 80% (Bekkers et al., 2004). Discussion regarding HPV transmission inspires conversation regarding condom use, not only to reduce the risk of HPV and other STDs but also to provide a barrier method to further reduce risk for unintended pregnancy. Ensuring receipt of HPV vaccination prior to initiation of sexual activity enhances vaccine protection as the individual is unlikely to have been exposed to any strains of HPV (Centers for Disease Control and Prevention, 2022a). Finally, assessment of smoking status offers the opportunity for cessation counseling, which may decrease risk of thromboembolism in users of estrogen-containing contraception methods (Curtis et al., 2016) while also eliminating a significant risk factor for persistent HPV infection and cervical dysplasia (Harper & Demars, 2014).

Finally, efforts must be made to not only disseminate updated guidelines to health care providers but also reinforce rationale for the updated recommendations to reduce skepticism and promote adherence. Considering that patients express concern regarding increased likelihood of getting or dying from cervical cancer should they extend their Pap testing interval to 3 or 5 years (Gerend et al., 2017), clinicians should be equipped to discuss the typically slow progression of invasive cervical cancer (Melnikow et al., 2018) and provide reassurance that half of cervical cancer cases are diagnosed in those who have never been screened (American Cancer Society, 2022).

While a web-based educational program has been developed for clinicians in an effort to reduce rates of overscreening in adolescents, the outcome measure was strictly knowledge-based so its effectiveness in reducing screening rates has not been demonstrated (Choma & McKeever, 2015).

Public Health Implications

The avoidable nature of cervical cancer makes it a prime public health initiative; safe, effective, and economical opportunities for primary, secondary, and tertiary prevention in individuals across multiple age groups offer numerous opportunities for action. The harmful effects of HPV extend well beyond those with cervical cancer; eradication of HPV has the potential to benefit all individuals, as those affected by the virus range from infants born prematurely due to cervical incompetence following dysplasia treatment to geriatric individuals with oropharyngeal cancer. Progress is being made toward attaining the Healthy People 2030 objective to achieve 80% coverage of HPV vaccination in adolescents (U.S. Department of Health and Human Services), and my findings suggest that this may be further improved through access to comprehensive SRH. To further reduce the burden of preventable cancers, we must also focus on ensuring that patients are adequately screened. Unfortunately, mounting evidence that Pap testing is decreasing over time is attributed to delayed or lack of screening rather than extended intervals in accordance with national guidelines (Garrido et al., 2020). Despite the acknowledged risks of excessive cervical cancer screening, it is crucial to promote initiatives to meet the Healthy People 2030 cancer prevention objective to increase the proportion of females who receive a cervical cancer screening to 84.3%.

While opportunities exist for SRH providers to promote clinical services such as vaccination and screening to individual patients, public health campaigns are crucial to educate consumers regarding cervical cancer prevention. Considering that lack of knowledge regarding the need for Pap and/or HPV testing was the most commonly cited reason for not receiving timely screening (Suk et al., 2022), screening campaigns must be reinstated. Historically, these efforts have been effective – a more than 70% decrease in cervical cancer mortality since 1969 has been attributed to campaigns to increase Pap testing (American Cancer Society, 2022). Further, while the clinical understanding of HPV continues to evolve and expand, public awareness regarding the virus actually decreased between 2008 and 2018 (Chido-Amajuoyi et al., 2021). Despite infecting greater than 80 and 90 percent of women and men, respectively (Chesson et al., 2014), only 60% of US adults were aware of both HPV and the HPV vaccine in 2018 (Chido-Amajuoyi et al., 2021). Strategic consumer education campaigns may simultaneously increase awareness of HPV and the HPV vaccine, promote screening completion, and publicize the recommended intervals to align patient expectations with clinical practice.

Health inequities in cervical cancer also require further investigation. Rates of HPV vaccination, Pap testing, cervical cancer diagnosis, and subsequent survival vary according to race and ethnicity, place of residence, immigration status, insurance coverage, and educational attainment (Buskwofie et al., 2020). In The American Cancer Society's 2017 release of *Cancer Facts & Figures* it is noted that the magnitude of the decline in cervical cancer incidence had slowed in recent years, "perhaps indicating that rates are approaching a lower limit" (p.28). However, until disparities in cervical cancer

prevention are eliminated, I find this assumption unacceptable. Targeted interventions are needed to reduce the rates of late-stage diagnosis in Black individuals, increase routine screening and vaccination in young White women, and reach the un- and under-screened, particularly in rural areas and the South. Interventions to increase vaccination and screening in rural populations must consider distance to services, including access to clinicians who provide comprehensive SRH, and decreased health-literacy in rural populations (Zahnd et al., 2009) – a known predictor of adherence to preventive care guidelines and cervical cancer screening (Newmann & Garner, 2005; Oldach & Katz, 2014).

Economic Impact

National expenditures for cervical cancer care reached \$2.3 billion in the United States in 2020, approximately 1% of all cancer treatment costs (National Cancer Institute, 2022). For individuals ages 19-49, HPV-associated disease represents the second greatest vaccine-preventable economic burden attributed to direct patient care costs and productivity losses due to lost wages related to treatment – over \$333 million in 2015 alone (Ozawa et al., 2016). This estimate is likely conservative as it includes only those conditions prevented by the initially licensed Gardasil formulation rather than Gardasil 9, which protects against more strains of HPV than its predecessor. However, the economic impact of excessive screening must also be acknowledged; in a single U.S. health system, the estimated total excess cost of “guideline nonadherent” (p.9) vaginal/cervical cancer screening exceeded \$166,000 over a 5-year period, and resulted in two (0.1%) high-grade dysplasia diagnoses (Teoh et al., 2018). That said, there is a tremendous economic opportunity in HPV and cervical cancer prevention

through increasing vaccination rates and completing Pap and/or HPV testing at appropriate intervals.

Policy Considerations

On a national level, policy can influence clinical care through reimbursement. As opposed to value-based care, accountable care aims to promote the provision of appropriate, evidence-based services. By eliminating reimbursement for unnecessary screenings, such as early Pap testing, payment reform may discourage clinicians from deviating from accepted guidelines and reduce the risk of harm related to overscreening. Ensuring insurance coverage for preventive services, as mandated by the Affordable Care Act (U.S. Centers for Medicare & Medicaid Services), reduces financial barriers to care and may increase utilization, but additional consideration regarding other barriers to preventive care is necessary to increase uptake in those enrolled in Medicaid programs (Alharbi et al., 2019). Nonetheless, if guidelines are to be adapted by the clinicians implementing them, national organizations must also acknowledge and address the skepticism and confusion expressed by providers.

Maintaining robust health care coverage for all citizens, especially for preventive care, must be a national priority. I found that uninsured respondents had lower odds of HPV vaccination and higher odds of being overdue for Pap testing. However, coverage for services is not the only consideration; the Vaccines for Children program covers the cost of HPV vaccination (Centers for Disease Control and Prevention, 2022b) and the NBCCEDP provides cervical cancer screening at no charge to low-income, uninsured and underinsured individuals (Centers for Disease Control and Prevention, 2019). Despite this, Pap testing programs are not widely utilized - about one-third of women

who are eligible for the program have not been screened for cervical cancer (Tangka et al., 2015) - and HPV vaccination rates remain low (Tangka et al., 2015; Walker et al., 2019).

As research on cancer prevention continues, the effect of technology and policy mandating widespread use of an electronic medical record (EMR) must also be acknowledged. Patient access to the EMR may strengthen the validity of survey research as immediate, free, and convenient access to test results may reduce recall bias. The 21st Century Cures Act mandates that patients have timely and unrestricted access to their medical record (OpenNotes, 2022), so patients may more easily discern which tests were conducted and when. Health maintenance reminders in the EMR may also use predetermined algorithms based on current guidelines to help patients and clinicians track when screening is indicated, reducing the likelihood of missed or excessive screening when left to clinical judgment or patient request alone. However, in one study patients with an activated personal health record, which suggests engagement within the health system, were significantly more likely to have undergone Pap testing before age 21 (Franklin et al., 2020).

Cervical cancer is preventable. Leveraging existing prevention, screening, and treatment strategies could save thousands of lives, millions of patients from unnecessary testing and procedures, and billions of dollars in health care expenditures. I found that provider-surveilled contraception use was associated with both protective factors, including increased HPV vaccination rates and decreased odds of being overdue for Pap testing, and potentially harmful practices, including early initiation of

Pap testing or a shorter Pap testing interval. Each sexual and reproductive health encounter presents an important opportunity to assess risk for both unintended pregnancy and cervical cancer. While contraception may be a sought-after service among individuals of childbearing potential, health care teams must also use each patient interaction to educate consumers regarding HPV and cervical cancer prevention measures. Further, health care consumers should have access to the full range of contraceptive options free from any type of coercion; while Pap or HPV testing at intervals consistent with current evidence-based guidelines should be offered, provision of one service should not be dependent on maintenance of another. The public should be counseled regarding the preventive nature of HPV and associated malignancies and understand the potential harms of overscreening. Finally, universal access to patient-centered and comprehensive SRH may promote physical, mental, and social well-being by helping individuals achieve family planning goals and attenuate unacceptable inequities in cervical cancer incidence and mortality.

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