Human Papillomavirus: Knowledge, Barriers and Facilitators to Access Anal Screening and Vaccination Among Men who Have Sex With Men

by

William Louth

Doctor of Medicine, Instituto Politécnico Nacional, Mexico, 2007

Submitted to the Graduate Faculty of

the Department of Behavioral and Community Health Sciences

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

2018

UNIVERSITY OF PITTSBURGH

GRADUATE SCHOOL OF PUBLIC HEALTH

This thesis was presented

by

William Louth

It was defended on

November 30, 2018

and approved by

Thesis Advisor:
James E Egan, PhD, MPH, Assistant Professor
Department of Behavioral and Community Health Sciences
Graduate School of Public Health, University of Pittsburgh

Committee Member:
Ken S Ho, MD, MPH, Assistant Professor of Medicine
Department of Medicine, Division of Infectious Diseases
School of Medicine, University of Pittsburgh

Committee Member:
Robert WS Coulter, PhD, MPH, Lecturer
Department of Behavioral and Community Health Sciences
Graduate School of Public Health, University of Pittsburgh

James E Egan, PhD, MPH

Human Papillomavirus: Knowledge, Barriers and Facilitators to Access Anal Screening and Vaccination Among Men who Have Sex With Men

William Louth, MPH

University of Pittsburgh, 2018

Abstract

Background: Men who have sex with men (MSM) experience a significantly higher risk of developing anal cancer secondary to HPV infection than men who have sex with women only (MSWO). Multiple social determinants, such as homophobia, internalized homophobia and other types of stigma play an important role in this disparity. Even though a vaccine to protect against HPV infection is available, and effective screening procedures to detect early changes of the anal mucosa secondary to HPV infection are also available, previous research suggests that there is still low uptake of vaccination, low knowledge of the association between HPV and anal cancer, and low engagement in screening procedures among MSM. In addition, there are still no national guidelines for screening recommendations among MSM. The proposed study seeks to understand the knowledge about the relationship between HPV infection and anal cancer, as well as the barriers and facilitators for screening and vaccination against HPV among MSM in Allegheny County.

Methods: The proposed study will use a theory-based electronically-delivered survey to assess the extent of knowledge about HPV among 200 MSM in Allegheny County (AC), as well as their attitudes, perceived barriers and perceived facilitators to engage in screening procedures and vaccination against HPV. In addition, this study will use spatial analysis methods (i.e. Moran's I, local Moran's I and spatial regression) to assess whether socioeconomic characteristics of zip code

of residency and distance to providers within the county are spatially associated or spatially dependent with knowledge about HPV, and screening and vaccination against HPV.

Public Health Significance: This study will be the first to examine knowledge, screening and vaccination among MSM, as well as the first to include a spatial analysis to understand this issue in the region. The formative data collected from this study will be the basis to develop interventions tailored specifically to MSM to reduce the incidence of anal cancer and associated deaths among this population.

Table of Contents

List of Tables

List of Figures

Preface

This thesis would not have been possible without the support and mentorship of Dr. James E. Egan, Dr. Ken S. Ho and Dr. Robert W.S. Coulter. I am looking forward to carrying out this study to better understand the issues that are keeping the population of MSM in Allegheny County from accessing the necessary procedures to identify anal cancer secondary to HPV infection at early stages, but most importantly, to prevent anal cancer and to reduce this important health disparity.

1.0 Specific Aims

According to the Centers for Disease Control and Prevention (CDC), infection by Human Papillomavirus (HPV) is the most common sexually transmitted disease in the United States (US). HPV is a double-stranded DNA virus that belongs to the Papillomaviridae Family;[1] more than 250 types of this virus have been identified, and more than 200 of these can infect humans.[1] All of them are associated with benign disease, but some of them are highly associated with the development of different cancers, including cervical, penile, oropharyngeal, rectal and anal.[1-3]

Men who have sex with men (MSM: gay, bisexual and other men who have sex with men) have a significantly elevated incidence of anal cancer when compared to men who have sex exclusively with women (MSWO). MSM living with HIV are particularly affected, with a likelihood of developing anal cancer 52 times higher than MSWO.[4]

In spite of the increased risk at which MSM are for developing anal cancer, there are still no national standardized screening guidelines to detect changes in the anal mucosa (anal intraepithelial neoplasia - AIN),[5]—possible precursors of anal cancer—produced by the HPV infection. This is partly perpetuated because, currently, there is not enough evidence regarding the natural history of HPV infection among men (i.e. the percentage of progression of low-grade lesions to high-grade lesions, the regression of high-grade lesions to normal tissue, or the progression of either types of lesions to anal cancer).[6,7]

Furthermore, there is still not enough evidence to validate the efficacy of screening and treatment of anal intraepithelial neoplasia to decrease incidence rates of anal cancer and mortality.[5,6,8] However, some caregivers have started recommending screening for anal dysplasia as part of the continuum of care for MSM, people living with HIV, and people with history of

receptive anal intercourse.[7] In addition, many countries have expanded the eligibility for vaccination against HPV to the age of 40-45 years among MSM, whereas in the United States private and public insurance only cover the costs of vaccination up to the age of 26 years.

Using quantitative data, this study will allow me to understand the facilitators and the barriers that gay, bisexual, and other MSM living in Allegheny County (AC) experience, and how these prevent them or motivate them to access adequate preventive, screening and treatment procedures for anal mucosa dysplasia secondary to HPV infection. This study will provide the data necessary to develop a community-based participatory intervention that will seek to increase the rates of vaccination against HPV, to increase the screening rates of anal dysplasia among this population in AC, and to detect a greater number of anal cancers in early stages and its precursors.

Previous research has shown that knowledge about the HPV infection and its association with cancer is higher among females than in men, and among those that have previously had a Pap smear.[9] I hypothesize that lack of knowledge of the association between HPV infection and anal cancer, the lack of effective interventions targeting MSM to increase screening and vaccination against HPV and social determinants of health inequities are partly responsible for this disparity. Without knowledge MSM cannot discuss this with their primary care physicians (PCPs) and, therefore, do not demand the access to health services that they need.

To accomplish aims 1 through 3, I will administer online surveys (appendix 1) using targeted ads in social media.

1.1 AIM 1. To determine the extent of knowledge of the association between HPV infection and anal cancer among MSM in Allegheny County.

Hypothesis: MSM in Allegheny County have limited knowledge about the link between HPV infection and anal cancer.

1.2 AIM 2. To identify the perceived individual and systemic barriers of access to screening for anal intraepithelial neoplasia and anal cancer among MSM living in Allegheny County.

Hypothesis: Anal health stigma, low self-perceived risk to develop anal cancer and fear of the diagnosis prevent MSM in Allegheny County from accessing screening procedures to detect AIN/anal cancer.

1.3 AIM 3. To examine how attitudes (e.g. fear of vaccination, discussing anal health with Primary care providers) are associated with HPV detection and prevention among MSM living in Allegheny County.

Hypothesis: Increased mistrust in healthcare will be associated with decreased uptake of diagnostic and preventive procedures among MSM in Allegheny County.

1.4 AIM 4. To assess whether there is an association between the geographical location of MSM within Allegheny County, the extent of knowledge of the association between HPV infection and anal cancer, and previous history of having engaged in screening for HPV-related changes of the anal mucosa and vaccination against HPV.

I will perform a spatial analysis taking into account zip code of residency, poverty rates and average educational attainment per zip code, distance to providers in the County that offer high-resolution anoscopy, knowledge about HPV and previous history of screening for HPV based on data collected via the online survey. *Hypothesis: Among MSM in Allegheny County, zip code of residency, extent of knowledge of HPV-related disease and distance to health care provider are associated with previous history of screening for HPV and vaccination against HPV.*

2.0 Research Strategy

2.1 Significance

2.1.1 Anal cancer disproportionately affects MSM

Anal cancer, secondary to HPV infection, disproportionately affects MSM. Anal cancer is a rare cancer in the general population, observing a rate of 1.8 cases per 100,000 population. However, in MSM the rates that have been observed range from 20 cases per 100,000 population of MSM and 40 cases per 100,000 of MSM living with HIV. This translates as a risk to develop cancer that is 32 times higher among MSM and 52 times higher among MSM living with HIV when compared to MSWO.[4] Additionally, the proportion of MSM living with HIV with anal dysplasia has been estimated to be between 34% to 58%.[4] Data suggests that anal cancer secondary to HPV infection is more common among MSM, than cervical cancer secondary to HPV infection is in women,[10] yet there is still not enough longitudinal data about the natural history of the disease, and the effectiveness of the current treatment options to prevent the apparition of cancer and the effects that treatment of lesions caused by HPV have on survival of MSM.

According to data from the National Cancer Institute from the National Institutes of Health the percentage of people with anal cancer with a 5-year survival in 2017 was 66.9%, with a mortality rate of 0.2 per 100,000 people per year, accounting for 1,100 deaths the same year. However, there are no public data available regarding MSM survival rates.

2.1.2 Anal Pap-smears, and high-resolution anoscopy can be cost-effective methods to detect cancer of the anus as well as precancerous lesions

However, screening is still not a generalized practice. The increased risk at which MSM are to develop AIN and anal cancer make it necessary to increase the screening rates for anal cancer and anal cancer precursors among this population. Two studies have shown that anal Pap smears are a cost-effective method to screen for anal dysplasia among HIV negative MSM and MSM living with HIV[11,12] and an additional study showed that high-resolution anoscopy is more cost-effective compared to Pap-smear.[13]

These methods can be useful to prevent anal cancer; however, many healthcare providers still do not include the recommendation of these procedures as part of their regular practices with MSM patients. In addition, not many healthcare professionals are trained to perform these.

2.1.3 Many systemic, provider and individual barriers keep MSM from accessing screening methods for anal dysplasia and anal cancer, as well as vaccination against HPV

Different individual, social and cultural factors are responsible for disparities in the sexual health of MSM, including the number of sexual partners, the characteristics of their social/sexual networks, poverty levels, homophobia, internalized homophobia and stigma.[14,15] Affective, anxiety, and substance use disorders, as well as other indicators of subclinical distress appear to be reactive to the effects of social stress.[16] It has been documented that minority sexual orientation is a risk indicator for health disadvantages, which include higher rates of tobacco use, attempts of

suicide, HIV infection (among men), and an elevated mortality risk, as compared with their same-sex heterosexual counterparts.[16,17]

Stigma negatively influences different processes, which ultimately lead to adverse health outcomes.[18] Fear of rejection and fear of negative evaluation by others can lead individuals with concealable stigmas to avoid engaging in close relationships, for fear of others discovering their stigmatized status.[15] This can lead them to experience high levels of social isolation, increasing their risk of poor health outcomes and other types of inequities, including access to effective health care.[15] Furthermore, higher rates of substance use among gay men,[19-22] have been consistently associated with an increased rate of unsafe sexual practices and, consequently, a higher risk of transmission of HIV and other sexually transmitted infections.

I am interested in understanding both the perceived facilitators and the barriers reported by the participants, to tailor interventions to increase the uptake in screening and vaccination using the strengths that MSM have. (Table 1)

2.1.4 Lack of knowledge of the association between HPV infection and anal cancer among MSM is a barrier that can be addressed by intervening at different levels of the Social Ecological Model (Figure 1)

Different studies have shown that awareness regarding HPV infection and its complications among MSM remains low.[23-30] A study showed that a high percentage of MSM had never heard of anal Papanicolau smears and of those who knew about it, only about 50% had discussed screening with a health professional.[23] Other barriers to healthcare are anticipated psychological or physical discomfort, stigma associated with the anus, heteronormativity in medical

practices,[31,32] policies of reimbursement for vaccination among MSM older than 26 years and fear of vaccination.

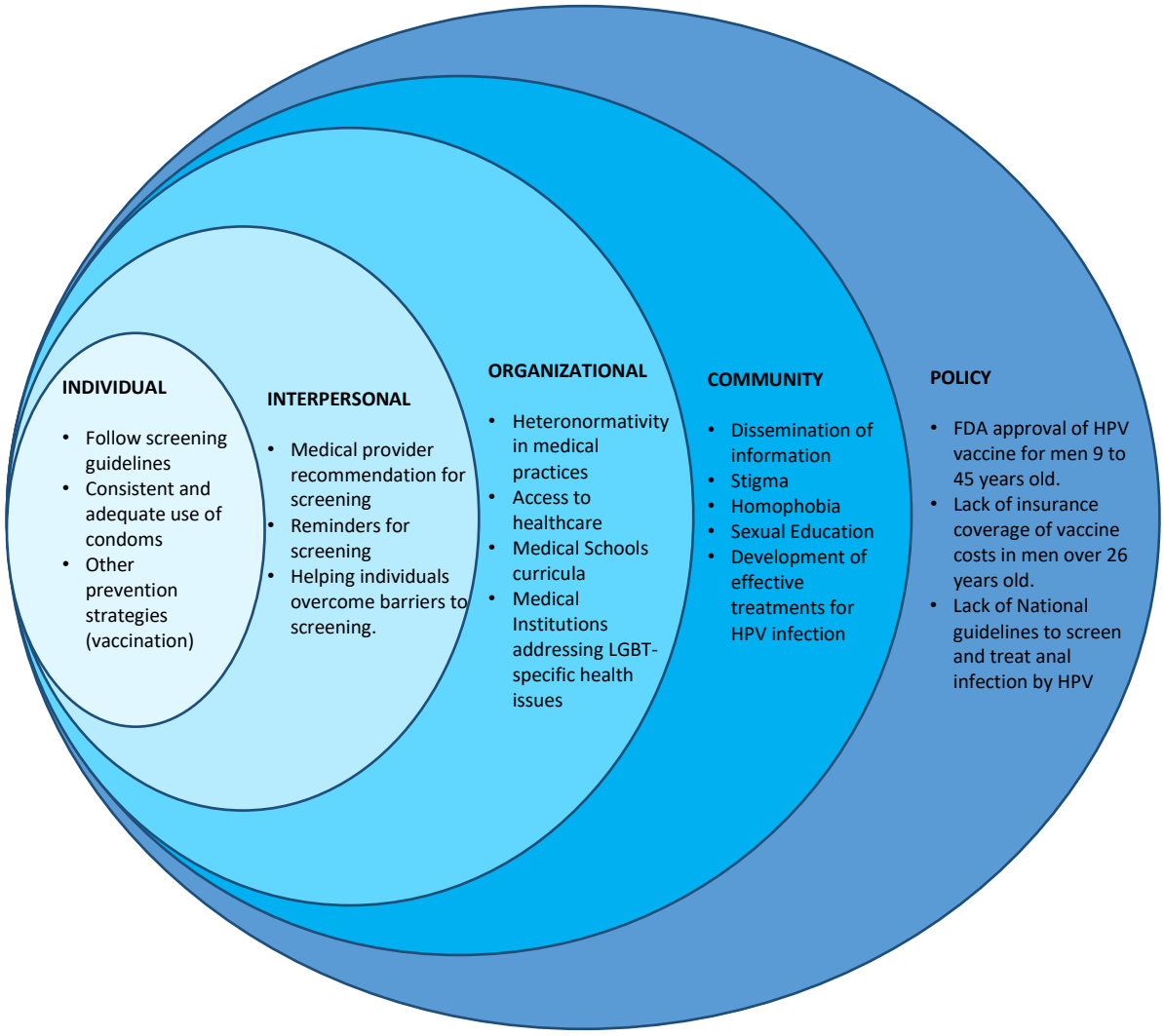


Figure 1. Social Ecological Model. Different suggestions for possible interventions

Table 1. Theoretical Framework and Possible Areas for Intervention in Different Levels of the Social Ecological Model

POLICY (Reciprocal Determinism – SCT)

- Creation of National guidelines for screening
- Change of reimbursement policies for vaccination among MSM older than 26 years of age

COMMUNITY (Reciprocal Determinism – SCT)

- Stigma (Moral disengagement – SCT)
- Homophobia (Moral disengagement – SCT)
- Sexual Education (Behavioral capability, observational learning – SCT)
- Effective treatment development

ORGANIZATIONAL (Reciprocal Determinism – SCT)

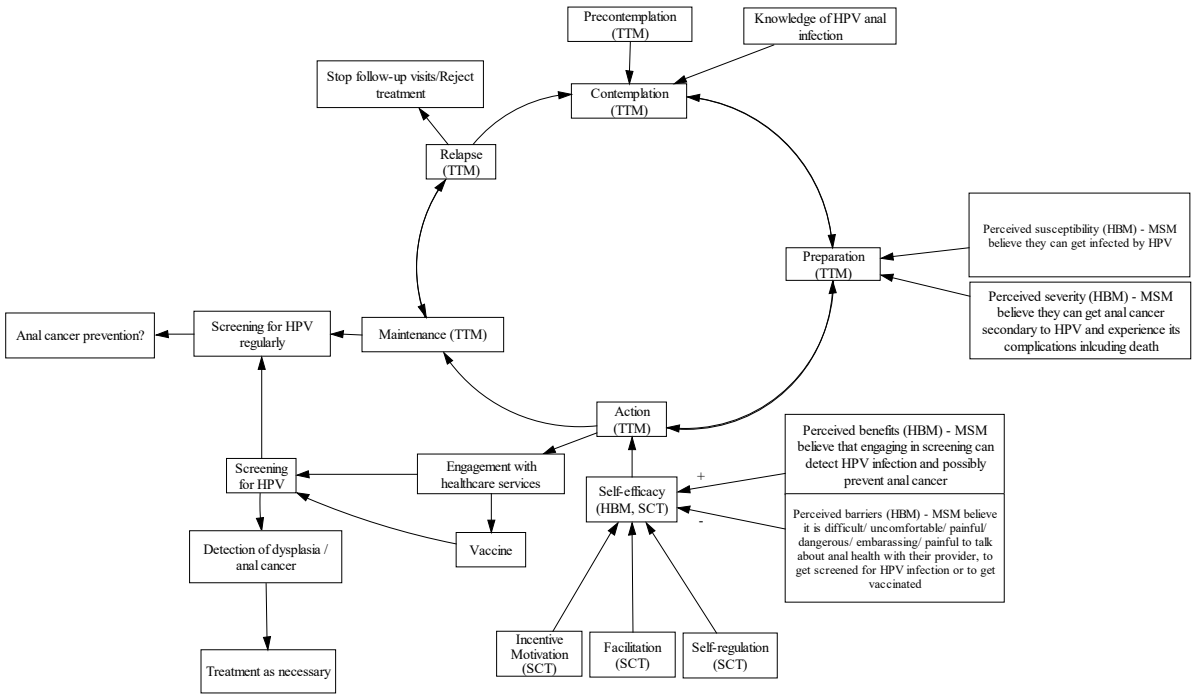
- Access to healthcare
- Medical Schools – curricula for MSM-related health issues (Behavioral Capability for Medical students – SCT)
- Medical Institutions

INTERPERSONAL (Reciprocal Determinism – SCT)

- Medical provider recommendation for screening/vaccination (cues to action – HBM)
- Reminders of screening (cues to action – HBM)
- Helping individuals overcome barriers to screening (cues to action – HBM, Behavioral Capability, observational capability – SCT)
- Sexual networks

INDIVIDUAL (Reciprocal Determinism – SCT)

- Follow screening recommendations (Action and Maintenance – TTM, Reinforcements – SCT)
- Consistent and adequate use of condoms (Action and Maintenance – TTM)
- Vaccine (Action – TTM)
- Other STI prevention strategies



Theoretical framework and constructs of the SCT, HBM and TTM at different levels of the Social Ecological Model suitable for implementation of interventions. SCT: Social Cognitive Theory, HBM: Health Belief Model, TTM: Transtheoretical model.

2.1.5 Mapping, spatial analysis and density of healthcare providers

Mapping of health issues, health disparities and available resources, as well as different spatial analysis methods are known to be useful tools to assess the geographical distribution of such issues[33-35] and to visually—and easily—represent important data to different stakeholders, such as advocates, the community, researchers and policy makers. In addition, there is also evidence that shows that avoidable cancer deaths can be reduced by increasing the density of physicians in a particular geographical area[36] and that socioeconomic status is positively associated with the development of HPV-related cancers.[37] In AC there are no data regarding the number of PCPs who recommend anal Pap smears to their MSM patients and there are only two providers of high-resolution anoscopy in the county; these are located in the central region and within medical facilities, which are not easily accessible to all the population. The lack of providers that offer these screening methods in the region and the location of the ones that are available could be impacting the uptake rates of AIN screening among MSM in the region. This study will be the first one to assess the geographical location of participants in relation to the location to medical facilities that offer these services.

2.2 Innovation

2.2.1 HPV knowledge and attitudes towards vaccination are understudied in MSM that are not eligible to get reimbursement by insurers

Although some research exists regarding the acceptability of HPV vaccine among gay and bisexual men, there currently are little data regarding the attitudes of MSM that, until recently, were no longer eligible to get reimbursement by insurers because of their age—26 years in the US. With the recent FDA approval of vaccination of men and women 27 to 45 years of age against HPV, it is imperative to understand this subgroup of men's attitudes towards screening and vaccination. This knowledge will contribute to the development of interventions to increase the uptake of these among this group, given that older age has been associated with a higher risk of high-grade anal dysplasia.[38] This study will contribute as a building block to the body of evidence about the efficacy of vaccination in this group of MSM.

2.2.2 There are currently no published spatial analyses that aim to assess the uptake of HPV screening and HPV vaccination among MSM

One study has assessed the spatial association of outcome and risk factor of cervical cancer,[39] as well as a multilevel spatial analysis of uptake of HPV vaccination.[40] There are currently no studies that have assessed the spatial relationship for uptake of screening for HPV infection and vaccination among MSM.[38] This study will be the first to study such association.

2.2.3 Currently, there are no effective interventions to address the disparity that MSM face regarding the rates of anal cancer

Most of the strategies that have been used to address this disparity are based on a health belief model, in which a lot of emphasis is placed on the individuals' awareness of the problem and their perceived susceptibility, perceived severity, perceived benefits and perceived costs associated with the possibility of developing anal cancer.[23,24,26,27,29,30,41-46] Even though this is important, because it empowers individuals to request screening, it has left healthcare professionals out of the effort to detect more precancerous anal lesions among MSM. Additionally, knowledge of the issue does not mean that the individuals will act upon this knowledge and will get screened or get vaccinated.

In spite of the increased risk at which MSM are for developing anal cancer, there are not standardized screening guidelines to detect changes in the anal mucosa (anal intraepithelial neoplasia),[5] possible precursors of anal cancer, produced by the HPV infection. Furthermore, there is not enough evidence regarding the natural history of HPV infection among men (i.e. the percentage of progression of low-grade lesions to high-grade lesions, the regression of high-grade lesions, or the progression of either types of lesions to anal cancer). Additionally, there is still not enough evidence to validate the efficacy of screening and treatment of anal intraepithelial neoplasia to reduce the rates of anal cancer and anal cancer-related deaths.[5,6,8] This study will collect data that will allow the development and implementation of future interventions; for instance, if we find in this study that MSM are not aware that there are screening procedures available to detect changes in the anal mucosa secondary to infection by HPV, but they have a good attitude towards getting screened, we could develop a health promotion intervention targeted to this population. Alternatively, if we find that MSM in AC know about the screening procedures,

but they are not motivated to get screened, then we can develop an intervention to change their attitude towards getting screened.

2.3 Approach

2.3.1 Study Design Overview

This study's design is descriptive cross-sectional; it includes four aims that complement each other. These will set the bases for the development of future interventions. The survey was adapted—using constructs of the Stages of Change Framework, the Transtheoretical Model and the Health Belief Model—from previously developed instruments[29,47] with the addition of demographic questions.

The Stages of Change model, also known as the Transtheoretical Model, posits that to achieve a behavioral change, people move through different stages that include precontemplation, contemplation, determination, action, and maintenance. The Stages of Change Model implies that different strategies should be used to achieve behavioral change in accordance with the "stage of change" in which people are situated. Using different constructs from the Health Belief Model and the Social Cognitive Theory will help understand what is driving the lack of engagement in prevention and HPV screening procedures, what is facilitating these behaviors among MSM at every stage of change, and what strategies could be useful to increase the uptake of preventive and screening procedures among the population of interest.[48,49]

The constructs of the Health Belief Model help predict why people engage in preventive, screening, and treatment or control behaviors for diseases, by establishing an association between

individual beliefs (perceived susceptibility, perceived severity, perceived benefits, perceived barriers and self-efficacy) and other modifying factors—such as demographic, social, psychological and economic variables—, and how this interaction leads to action.[48,49]

The Social Cognitive Theory, originated as the Social Learning Theory, posits that the combination of different personal, behavioral and environmental factors, altogether, are what influence human behavior and learning. The SCT emphasizes social influence, and external or internal social reinforcements, taking into consideration how individuals' past experiences determine whether an individual will engage in a specific behavior and will maintain such behavior, in this case, vaccination, and screening procedures to detect anal dysplasia and anal cancer.[48]

First (aims 1-4), we will apply online surveys to 200 MSM, to understand the extent of knowledge of the association of HPV anal infection and anal cancer, to better understand barriers to access to screening, to assess possible ways to overcome these, and to understand attitudes towards getting screened and receiving the vaccine against HPV. In addition, I will understand the participants' perceived self-efficacy to discuss screening for anal dysplasia/anal cancer with a medical provider, previous experience with screening, and their perceived risk of developing anal cancer, given that this population is at an increased risk for developing this type of cancer.

Second, using data from the survey, I will conduct a spatial analysis (aim 4) to test whether the socioeconomic characteristics of a given zip code influence the uptake of screening for HPV-related changes of the anal mucosa and the uptake of the vaccine against HPV. These objectives will provide me with the necessary quantitative data to plan future interventions to improve the uptake of AIN/anal cancer screening and vaccination among MSM in Allegheny County. For instance, if the results suggest that engagement in screening methods is low secondary to lack of

knowledge, health promotion and health education interventions could be developed to address this issue. Similarly, if the results suggest that a low uptake of screening for AIN is secondary to mistrust of PCPs or lack of engagement in conversations regarding anal health by PCPs, interventions addressing this among PCPs could also be developed, consequently improving the rates of diagnosis of anal cancer at early stages, and ultimately improving survival rates with a better quality of life among MSM.

2.3.1.1 Aim 1-4: Survey

To accomplish Aims 1 to 4, I will recruit a convenience sample of 200 MSM through targeted ads in social media (Facebook). The survey will assess the extent of knowledge of HPV infection and its complications, barriers of access to screening for anal dysplasia/anal cancer and individual attitudes that influence access to care and the uptake of HPV vaccination. The sample will include both men that have already undergone exams to screen for anal dysplasia and men who have not engaged in the screening process (See table 1 for the theoretical framework).

Aims 1-4. Eligibility and recruitment. The study will use convenience sampling (MSM who live in Allegheny County that have a Facebook account). The recruitment will take place online using the targeted ad feature of Facebook. To be eligible for this study, participants must be older than 18 years old, must self-identify as a man who has had anal sex with another man in the past year and must live in Allegheny County.

Aims 1-4. Data collection. The surveys will be administered online using Qualtrics. It will be accessible through personal computers, laptops or from the mobile phones of the participants. The instrument will be pilot tested with 5 men from the target population, and it will be designed to take approximately 30 minutes to respond (Table 2 shows the survey domains). The independent variables in this study will be knowledge of HPV, sexual behaviors, perceived risk of anal cancer,

HIV status and treatment, and access to healthcare. The dependent variables will be engagement in screening or preventive measures. The covariates will be the demographic characteristics of the participants.

Aim 1-4. Reimbursement. Every participant will receive a $20 gift card for their participation in this part of the study.

Table 2. Survey Domains

Type of variable	Construct	Description	Level of measurement
Covariates	Demographics	Country of birth	-------
		Latino/Hispanic origin	Dichotomous
		Subtype Hispanic	Nominal
		Race	Nominal
		Educational attainment	Ordinal
Dependent	Vaccine	Received immunization	Nominal
		Complete course	Nominal
Dependent	Anal Pap smear and anoscopy	Ever had anal Pap smear	Nominal
Independent	Zip code of residency	Zip code	Nominal
Independent	Vaccine	Discussion of vaccine with PCP	Nominal
		Health insurance	Nominal
		Pay cost unknown effectiveness	Ordinal
		Pay cost with partial effectiveness	Ordinal
Independent	Anal Pap smear and anoscopy	Heard of HPV infection	Nominal
		People affected by HPV	Nominal
		Heard of anal Pap smear	Dichotomous
		Where	Nominal
		What is anal Pap smear	Nominal
		Anal Pap smear embarrassing	Ordinal
		Anal Pap smear painful	Ordinal
		Intention to have anal Pap smear	Ordinal
		Anal Pap smear time-consuming	Ordinal
		Abnormal Pap smear	Nominal
		Normal Pap smear meaning	Nominal
		Changes in anal Pap smear meaning	Nominal
		Anal Pap smears always detect HPV	Nominal
		What is High-resolution anoscopy (HRA)	Nominal
		HRA examines	Nominal
Independent	Healthcare Provider	Access to Primary care provider (PCP)	Dichotomous
		Visit PCP in past six months	Nominal
		Last visit to PCP	Interval
		Outness to PCP	Nominal
		Comfortable to disclose sexuality with PCP	Nominal
		PCP talked about anal cancer prevention and screening	Nominal
		Comfort discussing anal health	Ordinal
			Ordinal

Table 2 Continued

		Comfort discussing anal health in MSM-specific clinic	Nominal
		Talked to PCP about getting anal Pap smear	Nominal
		PCP discussion or performance of other screening tests	
Independent	HIV and STIs	Ever tested for HIV	Dichotomous
		Last time tested for HIV	Ordinal
		HIV status	Nominal
		Ever tested for STIs	Nominal
		Last time tested for STIs	Ordinal
Independent	Sexual Behavior	Anal sex with casual partner past 6 months	Dichotomous
		Condom use casual partner past 6 months	Ordinal
		Anal sex with regular partner past 6 months	Dichotomous
		Condom use with regular partner past 6 months	Ordinal
Independent	HPV knowledge	HPV – Herpes	Nominal
		HPV – genital warts	Nominal
		HPV – anal cancer	Nominal
		HPV – wart-like growths	Nominal
		HPV – precancer if untreated	Nominal
		HPV risk – bottoming	Nominal
		Bloody anal discharge – anal cancer	Nominal
		Low-fiber diet and HPV	Nominal
		Fruit intake and HPV	Nominal
		Men susceptibility to HPV	Nominal
		Gay men susceptibility to HPV	Nominal
		Women susceptibility to HPV	Nominal
		HIV+ men susceptibility to HPV	Nominal
		Fat foods and HPV	Nominal
		HPV symptoms	Nominal
		Perception about prevention of HPV complications	Ordinal
		Age of starting an active sexual life and risk of HPV infection	Nominal
		Multiple sex partners and HPV infection	Nominal
		Partner's number of sexual partners and HPV infection	Nominal
		Condoms reduction of HPV risk	Nominal
		Treatment available for HPV	Ordinal
		Gay men and screening	Ordinal
		Anal cancer preventable	Ordinal
		Perceived risk of HPV	Ordinal
		Likelihood of getting HPV in lifetime	Ordinal
		Perceived risk for others to get HPV infection	Ordinal
		Anal Pap smear and likelihood of detection of HPV infection	Ordinal
		Perceived severity of HPV infection	Ordinal
		Anal Pap smears will detect HPV before it causes serious health issues	Ordinal
		Perceived difficulty to use condoms	Ordinal
		Little chance of curing HPV	Ordinal

Table 2 Continued

		Condoms and likelihood to get HPV infection HPV and discussion with fiends	Ordinal
Dependent	Vaccine	Received immunization Complete course Discussion of vaccine with PCP Health insurance Pay cost unknown effectiveness Pay cost with partial effectiveness	Nominal Nominal Nominal Nominal Ordinal Ordinal
Dependent	Anal Pap smear and anoscopy	Heard of HPV infection People affected by HPV Heard of anal Pap smear Where What is anal Pap smear Anal Pap smear embarrassing Anal Pap smear painful Intention to have anal Pap smear Anal Pap smear time-consuming Ever had anal Pap smear Abnormal Pap smear Normal Pap smear meaning Changes in anal Pap smear meaning Anal Pap smears always detect HPV What is High-resolution anoscopy (HRA) HRA examines	Nominal Nominal Dichotomous Nominal Nominal Ordinal Ordinal Ordinal Ordinal Nominal Nominal Nominal Nominal Nominal Nominal Nominal

2.3.2 Data Analysis

2.3.2.1 Aims 1-3: Survey

For aims 1-3, we will use descriptive statistics, including measures of central tendency and dispersion for continuous data, such as age. For categorical data and the dependent variables, we will estimate frequency distributions. We will also describe the characteristics of the participating men in the sample by calculating a score of HPV knowledge. I will calculate the prevalence rates of uptake of screening of HPV-related disease and HPV vaccine uptake among men in each group (See table 2 for survey domains).

2.3.2.2 Aim 4: Spatial Analysis

To achieve Aim 4, I will use the zip codes obtained in the survey to create a map on QGIS of the distribution of participants of the study. I will also map knowledge score and uptake of screening methods and HPV vaccine uptake. Once the shapefiles are created, I will perform a spatial analysis in Geoda. Particularly, I will assess clustering of the data using the Moran's I and Local Indicators of Spatial Association (LISA) test. I will estimate a spatial regression model to assess possible spatial associations between zip code of residency, poverty rates and average educational attainment per zip code, distance to providers in the County that offer high-resolution anoscopy, knowledge about HPV and previous history of screening for HPV.

2.3.3 Power Analysis

Aims 1-3 logistic regression: Because I do not know the proportion of subjects in the reference group and the dependent variables considered in this study have varied prevalence rates, I use Table 3 to illustrate the smallest odd ratios that we can find given N=200, α=0.05, power=80%, R^2=0.15 when event probabilities range from 10-60% and the reference group contains ≥5% of the subjects. We are aware that the current study will not be able to detect small differences between groups; however, this will be an exploratory pilot study to have a better understanding of the motivators and barriers for screening and vaccination among MSM in Allegheny County, which will allow us to develop an intervention tailored for them.

Table 3. Smallest detectable Odds Ratios for Logistic Regression Models

		Probability (%) of event in reference group					
		10	20	30	40	50	60
% in reference group	5	10.98	9.12	12.95	15.12	11.05	8.16
	15	4.4	3.64	3.48	3.61	4.07	5.48
	25	3.65	2.96	2.78	2.78	2.94	3.34
	35	3.36	2.71	2.54	2.51	2.6	2.84
	45	3.28	2.63	2.45	2.41	2.47	2.66
	55	3.35	2.66	2.46	2.41	2.46	2.63

2.3.4 Products of Data Analysis to Further Intervention Development

Even though some research has been done about the risk of anal cancer among MSM, little is understood about what motivates men to engage in screening for anal dysplasia or anal cancer with Pap-smears, despite the favorable results that have been observed in previous research. Furthermore, there are still no national guidelines, or effective interventions to increase the uptake of screening or vaccination among MSM. This study will provide me with invaluable information about the role that screening and vaccination against HPV could have in the incidence of anal cancer among MSM, and ultimately, improve their survival and the quality of their lives. The formative data obtained from this study will allow me to develop an effective intervention to increase the uptake of screening and vaccination among MSM in Allegheny County, and it will provide data necessary to move the field forward. Whether the lack of engagement is secondary to an educational, cultural, socioeconomic, provider-related, systemic or a combination of these factors, I will develop, implement and evaluate an intervention as an initial step towards elimination of HPV infection and anal cancer among MSM. Aims 1-3 will allow me to understand

the different factors that play a role in the behaviors being studied (screening and vaccination). Aim 4 will provide us with insight about these factors and will allow me to assess the spatial association between our independent and dependent variables to tailor interventions targeting the geographic areas in the County in most need.

2.4 Discussion

In this proposed study I expect to observe similar results to those that have been previously reported elsewhere[50-52] regarding knowledge and attitudes towards screening for AIN and uptake of vaccination among MSM. Even though a vaccine to prevent the infection by different oncogenic strains of HPV has been available for many years, different studies have shown that there are still low vaccination rates among MSM[50-52]. Recently, the US Food and Drug Administration approved the supplemental use of Gardasil 9,[53] the vaccine currently used in the US to protect against 9 strains of HPV linked with disease and cancer, among men and women from 27 to 45 years, expanding the coverage and benefits conferred by the vaccine, such as prevention of genital warts, prevention of precancerous lesions, and prevention of recurrent disease.[53] This change in policy should impact the current policies of reimbursement by insurance companies in the United States (US) which only cover the costs of vaccination for MSM up to the age of 26, leaving older MSM with the only option of paying for it out-of-pocket. This step pairs the US HPV vaccination guidelines with guidelines from other developed countries which prioritize MSM to receive this immunization up to the age of 45.[54,55]

This proposed study has multiple strengths. The survey will be accessed privately by each participant, and this could mean a better response rate, because it could be responded at the

participants' convenience and at their place of choice, granting privacy. The recruitment approach through social media might yield good participation rates, as it has been reported in other studies.[56,57]Additionally, there is currently no study that has examined knowledge about the association between anal infection by HPV and anal cancer, attitudes towards screening procedures to detect AIN and attitudes towards vaccination among MSM in the region; this will be the first attempt to do so, and the results will likely contribute to the development of public health interventions to increase the uptake of screening and vaccination against HPV, which will be tailored for PCPs and MSM of the region. After the completion of this exploratory study, it could be scaled-up to the region of Southwestern Pennsylvania and neighboring counties from West Virginia and Ohio.

However, I am aware of some limitations. First, the study will use a convenience sampling method, which might deem it not representative of the population of MSM in AC which could be achieved through a randomized sample. Second, given that the recruitment will be through Facebook targeted ads, I will miss individuals who do not use this platform or who do not follow or like pages that I will use to target the ads; this might mean that some MSM who are at risk of acquiring an anal infection by HPV but who are not overt about their sexual behaviors will not be reached (e.g. men in the down-low). Additionally, some of the questions deal with very sensitive information, which can potentially generate social desirability bias. Finally, the possibility of self-selection bias is also present; it is likely that the individuals that opt to respond the survey are already more likely to engage in screening methods to detect anal intraepithelial neoplasia or to have received the immunization.

Appendix Survey

Screener

1. What sex were you assigned at birth?
    a. Female
    b. Male
    c. Intersex
2. What gender do you currently identify as? (Mark all that apply)
    a. Female
    b. Male
    c. Non-binary
    d. Gender non-conforming
    e. Trans male (Female to male)
    f. Trans female (Male to female)
    g. Intersex
    h. Another gender identity. Please specify
3. Have you had sex with a man in the past year?
    a. Yes
    b. No
4. What is your age?
5. Do you live in Allegheny County?
    a. Yes
    b. No

Questionnaire.

I. Demographics.

Please respond the following questions.

1. What country were you born in?

2. What is your zip code?

3. Are you Latino, Hispanic or of Spanish origin?
    a. Yes
    b. No

4. If yes: Are you?
    a. Mexican/Mexican American/Chicano/
    b. Puerto Rican
    c. Cuban
    d. Another Hispanic, Latino/a, or Spanish origin.
        Please specify
    e. I don't know/Not sure
5. Which one or more of the following would you say is your race?
    a. White
    b. Black or African American
    c. American Indian or Alaska Native
    d. Asian
    e. Pacific Islander
    f. Other
        Please specify
    g. Don´t know-Not sure
6. What is the highest degree or level of school that you have completed?
    a. No schooling completed
    b. Less than high school degree
    c. High school diploma/GED or alternative credential
    d. Some college
    e. College degree
    f. Graduate degree

II. Anal Pap smear and anoscopy.

We are interested in understanding your knowledge about different methods to detect an HPV infection. For the following questions, please select one answer.

7. Have you heard of the infection by the Human papillomavirus (HPV)?
    a. Yes
    b. No
    c. I don't know
8. HPV infections can affect
    a. Only women
    b. Only men
    c. Only trans women
    d. Only trans men
    e. Anyone
    f. I don't know

9. Have you ever heard of anal Pap smears?
    a. Yes
    b. No
10. Where did you hear about anal Pap smears?
    a. Family/friends
    b. Magazines
    c. TV
    d. I have never heard of an anal Pap smear
    e. Doctor
    f. Other healthcare professional
    g. Other
11. What is an anal Pap smear test?
    a. Scraping of the anus to look for abnormal cells
    b. Test for sexually transmitted infections like syphilis, gonorrhea and chlamydia
    c. Speculum (instrument that is used to enlarge an orifice to make a part accessible to observation) in the anus
    d. Treatment for cancer
    e. I don't know

Prompt: An anal Pap smear is a test in which a PCP, your partner or you gently scrape cells from your anal canal to examine them under a microscope.

12. Have you ever had an anal Pap smear?
    a. Yes
        when was the last time you had an anal Pap smear?
    b. No
    c. I don't know
13. I would be embarrassed to have an anal Pap smear
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
14. I would feel pain if I had an anal Pap smear
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
15. I intend to have an anal Pap smear in the next 6-12 months
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree

16. I think having an anal Pap smear is time consuming
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
17. In most cases an abnormal anal pap smear result could indicate (Select as many options as you think apply):
    a. Cancer or Pre-cancerous changes
    b. Nothing
    c. HIV positive
    d. I don't know
18. If a man's anal Pap smear is normal, he does not have HPV.
    a. True
    b. False
    c. Don´t know
19. Changes in an anal Pap smear may indicate a man has HPV.
    a. True
    b. False
    c. Don´t know
20. Anal Pap smears will almost always detect HPV.
    a. True
    b. False
    c. Don´t know
21. What is a high resolution anoscopy?
    a. A treatment for anal cancer
    b. A test to check for anal precancer in the anal canal
    c. Same as a smear
    d. Test for cancer
    e. I don't know
22. What does a high resolution anoscopy examine?
    a. Bowel
    b. Stomach
    c. Intestines
    d. Anus
    e. I don't know

III. HPV knowledge

In the following questions, please select the answer you most agree with:

23. HPV is the virus that causes herpes.
    a. True
    b. False
    c. Don´t know

24. Genital warts are caused by HPV.
    a. True
    b. False
    c. Don´t know
25. The HPV virus can cause anal cancer.
    a. True
    b. False
    c. Don´t know
26. A symptom of HPV is wart-like growths.
    a. True
    b. False
    c. Don´t know
27. If untreated, HPV can cause pre-cancer.
    a. True
    b. False
    c. Don´t know
28. Bottoming/being the bottom/receiving increases the risk of HPV.
    a. True
    b. False
    c. Don´t know
29. Bleeding or a bloody anal discharge is a symptom of anal cancer.
    a. True
    b. False
    c. Don´t know
30. A low fiber diet increases the likelihood of HPV.
    a. True
    b. False
    c. Don´t know
31. High fruit intake decreases the likelihood of HPV.
    a. True
    b. False
    c. Don´t know
32. Men are not susceptible to HPV.
    a. True
    b. False
    c. Don´t know
33. Only gay men can get HPV.
    a. True
    b. False
    c. Don´t know
34. Only women are susceptible to HPV.
    a. True
    b. False
    c. Don´t know

35. Only HIV positive men are susceptible HPV.
    a. True
    b. False
    c. Don´t know
36. Eating foods high in fat increases my chances of contracting HPV.
    a. True
    b. False
    c. Don´t know
37. HPV produces symptoms
    a. Always
    b. Sometimes
    c. Never
    d. I don't know
38. The best way to prevent complications caused by HPV is to have regular anal Pap smears.
    a. Strongly agree
    b. Somewhat agree
    c. Somewhat disagree
    d. Strongly disagree
    e. I don't know
39. Starting an active sexual life at a young age increases the risk of acquiring an HPV infection
    a. Strongly agree
    b. Somewhat agree
    c. Somewhat disagree
    d. Strongly disagree
    e. I don't know
40. Having multiple sex partners increases the risk of acquiring an infection by HPV
    a. Strongly agree
    b. Somewhat agree
    c. Somewhat disagree
    d. Strongly disagree
    e. I don't know
41. Your risk for acquiring an infection by HPV is higher If your sexual partner has had multiple sexual partners
    a. Strongly agree
    b. Somewhat agree
    c. Somewhat disagree
    d. Strongly disagree
    e. I don't know
42. Using condoms during sex reduces my risk of acquiring an anal infection by HPV
    a. Strongly agree
    b. Somewhat agree
    c. Somewhat disagree
    d. Strongly disagree
    e. I don't know

43. Successful treatments are available to treat an HPV infection
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
44. It is important for gay men to screen for HPV
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
45. Anal cancer is a preventable form of cancer
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
46. My risk of getting HPV is very low compared to other men my age
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
47. It is likely that I will develop HPV at some point in my life
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
48. Not many people will get an HPV infection during their lifetime
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know

49. If I have regular anal Pap smears my chance of detecting HPV increases
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
50. I believe that HPV can cause serious health problems
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
51. If I have regular anal Pap smears I will detect HPV before it causes serious health problems
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
52. Using condoms is easy
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
53. There is little chance of curing HPV if detected early
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know
54. If I use condoms when having anal intercourse, I am less likely to get HPV
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know

55. HPV is serious enough to discuss with my friends
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
    f. I don't know

IV. Healthcare provider

We are interested in understanding the access to primary healthcare that is currently available to you

56. Do you have a primary care provider?
    a. Yes
    b. No
57. Have you visited your primary care provider/family doctor/other healthcare provider in the past 6 months?
    a. Yes
    b. No
    c. I don't know
58. When was the last time you visited your health provider, a Community-based Organization/Health Clinic (like Allies for Health + Wellbeing, Planned Parenthood, Central Outreach) or the Health Department for a sexual health check-up?
    a. Last month
    b. 2-6 months
    c. 6-12 months
    d. More than a year ago
    e. Never
    f. I don't know
59. Is your primary care provider aware that you have sex with other men?
    a. Yes
    b. No
    c. I don't know
60. If your doctor is unaware that you have sex with other men, would you be comfortable letting them know you have sex with other men?
    a. Yes
    b. No
    c. I don't know
61. Has your doctor ever talked to you about anal cancer prevention and screening?
    a. Yes
    b. No
    c. I don't know

62. I feel comfortable discussing anal health with my doctor
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
63. I would feel more comfortable discussing anal health in a clinic specifically for gay men
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
64. Have you ever asked your doctor about the possibility of having an anal Pap smear?
    a. Yes
    b. No
    c. I don't know
65. Has your doctor ever discussed with you other screening tests to potentially detect early signs of anal cancer?
    a. Yes
    b. No
    c. I don't know
66. Has your doctor ever performed other screening tests to potentially detect early signs of anal cancer?
    a. Yes
    b. No
    c. I don't know

V. Vaccine

67. Have you received the vaccine to protect against HPV infection?
    a. Yes
    b. No
    c. I don't know
68. If yes, how many HPV shots did you receive?
    a. One shot
    b. Two shots
    c. Three shots
    d. I don't know
69. Have you ever talked to your doctor or another healthcare professional about receiving the vaccine against HPV?
    a. Yes
    b. No
    c. I don't know

70. What type of health insurance do you have?
    a. I don't have health insurance
    b. Insurance through an employer/work
    c. Medicaid
    d. Medicare
    e. Private (e.g Aetna, UPMC, Highmark, etc.)
    f. Other
    g. I don't know
71. The HPV vaccine without insurance is between $400-$500. How much do you agree with this statement? I would be willing to pay the full amount, even if the effectiveness was unknown in people who are already sexually active
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
72. The HPV vaccine without insurance is between $400-$500. How much do you agree with this statement? I would be willing to pay the full amount, if it was shown to be <u>at least partially effective</u> in people who are already sexually active
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree

VI. HIV and Sexually Transmitted Infections

We are interested in understanding your screening practices for sexually transmitted infections and HIV. For the following questions, please select one answer.

73. Have you ever been tested for HIV (Human Immunodeficiency Virus)?
    a. Yes
    b. No
74. When was the last time you were tested for HIV?
    a. In the past 3 months
    b. Between 3 and 6 months ago
    c. Between 6 months and a year ago
    d. More than a year ago
75. My HIV status is:
    a. Negative
    b. Positive
    c. I don't know
    d. Prefer not to disclose
76. Have you ever been tested for any sexually transmitted disease?
    a. Yes
    b. No

77. When were you last tested for any sexually transmitted disease?
    a. In the past 3 months
    b. Between 3 and 6 months ago
    c. Between 6 months and a year ago
    d. More than a year ago

VII. Sexual behavior

For the following questions, please select one answer.

78. What is your sexual Identity
    a. Gay/Homosexual
    b. Lesbian/Homosexual
    c. Heterosexual/straight
    d. Bisexual
    e. Asexual
    f. Queer
    g. Another sexual identity. Please specify

79. Have you had anal sex with a casual partner in the past 6 months?
(By sex with a casual partner we mean: having anal intercourse—a penis in your butt or your penis in another man's butt—with a person with whom you are not in a committed relationship)
    a. Yes
    b. No

80. When having anal sex with a casual partner in the past 6 months I:
(By sex with a casual partner we mean: having anal intercourse—a penis in your butt or your penis in another man's butt—with a person with whom you are not in a committed relationship)
    a. Used a condom always
    b. Used a condom most of the time
    c. Used a condom sometimes
    d. Used a condom rarely
    e. Never used a condom

81. Have you had anal sex with someone that you were in a committed relationship with in the past 6 months?
(By sex with someone in a committed relationship we mean: having anal intercourse—a penis in your butt or your penis in another man's butt— with someone in an interpersonal relationship based upon a mutually agreed-upon commitment to one another)
    a. Yes
    b. No

82. When having anal sex in a committed relationship in the past 6 months I:
(By sex with someone in a committed relationship we mean: having anal intercourse—a penis in your butt or your penis in another man's butt— with someone in an interpersonal relationship based upon a mutually agreed-upon commitment to one another)
    a. Used a condom always
    b. Used a condom most of the times
    c. Used a condom sometimes
    d. Used a condom rarely
    e. Never used a condom

Bibliography

1. Araldi RP, Sant'Ana TA, Modolo DG, et al. The human papillomavirus (HPV)-related cancer biology: An overview. *Biomed Pharmacother.* 2018;106:1537-1556.
2. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC). *Sexually Transmitted Disease Surveilance 2016.* 2017.
3. Viens LJ, Henley SJ, M. W, et al. Human Papillomavirus - Associated Cancers - United States, 2008-2012. *MMWR Morb Mortal Wkly Rep.* 2016;65:661-666.
4. D'Souza G, Wentz A, Wiley D, et al. Anal Cancer Screening in Men Who Have Sex With Men in the Multicenter AIDS Cohort Study. *J Acquir Immune Defic Syndr.* 2016;71(5):570-576.
5. Limoges-Gonzalez M, Al-Juburi A. Anal Intraepithelial Neoplasia. *J Clin Gastroenterol.* 2017;51(3):203-207.
6. Ong JJ, Temple-Smith M, Chen M, et al. Why are we not screening for anal cancer routinely - HIV physicians' perspectives on anal cancer and its screening in HIV-positive men who have sex with men: a qualitative study. *BMC Public Health.* 2015;15:67.
7. Workowski KA, Bolan GA. Sexually Transmitted Diseases Guidelines, 2015. *MMWR Recomm Rep 2015.* 2015;64(3):138.
8. Dona MG, Vescio MF, Latini A, et al. Anal human papillomavirus in HIV-uninfected men who have sex with men: incidence and clearance rates, duration of infection, and risk factors. *Clin Microbiol Infect.* 2016;22(12):1004 e1001-1004 e1007.
9. Pitts MK, Heywood W, Ryall R, et al. Knowledge of human papillomavirus (HPV) and the HPV vaccine in a national sample of Australian men and women. *Sexual Health.* 2010;7(3):299-303.
10. Chin-Hong PV, Vittinghoff E, Cranston RD, et al. Age-related prevalence of anal cancer precursors in homosexual men: the EXPLORE study. *J Natl Cancer Inst.* 2005;97(12):896-905.
11. Goldie SJ, Kuntz KM, Weinstein MC, Freedberg KA, Palefsky JM. Cost-effectiveness of screening for anal squamous intraepithelial lesions and anal cancer in human immunodeficiency virus-negative homosexual and bisexual men. *Am J Med.* 2000;108(8):634-641.
12. Goldie SJ, Kuntz KM, Weinstein MC, Freedberg KA, Welton ML, Palefsky JM. The clinical effectiveness and cost-effectiveness of screening for anal squamous intraepithelial lesions in homosexual and bisexual HIV-positive men. *JAMA.* 1999;281(19):1822-1829.
13. Lam JM, Hoch JS, Tinmouth J, Sano M, Raboud J, Salit IE. Cost-effectiveness of screening for anal precancers in HIV-positive men. *AIDS.* 2011;25(5):635-642.
14. U. S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC). Reported STDs in the United States. 2015 National Data for Chlamydia, Gonorrhea and Syphilis [fact sheet]. In:2016.
15. Burkhalter JE, Margolies L, Sigurdsson HO, et al. The National LGBT Cancer Action Plan: A White Paper of the 2014 National Summit on Cancer in the LGBT Communities. *LGBT health.* 2016;3(1):19-31.

16. Cochran SD, Bjorkenstam C, Mays VM. Sexual Orientation and All-Cause Mortality Among US Adults Aged 18 to 59 Years, 2001-2011. *Am J Public Health.* 2016;106(5):918-920.
17. Stall R, Matthews DD, Friedman MR, et al. The Continuing Development of Health Disparities Research on Lesbian, Gay, Bisexual, and Transgender Individuals. *Am J Public Health.* 2016;106(5):787-789.
18. Hatzenbuehler ML, Phelan JC, Link BG. Stigma as a fundamental cause of population health inequalities. *Am J Public Health.* 2013;103(5):813-821.
19. Jabson JM, Farmer GW, Bowen DJ. Stress mediates the relationship between sexual orientation and behavioral risk disparities. *BMC Public Health.* 2014;14:401.
20. Drabkin AS, Sikkema KJ, Wilson PA, et al. Risk patterns preceding diagnosis among newly HIV-diagnosed men who have sex with men in New York City. *AIDS Patient Care STDS.* 2013;27(6):333-341.
21. Kalichman SC, Price D, Eaton LA, et al. Diminishing Perceived Threat of AIDS and Increasing Sexual Risks of HIV Among Men Who Have Sex with Men, 1997-2015. *Arch Sex Behav.* 2017.
22. Trecker MA, Waldner C, Jolly A, Liao M, Gu W, Dillon JA. Behavioral and socioeconomic risk factors associated with probable resistance to ceftriaxone and resistance to penicillin and tetracycline in Neisseria gonorrhoeae in Shanghai. *PLoS One.* 2014;9(2):e89458.
23. Blackwell CW, Eden C. Human papillomavirus and anorectal carcinoma knowledge in men who have sex with men. *The Journal of the Association of Nurses in AIDS Care : JANAC.* 2011;22(6):444-453.
24. Brewer NT, Ng TW, McRee AL, Reiter PL. Men's beliefs about HPV-related disease. *Journal of behavioral medicine.* 2010;33(4):274-281.
25. Butame SA, Lawler S, Hicks JT, et al. A qualitative investigation among men who have sex with men on the acceptability of performing a self- or partner anal exam to screen for anal cancer. *Cancer causes & control : CCC.* 2017.
26. Colon-Lopez V, Del Toro-Mejias LM, Ortiz AP, Tortolero-Luna G, Palefsky JM. HPV awareness and willingness to HPV vaccination among high-risk men attending an STI clinic in Puerto Rico. *Puerto Rico health sciences journal.* 2012;31(4):227-231.
27. D'Urso J, Thompson-Robinson M, Chandler S. HPV knowledge and behaviors of black college students at a historically black university. *Journal of American college health : J of ACH.* 2007;56(2):159-163.
28. Fenkl EA, Jones SG, Schochet E, Johnson P. HPV and Anal Cancer Knowledge among HIV-Infected and Non-Infected Men Who Have Sex With Men. *LGBT health.* 2015.
29. Pitts MK, Fox C, Willis J, Anderson J. What do gay men know about human papillomavirus? Australian gay men's knowledge and experience of anal cancer screening and human papillomavirus. *Sexually transmitted diseases.* 2007;34(3):170-173.
30. Sanchez DM, Pathela P, Niccolai LM, Schillinger JA. Knowledge of human papillomavirus and anal cancer among men who have sex with men attending a New York City sexually transmitted diseases clinic. *International journal of STD & AIDS.* 2012;23(1):41-43.
31. Newman PA, Roberts KJ, Masongsong E, Wiley DJ. Anal Cancer Screening: Barriers and Facilitators Among Ethnically Diverse Gay, Bisexual, Transgender, and Other Men Who Have Sex With Men. *Journal of gay & lesbian social services.* 2008;20(4):328-353.

32. Russo S, McCaffery K, Ellard J, et al. Experience and psychological impact of anal cancer screening in gay, bisexual and other men who have sex with men: a qualitative study. *Psycho-oncology.* 2017.
33. Samarasundera E, Walsh T, Cheng T, et al. Methods and tools for geographical mapping and analysis in primary health care. *Primary health care research & development.* 2012;13(1):10-21.
34. Auchincloss AH, Gebreab SY, Mair C, Diez Roux AV. A review of spatial methods in epidemiology, 2000-2010. *Annual review of public health.* 2012;33:107-122.
35. Rezaeian M, Dunn G, St Leger S, Appleby L. Geographical epidemiology, spatial analysis and geographical information systems: a multidisciplinary glossary. *Journal of Epidemiology and Community Health.* 2007;61(2):98-102.
36. Sundmacher L, Busse R. The impact of physician supply on avoidable cancer deaths in Germany. A spatial analysis. *Health Policy.* 2011;103(1):53-62.
37. Benard VB, Johnson CJ, Thompson TD, et al. Examining the association between socioeconomic status and potential human papillomavirus-associated cancers. *Cancer.* 2008;113(S10):2910-2918.
38. de Pokomandy A, Rouleau D, Ghattas G, et al. HAART and progression to high-grade anal intraepithelial neoplasia in men who have sex with men and are infected with HIV. *Clin Infect Dis.* 2011;52(9):1174-1181.
39. Kreuger FA, van Oers HA, Nijs HG. Cervical cancer screening: spatial associations of outcome and risk factors in Rotterdam. *Public Health.* 1999;113(3):111-115.
40. Riesen M, Konstantinoudis G, Lang P, et al. Exploring variation in human papillomavirus vaccination uptake in Switzerland: a multilevel spatial analysis of a national vaccination coverage survey. *BMJ Open.* 2018;8(5):e021006.
41. Bjekic M, Sipetic-Grujicic S, Dunic I, Salemovic D, Vlajinac H. Human papillomavirus and anal carcinoma knowledge in men who have sex with men in Belgrade, Serbia. *International journal of dermatology.* 2016;55(10):1082-1087.
42. Colon-Lopez V, Ortiz AP, Del Toro-Mejias LM, Garcia H, Clatts MC, Palefsky J. Awareness and knowledge of human papillomavirus (HPV) infection among high-risk men of Hispanic origin attending a sexually transmitted infection (STI) clinic. *BMC infectious diseases.* 2012;12:346.
43. Dodd RH, McCaffery KJ, Marlow LA, Ostini R, Zimet GD, Waller J. Knowledge of human papillomavirus (HPV) testing in the USA, the UK and Australia: an international survey. *Sexually transmitted infections.* 2014;90(3):201-207.
44. Fenkl EA, Schochet E, Jones SG, da Costa BR. Evaluation of an HPV/Anal Cancer Screening Awareness Program for HIV-infected Men Who Have Sex With Men. *The Journal of the Association of Nurses in AIDS Care : JANAC.* 2015;26(4):492-497.
45. Gerend MA, Magloire ZF. Awareness, knowledge, and beliefs about human papillomavirus in a racially diverse sample of young adults. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine.* 2008;42(3):237-242.
46. Giuliani M, Vescio MF, Dona MG, et al. Perceptions of Human Papillomavirus (HPV) infection and acceptability of HPV vaccine among men attending a sexual health clinic differ according to sexual orientation. *Human vaccines & immunotherapeutics.* 2016;12(6):1542-1550.

47. Moores A, Phillips JC, O'Byrne P, MacPherson P. Anal cancer screening knowledge, attitudes, and experiences among men who have sex with men in Ottawa, Ontario *The Canadian Journal of Human Sexuality.* 2015;24(3):228-236.
48. Glanz K, Rimer BK, Viswanath K. *Health Behavior and Health Education. Theory, Research and Practice.* 4th ed. San Francisco, CA: Jossey-Bass; 2008.
49. JS SL, JD F. Behavioral Interventions for STDs: Theoretical Models and Intervention Methods. In: Aral SO, Douglas JM, eds. *Behavioral Interventions for Prevention and Control of Sexually Transmitted Diseases.* Boston, MA: Springer; 2007.
50. Singh V, Crosby RA, Gratzer B, Gorbach PM, Markowitz L, Meites E. Disclosure of Sexual Behavior is Significantly Associated with Receiving a Panel of Healthcare Services Recommended for Men Who Have Sex with Men. *Sex Transm Dis.* 2018.
51. Meites E, Markowitz LE, Paz-Bailey G, Oster AM, Group NS. HPV vaccine coverage among men who have sex with men - National HIV Behavioral Surveillance System, United States, 2011. *Vaccine.* 2014;32(48):6356-6359.
52. Oliver SE, Hoots BE, Paz-Bailey G, Markowitz LE, Meites E, Group NS. Increasing Human Papillomavirus Vaccine Coverage Among Men Who Have Sex With Men-National HIV Behavioral Surveillance, United States, 2014. *J Acquir Immune Defic Syndr.* 2017;75 Suppl 3:S370-S374.
53. FDA approves expanded use of Gardasil 9 to include individuals 27 through 45 years old [press release]. MD, 10/09/2018 2018.
54. Joint Committee on Vaccination and Immunisation. Statement on HPV vaccination of men who have sex with men. In:2015.
55. European AIDS Clinical Society (EACS). EACS Guidelines version 9.0. In:2017.
56. Close S, Smaldone A, Fennoy I, Reame N, Grey M. Using information technology and social networking for recruitment of research participants: experience from an exploratory study of pediatric Klinefelter syndrome. *Journal of medical Internet research.* 2013;15(3):e48.
57. Yuan P, Bare MG, Johnson MO, Saberi P. Using online social media for recruitment of human immunodeficiency virus-positive participants: a cross-sectional survey. *Journal of medical Internet research.* 2014;16(5):e117.