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HIV knowledge mediates the relationship between HIV testing history and stigma in college students

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ABSTRACT

Objective: HIV-related stigma is one of the strongest barriers to prevention and treatment. HIV prevalence in U.S. college students is estimated around 0.02%, but is thought to be drastically underreported. We examined the influence of HIV knowledge on the relationship between HIV testing history and stigma in college students. **Participants**: A random sample of 2343 students, over the age of 18, attending a large university in the southeastern United States completed the survey in January 2016. **Methods**: A mediation model was constructed in regression framework to explore the relationship between HIV testing history, knowledge, and stigma. **Results**: HIV testing history was associated with higher knowledge scores (*a* path: B = 4.08, $p < .001$) and higher knowledge scores were associated with lower stigma (*b* path: B = .01, $p < .001$). These results suggest that HIV knowledge partially mediates the relation between HIV testing history and stigma in college students. **Conclusions**: HIV testing history may decrease stigma by increasing knowledge. Results can be used to inform college health promotion practice on developing programs and services.

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According to the Centers for Disease Control and Prevention, the United States is home to over 1.1 million people living with HIV (PLWH) over age 13.[1] Despite advancements in medical care, approximately 66% of diagnosed PLWH are not receiving care for their infection, and some live years without knowing their HIV status.[2] Accordingly, not only do undiagnosed PLWH not know that they need to be engaged in treatment, but they may unknowingly expose sexual partners, offspring, and needle sharing partners to the virus. In 2009, an estimated 45,000 transmissions of HIV occurred in the United States of which approximately 91.5% were from PLWH who were undiagnosed or diagnosed but not retained in care.[3] Thus, identifying PLWH and engaging them in treatment is a public health priority in the United States.

Young adults and adolescents (age 15–24) are disproportionately affected by sexually transmitted infections (STIs), with half-of-all new cases occurring in this age group[4,5]; further, in 2015, an estimated 22% of new HIV infections occurred in this population.[6] Traditionally aged college students (age 18–24) comprise a subset of the young adult and adolescent population who present a variety of sexual risk behaviors that place them at higher risk for STIs/HIV including high rates of sexual activity, numerous sexual partners, inconsistent condom use, and having sex under the influence of drugs or alcohol.[7,8] In Spring 2016, 0.2% of a national reference group of 94,141 college students reported being diagnosed or treated for HIV in the past year; however, less than 30% of those students had ever been tested.[7] Despite this low reported prevalence, HIV infection in this population, like STI positivity, is likely higher than previously thought.[9] College presents a unique opportunity for health education and health promotion, as young adults are more receptive to health messages and adopting healthy lifestyles at an early age has long-term benefits.[10,11] Thus, promoting healthy HIV prevention behaviors in this population may have long-term implications on reducing the prevalence of HIV.

HIV-related stigma has been identified as one of the strongest barriers to HIV prevention and treatment service utilization, including poor adherence to life-saving medication, inadequate use of testing services, and nondisclosure to sexual partners. Since the start of the HIV/AIDS epidemic, PLWH have been

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subjected to stigma and discrimination as a result of misconceptions and misinformation. Stigma affecting PLWH are generally either self-stigma or public stigma.[12] Self-stigma occurs when a PLWH believes they are socially unacceptable and can lead to self-blaming for their diagnosis, self-isolating behaviors, and refusal to adhere to treatment. Public stigma, however, is society's negative perception of the individual and manifests in forms of social distancing and blaming PLWH for their condition. When acted upon, public stigma creates inequitable environments for PLWH including discriminatory legislation, refusal of employment, and family difficulties.[13] Both self-stigma and public stigma perpetuate health disparities in PLWH, including negative mental health outcomes and lack of healthcare accessibility.[14] Because stigma is conceived through a process of the environment, the healthcare system, and the individual (PLWH or not), it is best conceptualized through the social-ecological model of health, as individual health outcomes are influenced by policy, community, interpersonal, and individual-level factors.[15] Thus, to improve HIV prevention and treatment efforts, it is imperative to identify how stigma can be reduced.

Among college students, HIV stigma manifests through lower engagement in STI and HIV testing services, increased social distance toward PLWH, and blaming PLWH for their condition.[16,17] These stigmas vary among demographic characteristics including socio-economic status, gender, sexual orientation, and age.[18–20] In addition, social networks affect HIV stigma, as people who know a PWLH have more positive attitudes towards HIV and PLWH.[18,21,22] One of the strongest predictors of HIV-related stigma, however, is fear of HIV transmission.[13,23] Fear of transmission is likely caused by misconceptions and misinformation related to HIV, and can be reduced by increasing HIV-related knowledge. As HIV-related knowledge increases, social discrimination and stigmatizing attitudes generally decrease.[12,21,24–26] Although college students have similar knowledge to the general American population, they display uncertainty related to HIV transmission.[23,27–29] When considering college students who are sexually active, lack of knowledge may affect their ability to accurately perceive their susceptibility to being exposed to HIV. Further, despite having higher knowledge than the general population, fear of transmission is also prevalent among students in preprofessional medical training programs, who may work with PLWH during their careers.[21,30] Accordingly, increasing HIV knowledge, including knowledge related to transmission, can help reduce HIV stigma in college populations and have long-term implications on the practice of future medical providers.

HIV testing is an effective strategy to reduce risk of HIV transmission and increase knowledge of HIV status.[31] Importantly, there is a reciprocal relationship between HIV testing and stigma. Individuals who have been tested for HIV have reduced stigma.[32,33] This could be due to individually tailored risk reduction education that occurs during some HIV testing sessions, which increases knowledge, prevention self-efficacy, and positive beliefs related to HIV.[34] This helps reduce public stigma, which leads to social norming of the HIV testing process and is associated with higher testing uptake.[35] In college students, the effects of HIV stigma are observed in the underutilization of testing services. For example, university students in New Zealand indicated that social concerns, including concern of being stigmatized, was one of the top three barriers to STI testing.[36] Similarly, students in the United States who reject HIV testing have less positive attitudes toward testing, more fear of being stigmatized, and fear of positive test result.[37,38]

Prior research indicates that HIV prevention knowledge- and skill-based interventions are efficacious in increasing knowledge and decreasing stigma,[34] and specifically highlights the moderating role of knowledge in stigma reduction.[39] This relation with HIV testing as an intervention has not been well assessed. Using the social-ecological model as a guide, the primary aim of the current study was to explore the impact of HIV knowledge on the relationship between HIV testing history and stigma. We hypothesized that when controlling for major of study, psycho-demographic, and behavioral variables, HIV knowledge mediates the relationship between HIV testing history and stigma in college students. In addition, in recognizing the role that future healthcare providers have in relation to the HIV care continuum, a secondary aim of this study was to assess differences in HIV-knowledge and stigma among majors of study.

Methods

Participants and procedure

We administered a web-based survey through Qualtrics Survey Management (Qualtrics, Provo, UT) to a sample of college students attending a public university in the southeast United States. Upon receiving ethics approval from the university's Institutional Review Board, the Registrar provided a simple random sample (without replacement) of 10,000 undergraduate and graduate students over the age of 18; because distance learning students may present atypical sexual behavior due to varying demographic characteristics, we restricted inclusion to students with local addresses on file. Students were invited (via e-mail) to the online survey in early

January 2016 to participate in "research on sexual behaviors, knowledge, and attitudes." Participants were sent three reminder e-mails over the course of the study. The survey was open for two weeks and participation was voluntary and anonymous. Prior to taking the survey, participants were required to read and agree to an informed consent describing the survey's contents, protection of information, and incentive. The first, middle, and last 10 participants to take the survey and complete an unlinked contact information form received an incentive consisting of a $20 Amazon® gift card. In total, the survey link was opened by 3162 students, with 23% ($N =$ 2343) of the invited participants fully completing the survey.

Measures

We measured HIV-related stigma, HIV transmission and treatment knowledge, testing history and sexual behaviors, and sample demographic data.

Participant characteristics

Demographic items assessed age, gender, self-reported race and ethnicity, and self-identified sexual orientation. Participants were asked to type their major of study, being as specific as possible, into a textbox after selecting their individual college of study. In addition, participants were asked if they had ever had an HIV test and if they have/had a friend, relative, or colleague who has HIV or AIDS.

HIV stigma

HIV-related stigma was measured using the SAT-PLWHA-S (*Scale of Stigmatizing Attitudes Towards People Living with HIV*).[18] The original instrument included 27-items measuring seven factors related to public stigma, including concerns about occasional encounters (3 items), avoidance of personal contact (3 items), responsibility and blame (6 items), liberalism (4 items), nondiscrimination (5 items), confidentiality of serological status (3 items), and criminalization of transmission (3 items). The SAT-PLWHA-S has undergone previous psychometric evaluation in a Canadian population.[18] Although the SAT-PLWHA-S measures attitudes about people living with both HIV and AIDS, the original survey employed terminology such as "AIDS virus" when describing HIV. To reduce misinformation, all instances of "AIDS virus" were changed to "HIV." In 2011, 33 states in the United States had one or more HIV-specific criminal laws that differ in disclosure requirements, behaviors criminalized, and defenses.[40] Accordingly, expert panel reviewers were concerned about the "criminalization of transmission" subscale being included in the survey. To reduce potential participant confusion on the legal issues related to HIV transmission, we removed the subscale (i.e., "Transmitting HIV is a crime," "Transmitting HIV should be punishable by law," and "People who know they are infected with HIV and who transmit the virus are criminals"). The internal consistency score in the current study (Cronbach's $\alpha = .92$) indicated that the overall scale (24 items) was reliable. A mean stigma score was calculated by averaging all 24-items included on the scale. Higher scores indicated more agreeable attitudes (i.e., lower stigma) toward HIV and PLWH.

HIV knowledge

Knowledge was measured using the 18-item version of the HIV Knowledge Questionnaire (HIV-KQ-18)[41]—a validated short version of the original 45-item HIV-K-Q.[42] Five additional items from the original HIV-K-Q were added to the instrument: "A person can get HIV from a toilet seat," "Eating healthy foods can keep a person from getting HIV," "A person can get HIV even if she or he has sex with another person only one time," "If a person tests positive for HIV, then the test site will have to tell all of his or her partners," and "Taking vitamins keeps a person from getting HIV." Items were adapted for inclusivity by replacing gender specific pronouns with neutral pronouns. We calculated a Kuder–Richardson Formula 20 (KR-20) score to measure internal consistency. (KR-20 is a special case of Cronbach's α used for dichotomous scales.[43]) The total knowledge scale had acceptable internal consistency (ρ(KR-20) = .79), indicating that the instrument was reliable. In accordance with the scale's scoring guidelines, "don't know" responses were coded as incorrect.[41] A mean knowledge score was calculated for each participant by dividing the number of correct answers by the total number of items, with higher scores indicating higher knowledge.

Sexual behavior

Sexual behavior items were benchmarked from the National College Health Assessment II, by asking the number of oral, anal, and vaginal sex partners respondents had in the past year.[7] Participants who responded with having one or more in any intercourse category were coded as sexually active.

Data analysis

Data were cleaned and analyzed using the Statistical Package for the Social Sciences version 22.0 (SPSS Inc., Chicago, IL, USA). Dichotomous variables were created to combine smaller demographic samples into groups that could be analyzed (i.e., sexual orientation coded as

either "LGBT+" or "Straight," and race was coded as "White" or "not-White"). In addition, a binary variable was created to distinguish if a participant had been sexually active in the past year. Major of study was coded as health-related or non–health-related based on content analysis of open-ended responses by two trained coders. Responses indicating an area related to pre-human health professional tracks, dentistry, pharmacy, and medicine were coded as health-related. The interrater reliability score for the coding of majors indicated strong interrater agreement ($\kappa = .997$), and any disagreements in coding were resolved through discussion.

Demographics of the sample were described by computing frequencies and percentages. Responses missing data for knowledge or stigma items were removed from the analysis. We tested for differences in knowledge and stigma according to key demographic variables. Bonferroni correction was applied to adjust for potential Type I error inflation due to multiple comparisons, setting Type I error rate at 0.006 instead of 0.05 for Pearson correlations and *t*-tests with Cohen's *d* effect sizes. In addition, mediation analysis was conducted in multiple linear regression framework to evaluate if HIV testing history (X) is related to knowledge (M), and if knowledge is in turn related to stigma (Y). Key covariates (i.e., participant age, gender, major of study, race, sexual orientation, knowing a PLWH, and sexual activity), determined *a priori*, were controlled for in examining mediational pathways. The mediated effect was estimated by taking the product of the two unstandardized regression coefficients (i.e., *ab*). Mediation was tested using bias-corrected bootstrapping methods implemented in the SPSS PROCESS macro[44] to take into account the non-normality of mediated effects.[45]

Results

Sample characteristics

A total of 2343 students were included in the data analysis. The age of respondents ranged from 18 to 58 years old, with an average age of 21.75 years old (SD = 4.10 years). As presented in Table 1, a majority of the respondents were white (72%), female (63%), and straight (87%). All 16 of the University's colleges were represented, with 36% of respondents enrolled in health-related majors. Approximately 10% of respondents reported knowing a PLWH. One-third (34%) of the sample had received an HIV test at some point during their lives. A majority (72%) of the sample was sexually active, having engaged in oral, anal, or vaginal sex in the 12 months preceding the survey. Due to the sampled university not collecting data on the racial categories of international students, who could have been included in the sample, we compared our sample demographics to that of another health behavior study using the same methodology conducted a year earlier.[46] The differences in the proportion of students by race, ethnicity, and gender were not significant ($p > .05$; see Table 1).

Table 1. Sample demographics.

	Our sample	HG 2015 sample[46]
Race/Ethnicity		
White	71.8%	70.8%
Not White	28.2%	29.2%
Hispanic or Latino(a)	20.4%	19.2%
Gender		
Female	63.3%	64.1%
Not female	36.7%	35.8%
Sexual orientation		
Straight	87.3%	
LGBT+	12.7%	
Major of study		
Human health related	35.9%	
Not human health related	64.1%	
Know PLWH	9.9%	
Tested for HIV (ever)	34.0%	
Sexually active	72.3%	

Note. Comparisons for the sampled university are not available after Fall 2013 and fail to measure the racial categories of international students. The Healthy Gators Student Survey on E-cigarettes[37] used the same sampling methodology as the current study, with a larger incentive, and was administered in Spring 2015. Differences in the proportion of students in each demographic category are not statistically significant ($p > 0.05$).

Table 2. Differences in HIV knowledge among key demographic variables.

	n	Mean (SD)	*t*-value	df	*p* value	*d*
Race/Ethnicity*			−3.12	2341	.002	0.14
White	1682	78.25 (15.67)				
Not White	661	76.03 (15.03)				
Gender			−0.82	2341	.41	
Female	1484	77.83 (15.13)				
Not female	859	77.28 (16.19)				
Sexual orientation*			−3.39	2341	.001	0.21
Straight	2046	77.21 (15.56)				
LGBT+	297	80.47 (15.01)				
Major of study*			−6.06	1874.65	< .001	0.26
Human health related	841	80.14 (14.51)				
Not human health related	1502	76.22 (15.90)				
Know PLWH			−3.22	2341	.001	0.23
Yes	232	80.73 (15.11)				
No/Prefer not to say	2111	77.28 (15.54)				
Tested for HIV (ever)*			−11.29	1945.84	< .001	0.47
Yes	797	82.22 (12.95)				
No	1546	75.26 (16.20)				
Sexually active*			−8.21	982.28	< .001	0.40
Yes	1693	79.40 (17.78)				
No	650	73.01 (14.18)				

[n] indicates the number of participants in that sub-group; mean, mean of knowledge score; SD, standard deviation; df, degrees of freedom; *d*, Cohen's *d*.
* Indicates significant difference after Bonferroni correction.
[a] Person living with HIV.

Table 3. Differences in HIV stigma among key demographic variables.

	n	Mean (SD)	*t*-value	df	*p*	*d*
Race/Ethnicity*			-4.93	2341	< .001	0.22
White	1682	3.14 (0.46)				
Not White	661	3.04 (0.46)				
Gender*			−4.26	2341	< .001	0.17
Female	1484	3.14 (0.45)				
Not female	859	3.06 (0.47)				
Sexual orientation*			−12.15	2341	< .001	0.76
Straight	2046	3.07 (0.45)				
LGBT+	297	3.41 (0.44)				
Major of study			−0.95	2341	.35	
Human health related	841	3.12 (0.45)				
Not human health related	1502	3.11 (0.46)				
Know PLWHa*			−5.62	2341	< .001	0.40
Yes	232	3.27 (0.44)				
No/Prefer not to say	2111	3.09 (0.46)				
Tested for HIV (ever)*			−7.15	2341	< .001	0.33
Yes	797	3.21 (0.45)				
No	1546	3.06 (0.46)				
Sexually active*			−4.50	2341	< .001	0.22
Yes	1693	3.14 (0.45)				
No	650	3.04 (0.47)				

n indicates the number of participants in that sub-group; mean, mean of stigma score; SD, standard deviation; df, degrees of freedom; *d*, Cohen's *d*.
* Indicates significant difference after Bonferonni correction.
[a] Person living with HIV.

HIV knowledge and stigma

Total HIV knowledge was high, with a mean score of 77.62 ($SD = 15.53$; range = 0–100). As shown in Table 2, independent samples t-tests indicated that there were several significant differences in knowledge with higher knowledge being identified in participants who are White, self-identify as LGBT+, health-related majors, know a PLWH, have previously received an HIV test, and who are sexually active. The size of the difference in knowledge between those who have received an HIV test and those who have not was of moderate effect (Cohen's $d = .47$). The SAT-PLWHA-S scores showed mostly agreeable attitudes towards HIV (i.e., less stigma; $M = 3.11$, $SD = .46$, range = 1.72–4.00), with higher scores indicating more positive attitudes. As shown in Table 3, more agreeable attitudes were identified in individuals who are White, Female-identifying, self-identify as LGBT+, know a PLWH, have previously received an HIV test, and who are sexually active. The difference in stigma scores by sexual orientation had the largest effect (Cohen's $d = .76$). HIV knowledge was correlated with more acceptable attitudes (less stigma), $r = .33$, $p < .001$. Stigma and knowledge were both correlated with age, $r = .07$ ($p < .001$) and $r = .18$ ($p < .001$), respectively.

Mediation analysis

Regression analysis was used to test the hypothesis that knowledge mediates the effect of HIV testing history on stigma (see Figure 1).

Results support the hypothesized relationship as HIV testing was a significant predictor of HIV knowledge (*a* path: B = 4.08, SE = .71, $p < .001$) and HIV knowledge was a significant predictor of stigma (*b* path: B = .01, SE = .001, $p < .001$). Of the covariates included in the relationship between HIV testing history and knowledge, older participant age, health related major of study, being White, identifying in the LGBT+ community, and being sexually active, were significant covariates of higher knowledge ($p < .001$). Being a woman, White, LGBT+, and knowing a PLWH were significant covariates for lower stigma ($p < .001$). Approximately 18.3% of the variance in stigma was accounted for by the predictors ($R^2 = .18$). The indirect effect was tested using a bootstrap estimate with 5000 samples. The results show that the unstandardized indirect effect was significant ($ab = .04$, SE = .01, 95%

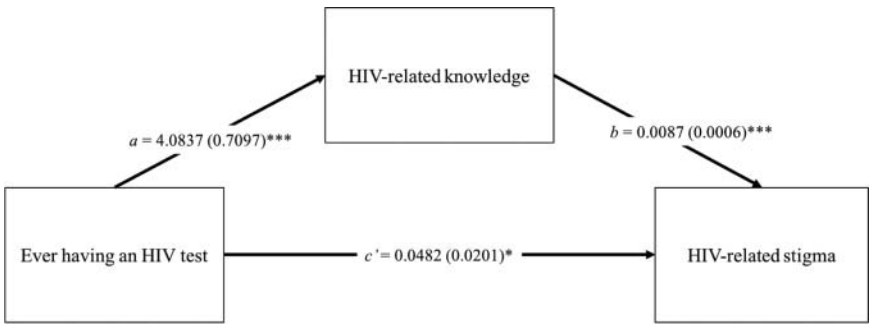

Figure 1. Hypothesized model testing the mediating effect of HIV knowledge on the relation between HIV testing history and stigma. *Note*. Significant covariates between HIV testing history and higher knowledge were: older participant age, health-related major of study, being White, identifying in the LGBT+ community, and being sexually active (*ps* < 0.001). Significant covariates of knowledge and lower stigma were: being female, White, LGBT+, and knowing a PLWH (*ps* < 0.001).*$p < 0.05$, ***$p < 0.001$.

CI: .02–.05) and that the direct effect was significant (*c*' path: B = .05, SE = .02, $p = .02$), indicating partial mediation. The proportion of the mediated effect (*ab*/*c*) was 0.424, indicating that knowledge accounted for more than two-fifths (42.4%) of the total effect of HIV testing history on stigma.

Comment

This study assessed the role of HIV knowledge on the relation between HIV testing history and HIV stigma. We found that knowledge partially mediated the relationship between HIV testing history and stigma in college students: having had an HIV test was associated with higher levels of knowledge that, in turn, were associated with more agreeable attitudes (i.e., less stigma). These results are consistent with prior research showing that HIV testing increases knowledge and decreases stigma.[32,33] Furthermore, 34% of the sample had ever received an HIV test; this proportion is higher than the 28% reported in the findings of the American College Health Association's National College Health Assessment's Spring 2016 national reference group, indicating that students in our sample have higher engagement with HIV testing.[7] In addition, a secondary aim of this study was to identify differences in HIV stigma and knowledge by major of study. Our results indicate that knowledge varies by major of study, but stigma does not. Although individuals in health related majors of study had higher knowledge, we expected the difference to have a larger effect. Surprisingly, major of study was not significantly associated with HIV-related stigma. Instead, our findings suggest that the sampled population already endorses positive attitudes towards PLWH.

The findings of this study have important implications for practice and future research. First, HIV related stigma impacts testing engagement and adherence to treatment.[26,47] Our results further highlight the relationship between HIV testing history and stigma, suggesting that those who have had an HIV test have lower stigma. Because stigma is a complex social process, increasing the number of individuals who have less stigma will help normalize the environment regarding HIV. Theoretically, this will help improve intention to engage in an HIV test, and impact PLWH's treatment adherence.[47,48]

Second, these findings describe a potential mechanism (i.e., knowledge) through which HIV testing decreases stigma while controlling for demographic covariates. Many states, including Florida, require that community based organizations provide prevention and tailored risk reduction counseling during the process of an HIV test.[49] However, some HIV tests include an oral swab or blood test without an education component. Adding an educational component to HIV testing sessions may increase individual prevention behaviors and reduce HIV stigma. In addition, if HIV testing becomes a normalized behavior, this could increase the proportion of the population who receives an HIV test (allowing for the identification of PLWH), increase knowledge, and help decrease stigmatizing attitudes. Accordingly, college health promotion specialists should advocate for the widespread use of HIV risk reduction counseling and testing programs to decrease public stigma.

Lastly, our results provide information on the levels of knowledge and stigma among identifiable demographic groups. Specifically, higher knowledge was observed in students who were a human health related major of study, while higher knowledge and lower stigma was observed among students who were white, LGBT+, knew a PWLH, had been tested for HIV, and who were sexually active. College health promotion specialists can use these results to guide the development of tailored health communication campaigns targeting demographic groups with lower knowledge and higher stigma. This may help lower public stigma and, in turn, help improve outcomes among the HIV care continuum.[17]

Strengths and limitations

The present study was conducted using cross-sectional data collected through a random sample survey. Although still low, the survey's response rate was consistent with other college health surveys administered in the study population.[46,50] This could be attributed to our use of best practices in survey administration of taboo topics, including offering an incentive, using an online survey, and emphasizing our protection of confidentiality and anonymity.[51] In addition, our sample was randomly selected among enrolled students at the university. Based upon previous random sample studies conducted at the institution, we believe that our sample was representative of the student population at the sampled institution.

Social desirability and response bias are major concerns for surveys measuring taboo topics such as HIV, sexual behavior, illegal behavior, and unsocial attitudes.[51,52] Survey respondents may favor a more normative presentation of their behaviors, which can lead to underreporting of behaviors. Likewise, this may also lead to over-reporting of more positive attitudes seen as normative.[53] Due to the perception of our topic as taboo, we went to extensive lengths to promote honesty, assuring participants that their responses were anonymous and confidential. Our survey did not identify the type of HIV test that the student engaged in, so we were unable to compare the relationships between HIV testing with

education, versus HIV testing without education—The differences in HIV testing interventions available, the location, length, and type of test could affect the relationship between knowledge and stigma.—Importantly, due to the cross-sectional nature of the survey, we cannot attribute causality between the variables. Path estimates provided by cross-sectional mediation do not always reflect estimates identified in longitudinal mediation,[54] due to the temporal precedence required for estimating cause-and-effect relationships. However, the empirical and theoretical evidence that HIV testing history affects knowledge and stigma, in addition to the results of our exploratory analysis, justifies the development of rigorous longitudinal studies to estimate the mediating effect of knowledge on HIV testing history and stigma. A final limitation is that the participants were recruited at a single institution, so our findings may not be generalizable to all college students.

Conclusions

In summary, we identified a specific mechanism, knowledge, by which HIV testing may affect HIV-related stigma. Our results provide evidence suggesting that HIV testing history can influence knowledge and, in turn, reduce stigma. Although we were limited in our analyses regarding the differences in knowledge and stigma depending on the type of HIV test, theory suggests that individuals who receive individualized pre-test counseling will have stronger knowledge gains. Thus, future research should focus on investigating the longitudinal effects of HIV testing engagement on knowledge and stigma, while taking into consideration the type of HIV test the participant gets (i.e., includes a counseling component or simply a biomedical test). In addition, researchers should explore methods to develop effective, resource efficient intervention strategies to increase knowledge and decrease stigma to increase HIV testing service engagement in at-risk populations and improve treatment adherence among PLWH.

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