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Short communication

# Are human papillomavirus knowledge and vaccine uptake associated with HIV status and social determinants of health in young sexual minority men?

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ABSTRACT

This brief report examines the relationship, if any, between human immunodeficiency virus (HIV) status, and individual-level and socio-sexual partner-level factors of social determinants of health (SDOH) that are associated with human papillomavirus (HPV) knowledge and vaccine uptake in young sexual minority men (YSMM). We used data from 126 YSMM recruited by network-based sampling during 2015–2016 in Houston, Texas. Descriptive statistics and regression analyses were conducted to test the association between HIV status, SDOH, and HPV knowledge and vaccine uptake. Those living with HIV had lower odds of knowledge of HPV-associated anal cancer (OR: 0.43, 95% CI: 0.18–0.97) and knowledge of HPV spreading via sexual contact (OR: 0.11, 95% CI: 0.01–0.64), and higher odds of HPV vaccine uptake (OR: 2.90, 95% CI: 1.11–8.02). HPV knowledge and vaccine uptake in YSMM was not associated with partner's attributes or individuals' SDOH factors in our study yet was significantly associated with HIV status. Future interventions are needed to increase HPV knowledge among individuals living with HIV and vaccine uptake particularly among YSMM living without HIV that are not engaged in healthcare.

## 1. Introduction

Infection with high-risk human papillomavirus (hrHPV) is the leading cause of anal carcinoma, and has been linked to other poor health sequelae in sexual minority men (SMM) such as penile and oropharyngeal cancers (Wheldon et al., 2011). HPV infection is common among young SMM (YSMM) (Nyitray et al., 2018) and infection with human immunodeficiency virus (HIV) has been associated with an increased prevalence of hrHPV infection in SMM (Nyitray et al., 2018). Vaccination against hrHPV infection is effective and recommended by the Advisory Committee for Immunization Practices for everyone aged 9–26 years with vaccination available for those aged 27–45 years based on shared clinical decision-making (Meites et al., 2019); however, vaccination is severely underutilized in SMM with an estimated 38% vaccine uptake (Loretan et al., 2019; Nadarzynski et al., 2021).

Studies suggest a myriad of factors influencing HPV vaccination in SMM (Loretan et al., 2019). Social determinants of health (SDOH) are also critical factors in preventive healthcare, yet these barriers are understudied, specifically among SMM. Recent studies have shown that disparities in income, education, and employment can contribute to poor health outcomes (Abbott & Williams, 2015; Jeffries & Henny, 2019). Specifically, economic and educational inequities are at the root of many barriers SMM experience in accessing preventive care, especially among racial/ethnic minority SMM (Harrison et al., 2022).

SMM also demonstrate low knowledge and awareness of HPV infection, and HPV vaccination (Blackwell & Eden, 2011; Colon-Lopez et al., 2012; Wheldon et al., 2021). Although SDOH has been used as a conceptual framework in research regarding HPV vaccination (Maness

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& Thompson, 2019) and acceptability among the SMM population (Zhao et al., 2021), only a few studies have examined the impact of social dimensions of SDOH on HPV knowledge and vaccination in YSMM (Gerend et al., 2016; Grandahl & Neveus, 2021), especially in the context of HIV.

Along with disparities driven by SDOH, infection with hrHPV genotypes (e.g., HPV-16, −18) can also be affected by socio-sexual networks (Fujimoto et al., 2022). Literature suggests that preventive health information can be passed through socio-sexual networks in SMM (Kanamori et al., 2022), however, little is known about the association, if any, between socio-sexual networks and HPV knowledge and vaccination within a SDOH framework. Thus, the purpose of this study is to comprehensively examine the relationship between various dimensions of SDOH (individual-level sociodemographic and behavioral dimensions, as well as socio-sexual partner-level attributes) along with individual-level HIV and syphilis statuses, and HPV knowledge and vaccination in YSMM.

## 2. Materials and methods

### 2.1. Study sample

This study utilizes data from the Young Men's Affiliation Project (YMAP), a longitudinal cohort study conducted in Chicago, Illinois and Houston, Texas assessing HIV risk and prevention, and health venue affiliation networks in YSMM. The YMAP used respondent driven sampling (RDS) methodology to recruit YSMM from December 2014 to June 2016 who were aged 16–29 years, male-identifying and assigned male at birth, had oral or anal sex with another male in the past 12 months, and lived in Houston (N = 378) or Chicago (N = 377) metropolitan area at baseline (2014–2016) and follow-up (2015–2017). A more detailed description has been published elsewhere (Fujimoto et al., 2018). Briefly, initial participants called "seeds" were selected to participate in research activities and then incentivized to recruit persons from their social networks to participate, and so on. The current analyses are based on a cross-sectional subset of the YMAP study population which included 126 YSMM from the Houston site who participated in YMAP supplemental data collection during the follow-up survey period in 2015–2016. The YMAP study protocol was reviewed and approved by the Committee for the Protection of Human Subjects (CPHS) at the University of Texas Health Science Center at Houston (UTHealth).

### 2.2. Study measures

Participants who were aware of HPV were asked about their knowledge of HPV's association with anal cancer through the item: "*Please listen to the following questions and tell me if you believe the following statements are true or false: HPV can cause anal cancer*". Knowledge of HPV being spread through sexual contact was assessed through the item: "*Please listen to the following questions and tell me if you believe the following statements are true or false: HPV can be spread by sexual contact*". Among those who had ever heard of the HPV vaccine, vaccination status was assessed through the item: "*Have you ever received an HPV vaccine?*".

Sociodemographic characteristics and SDOH assessed include age (years), race/ethnicity (non-Hispanic Black, other race/ethnicity), education (high school or below, at least some college education), health insurance (yes or no), employed (yes or no), tobacco use (yes or no), and incarceration history (ever jailed/detained/arrested, no). Biometric variables assessed include HIV status (positive or negative) determined by fourth generation Alere™ rapid test and confirmed by multispot or viral load quantitative test, and syphilis status (positive or negative) determined using a fluorescent treponemal antibody (FTA) test (Immunofluorescence Assay FTA-Absorption Test System, Zeus Scientific, New Jersey, USA). Behavioral variables include sexual behavior assessed through the number of anal sex partners in the past 6 months (continuous in square root transformation), and protective behavior measured by receiving biomedical prevention assessed through pre-exposure prophylaxis (PrEP) use (if self-reported HIV-negative) or adherence to antiretroviral therapy (ART) (if self-reported HIV-positive), and, having ever received an HIV test. Socio-sexual partner attributes assessed include having a sex partner(s) perceived as HIV-positive, having condomless anal sex with a receptive partner(s), having sex partners who live together, and having a sex or social partner(s) with incarceration history.

### 2.3. Statistical analyses.

Chi-square tests and Fisher's exact tests were performed to assess the association between categorical variables and outcomes, while t-tests were used for continuous variables. Unweighted log-binomial generalized linear models (GLM) were estimated using the GLMNET package to assess the multivariable associations between independent variables and HPV-related responses. The multivariable models were composed of independent variables that showed a statistically significant univariate association ($p < 0.05$) with the dependent variable. All statistical tests were two-tailed with an alpha probability of 0.05. All analyses were conducted in R Statistical Software.

## 3. Results

Table 1 describes the characteristics of the study population. The 126 participants had an average age of 25.7 years, 71.4% identified as non-Hispanic Black, 58.7% had above a high school education, 45.2% were living with HIV, and 31.7% had established syphilis. Further, 82.5% of the study population had heard of HPV. Of those, 43.3% had knowledge that HPV could cause anal cancer, and 90.4% had knowledge that HPV could spread through sexual contact. Of those who had ever heard of the HPV vaccine (n = 82), 35.4% had received the vaccine and 34% of those who were unvaccinated had intention on receiving the vaccine in the future. Regarding socio-sexual attributes, 31% had sex partners perceived as HIV-positive, 38.1% had condomless anal sex with receptive partners, 29.4% had sex partners who live together, and 62.7% had sex or social partners who were ever arrested.

In bivariable comparisons (data from chi-square tests not shown in tables) of those who had heard of HPV stratified by HPV knowledge and vaccine uptake, Black race/ethnicity ($p = 0.004$) and living with HIV ($p = 0.04$) were associated with knowledge of HPV's causal link with anal cancer. The number of sex partners ($p = 0.003$), Black race/ethnicity ($p = 0.02$), education ($p = 0.03$), living with HIV ($p = 0.02$), and syphilis positivity ($p = 0.05$) were associated with knowledge that HPV can spread through sexual contact. HIV positivity ($p = 0.03$) was the only predictor associated with HPV vaccination.

Table 2 assesses the unadjusted and adjusted relationships between HPV knowledge and vaccination, and selected variables. In unadjusted analyses, those who were Black had significantly lower odds of knowing about HPV's causal link to anal cancer (OR: 0.29, 95% CI: 0.12–0.68). Further, those who were living with HIV had significantly lower odds of knowing about HPV's causal link to anal cancer (OR: 0.43, 95% CI: 0.18–0.97). However, neither of these relationships remained statistically significant when adjusted for each other.

Additionally, in unadjusted analyses, those with a higher number of anal sex partners (square root transformed) had higher odds of knowing that HPV can spread via sexual contact (OR: 3.80, 95% CI: 1.31–14.16), as well as those with above high school education (OR: 4.31, 95% CI: 1.12–21.04). On the other hand, those who were living with HIV had lower odds of knowing that HPV can spread via sexual contact (OR: 0.11, 95% CI: 0.01–0.64), as well as those who were syphilis positive (OR: 0.17, 95% CI: 0.02–0.79). In the adjusted model, a higher number of anal sex partners (square root transformed) remained significantly associated with increased odds of knowing that HPV can spread via sexual contact (OR: 5.79, 95% CI: 1.45–44.00) and HIV positivity

**Table 1**
Characteristics of young sexual minority men in the YMAP study, Houston Texas.

| N = 126 | Yes n (%) | No n (%) | N/A n (%) |
|---|---|---|---|
| Age, years (mean, SD; min–max.) | 25.7, 2.8; 19–31 | | |
| Non-Hispanic Black (race/ethnicity) | 90 (71.4) | 36 (28.6) | 0 (0) |
| Above high school education | 74 (58.7) | 51 (40.5) | 1 (0.8) |
| Had health insurance | 75 (59.5) | 50 (39.7) | 1 (0.8) |
| Employed full-time | 118 (93.7) | 8 (6.3) | 0 (0.0) |
| Had been detained, arrested, or spent time in jail or prison in the last 12 months | 20 (15.9) | 105 (83.3) | 1 (0.8) |
| Living with HIV | 57 (45.2) | 60 (47.6) | 9 (7.1) |
| Ever taken PrEP (n = 69) [1] | 12 (17.4) | 57 (82.6) | 0 (0.0) |
| Ever prescribed ART (n = 57) [2] | 47 (82.5) | 8 (14.0) | 2 (3.5) |
| Positive syphilis (FTA) status | 40 (31.7) | 71 (56.3) | 15 (11.9) |
| Smoked tobacco in the past 30 days | 68 (54.0) | 58 (46.0) | 0 (0.0) |
| Had HIV testing | 83 (65.9) | 42 (33.3) | 1 (0.8) |
| Year of HIV test [3] | | | |
| Within 12 months prior to the survey | 36 (43.4) | — | — |
| Before 12 months prior to the survey | 46 (56.6) | — | — |
| Had sex partner(s) perceived as HIV+ | 39 (31.0) | 87 (69.0) | 0 (0.0) |
| Had condomless anal sex with receptive partner(s) | 48 (38.1) | 77 (61.1) | 1 (0.8) |
| Had sex partner(s) who live together (overlap of sex partner with proximity) | 37 (29.4) | 89 (70.6) | 0 (0.0) |
| Had sex or social partner(s) who were ever detained, arrested or jailed | 79 (62.7) | 47 (37.3) | 0 (0.0) |
| Heard of HPV | 104 (82.5) | 22 (17.5) | — |
| Self-perceived susceptibility to HPV [4] | 54 (51.9) | 50 (48.1) | — |
| Perceived severity of HPV [4] | 77 (74.0) | 27 (26.0) | — |
| Knowledge of HPV causal link to anal cancer [4] | 45 (43.3) | 59 (56.7) | — |
| Knowledge of HPV causal link to anal warts [4] | 65 (62.5) | 39 (37.5) | — |
| Knowledge of HPV spread via sexual contact [4] | 94 (90.4) | 10 (9.6) | — |
| Received HPV vaccine [5] | 29 (35.4) | 53 (64.6) | — |
| Intention to receive HPV vaccine [6] | 18 (34.0) | 35 (66.0) | — |

[1] Only among 69 participants who perceived themselves as HIV-negative (not based on HIV testing) or were unsure.
[2] Only among 57 participants who perceived themselves as living with HIV.
[3] Only among 83 participants who had received an HIV test.
[4] Only among 104 participants who responded aware of HPV. Those who answered "not aware" were excluded from further questions.
[5] Only among 82 participants who had ever heard of HPV vaccines. Those who answered "not aware" were excluded from further questions.
[6] Only among 53 who were unvaccinated. Those who were vaccinated were excluded from this question.

remained significantly associated with decreased odds of knowing that HPV can spread via sexual contact (OR: 0.09, 95% CI: 0.004–0.57). Syphilis status was not adjusted for as it was highly correlated with HIV status.

Lastly, those who were living with HIV had higher odds of having received the HPV vaccine when compared to those who were HIV-negative (OR: 2.90, 95%: 1.11–8.02) in unadjusted analyses. No other variables were significantly associated with vaccination thus no adjusted model was built.

## 4. Discussion

This exploratory cross-sectional analysis assesses the relationships between individual's characteristics, multilevel SDOH factors and HIV and syphilis statuses with HPV knowledge and HPV vaccination in YSMM. The results of our study suggest that HPV knowledge and vaccine uptake in YSMM may not be characterized by SDOH factors including socio-sexual partner attributes, but may be mostly associated with HIV status.

Those living with HIV had a lower prevalence of HPV knowledge yet had a higher prevalence of HPV vaccination. The reasoning for this finding is unknown as literature suggests that SMM living with HIV are mostly unaware of the HPV vaccine (Feeney et al., 2019; Finneran et al., 2021; Koskan & Fernandez-Pineda, 2018). However, receipt of HIV care can often include evaluation for HPV and particularly recommendations for HPV vaccination, which could lead to higher vaccine uptake among SMM living with HIV.

Due to the increased risk of HPV infection that SMM experience, there may be a need for targeted interventions to increase HPV knowledge, specifically in YSMM vulnerable to HIV. Being that our findings indicate a higher HPV vaccine uptake, yet lower HPV knowledge in SMM living with HIV, point-of-care discussions between providers and SMM living with HIV and/or those without HIV who are utilizing prevention (i.e., HIV testing, PrEP) may provide an avenue to implement patient education. This may assist SMM in making informed decisions that could help prevent future HPV infections and associated sequelae, as some YSMM become infected over time.

### 4.1. Study Limitations.

When interpreting the results of this study, some limitations should be considered. Our study used limited sample size; thus, our analysis may not have enough power and may have missed other potential variables associated with HPV knowledge and vaccine uptake. Notably, the lower bound of both confidence intervals for assessing knowledge that HPV can spread via sexual contact by HIV positivity and syphilis positivity were near 0, thus this should be interpreted with caution. Similarly, due to sample size limitations, the multivariable model for knowledge that HPV can spread via sexual contact produced highly inflated standard errors thus estimates may be unstable. Further research with a larger sample size should be conducted to fully assess the relationship between SDOH and HPV knowledge and vaccine uptake in SMM.

## 5. Conclusions

In conclusion, our exploratory analysis did not find any support for SDOH factors associated with HPV knowledge and vaccination in YSMM. Rather, it suggests that HIV positivity may be related to lower HPV knowledge, yet higher vaccine uptake. This may be because YSMM living with HIV are more likely to be engaged in care than those living without HIV, particularly in a non-Medicaid expansion context such as Houston. Further research that includes interventions engaging YSMM living with HIV in relation to HPV knowledge, and YSMM living without HIV in relation to vaccine uptake are needed to inform effective context-based HPV prevention programs.

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**Table 2**
Assessing the association between HPV knowledge and vaccination, and selected predictors using univariable and multivariable unweighted log-binomial generalized linear models.

| | HPV Knowledge (Anal cancer)[1] | | HPV Knowledge (Spread via sexual contact)[1] | | Received HPV Vaccine[2] |
|---|---|---|---|---|---|
| | OR (95% CI) | aOR (95% CI) | OR (95% CI) | aOR (95% CI) | OR (95% CI) |
| Sqrt number of sex partners | 0.97 (0.69–1.35) | — | **3.80 (1.31–14.16)** | **5.79 (1.45 – 44.00)** | 0.90 (0.57–1.29) |
| Non-Hispanic Black (race/ethnicity) | **0.29 (0.12–0.68)** | 0.40 (0.14–1.08) | — | — | 0.91 (0.36–2.37) |
| Above high school education | 1.74 (0.78–4.00) | — | **4.31 (1.12–21.04)** | 5.04 (1.00 – 38.22) | 0.63 (0.25–1.61) |
| Had health insurance | 1.08 (0.48–2.44) | — | 2.91 (0.78–12.07) | — | 1.86 (0.72–5.18) |
| Had been detained, arrested, or spent time in jail or prison in the last 12 months | 0.41 (0.12–1.15) | — | 0.48 (0.12–2.40) | — | 2.09 (0.64–6.84) |
| Had sex partner(s) perceived as HIV+ | 0.74 (0.31–1.68) | — | 0.45 (0.12–1.72) | — | 0.88 (0.32–2.28) |
| Had condomless anal sex with receptive partner(s) | 1.18 (0.52–2.66) | — | 2.37 (0.56–16.31) | — | 0.80 (0.31–2.00) |
| Living with HIV | **0.43 (0.18–0.97)** | 0.61 (0.24–1.55) | **0.11 (0.01–0.64)** | **0.09 (0.004–0.57)** | **2.90 (1.11–8.02)** |
| PrEP/ART combo | 0.66 (0.29–1.48) | — | 0.34 (0.08–1.29) | — | 1.37 (0.54–3.49) |
| Had sex partner(s) who live together (overlap of sex partner with proximity) | 1.09 (0.46–2.59) | — | 0.34 (0.09–1.33) | — | 0.81 (0.27–2.23) |
| Had sex or social partner(s) who were ever detained, arrested or jailed | 1.11 (0.49–2.53) | — | 0.44 (0.06–1.88) | — | 0.91 (0.36–2.37) |
| Positive syphilis (FTA) status | 0.43 (0.17–1.03) | — | **0.17 (0.02–0.79)** | — | 1.33 (0.47–3.70) |
| Smoked tobacco in the past 30 days | 0.74 (0.34–1.64) | — | 1.54 (0.40–5.90) | — | 1.25 (0.49–3.28) |
| Had HIV testing | 0.86 (0.38–1.96) | — | 0.46 (0.07–1.98) | — | 0.77 (0.30–2.02) |

[1] Among 104 participants who responded aware of HPV. Those who answered "not aware" were excluded from further questions.
[2] Among 82 participants who had ever heard of HPV vaccines. Those who answered "not aware" were excluded from further questions.

or University of Texas Health-MD Anderson.

## 7. Ethics approval

The YMAP study protocol was reviewed and approved by the Committee for the Protection of Human Subjects (CPHS) at the University of Texas Health Science Center at Houston (UTHealth).

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

The data that has been used is confidential.

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