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Sex marks the spot: Spatial variation of HIV risk and prevention behaviors among men who have sex with men

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Sex marks the spot: Spatial variation of HIV risk and prevention behaviors among men who have sex with men

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An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
in Epidemiology
2016

Abstract

Sex marks the spot: Spatial variation of HIV risk and prevention behaviors among men who have sex with men

By Adam S. Vaughan

Place is critical to our understanding of human immunodeficiency virus (HIV) among men who have sex with men (MSM) in the United States. However, within the scientific literature, place is typically represented by residential location, suggesting a fundamental assumption of equivalency between residential neighborhood, place of risk, and place of prevention. The concept of activity spaces, defined as a set of locations to which an individual is routinely exposed, seeks to address this imbalance.

In the first study, we examined the completeness and reliability of detailed location data collected from an online sample of MSM. Using an online map tool, participants were generally willing and able to provide accurate data regarding home and non-residential locations. This tool may be used in more nuanced studies of place and behaviors of MSM.

In the second study, we used latent class analysis to develop a measure of activity spaces and examined correlates of that measure. Classes were distinguished by the degree of spatial variation in routine and prevention behaviors (which were the same within each class) and in potential sexual risk behaviors (i.e., sex locations and locations of meeting sex partners). Reporting any casual sex partners represented a key correlate of activity space. These patterns of spatial behavior illustrate significant spatial variation in locations of routine, potential HIV sexual risk, and HIV prevention behaviors among MSM.

In the third study, we explored associations between activity spaces and two HIV-related behaviors (recent HIV testing and unprotected anal intercourse) among MSM and examined differences in these associations by residential poverty. We found meaningful and significant differences in both behaviors by activity spaces among men living in high poverty areas, but not among men living in low poverty areas.

Our findings reinforce the importance of incorporating activity spaces into contextual studies of HIV among MSM. They suggest the need for interventions targeted using more than residential locations, requiring behavioral and disease surveillance systems to collect additional place-based data. Future work should continue to explore the determinants of activity spaces and their relationships to HIV-related behaviors among MSM.

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ACKNOWLEDGMENTS

Completing this dissertation reflects the support of so many in both my academic and personal lives. I'd first like to acknowledge my committee for guiding me through a path with a nebulous beginning and unexplored territory laying ahead. To Michael Kramer, thank you for listening to my unstructured ramblings about these analytic methods and results, and for turning detours and dead-ends into opportunities to enjoy the ride. To Patrick Sullivan, thank you for taking a chance on an MPH student six years ago, for giving me the opportunity to work independently, and for continuing to provide the positive support that I needed throughout my PhD. "Don't let perfect be the enemy of good" was the reminder that I often needed. To Hannah Cooper, thank you for suggesting new directions, for making connections across disciplines, and for being unflinchingly positive about my work. To Eli Rosenberg, for helping me to think through methods and helping me to keep this work in perspective.

To my parents, across years and career changes, I've benefited from your unwavering support and strong belief in the transforming power of education. Finally, to Rich, for continually reminding me what's important in epidemiology and helping me discover more that's important in life.

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CHAPTER 1. BACKGROUND AND SIGNIFICANCE

HIV PREVALENCE AND INCIDENCE IN THE UNITED STATES

At the end of 2012, an estimated 1.2 million individuals in the United States were living with HIV [1]. Roughly 45,000 individuals are newly diagnosed with HIV each year, a figure that has remained roughly constant for the past decade [1,2]. However, the burden of HIV remains unequally distributed by geography and across sociodemographic groups.

In 2012, rates of new HIV diagnosis were highest in the South (20.5 per 100,000 person-years (PY)) and lowest in the Midwest (9.0 per 100,000 PY) [1]. Despite accounting for 37% of the total US population [3], the South also accounts for 43% of individuals, or 370,000 persons, living with HIV and half of cases diagnosed annually [1,4], while accounting for 37% of the total US population. The burden of HIV is also concentrated, but not confined to, cities in the United States. While major metropolitan areas comprised 83% of all newly diagnosed HIV cases in 2012 [1], some rural areas with high populations of at-risk groups, especially those along the US-Mexico border and in the Mississippi Delta, have similarly high rates of HIV diagnosis [5,6].

Disparities in diagnosed HIV prevalence among the three major racial/ethnic groups (white, black and Hispanic) are striking. Estimated diagnosed HIV prevalence rates among blacks at the end of 2012 was 1,011 per 100,000 population, reaching the threshold for a generalized epidemic [1]. Among Hispanic/Latinos, the estimated diagnosed HIV prevalence rate was 348 per 100,000 population. Thus, compared to whites (with an estimated diagnosed HIV prevalence rate of 149 per 100,000 population), blacks were 6.8 times and Hispanic/Latinos were 2.3 times as likely to be living with an

HIV diagnosis. Estimates of HIV incidence show similar racial/ethnic disparities. With an incidence rate of 69.9 new HIV infections per 100,000 person-years, black Americans are over 7 times as likely to become infected with HIV than white Americans and 2.6 times as likely than Hispanic Americans [2]. These stark disparities, which exist across age groups, sex, and risk categories, are especially evident in the South, where almost three times the number of blacks are diagnosed with HIV as whites [1].

HIV AMONG MSM

The HIV epidemic in the United States is highly concentrated in men who have sex with men (MSM), and particularly focused in urban areas, the southern United States, and among MSM of color [7,8]. Despite accounting for an estimated 6% of the total US population [9], MSM represent over half of individuals (or 527,000 men) living with HIV and roughly two-thirds of all new HIV diagnoses [1]. The number of new diagnoses in this group has held relatively constant since 2002, despite declines in other risk groups [10].

However, considering MSM as a whole masks disparities and increasing incidence among some groups. HIV prevalence and incidence remain markedly higher among black MSM than among white MSM [11–14]. These disparities are especially pronounced in the South. Prevalence among black MSM in the South is estimated to be 21%, or almost five-fold that of white MSM [7]. Similarly, young MSM have being increasingly impacted by HIV. Incidence among this group has increased in recent years, with much of the increase occurring among young MSM of color [14,15].

This increasing incidence in some populations and continued racial disparities, suggest that, relative to other high-risk groups, large-scale HIV prevention efforts focusing on individual behavior change have been less effective in controlling ongoing infections and have not been uniformly effective in slowing the HIV epidemic among MSM [16]. Additionally, despite most interventions' focus on behavior change, individual-level factors fail to explain increasing incidence and racial/ethnic disparities in HIV among MSM [12,14,17,18]. Consequently, recent work has focused on the role of network and structural factors as drivers of the epidemic [12,19–21]. Disparities in black and white HIV incidence may be explained by these broad constructs in the form of having black partners and having health insurance [14]. As structural factors are often represented as place-based characteristics, these investigations first require a greater understanding of the complex relationships between individuals and places, including both the influence of place on individuals and, conversely, how individuals define place.

THEORIES AND CONCEPTUAL FRAMEWORKS

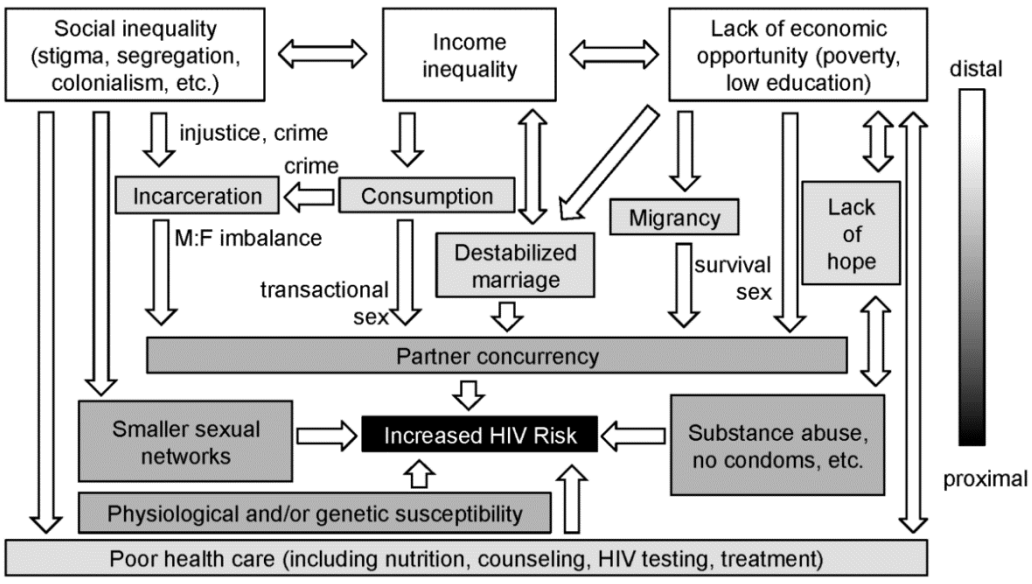
Space refers to the physical location and geographic relationships between locations. Space is defined by coordinate systems and directions. On the other hand, place inherently relies on individuals. A place is defined by the individuals who inhabit, use, or idealize that physical location [22]. However, places may also exert influence over individuals, meaning that place both defines and is defined by individuals [23,24].

From the perspective of HIV, the potential sexual risk and prevention behaviors among MSM occur at specific places, which are in turn physically located within areas of differing socio-structural factors and HIV epidemiology. As such, we may consider that conditions and contexts that exist at these locations may influence an individual's

potential sexual risk and prevention behaviors (i.e. serve as an exposure), but also that an individual's choices and external constraints influencing those choices define these locations [22]. For example, some venues may promote HIV testing or condom use, but men may attend those venues as a result of the spatial distribution of resources [25–27] and the physical separation of activities, especially when those activities may be stigmatized or excluded from an individual's everyday life [28,29].

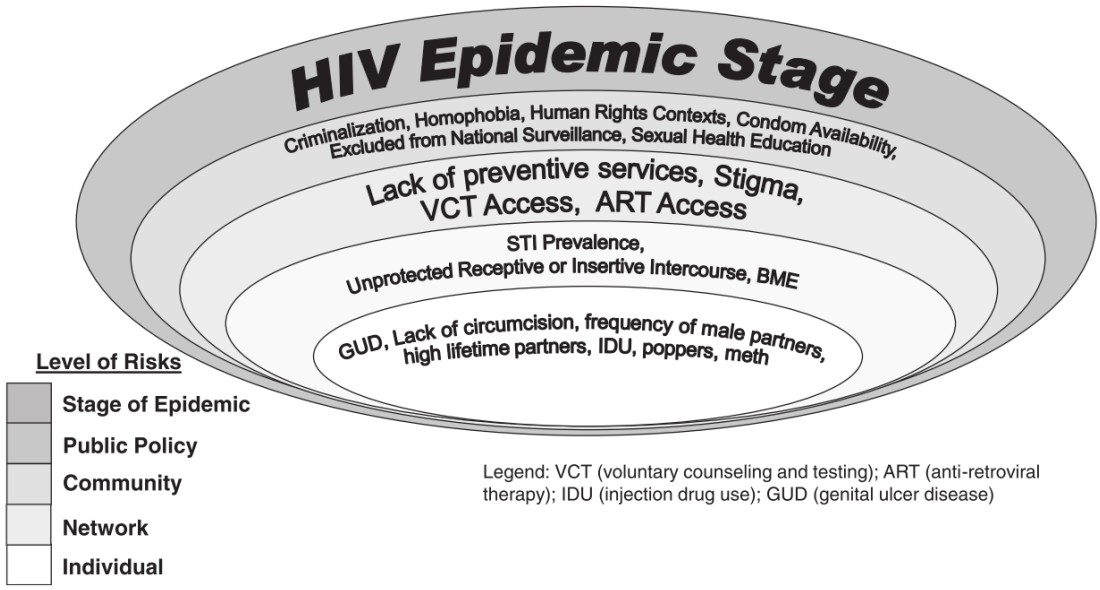
This relational view of place is supported by broad conceptual frameworks which link environments to both general health and HIV-related outcomes [23,24]. These frameworks propose multiple levels, from the molecular through the geo-political, simultaneously acting to affect health through biological and behavioral processes [21,30–32]. Multilevel theories have been proposed to explain observed associations between environments and HIV-related outcomes (Figure 1) [19,21] and specifically for MSM (Figure 2) [20,21].

Figure 1. Proposed model linking distal socioeconomic factors to HIV-related behaviors. From Buot, PLOS One, 2014.



These frameworks also point to the relevance of multiple places in establishing behaviors, including those outside of the home. Places represent both a foundational environments and potential modifiers of pathway between place and health outcomes. These non-residential places may be especially important among studies of MSM, since stigmatization and the spatial distribution of resources may lead to geographically dispersed routine, sexual risk, and HIV prevention behaviors [28,33–38].

Figure 2. Modified ecological model for HIV risk in men who have sex with men. From Baral, et al., BMC Public Health, 2013.



ASSOCIATIONS BETWEEN PLACE AND INDIVIDUAL HIV-RELATED BEHAVIORS

This theoretical basis for the role of place in the epidemiology of HIV among MSM is supported by research illustrating associations between place and specific behaviors, including HIV testing, treatment, and risk behaviors.

Place and HIV Testing

Place has been strongly associated with HIV testing, through both spatial access to providers and through characteristics of places. Distance to testing locations is a key determinant of recent HIV testing [39,40]. Possibly reflecting the influence of social norms, MSM living in gay neighborhoods are more likely to have ever been tested for HIV compared to MSM living outside of gay neighborhoods [41,42].

Additionally, HIV testing is strongly differential by urbanicity. Individuals living outside of metropolitan statistical areas (MSAs) are less likely to report ever having had an HIV test [43,44], possibly reflecting poorer access to HIV testing [45], and possibly leading to later diagnosis of HIV and poorer outcomes among individuals living with HIV [43]. These associations reflect a dose-response with urbanicity, with poorer test-related outcomes with each decreasing level of urbanicity. In addition to having ever tested, individuals in rural areas may test less frequently [5], again leading to later HIV diagnoses in rural areas than in urban areas [46,47]. However, the mechanisms underlying later diagnosis in rural areas may differ from those in urban areas. Although socioeconomic and healthcare density are strongly associated with HIV testing in urban areas, these same factors do not explain late diagnosis of HIV in rural areas [46], suggesting other mediating contextual factors in these non-urban areas.

Place and HIV Treatment

Similar to HIV testing, HIV treatment exhibits spatial patterns. Neighborhoods with greater poverty and disorder have poorer adherence and response to HIV medications [48,49]. This contextual association may result from spatial patterning of HIV providers, who are often located outside of neighborhoods with the greatest need [26]. This spatial

patterning requires greater travel distances and times for individuals living with HIV in these neighborhoods, potentially influencing participation at every level of the HIV treatment cascade [27,50–52].

Place and Sexual Risk Behaviors

As the epidemiology of HIV differs by neighborhoods, residence in neighborhoods with certain characteristics have been found to both directly and indirectly increase sexual risk behaviors. Among black heterosexual men, associations between neighborhood factors are mediated by both substance use [53], depression [54], and racial segregation [55]. Other potential mediators of these residence-based associations include markers of sexual network risk [56] and gay stigma [57–59]. However, the associations between residential neighborhoods and HIV risk behaviors are not fully explained by these mediators, suggesting the existence of other spatially patterned factors in these pathways.

One potential neighborhood-level factor may be living in a neighborhood with a large concentration of MSM (e.g. “gay ghettos”). However, reports of greater unsafe sex among those living in gay neighborhoods have not been uniformly observed. In MSM, residence in gay neighborhoods has been associated with less condom use [60,61], greater condom use [41,62], and similar condom use [63] relative to MSM living outside gay neighborhoods. These disparate findings may reflect differences in the neighborhoods under study, differences in peer norms, or differences in the broader context in which these neighborhoods exist [42]. Despite this inconsistency in findings regarding condom use, MSM living in gay neighborhoods report more drug use concurrent with sex [60,61,63]. As with the conceptual frameworks, these observed associations again point to the importance of place in defining HIV risk among MSM as

it represents both a physical community and a social structure with a set of social norms within which behaviors occur.

Place and Sexual Networks

Negative associations between place and HIV-related outcomes have been proposed to operate through sexual network structure [19,20]. Heterosexuals living in a high poverty neighborhood are more likely to be in non-monogamous sexual networks, increasing the probability of encountering HIV and other STIs [64,65]. Additionally, MSM living outside of urban centers may travel long distances in order to socialize or to meet sex partners [45,66,67]. As rural MSM who visit cities are more likely to report high-risk sex behaviors than urban MSM [68], this travel may expose these MSM living in areas with relatively low HIV prevalence to higher-prevalence partner pools. Finally, these associations between place and sexual networks may be differential by race, especially given geographic variation in HIV prevalence and incidence by smaller geographic areas [65].

Consequently, place and sexual networks are intimately entwined [34,69]. Sexual networks may span geography and link individuals across residential neighborhoods. Just as we may view place from a relational perspective [23], we can also view the geography of sexual networks relationally. The spatial distribution of HIV epidemiology, sexual partners, stigma, and homophobia may push and pull MSM to meet sex partners and have sex in specific locations. Consequently, sexual networks, and the disparities that they may perpetuate, may be reinforced by spatial processes [70].

LIMITATIONS OF PLACE-BASED STUDIES OF HIV

This significant body of research surrounding place and HIV includes three broad limitations: a focus on residential exposures, the definition of neighborhoods, and the assumed one-directional nature of the relationship.

First, place-based research and surveillance have generally assumed equivalency between neighborhood of residence, place of risk, and place of prevention. US national HIV surveillance data make this same assumption by most often reporting data based on where people living with HIV were living at the time of diagnosis [1], thereby implying home location to be the location of acquisition HIV risk. By extension, these data, based on residence at diagnosis, are used both as a proxy for HIV risk and to allocate prevention and care resources.

Apart from surveillance data, almost all studies similarly define place using residential location, assuming that the residential contextual exposures are the most relevant. However, given the significant spatial variation in locations of behaviors among MSM [35,37,71–74] and the potential importance of non-residential locations in defining behaviors of MSM [19–21], this assumption may not hold true. Individuals are almost certainly exposed to multiple non-residential locations throughout the course of a routine day, with specific behaviors occurring at specific locations.

Outside of the HIV literature, the importance of recognizing these non-residential locations is becoming clearer. Studies have found a dose-response relationship between exposure to less disadvantaged non-residential neighborhoods and better overall health, with these non-residential exposures explaining variability in the in associations between residential neighborhoods and health [75]. Consequently, using only residential

neighborhood as a proxy for the socio-contextual factors may miss critical exposures that may influence health.

Second, place-based studies often define neighborhoods using an administratively-defined area, such as census tracts and ZIP codes, or using an individual's definition of their neighborhood. Apart from the implicit limitations in using a residential neighborhood, an individual's definition of his/her neighborhood rarely coincides with administrative area definitions, resulting in a potential misrepresentation of important structural determinants underlying risk and prevention behaviors, including HIV testing and treatment [71,76,77]. A residential neighborhood may not be where men socialize or have sex [33,35,37] and, thus, focusing on this may not encapsulate all relevant behaviors.

Finally, much health research assumes a one-directional link between place and health outcomes, namely that place is the cause and health is the effect. However, this concept ignores the relational perspective of place in which place defines individuals and individuals define place [23,78]. While the cyclic nature of this relationship presents problems for epidemiologic causal inference, it suggests the needs to view places as dynamic nodes, rather than fixed areas. These nodes operate within a context defined by multiple spatial scales and over time [78]. The methodologic challenges to implementing these methods are extensive, especially from a causal perspective. However, limiting the use of area-based measures and interpreting results within the context of the place represent measureable steps toward a more relational view of place.

SPATIAL POLYGAMY AND ACTIVITY SPACES

Responding to these limitations then requires consideration of a new framework that can more fully link place and health. The framework of spatial polygamy was recently developed to account for the role of multiple, potentially non-residential, place-based exposures and the potential influence of the spatial structure of those places on health outcomes [79]. By rejecting the notion that the residential neighborhood is neither the only appropriate scale nor the only appropriate location for exploring contextual effects on health, spatial polygamy focuses on the idea that individuals move through a number of different contexts over time and that variation in these spatial exposures may shape health outcomes.

This framework of spatial polygamy may then be operationalized using activity spaces. Activity spaces have long been employed in transportation research and have only recently entered the health literature, most notably in the fields of obesity research [80–82], environmental health [83], and drug use research [84]. An activity space is a set of locations to which an individual has been exposed, generally on a daily or habitual basis [77]. Under the theory of spatial polygamy, these locations, which may be represented by specific points, paths between points, or areas defined by points, then represent a set of conditions and contexts which may influence health and health-related behaviors [85].

Measuring Activity Spaces

Although an activity space is conceptually clear, its measurement and subsequent application in health research is more complex. Specifically, the use of activity spaces in research presents two challenges: the collection of spatial data for a wide number of

locations and the summarization of those locations into a concise, useful, and meaningful measure or measures.

First, the measurement of activity spaces requires the collection of latitude and longitude (i.e. geocoded data) for locations of interest. These data have been collected, almost exclusively, using two different methods, global positioning systems (GPS) [25,81,86–89] and interviewer assisted means for establishing specific locations [71,72]. These methods provide a set of locations that are precise and can represent all visited locations, rather than a sample of locations.

However, these methods have inherent limitations. GPS data collection requires participants to continually carry a device (or a cell phone equipped with a specific program) for some fixed amount of time, or require researchers to collect data from participants passively [89]. This process generates a tremendous amount of continuously collected location data that must then be analyzed using methods that have not been applied in epidemiology. These data also raise privacy issues, especially when using participants' personal devices. Additionally, GPS data collection represents a large financial investment for studies in purchasing and maintaining the equipment.

Similarly, interviewer assisted methods of identifying specific locations are also resource intensive from both time and staffing perspectives, potentially limiting the numbers of potential participants in a study. As described in the literature [71], interviewer assisted methods require an interviewer to request and validate each location of interest. This process also requires the participant to disclose potentially sensitive information (e.g. place of last sexual encounter) to the interviewer.

The second challenge of using activity spaces in health research is summarizing multiple spatial locations and spatial relationships into a single value or values that represent specific qualities of the activity space. Ideally, a measure of activity space should be concise, interpretable, and able to be used analytically. Visual inspection of maps or graphs of activity spaces may address the first two criteria and may provide key qualitative information, but cannot be subsequently analytically [76,90]. Critically, in epidemiology, a measure of activity spaces must also be translatable to public health action through either better describing underlying distributions or better defining interventions and policy.

In the current literature, these measures have taken the forms of geometric measures or measures of spatial concordance. Geometric measures, including standard distance, standard deviational ellipses (SDE), road network buffers, standard travel time, convex hulls, and kernel densities, quantify the spatial structure of points using distances and areas [80,88,91–97]. These measures all have rigorous assumptions regarding the underlying uniform distribution of points and may cover areas to which the individual has not been exposed. Many such methods are also appropriate only when all locations of interest are known completely and exactly [93,94]. Additionally, these measures may be appropriate in cases where distances and areas can be acted upon for public health interventions, such as obesity or environmental exposures, but their interpretation and application are less clear for HIV.

In response to these limitations, recent analyses of activity spaces among MSM have focused on the spatial concordance of reported locations [71,72]. These measures require the definition of an area (e.g. a neighborhood or county) within which behaviors occur

and then an evaluation of overlap of those areas. However, this construct lacks nuanced information about the degree and spatial structure of that geographic separation. By exploring *where* geographic overlap occurs instead of simply *if* geographic overlap occurs, we may better understand the spatial structure of behaviors and better target interventions.

Spatial Polygamy among MSM and in HIV Research

Place-based research in HIV and among MSM has long suggested the need to consider spatial polygamy in defining structural exposures. Substantial geographic variation in the locations of residence, HIV risk behaviors, and treatment was suggested early in the epidemic, with research finding substantial geographic variation in locations of residence, probable location of HIV acquisition, and care providers among HIV-infected individuals [73]. One study of HIV-infected individuals in non-metropolitan areas in the South found that roughly one in four believed that they acquired HIV outside those areas [74]. These individuals were also more likely to engage in high-risk sexual behaviors in these areas away from their homes. Despite these findings, and likely due to the challenges of obtaining more detailed place-based data, research has generally continued to use place of residence (and its associated characteristics) rather than more specific locations.

More recent work has attempted to correct this imbalance by focusing on defining places associated with high-risk behaviors and attempting to define activity spaces of MSM. These studies all found substantial geographic variation in behaviors that extended far beyond an individual's home. A study of black MSM in Baltimore found spatial clustering of where drugs and alcohol were used, but not of residence [35]. These places were clustered according to participants' age, reported sexual orientation, and HIV status.

Similarly, MSM living with HIV in Jackson, Mississippi reported having sex partners from across the state and across the South [37]. Participants met these partners at a handful of venues that linked these men living with HIV.

Genetic analyses have further confirmed the importance of spatial polygamy and spatial variation in behaviors among MSM. A study of genetic clustering of HIV in Mississippi found that over half of the clusters included persons residing in multiple parts of the state or in other states [36]. Additionally, 20% of this sample reported traveling away from home to have sex in the past 12 months. A similar network-based study in Jackson, Mississippi found that young black MSM living with HIV reported sex partners from across the state [37]. These men were also connected by a small number of venues where they socialized and met sex partners. Finally, a genetic analysis of HIV in North Carolina found that genetic clustering is not equivalent to geographic clustering, with similar genetics occurring over large physical distances and across levels of urbanicity [38].

Given these findings, recent studies have sought to more rigorously and explicitly explore activity spaces among MSM [71,72]. In New York City, 75% of young MSM reported socializing, having sex, and living in different boroughs [72]. Although behaviors of individuals of lower SES were more likely to be in a single borough, those reporting concordant locations were no more likely to engage in high risk behaviors than MSM reporting discordant locations. At a more granular level, using participant-defined neighborhoods in New York City, one-third of MSM reported no geographic overlap of social, sexual, and home neighborhoods and 15% reported complete overlap [71]. However, this finding was differential by race, with a greater proportion of white MSM

reporting that the neighborhoods were the same and a greater proportion of MSM of color reporting that the neighborhoods were different.

While these studies represent a positive first step in exploring and quantifying non-residential exposures in MSM, their methodology produces limitations. First, these studies tend to use broad geographic areas (e.g. boroughs in New York City) to define spatial polygamy, rather than specific locations or smaller administratively-defined areas [72]. The locations that are included tend to focus of locations of risk (e.g. locations of sexual encounters or meeting sex partners), while neglecting locations association with preventive behaviors, such as HIV testing, physicians, and pharmacies. Finally, these studies included populations from limited geographic areas (New York City, Baltimore, and Jackson, Mississippi), potentially limiting the generalizability of the findings to MSM in other parts of the country and in less urban settings [71,72].

Opportunities in Activity Space Research among MSM

Given the relative novelty of the application of activity spaces in research among MSM, a number of opportunities exist for refining this concept and incorporating it into the epidemiologic literature. First, the challenges of existing collection of geolocated data suggest the need for a new means of collecting these data. A method with the potential to overcome some of the current challenges is the use of a map-based tool embedded within web-based surveys [98]. This tool has the potential to collect precise, location-based data from a large sample of MSM for a large number of locations. While this tool has been used and validated for the collection of data regarding residential and treatment locations among MSM living with HIV, it has not been used to collect data from a wider range of places representing the activity spaces of MSM.

Given the ability to collect these data, measuring and quantifying activity spaces for use in research requires summarizing multiple properties of the locations of interest in the study. As previously described, existing measures are limited in which aspects of space and place are measured. The use of new methods to define and categorize activity spaces of MSM represents a critical advance for this line of research.

Finally, the associations between geographic variation encompassed by activity spaces and specific risk and prevention behaviors are unknown. Detailed geolocated data would expand the findings of this nascent literature. Locations that could be important for understanding both HIV risk and prevention behaviors, including those related to HIV testing, meeting sex partners, and going to the doctor, could represent a critical step in connecting contextual exposures with individual behaviors.

Specific Dissertation Aims

Therefore, in this dissertation, we extend previously established methods of collecting geolocated data and provide the first applications of these data to the study of activity spaces in MSM. Specifically, this dissertation will achieve the following three specific aims:

1. Examine the willingness of MSM to specify locations of daily activities and HIV prevention and potential sexual risk behaviors using an online map-based tool.
2. Describe spatial variation in locations of daily activities and potential sexual risk and prevention behaviors both within and across MSM.
3. Explore associations between HIV risk and prevention behaviors and their spatial variation among MSM.

STRUCTURE OF THIS DISSERTATION

First, Chapter 2 describes the data sources used to accomplish these dissertation aims. In Chapters 3-5, each research aim is presented in the format of an original manuscript. Finally, Chapter 6 synthesizes all three aims into a concluding chapter that describes the significance of these findings, innovation within the dissertation, future directions, and public health relavance. The appendices include additional documents which are referenced throughout the text.

CHAPTER 2. DATA SOURCES

SEX MARKS THE SPOT STUDY

Data presented in this dissertation comes primarily from the Sex Marks the Spot Study (Figure 3), a cross-sectional, online survey designed specifically for this dissertation. This study collected detailed, geolocated data regarding locations of daily activities and of potential risk and prevention locations among MSM. We collected data in two phases: an initial, geographically limited collection used to assess the feasibility of collecting these location-based data and a secondary collection from a population of MSM living in MSAs with high HIV numbers of new diagnoses. Design of the study methodology, development of the survey instrument, recruitment, and data analysis were primarily completed by the Principal Investigator, Adam Vaughan. These activities fulfilled departmental requirements for data collection during the PhD program.

Figure 3. Logo for the Sex Marks the Spot study.

Study Population and Recruitment

Eligible participants were required to be: male at birth, aged 18 years or over, able to read and write English, and had to report at least one male sex partner in the past 6 months. Potential participants who meet eligibility criteria completed an online consent form.

For the initial data collection used in Aim 1, participants were required to reside in Georgia, Texas, or Wisconsin. We selected these three states due to existing relationships between our research group and local departments of health and community-based organizations in these states. These three states vary in their underlying HIV epidemiology, demographics, and contextual factors, which could be associated with willingness to answer our map questions and allowed us to draw conclusions based on a diverse convenience sample of MSM. This population also expanded on the population used in the prior validation of this tool [98].

For the secondary data collection used in Aims 2 and 3, participants were required to reside in one of nine metropolitan statistical areas (MSA) with the largest numbers of new diagnoses in 2013 (New York City, Miami, Los Angeles, Washington, DC, Atlanta, Chicago, Houston, Dallas, and Philadelphia). In the United States, these MSAs represent half of all new HIV cases [1] and approximately 35% of the MSM population [99]. MSA boundaries were defined using the U.S. Census Bureau's 2013 delineations [100].

Participants were recruited using Facebook banner ads, a method that has been shown to yield samples with similar risk behaviors and demographics (excepting race) as venue-based methods of recruiting MSM [101]. As an incentive, a $3 donation was provided to a charity participant's selected from a pre-selected list.

In the first sample limited to the three states, of 105,815 men presented with the Facebook ad, 3,058 men (2.9%) clicked on the ad to enter the eligibility screening. Of these, 624 men (20.4%) were eligible, of whom 341 men (11.1% of those screened;

54.6% of those eligible) consented to participate in the study. 247 men (72.4%) completed the survey and were included in Aim 1 analyses.

In the second sample from nine MSAs, of 136,402 men presented with the Facebook ad, 5,281 men (3.9%) clicked on the ad to enter the eligibility screening. Of these, 949 men (18.0%) were eligible and consented to participate in the study. 648 men (68.3%) completed the survey.

Data Elements

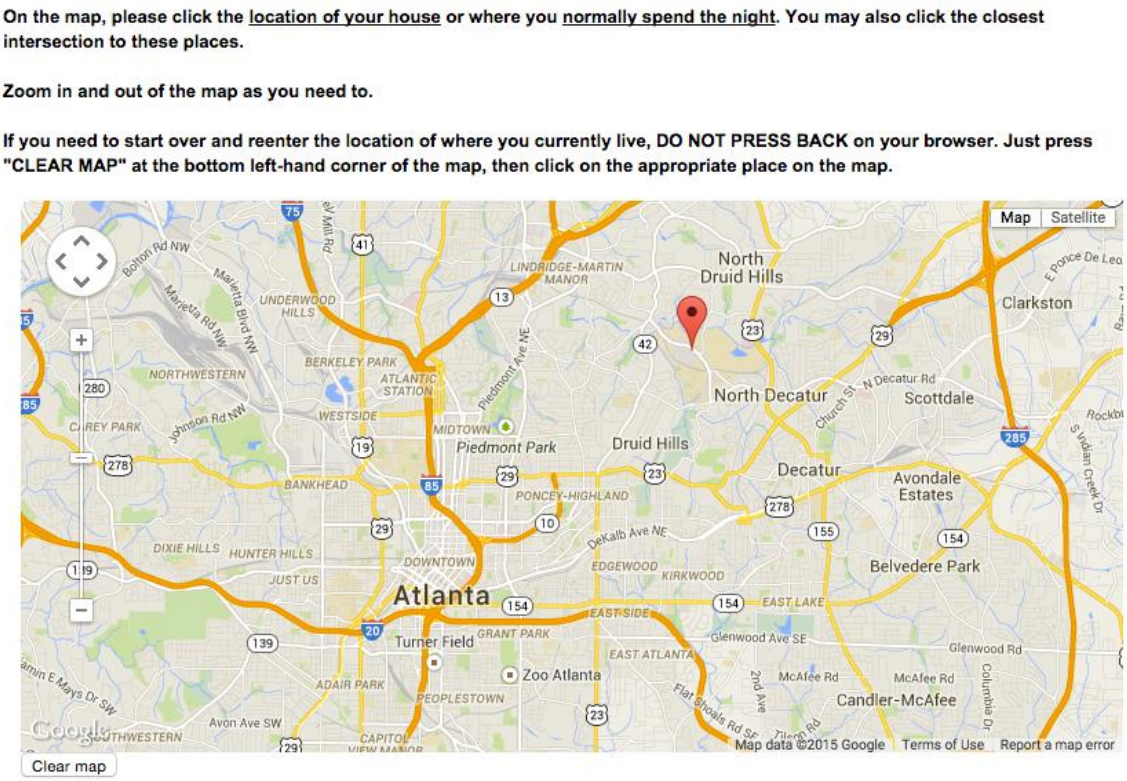
Spatial Data

Location data were the foundation of this dissertation. For each location, participants dropped a pin onto a Google map within the online survey (Figure 4). This map-based tool has been shown to be valid and reliable in a sample of HIV-positive MSM who were indicating residential and treatment locations [98]**.** Participants were also allowed to indicate their preference to not provide this information and, if so, asked to indicate a reason. In both samples, participants were asked to indicate the following locations:

1. Current town or city.
2. Home. Participants also reported ZIP code of current address.
3. Work or school location, if the participant reports working at least part time or being a student.
4. Up to three sexual encounters based on the number of partners and locations reported in the past six months. Participants also reported the type of location, sexual behavior, and partner status (i.e. main/casual) at last sex.

5. Locations of meeting up to three sex partners. These locations were collected only for the second sample.
6. Two socialization locations, including the type of location.
7. Last HIV test, with the test result, month and year of the test.
8. Last test for a sexually transmitted infection (STI), within the past year.
9. Primary care physician, if the participant reported having a primary care physician.
10. Pharmacy, if the participant reported using a pharmacy.
11. Free condoms, if the participant reports picking up free condoms in the past six months. This location was only asked of the initial sample.

Figure 4. Sample of Google maps question embedded within the online survey.



For each location of interest, participants could choose to not answer the map question and were asked to indicate why they chose not to answer. Participants were also allowed to indicate that a location was the same as another previously reported location (e.g. report sex at home). In these cases, participants were not required to select the location a second time or to indicate a reason for not selecting the location. Willingness to use the map-based tool to answer the second location was assumed the same as that of the previously reported location.

Additionally, for each location, participants entered a name that was used to reference that location throughout the survey. This name was entered by participants and could be generic (e.g., home, work, bar) or specific (e.g., Dr. Smith, Walgreens).

Other Participant-Reported Data

Participants were also asked non-map-based questions, including age, race, income, residential ZIP code, primary mode of transportation, housing stability, and HIV status. For up to the last three sex partners, participants reported sexual risk behaviors, including main or casual partner status, sexual role, and condom use. For each socialization location, participants reported having ever met a sex partner at that location.

Data Security and Confidentiality

Data from the survey were stored on a HIPAA-compliant survey at the main SurveyGizmo office in Boulder, CO. Only the investigators of this project were given access to these data. Data were downloaded from the SurveyGizmo website onto a secure drive on the Emory network. Only the investigators had access to the secure drive. Because sensitive geocoded information was collected, datasets were stored on the

network with generic variable names only. For further protection, we obtained a Certificate of Confidentiality from the National Institute of Mental Health (NIMH).

Funding

This work was supported by: MAC AIDS Fund, Emory University Center for AIDS Research (P30AI050409), National Institute of Mental Health (F31MH107343-01).

Ethics

This study was approved by the Emory University IRB (protocol #IRB00074519). Informed consent was obtained from all study participants using an online consent form.

AREA-LEVEL DATA

Given the location-based nature of these data, these analyses required additional data in order to represent the socio-structural context and the spatial distribution and availability of resources across which individual behaviors occur. These data were obtained from governmental sources and were freely available. Specifically, we included area-based measures of poverty, population density, and urbanicity. Poverty data were obtained from the U.S. Census Bureau's 5-Year American Community Survey estimates [3]. Population density was based on 2010 decennial estimates from the US Census Bureau. Urbanicity was defined using the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties [102].

To link area-based data to specific locations, specific locations were geocoded to administratively defined areas (e.g. ZCTAs, census tracts, counties, MSAs). This assignment of points to areas required the use of shapefiles, also freely available from the US Census Bureau.

CHAPTER 3. COMPLETENESS AND RELIABILITY OF LOCATION DATA COLLECTED ONLINE: ASSESSING THE QUALITY OF SELF-REPORTED LOCATIONS IN AN INTERNET SAMPLE OF MSM

ABSTRACT

Background: Place is critical to our understanding of human immunodeficiency virus (HIV) among men who have sex with men (MSM) in the United States. However, within the scientific literature, place is almost always represented by residential location, suggesting a fundamental assumption of equivalency between neighborhood of residence, place of risk, and place of prevention. However, the locations of behaviors among MSM show significant spatial variation and theory has posited the importance of non-residential contextual exposures. This focus on residential locations has been at least partially necessitated by the difficulties in collecting detailed geo-located data required to explore non-residential locations.

Objective: Using an online map tool to collect locations which may be relevant to the daily lives and health behaviors of MSM, this study examines the completeness and reliability of the collected data.

Methods: MSM were recruited online and completed an online survey. Within this survey, men used a map tool embedded within a question to indicate their homes and multiple non-residential locations, including those representing work, sex, socialization, physician, and others. We assessed data quality by examining data completeness and reliability. We used logistic regression to identify demographic, contextual, and location-specific predictors of answering all eligible map questions and answering specific map

questions. We assessed data reliability by comparing selected locations with other participant-reported data.

Results: Of 247 men completing the survey, 167 (67.6%) answered the entire set of eligible map questions. Most participants (>80%) answered specific map questions, with sex locations being the least reported (80.6%). Participants with no college education were less likely than those with a college education to answer all map questions (Prevalence Ratio [PR]: 0.4; 95% CI: 0.2, 0.8). Participants who reported sex at their partner's home were less likely to indicate the location of that sex (PR: 0.8; 95% CI: 0.7, 1.0). 83% of participants placed their home's location within the boundaries of their reported residential ZIP code. Of locations having a specific text description, the median distance between the participant-selected location and the location determined using the specific text description was 0.29 miles (25^{th} and 75^{th} percentiles: 0.06-0.88).

Conclusions: Using this online map tool, this online sample of MSM were generally willing and able to provide accurate data regarding both home and non-residential locations. This tool provides a mechanism to collect data that can be used in more nuanced studies of place and sexual risk and preventive behaviors of MSM.

PUBLICATION

Published in the Journal of Medical Internet Research, 18(6), e142. doi:10.2196/jmir.5701.

INTRODUCTION

Place, or the context simultaneously experienced and defined by individuals [23], is critical to our understanding of human immunodeficiency virus (HIV) among men who have sex with men (MSM) in the United States. Through surveillance data, place fundamentally shapes our understanding of the epidemiology of the epidemic [1]. As a contextual exposure, place represents both a foundational environment in which HIV-related behaviors occur and a potential modifier of the pathway between other contextual exposures and HIV-related outcomes [19,20]. However, within the public health literature, place is almost always defined as a residential location [39,53,57–61,103,104], suggesting a fundamental assumption of equivalency between place of residence, place of sexual risk, and place of prevention. US national HIV case surveillance data make the same assumption, most often reporting data based on residence at the time of diagnosis [1].

Despite this implicit assumption, HIV-related sexual risk and prevention behaviors of MSM do not necessarily occur within the residential neighborhood [35,37,71–74]. Social ecologic theory acknowledges the importance of non-residential locations (such as the broader urban environment and gay venues) in determining these behaviors [19–21,30–32]. For example, the availability of HIV testing services and venues where MSM gather may be influenced by broader social characteristics and norms. Access to these services and venues may then influence the formation of sexual networks and promote or inhibit individual-level behaviors, such as regular HIV testing and unprotected sex [19–21,69]. Consequently, using only residential neighborhood as a proxy for the many levels of socio-contextual factors may miss critical health-related exposures. To address this

potential misclassification, the concept of activity spaces, which represent the collection of locations to which an individual has been exposed, has recently been introduced into the HIV literature [71,72,79].

Measuring activity spaces requires collecting large amounts of detailed geographic data. Prior studies have used global positioning systems (GPS) [25,81,86–89] or interviewer-assisted means to establish specific locations and, ultimately, to measure activity spaces [71,72]. Although these methods provide a precise and comprehensive set of locations, they have limitations. Collecting locations with GPS requires processing large amounts of data and a large investment in purchasing and maintaining the GPS devices. Interviewer-assisted methods require a large time and budget commitment, limiting the number of potential participants in a study.

To begin to address these limitations, our research group recently developed a web-based online tool that allows participants to select locations using a Google Maps question embedded within an online survey [98]. Given the potentially sensitive nature of these data, participants may be more comfortable reporting such data in an anonymous online survey [105]. In validation of this online tool using home and healthcare provider locations among a cohort of HIV-positive Atlanta-area MSM, approximately 84% of participants indicated these locations using the map-based tool [98]. Among participants recruited online, 50% of locations entered using the map-based tool were found to be within 0.3 miles of the true location (interquartile range: 0.1-1.1 miles). However, this previous study collected data for a limited number of locations from a population defined by a single geographic area (Atlanta, Georgia) and health status (HIV-positive). Since

research participation may differ by demographic and health-related factors, these results may not be generalizable to a broader population of MSM [101,106–108].

Therefore, given the need to gather detailed spatial data for HIV-related behaviors among MSM, to overcome current challenges in its collection, and to expand upon prior validation efforts, this study examines the quality of spatial data collected using an online map tool. Specifically, using an online map tool to collect both residential and relevant non-residential locations (e.g. sex locations, HIV testing, work, socialization), this study examines the completeness and reliability of data collected from MSM living in a wide range of geographic locations and independent of HIV status.

METHODS

Recruitment

Participants were recruited using Facebook banner ads, a method that has been shown to yield samples with similar risk behaviors and demographics (excepting race) as venue-based methods of recruiting MSM [101]. Ads were targeted to users based on geography and interests. A $3 donation to a charity the participant selected from a pre-defined list was provided as incentive.

Eligible participants were required to be: male at birth, aged 18 years or over, be able to read and write English, and had to report at least one male sex partner in the past 6 months and to reside in Georgia, Texas, or Wisconsin. These three states vary in their underlying HIV epidemiology, demographics, and contextual factors, which could be associated with willingness to answer our map questions and allowed us to draw conclusions based on a diverse convenience sample of MSM. This population also

expands on the population used in the prior validation of this tool [98]. Participants who met eligibility criteria completed an online consent form.

Collection of Place-Based Data

Consenting participants completed an online survey that included demographic and behavioral questions, and an item on residential ZIP code at the time of data collection.

In addition to these questions, participants were asked to use a map-based tool [98] (Figure 4) to drop a pin onto a Google map to indicate the following specific locations that may be relevant to the daily lives and health-related behaviors of MSM:

- Home.
- Work or school location, if the participant reported working at least part time or being a student.
- Locations of up to three sexual encounters in the past six months.
- Locations of up to two socialization locations.
- Location of last HIV test, within the past year.
- Location of last test for another sexually transmitted infection (STI), within the past year.
- Primary care physician, if the participant reported having a primary care physician.
- Pharmacy, if the participant reported having a regular pharmacy.
- Location where he received free condoms, if the participant reported picking up free condoms in the past six months.

For each location of interest, participants could choose to not answer the map question and were asked to indicate why they chose not to answer. These reasons were then categorized as either unable or unwilling to answer the question. Answer options indicating that a participant was unable to select the location were: “I can’t remember where this location is”, “I’m not sure where that place is on a map”, “I’m not comfortable using the map to select locations”, “This place is in a different city”. Answer options indicating that a participant was unwilling to select the location were: “Didn’t feel comfortable giving that information”, “Worried about a loss of privacy”, “Worried about what friends, family, or coworkers would think”.

Participants were also allowed to indicate that a location was the same as another previously reported location (e.g. report sex at home). In these cases, participants were not required to select the location a second time or to indicate a reason for not selecting the location. Willingness to use the map-based tool to answer the second location was assumed the same as that of the previously reported location.

For many types of locations, participants needed to report engaging in a qualifying behavior in order to be eligible to answer the corresponding map-based question. For example, participants needed to report having a regular physician prior to being presented with the map to identify physician location. As a result, the number of participants eligible to answer each location question varied.

Additionally, for each location, participants entered a name that was used to reference that location throughout the survey. This name was entered by participants and could be generic (e.g., home, work, bar) or specific (e.g., Dr. Smith, Walgreens).

Primary Outcome Definitions

This analysis employs two different primary outcomes: answering the entire set of map questions and answering specific map questions. A participant was considered to have answered the entire set of map questions if he used the map-based tool to indicate all locations for which he was eligible to answer. More granularly, the second outcome required participants to indicate specific eligible locations (e.g., home, socialization, sex) using the map-based tool.

Covariate Definitions

The covariates of interest in this study represent demographic variables, contextual factors related to residential location, and factors specific to given location types. All of these factors could potentially be associated with an individual being unwilling or unable to answer the location-based questions.

Age was categorized into three groups with breaks at ages 25 and 50 , in accordance with age group definitions used in the Centers for Disease Control and Prevention reporting of HIV surveillance data [109,110]. Due to a limited number of non-white participants, self-reported race was categorized as white or non-white. Education was categorized as high school diploma or less, any college, or college degree. HIV status was self-reported. State was defined as the state where the participant reported currently living. Each participant was asked to indicate his primary mode of transportation, and this was dichotomized into primarily using a car and primarily using other, non-car transportation.

Residential poverty and residential urbanicity were defined based on the reported residential ZIP code. Poverty was defined using ZIP code tabulation areas (ZCTA) from

the US Census Bureau's 2009-2013 5-Year American Community Survey estimates and categorized as low poverty (<20% poverty), high poverty (≥20% poverty), or concentrated poverty (≥40% poverty), based on federal poverty definitions [111]. Urbanicity was defined using the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties [102], with the two most rural categories combined.

For each sex location, participants reported the type of location (e.g. sex partner's home). Participants also reported any condomless anal intercourse (CAI) at last sex at each reported sex location.

Statistical Analysis

Overview

Following calculation of descriptive statistics for the covariates of interest, this analysis had three parts. We first examined factors associated with answering the entire set of map questions. Second, in an item-specific analysis, we examined factors associated with answering specific map questions (e.g., home, sex locations). Finally, we examined the reliability of the reported locations.

Response to the Entire Set of Map Questions

Data regarding answering the entire set of map questions for which participants were eligible were first summarized by the covariates of interest. In bivariate analyses, we compared completeness across the levels of each covariate using chi-squared and Fisher's exact tests.

We then performed multivariable analyses to examine associations between the given covariates and answering all eligible map questions. Predictive margins methods were used with logistic regression to estimate adjusted prevalence ratios (PR) for answering all map questions [112,113]. This method permitted direct estimation of adjusted prevalence ratio, rather than an estimated prevalence odds ratio (POR). Since we expected most men to respond to these question (i.e. the outcome is not rare) [98], the POR estimated using logistic regression would be larger than the true PR and, consequently, direct estimation of the PR is preferred [114]. This method also avoids statistical convergence issues that may occur when estimating PR using other methods, such as log-binomial regression [115]. This model included the following possible predictors: age, race, poverty category for the residential ZIP code, residential urbanicity, state, education, HIV status, HIV test within the past year, and primary mode of transportation.

Response to Specific Map Questions

Data regarding answering specific map questions (i.e. locations of home, sex, socialization, work/school, last HIV test, last STI test, primary care physician, pharmacy, and free condoms) were first summarized by the covariates of interest. In bivariate analyses, we compared completeness in answering each type of map questions across the levels of each covariate using chi-squared and Fisher's exact tests. Proportions of the reasons for non-response were calculated.

We again used predictive margins methods with logistic regression to examine associations between the covariates of interest and answering specific map questions. Nine models were created, one for each location type. Each model included the following possible predictors of prevalence of response: age, race, residential poverty, residential

urbanicity, state, education, HIV status, HIV test within the past year, and primary mode of transportation. The model for sex locations also included CAI and sex at the partner's home. The model for reporting an HIV test location was restricted to HIV-negative participants.

Each participant entered up to two socialization locations and up to three sex locations. Consequently, models for these two types of locations accounted for within-participant correlation using marginal models with exchangeable correlation structure.

Data Reliability

Data reliability was assessed using two methods. First, agreement between a reported ZIP code and residential location was determined. Other address information was not collected in this study. To measure this agreement, each residential location identified using the map tool was geocoded to a zip code tabulation area (ZCTA), the US Census Bureau's representation of ZIP codes. Agreement between the geocoded ZCTA and the participant self-reported ZIP code was then defined as an exact match between the two values.

Additionally, reliability was assessed using distances between the reported location and name of the reported location. In this study, we asked men to identify locations for which they may not readily know the addresses and, consequently, for which a formal validation was not possible within this study. Therefore, for each location, participants entered text to help them identify the location in additional questions about that location. Using this text and the type of location, a Google Maps search was completed around the location selected using the map tool. If this search was informative, the distance between the

reported point and the actual point were recorded. If the participant-entered text was generic (e.g. doctor), rather than a specific name (e.g. Dr. Smith), then the driving distance between the selected location and the nearest location matching that description was recorded. Distances were summarized by those matched by a generic name, those matched by a specific name, and those matched using only a geographic location.

Analysis Software

Data management was performed using SAS v9.4 (SAS Institute, Cary, NC). Geocoding and spatial data manipulation were completed in R v3.2.1 (R Foundation for Statistical Computing, Vienna, Austria) [116]. Predictive margins models were performed using SAS-callable SUDAAN v11.0.1 (Research Triangle Institute, Research Triangle Park, NC).

RESULTS

Sample Characteristics and Question Completeness

Of 105,815 men presented with the Facebook ad, 3,058 men (2.9%) clicked on the ad to enter the eligibility screening. Of these, 624 men (20.4%) were eligible, of whom 341 men (11.1% of those screened; 54.6% of those eligible) consented to participate in the study. 247 men (72.4%) completed the survey and are included in this analysis. Our sample represented a wide range of ages, urbanicity, and poverty levels (Table 1). Our sample was highly educated and largely white.

Response to the Entire Set of Map Questions

Table 1. Sample characteristics (n=247).

Covariate	Number (%)
Age	
18-25	66 (26.7)
26-50	103 (41.7)
51 and over	78 (31.6)
Race	
White	202 (81.8)
Non-white race	45 (18.2)
Reported HIV-positive	36 (14.6)
HIV test within the past year [a]	119 (56.4)
Education	
High school or less	22 (8.9)
Some college	89 (36.0)
College degree	136 (55.1)
State	
Georgia	76 (30.8)
Texas	134 (54.3)
Wisconsin	37 (15.0)
Primary mode of transportation	
Car	227 (91.9)
Other	20 (8.1)
Residential poverty	
Low	157 (63.6)
High	71 (28.7)
Concentrated	19 (7.7)
Urbanicity	
Urban core	108 (43.7)
Suburban	48 (19.4)
Medium metro	41 (16.6)
Small metro	31 (12.6)
Non metropolitan	19 (7.7)

[a] Among participants who do not report being HIV-positive

Of included participants, 167 (67.6%) answered all map questions for which they were eligible. Nine participants (3.6%) answered none of the map questions for which they were eligible. Of the remaining participants, 71 (28.7%) answered at least one, but not all, map questions.

In unadjusted analyses (Figure 5), only less education was associated with significantly less completion of all map questions ($p<0.001$), with 31.8% of participants with a high school diploma or less answering all questions, compared to 70.0% of participants with some college and 72.1% of participants with a college degree. This finding was confirmed in adjusted analyses (Figure 6), with participants with no college education being roughly half as likely as those with a college education to answer all eligible map questions (PR: 0.4; 95% CI: 0.2, 0.8). No other covariate was significantly associated with answering all eligible map questions in unadjusted or adjusted analyses.

Figure 5. Crude percent of participants answering all eligible map questions and specific map questions. Percentages are the proportion of individuals within the given covariate level eligible to answer the map question who completed the given map question. Statistically significant differences are indicated in black filled circles.

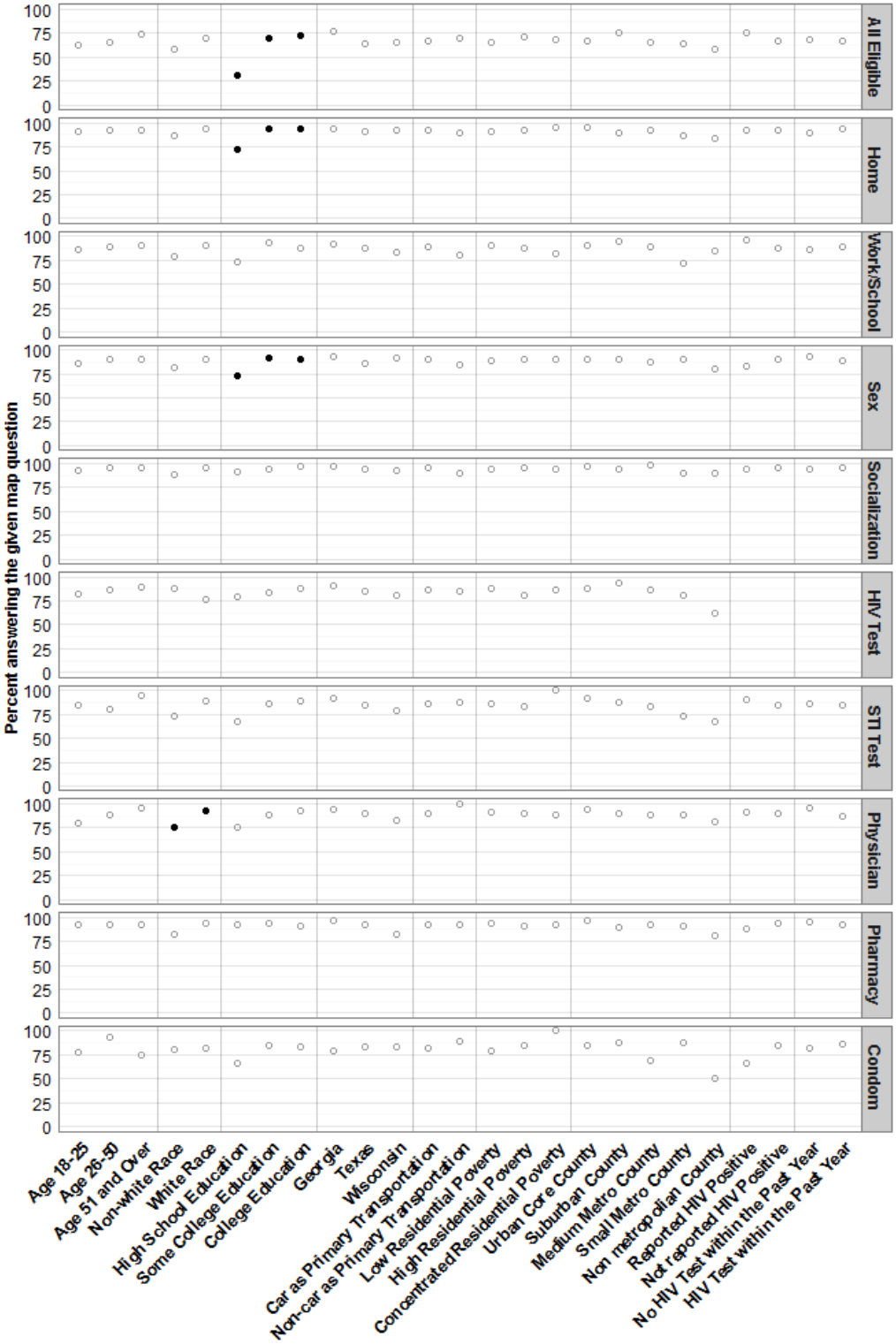
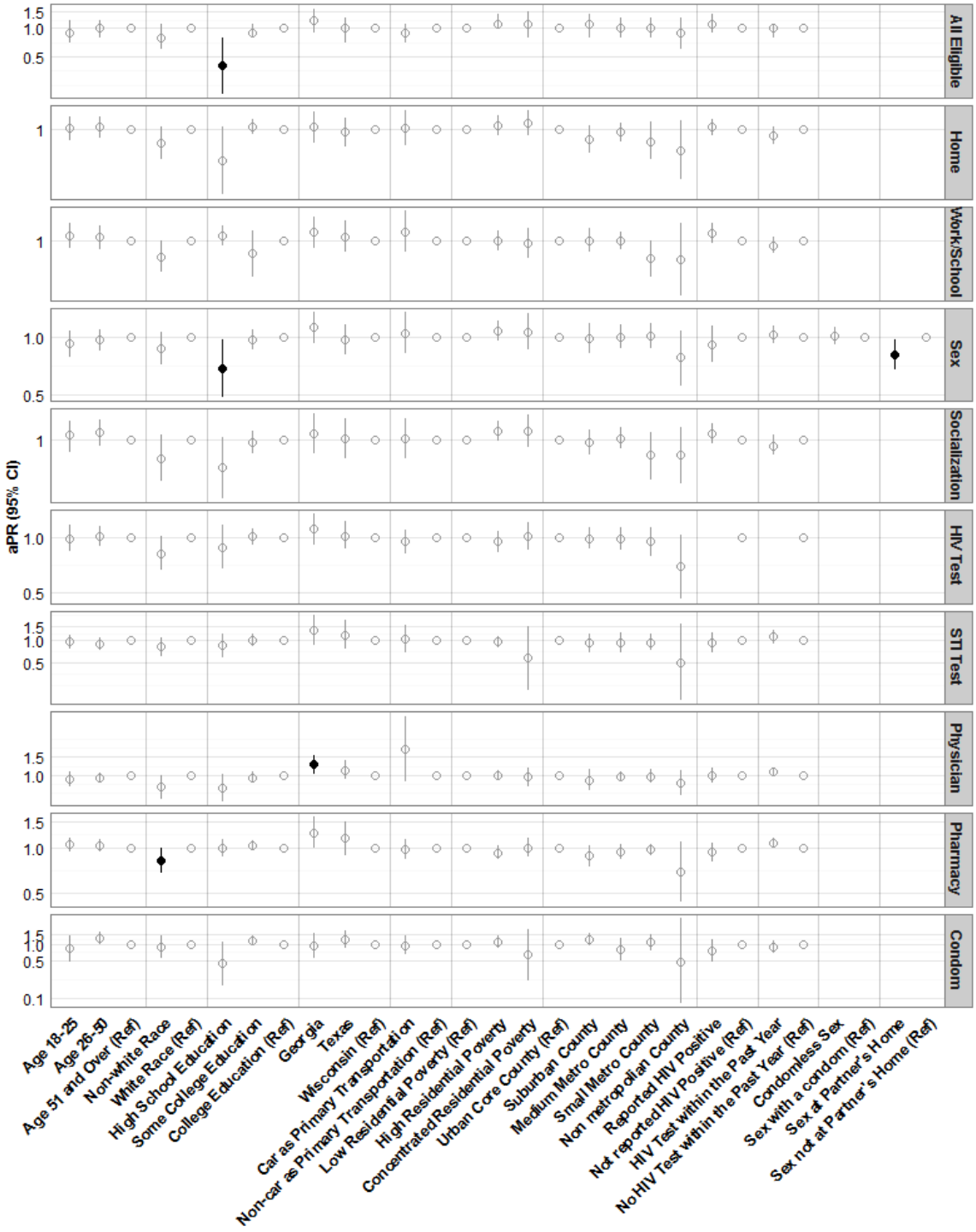


Figure 6. Adjusted prevalence ratios (aPR) and 95% CI for answering all eligible map questions and specific map questions by each covariate. aPR are adjusted by all other covariates. Statistically significant aPR are indicated with black filled circles. The scale of the y-axis is logarithmic and differs across location types to better visualize the CI.



Response to Specific Map Questions

In item-specific analyses, most (>80%) of those eligible answered each individual map question (Table 2). Sex locations were the least likely to be answered (80.6%). For most locations, participants who chose to not answer the map-based question were generally unwilling to answer, rather than unable to answer (Table 2). However, for sex locations and HIV testing locations, the proportion of participants who were unable to answer was similar to the proportion who were unwilling to answer.

Table 2. Ability and willingness to answer specific map-based questions.

Location	Total eligible (%)	Answered (%)	Unable (%)	Unwilling (%)	Both unwilling and unable (%)	No reason given (%)
Home	247 (100)	227 (91.9)	2 (0.8)	15 (6.1)	3 (1.2)	0 (0)
Work/school	209 (84.6)	185 (88.5)	2 (1.0)	21 (10.0)	0 (0)	1 (0.5)
Socialization[a]	474 (96.0)	430 (90.7)	6 (1.3)	33 (7.0)	3 (0.6)	2 (0.4)
Sex[b]	396 (53.4)	319 (80.6)	30 (7.6)	36 (9.1)	3 (0.8)	8 (2.0)
HIV test[c]	119 (56.4)	103 (86.6)	9 (7.6)	7 (5.9)	0 (0)	0 (0)
STI test	120 (48.6)	103 (85.8)	7 (5.8)	11 (11.2)	1 (1.0)	3 (3.1)
Physician	178 (72.1)	161 (90.4)	5 (2.8)	7 (13.7)	0 (0)	3 (5.9)
Pharmacy	183 (74.1)	169 (92.3)	3 (1.6)	7 (5.9)	0 (0)	0 (0)
Free condoms	78 (31.6)	64 (82.1)	3 (3.8)	9 (7.5)	1 (0.8)	0 (0)

[a] Participants reported up to two socialization locations.
[b] Participants reported up to three sex locations.
[c] Among participants who do not report being HIV-positive.

In unadjusted analyses, less than college education was associated with not reporting home location (p=0.003) and sex locations (p=0.05) (Figure 5). Non-white race was significantly associated with not reporting physician (p=0.01) locations. Sex at the partner's house was significantly associated with not reporting the sex location (p=0.001). No other bivariate associations were statistically significant.

In adjusted analyses, only four covariates were significantly associated with answering specific map questions (Figure 6). Non-white participants were less likely than white

participants to locate a pharmacy (PR: 0.8; 95% CI: 0.7, 1.0). Participants living in Georgia were more likely than participants living in Wisconsin to locate a primary care physician (PR: 1.3; 95% CI: 1.0, 1.6). Participants reporting sex at their partner's home were less likely to indicate the sex location (PR: 0.8; 95% CI: 0.7, 1.0). Similarly, participants with less than a college education were less likely to indicate a sex location than participants with a college degree (PR: 0.7; 95% CI: 0.5, 1.0).

No other model-based associations between the covariates and answering specific map questions were statistically significant. For example, participants who reported CAI were no more likely to report sex locations (PR: 1.0; 95% CI: 0.9, 1.1).

Data Accuracy

Of the 226 participants whose map-based home location could be assigned to a ZCTA, 187 (83%) placed the home location within the boundaries of the reported residential ZIP code. Of the 39 participants (17%) who placed a home location outside of the boundaries of the reported residential ZIP code, 29 placed the home location in an adjacent ZIP code, 2 reported post office box or institutional ZIP codes with a correct pin drop, and 8 placed the home location in a non-adjacent ZIP code. Reliability of residential location did not vary with urbanicity (p=0.15).

Of the 1,176 unique locations reported by the participants, the combination of the location type and the participant's text description permitted 575 locations (49%) to be identified. Of these, 278 text descriptions (48%) were a specific name (e.g. Walgreens), 61 (11%) were a geographic area (e.g. downtown, San Antonio), and 236 (41%) were a generic name (e.g. doctor, pharmacy, hospital). Of the 61 locations identified as a

geographic area, 53 (87%) were placed in the correct geographic area. Locations were not able to be identified because of a name that had meaning only to the participant (e.g., home, work, guy 2's place, RLD).

Table 3. Distance in miles between selected location and location determined using any text description.

Location	Count	Median	IQR
Home	4	0.61	0.49-0.64
Work	9	0.77	0.57-2.88
Socialize	154	0.33	0.09-0.92
Doctor	141	0.19	0.05-0.65
Pharmacy	45	0.37	0.12-0.89
Sex	86	0.34	0.10-0.74
Condoms	31	0.08	0.01-0.50
HIV Test	19	0.22	0.01-0.52
STD Test	24	0.22	0.13-0.49

Of all locations having a specific text description, the median distance between the participant-selected location and the location determined using the specific text description was 0.29 miles (IQR: 0.06-0.88). Of all locations having a generic text description, the median distance between the selected location and the location determined using the generic text description was 0.29 miles (IQR: 0.08-0.64). When stratified by location type, median distances between the selected location and location determined using the text descriptions were generally <one-third mile (Table 3). Although home and work have the highest median distances, very few locations could be identified based on the participant's text description.

DISCUSSION

Principal Results

In this paper, we examined the feasibility of collecting location-based data using an online, map-based tool among an online convenience sample of MSM. Overall, participants were willing and able to use this tool to accurately indicate the requested locations, suggesting that this method of data collection is feasible, and results in complete, good quality data. Additionally, for most locations, men who chose to not use the map tool were not significantly different from men who did use the tool with respect to demographic factors and HIV-related behaviors. The notable exception to this finding is that men were 20% less likely to report a sex location if that location was a partner's home, reflecting both confidentiality concerns and uncertainty in the exact location.

The lack of significant associations between the examined covariates and using the map tool has critical implications for the use and subsequent interpretation of these data. Analyses relying on these locations in similar online populations will have minimal bias resulting from nonresponse to these questions, with respect to the covariates measured in this study, although bias may exist due to non-participation. A first key exception to this finding was the observed educational gradient in which participants with no college education were less likely to provide all requested locations and sex locations. Missing data among these individuals may especially be a concern in online research, where MSM of color are more difficult to recruit [117].

A second key exception is the potential for bias in analyses using sex location when sex occurs at the partner's home (although a large majority still provided this location). Therefore, these missing data may bias analyses where either having sex at the partner's

home or education is associated with both the exposure and outcome [118]. This finding may be critical for confounding by education since lower levels of education are frequently associated with locations and with poorer health outcomes.

Men who did not provide the requested locations were generally unwilling, rather than unable, to provide the locations. Even in an anonymous online survey, privacy remained a concern among a small fraction of participants. Although most participants responded to these map questions, privacy concerns for these few individuals must be considered in the implementation and interpretation of future surveys. Providing participants with the opportunity to learn more about their data's security and reinforcing the acceptability of reporting approximate locations (e.g., the nearest intersection) may help to assuage these concerns.

Similarly, participants' inability to provide these locations could also be addressed within the online survey. This inability may stem from a lack of geographic knowledge or uncertainty in locations. Incorporating text search boxes to search for a given street name or emphasizing the acceptability of identifying an intersection or other landmark could potentially address this limitation. This recommendation could also reduce the observed educational gradient in responding to these questions.

As with all participant-reported data, reliability is an important concern. Despite asking numerous locations for which participants may not readily know an address, we found good agreement between the reported locations and other reported characteristics of those locations. These results are similar to the results of a prior validation of this tool for home and treatment locations among HIV-positive MSM [98]. Participants generally placed

home locations within the correct ZIP code, and placed other types of locations near the probable true location. This finding suggests that, although precise measures should be used with caution, within-person and between-person relative measures are likely appropriate.

Our findings with respect to answering specific questions contrast with past studies of broader online survey participation. These studies found differential participation in online surveys by demographic and health related factors. Non-urban MSM have participated in online surveys more than their urban counterparts [106,107]. Also, individuals with a given medical condition are more likely to participate in research about that condition [108], suggesting that HIV-negative men could have been less likely to provide the requested data compared to men living with HIV.

Compared to previous validation studies [98], this analysis has expanded both the population and types of locations for which valid online map data may be collected. We included MSM, independent of HIV status, from urban, suburban, and rural locations, not only large urban areas that are the typical geographic focus of much HIV research. We also included a wide variety of non-residential locations that may be contextually important to the health of MSM.

As this study verified that these non-residential location data can be collected from online samples of MSM, these locations may now be used to describe the activity spaces of MSM and to explore associations between non-residential places and HIV-related behaviors among MSM. This online tool will permit these location data to be collected using relatively low-resource methods that preserve participants' anonymity. The results

of future analyses may allow us to better consider how differing contexts are associated with HIV risk and prevention. National surveillance data, which are based on residential locations, may be interpreted differently depending upon the spatial variation in HIV-related behaviors. Also, future analyses may permit interventions and policy to be geographically targeted using the locations of relevant behaviors, rather than residential locations.

Limitations

Despite the breadth of data being collected, this study does have limitations. First, the generalizability of this study may be limited. Our online convenience sample is likely not representative of MSM in Texas, Wisconsin, and Georgia. Our sample is less racially diverse, younger, and more educated compared to the general populations in these states. Also, despite the breadth of HIV epidemiology, demographic, and contextual factors represented by these states, these MSM may not be representative of MSM across the United States. However, prior studies using venue-time based sampling of MSM reported demographics similar to this study and to internet samples of MSM [11,101,117].

This analysis produced fully-adjusted measures of association for a large number of outcomes and their potential predictors. Consequently, some of these measures may be statistically significant due to Type 2 error.

This analysis also used participant-reported ZIP codes as the basis for poverty and urbanicity measures. The use of areas to represent contextual variables may lead to misclassification, especially when using ZCTAs to represent ZIP codes [119,120]. The degree of this misclassification may be less in more urban areas [121–124], although this

was not true in our predominantly urban sample. However, ZIP codes are a geographic measure that is readily accessible to participants and are therefore useful despite their limitations.

This study also was unable to validate all locations using a physical address. With our study's expansion to locations that include where individuals socialized and had sex, validation becomes more difficult as participants may not readily know addresses of these non-residential locations. Consequently, data reliability could be assessed only using the methods we employed. Additionally, the text descriptions of these places were useful for only half of locations, limiting conclusions regarding reliability of the remaining half of locations. It is possible that the half of locations that could be validated may have favorably biased the calculated accuracy. Additional validation of geographic reliability may be the subject of future work.

Conclusions

Using an online map tool, MSM participants were generally willing and able to indicate all requested locations. Critically, although most MSM reported sex locations, these locations were reported less frequently than all other locations. Consequently, within this online setting and MSM population (and with careful consideration of the potential biases associated with online research in this population), this method of data collection is feasible, resulting in highly complete, good quality location data.

CHAPTER 4. MEASURING ACTIVITY SPACES: AN ANALYSIS OF GEOGRAPHIC VARIATION IN LOCATIONS OF ROUTINE, POTENTIAL SEXUAL RISK, AND PREVENTION BEHAVIORS AMONG MEN WHO HAVE SEX WITH MEN

ABSTRACT

Though both theory and research on HIV and among men who have sex with men (MSM) have long suggested the importance of non-residential locations in defining structural exposures, most studies within these fields define place as a residential context, neglecting the potential influence of non-residential locations on HIV-related outcomes. The concept of activity spaces, defined as a set of locations to which an individual is routinely exposed, represents one theoretical basis for addressing this potential imbalance. Using a one-time online survey to collect demographic, behavioral, and spatial data from MSM, this paper develops a measure of activity spaces and examines correlates of that measure. We used latent class analysis to identify categories of activity spaces using data on home, routine, potential sexual risk, and HIV prevention locations. We then assessed individual and area-level covariates for their associations with these categories. Classes were distinguished by the degree of spatial variation in routine and prevention behaviors (which were the same within each class) and in sexual risk behaviors (i.e., sex locations and locations of meeting sex partners). Partner type (e.g. casual or main) represented a key correlate of the activity space. In this early examination of the activity spaces of MSM, patterns of spatial behavior represent further evidence of significant spatial variation in locations of routine, potential HIV sexual risk, and HIV prevention behaviors among MSM. Although prevention behaviors tend to have similar

geographic variation as routine behaviors, locations where men engage in potentially high-risk behaviors may be more spatially focused for some MSM than for others.

PUBLICATION

To be submitted to Social Science and Medicine.

INTRODUCTION

Despite recent global and national declines in new HIV infections, HIV incidence has increased among young MSM and both geographic and racial/ethnic disparities remain [1,2,7,15,125]. These continued disparities suggest that, relative to other high-risk groups, large-scale HIV prevention efforts focusing on individual behavior change have been less effective in slowing the HIV epidemic among MSM [16]. In response, the role of place, including network and structural factors, in patterning risk and prevention behaviors has received renewed attention [12,19–21].

However, most studies within the HIV literature define place as a residential context, neglecting the potential influence of non-residential locations on HIV-related outcomes [32,39,48,53,57–61]. Place-based theory and research on HIV and among MSM have long suggested the importance of non-residential locations in defining structural exposures [19–21,73,74]. Non-residential locations may be especially critical in health research among MSM, for whom routine behaviors may be separate from HIV risk and prevention behaviors due to either stigmatization or the spatial distribution of resources [28,33–38]. In response, the concept of activity spaces, defined as a set of locations to which an individual is routinely exposed, has been developed to formally acknowledge

the potential influence of non-residential locations [75,77,79,95] and have recently been introduced to health research of MSM [71,72].

Using activity spaces in epidemiologic research first requires summarizing multiple spatial locations into a concise, meaningful measure with application to public health action. Research in other fields (such as obesity and environmental epidemiology) has focused on geometric measures, such as standard deviational ellipses and standard distances [77,88,92,94,95], or on visual inspection of spatial patterns [76,90]. However, since a lack of physical activity and movement are not direct risk factors for HIV, these measures may be less applicable to HIV epidemiology and to the subsequent development of interventions.

Consequently, recent studies of HIV-related activity spaces have used the overlap of areas defined by that individual's behaviors, either administratively-defined areas (e.g. counties) [72] or participant-defined neighborhoods [71]. The presence of overlapping areas in which an individual engages in specific behaviors provides key information regarding the existence of geographic separation with specific behaviors. However, this construct lacks more nuanced information about the degree and spatial structure of that geographic separation. By exploring *where* geographic overlap occurs instead of simply *if* geographic overlap occurs, we may better understand the spatial structure of behaviors and better target interventions.

Thoroughly investigating the role of place in HIV sexual risk and prevention behaviors of MSM first requires understanding the spatial distributions of these behaviors. Using a one-time survey to collect demographic, behavioral, and spatial data from an online

sample of MSM, this analysis develops a measure of activity space for MSM and examines correlates of that measure.

METHODS

Recruitment

Participants were recruited using Facebook banner ads targeted to users based on geography and interests. This method yields samples with similar sexual risk behaviors and demographics (excepting race) as venue-based methods of recruiting MSM [101]. A $3 donation to a charity the participant selected from a pre-defined list was provided as incentive.

Eligible participants were required to be: male at birth, aged 18+ years, report at least one male sex partner in the past 6 months, able to read and write English, and to reside in one of nine metropolitan statistical areas (MSA) with the largest numbers of new diagnoses in 2013 (New York City, Miami, Los Angeles, Washington, DC, Atlanta, Chicago, Houston, Dallas, and Philadelphia). In the United States, these MSAs represent half of all new HIV cases [1] and approximately 35% of the MSM population [99]. MSA boundaries were defined using the U.S. Census Bureau's 2013 delineations [100].

Collection of Place-Based Data

Consenting participants completed an online survey containing demographic and behavioral questions, including residential ZIP code at the time of data collection. In addition to these questions, participants indicated specific locations using a map-based tool to drop a pin onto a Google map. This tool has been shown to be valid and reliable in a broad sample of MSM [98,126]. The requested locations may be grouped into those

associated with routine behaviors, with potential HIV sexual risk behaviors, and with HIV prevention behaviors as follows:

- Routine locations: Home; work or school location (if the participant reported working at least part time or being a student); two socialization locations; primary care physician (if the participant reported having a regular primary care physician); pharmacy (if the participant reported having a regular pharmacy).
- Potential sexual risk locations: For the past three sex partners within the past six months, the location where the participant met the partner and the location of the most recent sexual encounter. The locations of meeting sex partners are included in this category since these types of locations may connect sexual networks and be associated with high-risk sexual behaviors [35,37,63].
- Prevention locations: Location of last HIV test, within the past year; location of last test for another sexually transmitted infection (STI), within the past year; primary care physician and pharmacy (if the participant is current being treated for HIV or regularly taking pre-exposure prophylaxis (PrEP)). Pharmacy and physician locations included as prevention locations were excluded as routine locations.

Covariate Measures

Individual-Level Covariates

As an individual's activity space may be defined by either the individual's choices or by constraints placed upon the individual [79], covariates included in the study represented demographic variables, transportation-related variables, HIV-related variables, and geographic factors that could spatially influence an individual's activity space.

Demographic variables were: age, race, and education. Age was categorized into three groups with breaks at ages 30 and 51, with the age 30 representing the age division between increasing and stable rates of new HIV diagnosis and age 51 and over reflecting the Centers for Disease Control and Prevention reporting of HIV surveillance data [1,110]. Self-reported race/ethnicity was categorized as Hispanic/Latino, non-Hispanic black ("black"), non-Hispanic white ("white"), or non-Hispanic other ("other"). Education was categorized as high school diploma or less, any college, or college degree.

Transportation-related variables included primary mode of transportation, transportation instability, and recent immigration to the city. Primary mode of transportation was dichotomized into primarily using a car or primarily using other, non-car transportation. Transportation instability was defined as any reported instance within the past six months of being unable to do something necessary because of not having a way to get there. Participants were also asked when they moved to the town where they currently live.

HIV-related factors included HIV-status, partner type, and outness. HIV status was self-reported. Participants were allowed to respond to questions about up to three sex partners in the last six months. Each sex partner was identified as a main or casual partner. The degree to which the participant's sexual orientation was known to others ("outness") was assessed using a previously reported seven-point scale and categorized as completely out (values of 6 or 7) or not completely out (values 1 through 5) [127].

Area-Level Covariates

We also included geographic factors that represent higher-level social context and the spatial distribution and availability of resources. MSA was defined as the MSA where the

participant reported currently living. Residential poverty and residential population density were defined based on the census tract of the reported residential location. Poverty was obtained from the US Census Bureau's 2009-2013 5-Year American Community Survey estimates and categorized as low (<20% poverty) or high (≥20% poverty), based on federal poverty definitions [128]. Population density was based on 2010 population estimates from the US Census Bureau. For each MSA, high density was defined as the top quartile of census tracts. Categories of poverty and population density were then combined into a single variable representing the potential distribution and availability of resources.

Measuring Activity Spaces

To define activity spaces of MSM for analytic purposes, we must quantify the spatial structure of locations. Although prior studies have used the presence or absence of overlapping areas where specific behaviors occur [71,72], a more nuanced approach would define the geographic level at which behaviors overlap (e.g. census tract, county). For example, we could consider whether an individual's home and doctor are in the same census tract, county, or MSA, creating a measure of the degree of spatial variation across these locations. Additionally, as opposed to potential geometric measures, using administratively-defined areas to define the degree of overlap (or concordance) may also inform interventions and resource allocation.

Therefore, to measure the concordance of administratively-defined areas where routine, potential sexual risk, and prevention behaviors occur, all locations were first geocoded to a census tract, county, and MSA. Using these geocoded values, we then found the smallest geographic level (census tract, county, MSA, or out of the MSA) for which the

locations were concordant. To account for varying sizes of census tracts across levels of urbanicity and across MSAs, census tracts were considered to be concordant if they were immediately adjacent or, for the smallest quartile of census tracts, were second-order adjacent (e.g. neighbors of neighbors).

This large number of comparisons of concordance between all pairs of fourteen collected locations then needed to be reduced. We used latent class analysis (LCA) to reduce these multiple complex geographic relationships into a single activity space measure. LCA posits that the observed data reflect an unobserved underlying structure and creates categories reflecting this latent structure [129,130].

The LCA inputs were select measures of concordance between the locations of routine, potential sexual risk, and prevention behaviors. They described the degree of geographic overlap of these behaviors and acknowledged the centrality of home as a geographic reference point. With the exception of the last variable, these inputs took one of four values (census tract, county, MSA, or beyond the MSA). These inputs were defined as follows:

1. Geographic variation in routine locations: The smallest geographic level (i.e. census tract, county, MSA, beyond MSA) containing two-thirds of six possible routine locations. This variable represents the geographic area in which the participant performs most routine activities, but does not require the centrality of home.
2. Geographic variation in home and work/school: The smallest geographic level containing both home and work/school.

3. Geographic variation in home and socialization locations: The smallest geographic level containing home and either reported socialization location.
4. Geographic variation in home and testing locations: The smallest geographic level containing home and the location of the HIV or STI test.
5. Geographic variation in home and treatment locations: The smallest geographic level containing home and either the physician or pharmacy locations for HIV-positive participants or participants regularly using PrEP.
6. Geographic variation in sex locations: The smallest geographic level containing all sex locations.
7. Geographic variation in locations of meeting sex partners: The smallest geographic level containing all locations where sex partners were met.
8. Concordance between home and sex locations: Whether all, some, or no sex was reported at home.

Using these eight variables, we fit latent class models with 2 to 10 classes. We assessed model fit using change in log-likelihood, Bayesian information criterion (BIC), and entropy [129,131]. We also considered interpretability of the model results in determining the number of classes [132]. After selecting the LCA model, the posterior probability of each participant's membership in each class was obtained.

Associations between Covariates and LCA Class Membership

We then used logistic regression to describe characteristics of individuals composing the activity space classes. Given the multi-level, unordered measure of activity space, we could have used polytomous logistic regression [133]. However, interpreting results from these models is not intuitive as they require defining both exposure and outcome

reference groups. Consequently, we using logistic regression to model the odds of an individual being in a given class compared to not being in that class. Potential correlation of participants within MSAs was accounted for using a random intercept for each MSA. All covariates described above were included in the model.

To account for uncertainty in the assignment of participants to LCA classes, these logistic regression models were run for 1000 replications, with the LCA class for each participant assigned using the posterior probability of class membership. We then used combining equations to calculate the summary OR and 95% confidence intervals (CI) [134].

Analysis Software

Data management and analysis were performed using SAS v9.4 (SAS Institute, Cary, NC). Latent class analysis was performed using proc LCA v1.3.2 [135,136]. Geocoding and spatial data manipulation were completed in R v3.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Sample Characteristics

Of 136,402 men presented with the Facebook ad, 5,281 men (3.9%) clicked on the ad to enter the eligibility screening (Figure 7). Of these, 949 men (18.0%) were eligible and consented to participate in the study. 648 men (68.3%) completed the survey.

To reduce misclassification of locations, participants were further restricted based on the quality of the reported spatial data. Of 446 participants who placed a home location in the reported ZIP code, the range of distances between the ZCTA centroid and the home location was 0.1 to 9.3 km. Using this range as a threshold for data quality, 73

participants indicating a home location >9.3 km from the reported ZCTA centroid were excluded. An additional 18 participants who did not report a home location and provided data of sufficient quality were also included. Therefore, the final sample included 588 participants.

Our sample represented a wide range of ages and incomes, living in both high and low poverty census tracts (Table 4). Our sample was young, highly educated, and largely white.

Figure 7. Recruitment and study inclusion among MSM in this study.

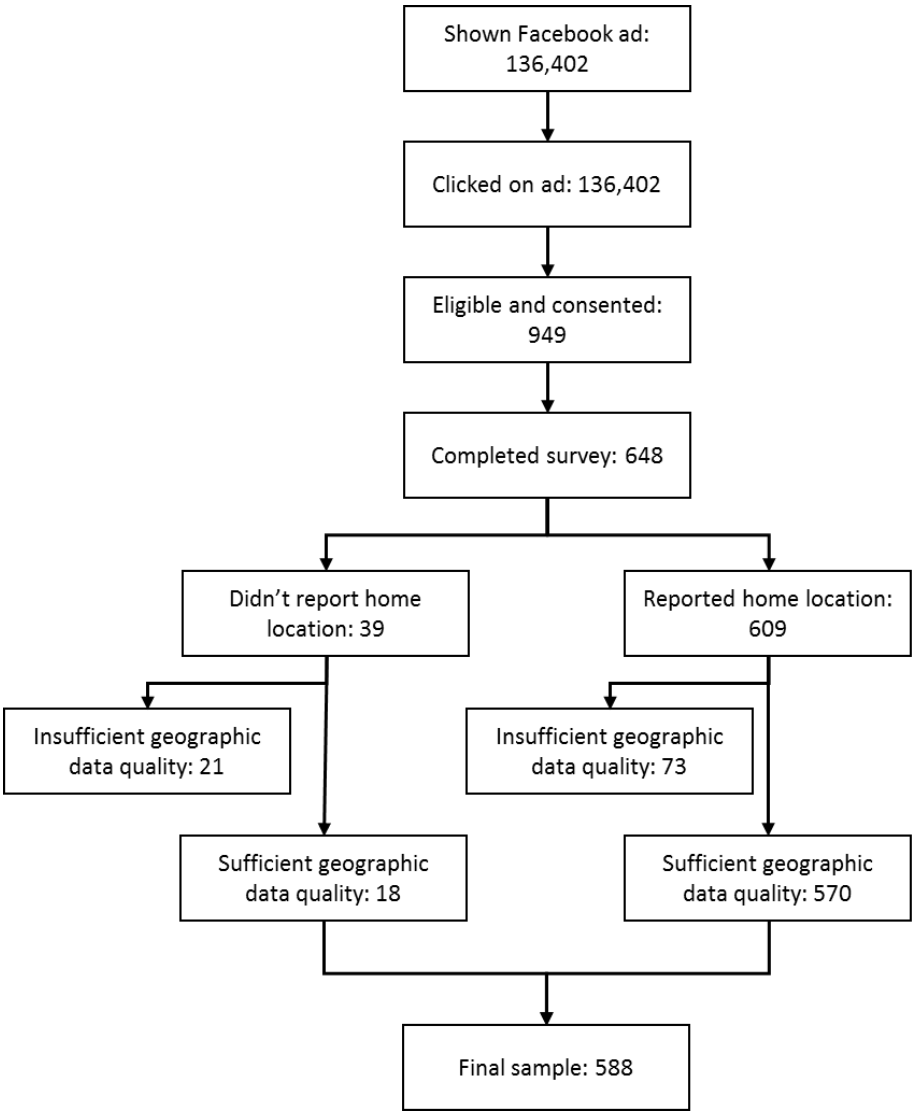


Table 4. Characteristics of an online sample of 588 participating men who have sex with men (MSM) from 9 United States metropolitan statistical areas (MSA) in 2015.

Covariate	n (%)
Age	
18-29	214 (36.4)
30-50	286 (48.6)
51 and over	88 (15.0)
Race	
White	430 (73.1)
Black	37 (6.3)
Hispanic	60 (10.2)
Other	61 (10.4)
Education	
High school or less	28 (4.8)
Some college	131 (22.3)
College degree	429 (73.0)
Car as primary mode of transportation	341 (58.0)
Any transportation instability	152 (25.8)
Moved to the city in the past 6 months	45 (7.7)
Reported HIV positive	45 (7.7)
Sex partners	
Main partners only	179 (30.4)
Main and casual partners	203 (34.5)
Casual partners only	206 (35.0)
Completely out	465 (79.1)
Metropolitan statistical area (MSA)	
Atlanta	40 (6.8)
Chicago	71 (12.1)
Dallas	37 (6.3)
Houston	32 (5.4)
Los Angeles	91 (15.5)
Miami	26 (4.4)
New York	179 (30.4)
Philadelphia	41 (7.0)
Washington, DC	71 (12.1)
Residential density and poverty	
Average density – Low poverty	232 (39.5)
Average density – High poverty	52 (8.8)
High density – Low poverty	192 (32.7)
High density – High poverty	112 (19.1)

Activity Space Categories

Using a combination of model fit and interpretability, the five-class model was considered the most appropriate (Table 5). Item-response probabilities corresponding to each identified LCA class are shown in Figure 8. These values represent the probability of a particular response to a particular variable being included in a given latent class.

Table 5. Model fit statistics for LCA models with 2 to 10 classes.

Number of classes	**Log-likelihood**	**BIC**	**Entropy**
2	-3118	1526	0.92
3	-3007	1459	0.84
4	-2953	1502	0.86
5	-2869	1487	0.87
6	-2857	1616	0.86
7	-2838	1731	0.84
8	-2809	1828	0.86
9	-2797	1956	0.87
10	-2776	2067	0.89

Figure 8. Item-response probabilities corresponding to each LCA class. All items except those related to potential sexual risk are grouped by the geographic level containing the given behaviors.

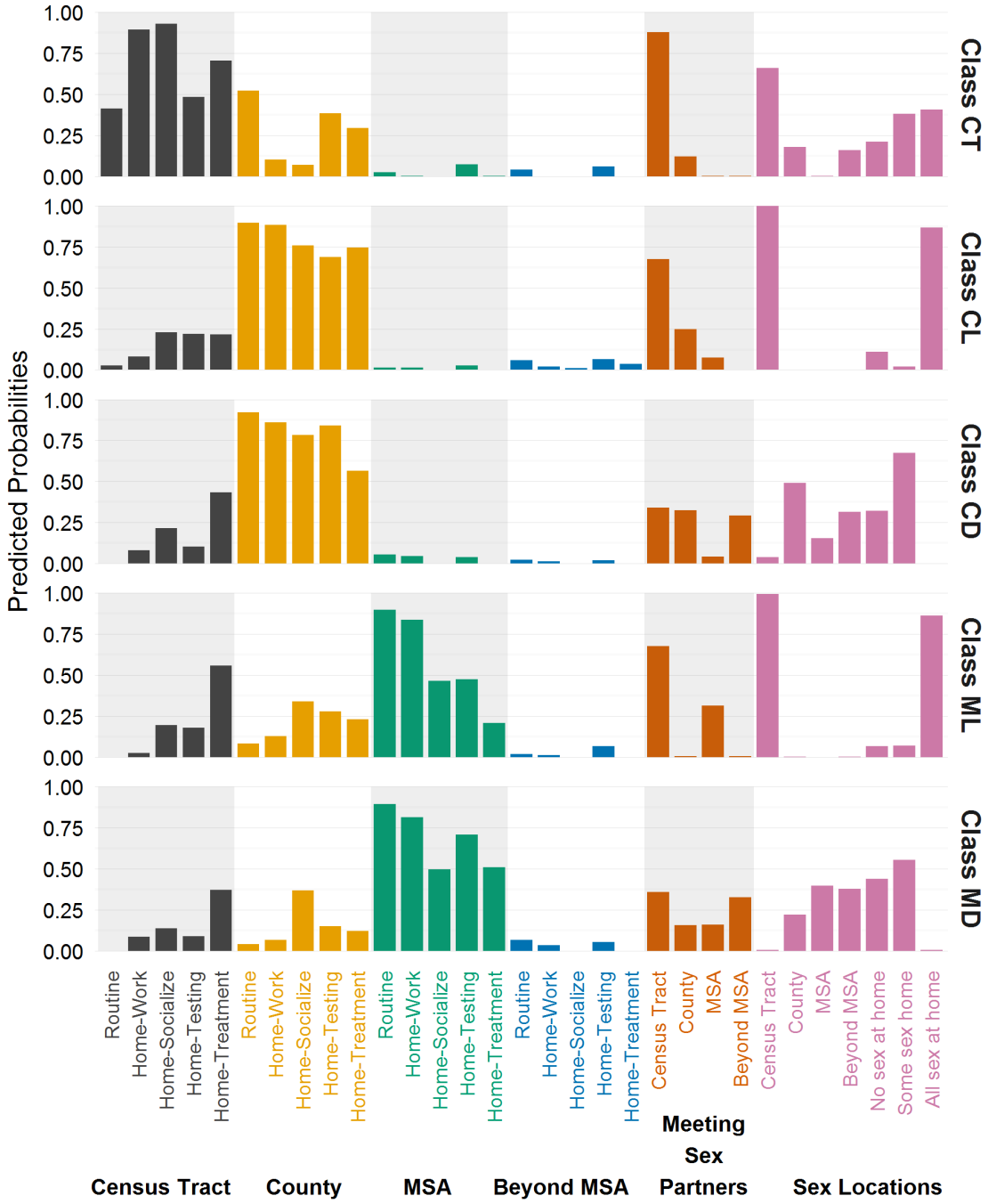


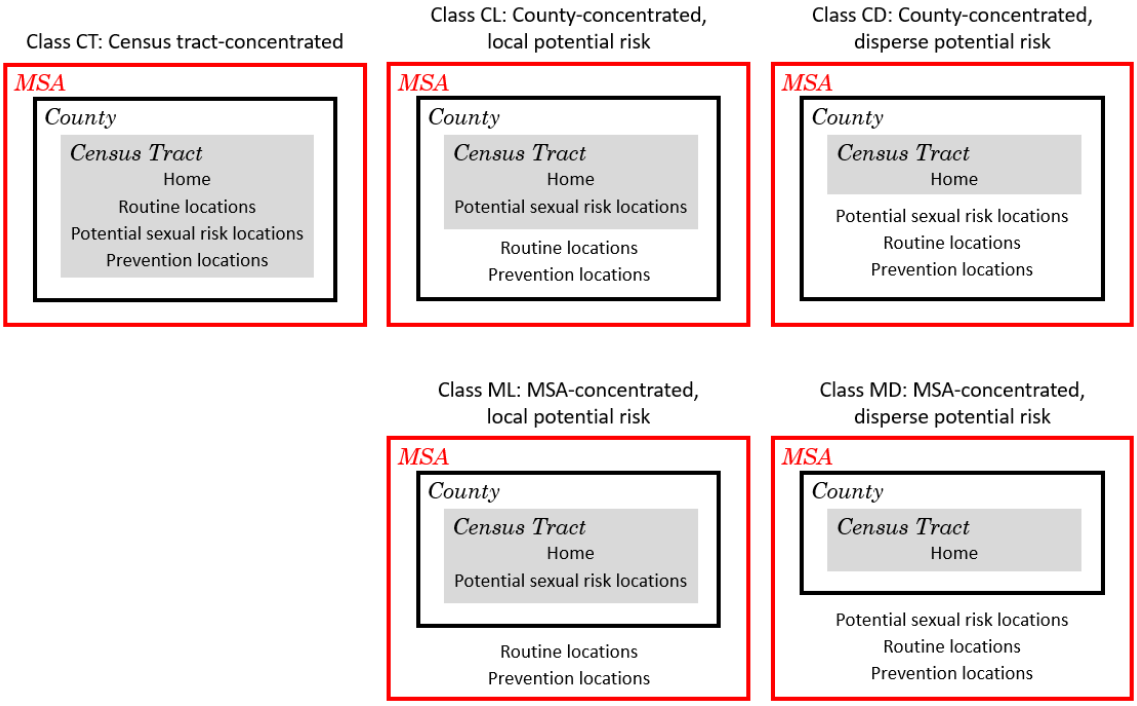
Table 6 summarizes the characteristics of each class; Figure 9 provides a high-level graphical representation of the nesting of behaviors within geographic areas for each class. Classes were distinguished by the geographic level of concordance in routine and prevention behaviors (which were the same within each class) and in potential sexual risk behaviors (i.e., sex locations and locations of meeting sex partners). Based on the item-response probabilities, we labeled the five classes as: "census tract-concentrated" (abbreviated as CT, 16% of the sample using most likely class membership), "county-concentrated, local potential risk" (CL, 30%), "county-concentrated, disperse potential risk" (CD, 24%), "MSA-concentrated, local potential risk" (ML, 15%), "MSA-concentrated, disperse potential risk" (MD, 15%). Men in the "census tract-concentrated" class generally reported all locations including locations of sex and meeting sex partners, close to home (i.e. in the same or adjacent census tracts). Men in the "county-concentrated, local potential risk" and "MSA-concentrated, local potential risk" classes generally reported routine and prevention behaviors farther from home (i.e., within in the same county and MSA, respectively, as their home), with potential sexual risk behaviors limited to a small area surrounding the home. Conversely, men in the "county-concentrated, disperse potential risk" and "MSA-concentrated, disperse potential risk" classes generally reported routine, prevention, and sexual risk behaviors far from home, in the same county and MSA, respectively.

Table 6. Description of latent classes from the five-class model.

Class (Abbreviation)	Size of class* (%)	Description
Census tract-concentrated (CT)	16%	Routine behaviors are contained within a census tract or county. Routine, risk, and prevention behaviors occur in the same or adjacent census tract as home. Sex partners are met within the same or adjacent census tracts. Sex occurs within the same census tract, with at least some sex occurring at home.
County-concentrated, local potential risk (CL)	30%	Routine behaviors are contained within the county. Routine, risk, and prevention behaviors occur in the same county as home. Sex partners are met within the same or adjacent census tracts. Sex occurs only at home.
County-concentrated, disperse potential risk (CD)	24%	Routine behaviors are contained within the county. Routine and prevention behaviors occur in the same county as home. Sex partners are met across the county, including locations outside the MSA. Sex occurs across the county and outside the home, including outside the MSA.
MSA-concentrated, local potential risk (ML)	15%	Routine behaviors are contained within the MSA. Routine and prevention behaviors occur in the same MSA as home. Sex partners are met within the same or adjacent census tracts. Sex occurs only at home.
MSA-concentrated, disperse potential risk (MD)	15%	Routine behaviors are contained within the MSA. Routine and prevention behaviors occur in the same MSA as home. Sex partners are met in multiple locations, including locations outside the MSA. Sex occurs across the MSA and outside the home, including outside the MSA.

* Based on most likely class membership

Figure 9. Summary of latent classes from the five-class model.



Associations between LCA Classes and Covariates

Class CT: Census Tract-Concentrated

In adjusted analyses, participants in this class were more likely to be less educated (OR for high school or less: 2.2, 95% CI: 0.8-5.8; OR for some college: 1.6, 95% CI: 0.9-2.8; reference group is those having a college degree) and live in poorer areas (OR for average density, high poverty compared to average density, low poverty: 2.0, 95% CI: 0.9-4.4) than participants of the other classes combined (Table 7). Members of this class with the least spatial variation were twice as likely to not use a car as the other classes combined (OR: 2.1, 95% CI: 1.2-3.7), and had recently moved to town (OR: 2.2, 95% CI: 1.0-4.4). Finally, these individuals in the "Census-tract concentrated" class were twice as likely to have both main and casual partners (OR: 1.9, 95% CI: 1.1-3.5) as to have only main partners.

Class CL: County-Concentrated, Local Potential Risk

Participants in this class were much less likely to report having any casual partners than participants in other classes (OR for both main and casual partners: 0.1, 95% CI: 0.1-0.3, OR for only casual partners: 0.3, 95% CI: 0.2-0.5) and to be over age 50 (OR: 2.2, 95% CI: 1.2-4.0). Members of this class were also more likely to live in highly urban areas (OR for high density, low poverty: 1.9, 95% CI: 1.1-3.2; OR for high density, high poverty: 2.5, 95% CI: 1.4-4.5). Members of this class were also more likely to live in the Los Angeles MSA and less likely to live in the New York City MSA (Table 8).

Class CD: County-Concentrated, Disperse Potential Risk

Participants of this class were more likely to be younger (OR for ages 18-29 compared to ages 30-50: 1.6, 95% CI: 1.0-2.5). They overwhelmingly reported having casual sex partners (OR for both main and casual partners: 8.9, 95% CI: 4.4-18.0, OR for only casual partners: 7.4, 95% CI: 3.6-15.0). Members of this class were also more likely to live in the Los Angeles MSA and less likely to live in the New York City MSA.

Class ML: MSA-Concentrated, Local Potential Risk

Compared to all other classes, participants in this class were much less likely to report any casual partners (OR: 0.3, 95% CI: 0.2-0.6, OR for only casual partners: 0.3, 95% CI: 0.2-0.6). They also were more likely to live in the New York City or Washington, DC MSAs and less likely to live in the Los Angeles MSA.

Table 7. Adjusted odds ratios (aOR) and 95% CI for associations between membership in each latent class compared to membership in all other latent classes. aOR for all variables are adjusted for all other variables and account for potential correlation within MSA.

Covariate	Class CT: Census tract-concentrated	Class CL: County-concentrated, local potential risk	Class CD: County-concentrated, disperse potential risk	Class ML: MSA-concentrated, local potential risk	Class MD: MSA-concentrated, disperse potential risk
Age					
18-29	0.9 (0.6, 1.6)	0.9 (0.6, 1.5)	1.6 (1.0, 2.5)	0.6 (0.3, 1.0)	1.0 (0.6, 1.8)
30-50	Ref	Ref	Ref	Ref	Ref
51 and over	0.9 (0.5, 1.9)	2.2 (1.2, 4)	1.1 (0.6, 1.9)	0.6 (0.3, 1.3)	0.4 (0.2, 1.0)
Race					
Black	1.3 (0.5, 3.3)	1.7 (0.7, 4)	0.4 (0.1, 1.2)	0.8 (0.3, 2.3)	0.9 (0.3, 2.6)
Hispanic	0.7 (0.3, 1.7)	1.5 (0.8, 2.8)	0.9 (0.4, 1.9)	1.5 (0.7, 3.3)	0.6 (0.2, 1.7)
Other	0.7 (0.3, 1.6)	1.2 (0.6, 2.4)	0.8 (0.4, 1.5)	1.3 (0.6, 3.1)	1.3 (0.6, 2.9)
White	Ref	Ref	Ref	Ref	Ref
Education					
High school or less	2.2 (0.8, 5.8)	1.2 (0.5, 3.1)	1.0 (0.4, 2.6)	0.6 (0.1, 2.5)	0.3 (0.0, 2.0)
Some college	1.6 (0.9, 2.8)	0.9 (0.5, 1.5)	0.8 (0.5, 1.3)	1.2 (0.7, 2.2)	0.9 (0.5, 1.6)
College degree	Ref	Ref	Ref	Ref	Ref
Non-car primary mode of transportation	2.1 (1.2, 3.7)	1.1 (0.6, 1.8)	0.7 (0.4, 1.2)	0.7 (0.4, 1.2)	0.7 (0.4, 1.4)
Any transportation instability	0.6 (0.3, 1.1)	1.5 (0.9, 2.6)	0.7 (0.4, 1.1)	0.7 (0.4, 1.3)	1.9 (1.1, 3.3)
Moved to town in the past six months	2.1 (1.0, 4.4)	1.2 (0.6, 2.6)	0.2 (0.1, 0.6)	1.7 (0.7, 4)	0.8 (0.3, 2.1)
Not completely out	1.3 (0.7, 2.2)	0.7 (0.4, 1.1)	1.2 (0.7, 1.9)	0.9 (0.5, 1.8)	1.4 (0.8, 2.5)
Reported HIV positive	0.6 (0.2, 1.7)	1.0 (0.4, 2.2)	0.9 (0.4, 2.1)	0.8 (0.3, 2.2)	2.1 (0.9, 5)

Table 7. Continued from previous page.

Covariate	Class CT: Census tract-concentrated	Class CL: County-concentrated, local potential risk	Class CD: County-concentrated, disperse potential risk	Class ML: MSA-concentrated, local potential risk	Class MD: MSA-concentrated, disperse potential risk
Sex partners					
Main partner only	Ref	Ref	Ref	Ref	Ref
Both main and casual	1.9 (1.1, 3.5)	0.1 (0.1, 0.3)	8.9 (4.4, 18)	0.3 (0.2, 0.6)	4.0 (1.9, 8.2)
Only casual	1.4 (0.7, 2.5)	0.3 (0.2, 0.5)	7.4 (3.6, 15)	0.3 (0.2, 0.6)	3.4 (1.7, 7)
Population Density and Poverty					
Average density - Low poverty	Ref	Ref	Ref	Ref	Ref
Average density - High poverty	2.0 (0.9, 4.4)	1.2 (0.6, 2.4)	0.6 (0.2, 1.4)	1.6 (0.7, 3.8)	0.4 (0.1, 1.2)
High density - Low poverty	1.0 (0.5, 1.8)	1.9 (1.1, 3.2)	1.6 (0.9, 2.8)	0.7 (0.4, 1.3)	0.4 (0.2, 0.8)
High density - High poverty	0.8 (0.4, 1.6)	2.5 (1.4, 4.5)	1.4 (0.8, 2.6)	0.9 (0.4, 1.8)	0.2 (0.1, 0.5)

Table 8. Random intercepts and 95% CI for membership in each latent class compared to membership in all other latent classes.

MSA	Class CT: Census tract-concentrated	Class CL: County-concentrated, local potential risk	Class CD: County-concentrated, disperse potential risk	Class ML: MSA-concentrated, local potential risk	Class MD: MSA-concentrated, disperse potential risk
Atlanta	0.0 (-0.4, 0.5)	-0.3 (-1.1, 0.5)	-0.4 (-0.9, 0.2)	0.5 (-0.5, 1.4)	1.1 (0.1, 2.1)
Chicago	0.0 (-0.4, 0.5)	0.5 (-0.2, 1.2)	0.0 (-0.5, 0.5)	-0.8 (-1.9, 0.2)	-0.2 (-1.3, 0.8)
Dallas	-0.3 (-0.7, 0.2)	0.2 (-0.6, 1.0)	0.2 (-0.4, 0.7)	0.5 (-0.5, 1.5)	0.0 (-1.1, 1.1)
Houston	0.2 (-0.2, 0.7)	0.7 (-0.1, 1.5)	-0.1 (-0.7, 0.5)	-0.9 (-2.2, 0.3)	-1.0 (-2.3, 0.4)
Los Angeles	0.0 (-0.4, 0.5)	0.7 (0, 1.3)	0.4 (0, 0.9)	-1.4 (-2.5, -0.3)	-1.4 (-2.5, -0.3)
Miami	0.1 (-0.4, 0.6)	0.2 (-0.6, 1.0)	0.2 (-0.4, 0.7)	-0.1 (-1.2, 1.0)	-0.8 (-2.2, 0.5)
New York	-0.2 (-0.6, 0.2)	-1.0 (-1.6, -0.3)	-0.3 (-0.7, 0.2)	1.2 (0.4, 2)	1.2 (0.4, 2.1)
Philadelphia	0.0 (-0.4, 0.5)	-0.4 (-1.1, 0.4)	-0.1 (-0.6, 0.5)	0.2 (-0.8, 1.2)	0.8 (-0.2, 1.8)
Washington, DC	0.0 (-0.4, 0.4)	-0.6 (-1.3, 0.1)	0.1 (-0.4, 0.6)	0.9 (0, 1.8)	0.3 (-0.7, 1.3)

Class MD: MSA-Concentrated, Disperse Potential Risk

Members in this class were generally under age 50 (OR for ages 50 and over compared to ages 30-50: 0.4, 95% CI: 0.2-1.0) and were more likely to report transportation instability (OR: 1.9, 95% CI: 1.1-3.3). These men also were much more likely to report having casual sex partners (OR for both main and casual partners: 4.0, 95% CI: 1.9-8.2, OR for only casual partners: 3.4, 95% CI: 1.7-7.0). Members of this class were also more likely to live in the New York City or Atlanta MSAs and less likely to live in the Los Angeles MSA, and to live outside of high density areas (OR for high density, low poverty: 0.4, 95% CI: 0.2-0.8; OR for high density, high poverty: 0.2, 95% CI: 0.1-0.5).

DISCUSSION

Using LCA, we categorized and described spatial variation in routine activities and HIV-related potential sexual risk and prevention behaviors among MSM. Specifically, this analysis reduced a large number of locations important in the lives of MSM into a single, concise measurement. We then identified categories of activity spaces, ranging from those in which men remain near home for all behaviors to those in which behaviors span multiple counties. Overall in our study, the activity spaces of 84% of participants were defined by behaviors occurring outside of the home census tract.

This analysis revealed two key factors defining the activity spaces of MSM: the spatial overlap of routine and prevention behaviors and the potential spatial segregation of sexual risk behaviors from routine and prevention behaviors. Although the lack of geographic concordance between home and other behaviors has been reported for MSM [36,37,71,72], our study found that an individual's prevention behaviors generally have similar spatial distribution as routine behaviors, but potential sexual risk behaviors may

vary from this routine spatial pattern. With this variation, individuals may encounter multiple contexts, including economic, structural, and health-related, which may vary greatly from their residential context [75].

These classes of activity space in turn reflect geographic and personal factors that may constrain or expand movement with or without the express volition of the individual. Our results first suggest the importance of geography in constraining activity spaces. As our categories are based on the overlap of administratively-defined areas, the size of the census tracts, counties, and MSAs directly determine the potential for behaviors to be in the same area. For census tracts, we accounted for this by effectively enlarging smaller tracts using their neighbors. Similarly, associations between activity space classes and specific MSAs may be markers of MSA geography. For example, the Los Angeles MSA is composed of two counties, one much larger than the other, potentially restricting its residents to county-based classes. Similarly, the New York City MSA is composed of relatively small, highly-connected counties, affording its residents greater spatial variation in behaviors and thus facilitating membership in the MSA-concentrated classes.

Apart from the geography of MSAs, the spatial distribution of resources may push MSM away from or pull MSM towards specific locations to engage in certain behaviors. Our combined measure of population density and poverty represented a broad measure of resource availability and access. Patterns of associations between the activity space classes and this combined measure may reflect difference in both the spatial distribution and accessibility of locations where prevention and sexual risk may occur, including HIV testing, HIV treatment, and locations where MSM are concentrated. High poverty, average density areas of MSAs may have less availability of testing and prevention

resources and men may have less access to those resources [39,52,137], providing one possible explanation of a spatially restricted activity space. Men living in these high poverty, average density areas were also more likely to be members of an activity space class with local, rather than diverse, sexual risk, possibly due to the spatial distribution of MSM and limited locations where MSM may congregate [25]. In contrast, individuals living high poverty, high density areas may have greater access to potential locations of risk and prevention behaviors, despite having fewer resources, resulting in the county-concentrated activity spaces among men in these areas.

Within these spatial structures, the individual must then engage in behaviors at specific locations to define his activity space [20,21]. Spatial variation in routine and prevention behaviors, which tended to spatially overlap in this study, could be limited by recently moving to town or by transportation access [52,137]. However, as a key component of this measure of activity space, the spatial variation in an individual's potential sexual risk behaviors may especially be shaped by individual, rather than geographic, factors. Younger MSM, who are at highest risk of acquiring HIV [10,14], were more likely to engage in potential sexual risk behaviors across a county. Additionally, in this study, partner types represented a key determinant of the activity space. Having only casual partners or concurrent casual and main partners may place MSM at greater sexual risk for HIV and STI acquisition [138]. The observed activity space categories may then serve as markers of sexual networks with elevated risk.

The observed spatial variation in these key behaviors has critical implications for developing and implementing HIV-related interventions among MSM. Calls have been made for increased geographic targeting of interventions in order to reach most at-risk

populations [139–141]. However, when informed by surveillance data, this targeting is generally based only on residential locations. Our results show that, for most MSM, interventions targeted in this manner could miss key geographic opportunities. For example, interventions could be targeted to locations where sexual risk and prevention behaviors occur, which are frequently outside the home neighborhood in high-risk groups.

However, our observed spatial variation may also confer a hidden benefit to the current residence-based geographic targeting of interventions. The large observed spatial variation may give MSM greater opportunity to be exposed to interventions. By visiting locations across his county or his MSA, an individual may encounter geographically-targeted interventions that were not designed to reach him. Similarly, MSM living in locations targeted by interventions may also diffuse interventions through their travels.

This study represents an early exploration of the activity spaces of MSM and attempt to quantify activity spaces for epidemiologic research. Future work will refine this view, including better accounting for the time in attendance at each location and acquiring a more complete set of visited locations [89]. Future work may also examine the variation in contextual exposures contained within these activity spaces and determining which contexts are most important for specific behaviors, since home may not be the most relevant exposure [142].

This study has limitations. Potential misidentification of locations is of critical concern [120]. As we ask about locations that have recently occurred, this concern may be minimal, provided that participants are able to correctly use the map. This concern may

be further minimized by the use of a familiar Google map in an online population which has been previously shown to be valid and result in quality data [98,126]. Additionally, our use of LCA with our selected inputs represents just one method of potentially categorizing activity spaces, and it neglects timing and other potentially relevant locations. However, theory informed our selected inputs [19–21,23,28], permitting spatial separation across different behaviors. As a result, this study's categorization may be useful for future research.

Finally, with any analysis involving geographic areas, the modifiable area unit problem (MAUP) represents a key limitation [143]. Since administratively-defined areas differ in size both within and across MSAs, the inclusion of behaviors within a given administratively-defined areas depends on the spatial structure of the place. However, these areas represent geographic levels for which HIV epidemiology is reported and at which policy and interventions are targeted. Consequently, their use remains relevant despite this limitation.

Conclusion

In this early examination of the activity spaces of MSM, we observed further evidence of the significant spatial variation in locations of routine, potential HIV sexual risk, and HIV prevention behaviors among MSM. Although prevention behaviors tend to occur over the same geographic areas as routine behaviors, locations where men engage in potentially high-risk sexual behaviors may be more spatially focused for some MSM than for others. Studies of the associations between context and HIV-related outcomes should incorporate the potential exposure to these varied locations. The geographic targeting of interventions should also acknowledge this potential for relevant behaviors occurring outside the home.

CHAPTER 5. SEX MARKS THE SPOT: RESIDENTIAL POVERTY, ACTIVITY SPACES, AND SEXUAL RISK AND HIV TESTING BEHAVIORS AMONG AN ONLINE SAMPLE OF MEN WHO HAVE SEX WITH MEN

ABSTRACT

Among men who have sex with men (MSM), neighborhood disadvantage has been linked to elevated HIV incidence and prevalence and behavioral outcomes. Activity spaces, or spatial variation in routine activities, may represent crucial contextual exposures for MSM and have only recently entered the literature. Using an online sample of MSM, this paper explores associations between activity spaces and two HIV-related behaviors (HIV testing and UAI) and examines differences in these associations by residential poverty. We found meaningful and statistically significant differences in recent HIV testing and reporting UAI by activity spaces among men living in high poverty areas, but not among men living in low poverty areas. These results highlight the importance of accounting for both residential and non-residential locations in studies examining the role of context in HIV-related outcomes among MSM.

PUBLICATION

To be submitted to AIDS and Behavior.

BACKGROUND

Among men who have sex with men (MSM), exposure to place-based economic disadvantage has been linked to HIV incidence and prevalence [1,144–146], and to behavioral outcomes, including unprotected anal intercourse (UAI), and poorer HIV testing and treatment outcomes [19–21,32,147]. However, this extensive body of research

has almost exclusively defined these exposures based on *residential* places, ignoring the potential importance of *non-residential* places. Non-residential locations may represent a particularly key set of places for MSM, since stigmatization and the spatial distribution of resources may lead to geographically dispersed routine, sexual risk, and HIV prevention behaviors [28,33–38]. The concept of activity spaces, defined as the set of locations to which an individual is routinely exposed, has been recently introduced to the literature examining health outcomes among MSM [71,72,79,95].

An emerging body of literature suggests that the activity spaces of MSM are varied, and often extend beyond the residential neighborhood. In two recent studies of the activity spaces of MSM in New York City, large majorities reported living, socializing, and having sex in different neighborhoods and boroughs (i.e. the behavior-defined neighborhoods were "discordant") [71,72]. Similarly, studies of MSM living with HIV in Mississippi and North Carolina found similar HIV genetics among men living across the state, suggesting spatial discordance in the places where MSM live, meet sex partners, and have sex [36,38]. Spatial studies of sexual networks have confirmed this finding, with socialization locations (but not residential neighborhoods) linking the sexual networks of MSM [35,37].

These non-residential locations may then modify associations between neighborhood context and health outcomes. One study of individuals living in impoverished areas of Los Angeles County found that greater spatial variation, and the resulting exposure to less disadvantaged neighborhoods, was associated with improved overall health [75]. However, given the nascent research of activity spaces among MSM, these associations

have not been explored for HIV sexual risk and preventive behaviors which link context to individual-level outcomes.

Therefore, using survey data from an online convenience sample of MSM, this paper quantifies associations between activity spaces and two HIV-related behaviors (HIV testing and UAI) and examines differences in these associations by residential poverty.

METHODS

Recruitment

Participants were recruited using Facebook banner ads, a method that has been shown to yield samples with similar sexual risk behaviors and demographics (excepting race) as venue-based methods of recruiting MSM [101]. Ads were targeted to users based on geography and interests. A $3 donation to a charity the participant selected from a pre-defined list was provided as incentive.

Eligible participants were: male at birth, aged 18 years or over, report at least one male sex partner in the past 6 months, able to read and write English, and to reside in one of nine metropolitan statistical areas (MSA) with the largest numbers of new diagnoses in 2013 (New York City, Miami, Los Angeles, Washington, DC, Atlanta, Chicago, Houston, Dallas, and Philadelphia). In the United States, these MSAs represent half of all new HIV cases [1] and approximately 35% of the MSM population [99]. MSA boundaries were defined using the U.S. Census Bureau's 2013 delineations [100].

Collection of Place-Based Data

Consenting participants completed an online survey that included demographic and behavioral questions, including HIV status. In addition to these questions, participants

indicated specific locations using a valid, reliable map-based tool to drop a pin onto a Google map [98,126]. The requested locations, which are used to define an individual's activity space, may be grouped into those associated with routine behaviors, with potential sexual risk behaviors, and with HIV prevention behaviors as follows:

- Routine locations: Home; work or school location (if the participant reported working at least part time or being a student); two socialization locations; primary care physician (if the participant reported having a primary care physician); pharmacy (if the participant reported having a regular pharmacy).
- Potential sexual risk locations: For the past three sex partners within the past six months, the location where the participant met the partner and the location of the most recent sexual encounter. The locations of meeting sex partners are included in this category since these types of locations may connect sexual networks and be associated with high-risk sexual behaviors [35,37,63].
- HIV prevention locations: Location of last HIV test, within the past year; location of last test for another sexually transmitted infection (STI), within the past year; primary care physician, if the participant is current being treated for HIV or regularly taking pre-exposure prophylaxis (PrEP); pharmacy, if the participant is current being treated for HIV or regularly taking PrEP. Pharmacy and physician locations included as prevention locations were excluded as routine locations.

Exposure

These locations then provide a basis for this analysis' primary exposure: a combined measure of residential poverty and activity space. Exposure to non-residential locations have been found to modify associations between general health and residential poverty,

suggesting potential heterogeneity among measures of activity space [75]. Residential poverty was defined for the participant's residential census tract using 2010-2014 5-Year American Community Survey estimates. Poverty was categorized into high and low, using the 20% threshold established by federal poverty definitions [111].

We previously developed and described the measure of activity space used in this study (see Chapter 4). Briefly, this measure classifies an individual's activity space based on spatial relationships of the locations of routine, sexual risk, and prevention behaviors and the degree of geographic concordance of these behaviors. Concordance was defined as the smallest administratively-defined area (e.g. census tract, county) containing the given behaviors. We then used latent class analysis (LCA) [129] to summarize these multiple measures of concordance into five categories which were distinguished by the degree of spatial variation in routine and prevention behaviors (which were the same within each class) and spatial variation in sexual risk behaviors (i.e., sex locations and locations of meeting sex partners).

The five classes were: "census tract-concentrated" (labeled as CT), "county-concentrated, local potential risk" (CL), "county-concentrated, disperse potential risk" (CD), "MSA-concentrated, local potential risk" (ML), and "MSA-concentrated, disperse potential risk" (MD) (Figure 9). Men in the "census tract-concentrated" class generally reported all locations including locations of sex and meeting sex partners, close to home (i.e. in the same or adjacent census tracts). Men in the "county-concentrated, local potential risk" and "MSA-concentrated, local potential risk" classes generally reported routine and prevention behaviors farther from home (i.e., within in the same county and MSA, respectively, as their home), with potential sexual risk behaviors limited to a small area

surrounding the home. Conversely, men in the "county-concentrated, disperse potential risk" and "MSA-concentrated, disperse potential risk" classes generally reported routine, prevention, and sexual risk behaviors far from home, in the same county and MSA, respectively. Each participant was assigned to the best-fitting LCA class.

Because we hypothesize heterogeneity by both poverty and activity space, the two levels of residential poverty and the five levels of activity space were then combined to form a single, 10-level exposure variable.

Outcomes

The two self-reported outcomes of interest for this study were: having tested for HIV in the past year and reporting any UAI at last sex with up to three partners in the past six months. UAI was defined as not reporting regularly taking pre-exposure prophylaxis (PrEP) or, in the absence of PrEP, reporting not using a condom with at least one sex partner. Participants who reported being HIV-positive were excluded from analysis of HIV testing as the outcome.

Potential Confounders

Potential confounders have been associated with this measure of activity space (see Chapter 4), or may be associated with the outcomes of interest, through either demographic differences in testing and sexual risk behaviors or the spatial distribution of resources [15,18,52,62,106,147,148]. Demographic variables were: age, race, and education. Age was categorized into three groups with breaks at ages 30 and 51, with the age 30 representing the age division between increasing and stable rates of new HIV diagnosis and age 51 and over reflecting the Centers for Disease Control and Prevention

reporting of HIV surveillance data [1,110]. Self-reported race/ethnicity was categorized as Hispanic/Latino, non-Hispanic black ("black"), non-Hispanic white ("white"), or non-Hispanic other race ("other"). Education was categorized as receiving a high school diploma or less, completing some college, or receiving a college degree.

HIV-related factors included: HIV-status, partner type, and outness. HIV status was self-reported. Participants were allowed to respond to questions about up to three sex partners in the last six months. Each sex partner was identified as a main or casual partner. The degree to which the participant's sexual orientation was known to others ("outness") was assessed using a previously reported seven-point scale and categorized as completely out (values 6 or 7) or not completely out (values 1 through 5) [127].

Transportation-related variables reflected the need for individuals to access resources that may be spatially patterned [25,26,51]. They included: primary mode of transportation, transportation instability, and recent immigration to the city. Primary mode of transportation was dichotomized into primarily using a car or primarily using other, non-car transportation. Transportation instability was defined as any reported instance within the past six months of being unable to do something necessary because of not having a way to get there. Participants were also asked when they moved to the town where they currently live.

Analysis

In bivariate analyses, the crude prevalence of each outcome was calculated within each level of the combined measure of residential poverty and activity space. We then

calculated prevalence ratios (PR) and differences (PD) comparing categories of activity space within each level of residential poverty.

Propensity Score Modeling

To account for a potentially large number of confounders and small numbers of participants within some levels of the outcome, we used propensity score weighted logistic regression with predictive margins for each outcome [112,113,149,150]. Propensity scores represent the probability of exposure given a set of covariates. Given a properly specified propensity score model, weighting subsequent analyses by the inverse of the propensity score should balance exposure groups across the covariates included in the propensity model, controlling confounding by measured confounders [149,151].

In this analysis, we estimated propensity scores using polytomous logistic regression models [133] of the exposure (i.e. the combined measure of poverty and activity space) as a function of the described covariates. The propensity model used for the HIV testing outcome also included reporting any UAI; that for the UAI outcome also included HIV status. We built these propensity models by selecting covariates *a priori* and verifying each to be strongly, but not necessarily significantly, associated with the outcomes (i.e. HIV testing, reporting UAI) in multivariate analyses [152].

To assess the ability of the propensity scores to control for confounding, we assessed the model's common support and balance [149,150,153,154]. Common support evaluates the degree to which propensity scores overlap across exposure groups (i.e. supports positivity) and was assessed through visual comparison of the distributions of modeled probabilities within each exposure group. Balance evaluates the distribution of covariates

across exposure groups (i.e. supports exchangeability), indicating the degree to which measured confounding has been controlled. We assessed balance by calculating standardized differences and performing chi-squared tests for both the unweighted and weighted samples [155,156]. Assessing balance using standardized difference is subjective. Thresholds of 0.10 and 0.25 have been suggested to indicate balance of the potential confounder between exposure groups [157,158]. However, the interpretation of standardized difference is affected by sample size and moderate imbalance can be expected in small samples [159].

Calculating Adjusted Prevalence and Measures of Association

To calculate adjusted measures of association, we then applied these propensity scores to predictive margins with a logistic regression model weighted by the inverse of the propensity score [112,113,149]. Weights were stabilized and truncated at 0.1 and 10 to avoid bias due to extreme weights [153,160]. Potential correlation of participants within MSAs were accounted for using marginal models with an exchangeable correlation structure. The exposure was the 10-level variable representing the combination of residential poverty and activity space, permitting calculation of measures of association both within strata of residential poverty and within strata of activity space.

Predictive margins methods permitted direct estimation of adjusted prevalence, adjusted prevalence ratio (aPR), and adjusted prevalence difference (aPD), rather than an estimated prevalence odds ratio (POR). Since we expected the outcomes to be common, the POR estimated using logistic regression would be larger than the true PR and, consequently, direct estimation of the PR is preferred [114]. This method also avoided

statistical convergence issues that may occur when estimating PR using other methods, such as log-binomial regression [115].

Analysis Software

Data management and analysis, including propensity score estimation [161] and standardized differences [162], were performed using SAS v9.4 (SAS Institute, Cary, NC). Predictive margins methods were performed using SAS-callable SUDAAN v11.0.1 (Research Triangle Institute, Research Triangle Park, NC). Geocoding and spatial data manipulation were completed in R v3.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Sample Characteristics

Details of this sample have been previously reported in Chapter 4. Of 136,402 men presented with the Facebook ad, 5,281 men (3.9%) clicked on the ad to enter the eligibility screening. Of these, 949 men (18.0%) were eligible and consented to participate in the study. 648 men (68.3%) completed the survey. To reduce misclassification of locations, participants were further restricted based on the quality of the reported spatial data (see Chapter 4), leaving 588 men in the final sample.

Our sample represented a wide range of ages, transportation access, and partner types (Table 9). Our sample was young, highly educated, and largely white. A large majority of men reported testing for HIV in the past twelve months (66.3%) and reported UAI with at least one partner in the past six months (80.4%).

In this sample, 428 men (72.8%) lived in low poverty census tracts (Table 10). Distributions of activity spaces differed by residential poverty (p=0.03). Compared to men in living in low poverty areas, men living in high poverty areas were less likely to have an activity space classified as “MSA-concentrated, disperse potential risk” and more likely to be classified as “county-concentrated, local potential risk.”

Table 9. Characteristics of an online sample of 588 participating men who have sex with men (MSM) from 9 United States MSAs in 2015.

Covariate	n (%)
Age	
18-29	214 (36.4)
30-50	286 (48.6)
51 and over	88 (15)
Race	
White	430 (73.1)
Black	37 (6.3)
Hispanic	60 (10.2)
Other	61 (10.4)
Education	
High school or less	28 (4.8)
Some college	131 (22.3)
College degree	429 (73.0)
Car as primary mode of transportation	341 (58)
Any transportation instability	152 (25.9)
Moved to the city in the past 6 months	45 (7.7)
Completely out	465 (79.1)
Sex partners	465 (79.1)
Main partners only	179 (30.4)
Main and casual partners	203 (34.5)
Casual partners only	206 (35)
Reported HIV positive	45 (7.7)
Metropolitan statistical area (MSA)	
Atlanta	40 (6.8)
Chicago	71 (12.1)
Dallas	37 (6.3)
Houston	32 (5.4)
Los Angeles	91 (15.5)
Miami	26 (4.4)
New York	179 (30.4)
Philadelphia	41 (7.0)
Washington, DC	71 (12.1)
HIV test in the past 12 months*	360 (66.3)
Any reported URAI	309 (52.6)
Any reported UIAI	310 (52.7)

* Among those not reporting HIV-positive

Table 10. Activity space categories and residential poverty of an online sample of 588 participating men who have sex with men (MSM) from 9 United States MSAs in 2015.

Activity Space Category	Low Residential Poverty	High Residential Poverty
Total	428 (72.8)	160 (27.2)
Class CT: Census tract concentrated	67 (15.7)	25 (15.6)
Class CL: County-concentrated, local potential risk	111 (25.9)	59 (36.9)
Class CD: County-concentrated, disperse potential risk	111 (25.9)	35 (21.9)
Class ML: MSA-concentrated, local potential risk	62 (14.5)	25 (15.6)
Class MD: MSA-concentrated, disperse potential risk	77 (18)	16 (10)

Propensity Score Diagnostics

Overall, the propensity score model was well-specified. The model exhibited common support across levels of the exposure (Figure 10). Despite significant differences in covariate distributions across exposure groups in unweighted samples, differences in weighted samples were not statistically significant (Table 11, Table 12). Standardized differences were generally below the 0.25 threshold for all variables within all exposure groups, and frequently below the more conservative 0.1 threshold (Table 13, Table 14). Some standardized differences in the high residential poverty strata exceeded these thresholds, but they were generally reduced in the weighted sample and, given small sample sizes, this may not indicate a lack of balance [152].

Figure 10. Evaluation of common support by examining distributions of propensity scores for the combined measure of residential poverty and activity space.

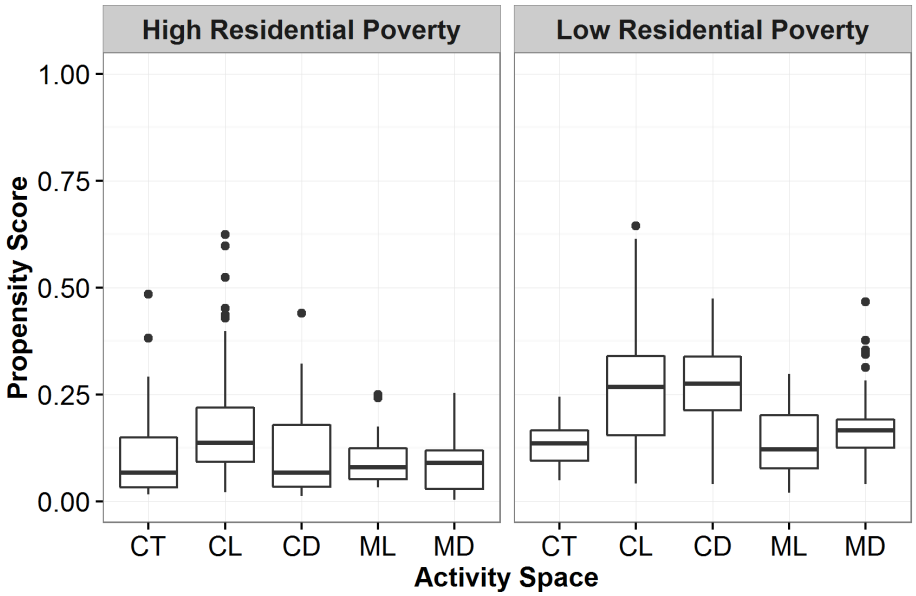


Table 11. Significance testing and proportions of covariates by the combined measure of residential poverty and activity space for the unweighted sample.

		Low residential poverty activity spaces (%)					**High residential poverty activity spaces (%)**				
	p-value	**CT**	**CL**	**CD**	**ML**	**MD**	**CT**	**CL**	**CD**	**ML**	**MD**
Age	0.19										
18-29		31	32	38	29	42	64	37	40	36	31
30-50		54	47	45	58	48	28	46	46	56	69
51 and over		15	22	17	13	10	8	17	14	8	0
Race	0.19										
White		75	69	82	76	74	84	66	60	64	69
Black		8	6	1	5	10	4	14	9	4	0
Hispanic		9	15	8	13	4	4	8	14	12	19
Other		9	9	9	7	12	8	12	17	20	13
Education	0.33										
High school or less		7	4	5	2	1	12	10	6	4	0
Some college		22	18	22	23	24	32	29	20	12	31
College degree		70	78	74	76	75	56	61	74	84	68
Car as primary mode of transportation	0.1	51	65	66	61	60	40	52	54	48	38
Any transportation instability	0.0004	18	23	21	18	31	36	46	20	16	56
Moved to the city in the past 6 months	0.02	9	9	2	6	9	24	7	6	16	0
Completely out	0.13	75	83	80	89	75	72	86	69	68	69
Sex partners	<0.0001										
Main partners only		22	54	10	53	17	16	44	9	52	6
Main and casual partners		42	18	47	23	44	52	20	46	28	38
Casual partners only		36	28	42	24	39	32	36	46	20	56
Reported HIV Positive	0.54	7	6	8	6	12	0	12	3	4	13

Table 12. Significance testing and proportions of covariates by the combined measure of residential poverty and activity space for the weighted sample.

		Low residential poverty activity spaces (%)					High residential poverty activity spaces (%)				
	p-value	**CT**	**CL**	**CD**	**ML**	**MD**	**CT**	**CL**	**CD**	**ML**	**MD**
Age	0.19										
18-29		35	38	38	34	37	39	36	49	26	46
30-50		50	47	46	51	45	48	51	38	45	54
51 and over		15	15	16	15	19	14	13	13	29	0
Race	0.65										
White		72	70	78	68	75	78	73	70	79	74
Black		7	7	5	8	7	5	5	10	9	0
Hispanic		12	12	9	9	8	9	13	10	7	4
Other		9	11	9	15	10	8	9	10	5	22
Education	0.76										
High school or less		6	6	3	2	2	5	4	5	2	0
Some college		23	21	21	20	23	13	15	26	22	18
College degree		71	73	76	78	75	82	81	69	77	82
Car as primary mode of transportation	0.42	59	59	60	54	59	48	64	47	66	55
Any transportation instability	0.85	26	27	23	24	25	25	26	33	33	34
Moved to the city in the past 6 months	0.66	8	9	5	5	6	6	6	7	9	0
Completely out	0.98	81	74	78	79	77	77	78	73	77	75
Sex partners	0.87										
Main partners only		31	31	27	30	30	23	35	17	25	21
Main and casual partners		34	33	35	35	33	39	32	48	40	39
Casual partners only		35	36	38	34	37	38	33	35	35	40
Reported HIV Positive	0.65	6	6	5	9	8	0	5	4	6	7

Table 13. Standardized differences between the given activity space category and Low Poverty Category CT for all covariates in the unweighted sample.

	Low residential poverty activity spaces					High residential poverty activity spaces				
Covariate	**CT**	**CL**	**CD**	**ML**	**MD**	**CT**	**CL**	**CD**	**ML**	**MD**
Age	Ref	0.19	0.18	0.09	0.23	0.69	0.16	0.19	0.22	0.61
Race	Ref	0.20	0.34	0.18	0.24	0.27	0.23	0.34	0.37	0.50
Education	Ref	0.21	0.13	0.29	0.30	0.30	0.19	0.10	0.33	0.43
Car as primary mode of transportation	Ref	0.29	0.31	0.21	0.18	-0.22	0.04	0.07	-0.06	-0.27
Any transportation instability	Ref	-0.14	-0.07	0.00	-0.31	-0.42	-0.63	-0.05	0.05	-0.86
Moved to the city in the past 6 months	Ref	0.00	-0.32	-0.09	0.00	0.41	-0.08	-0.12	0.21	-0.44
Completely out	Ref	0.20	0.13	0.37	0.02	-0.06	0.30	-0.13	-0.15	-0.13
Sex partners	Ref	0.73	0.34	0.68	0.14	0.22	0.56	0.40	0.65	0.55
Reported HIV Positive	Ref	-0.05	0.02	-0.04	0.14	-0.40	0.15	-0.21	-0.15	0.17

Table 14. Standardized differences between the given activity space category and Low Poverty Category CT for all covariates in the propensity score weighted sample.

	Low residential poverty activity spaces					**High residential poverty activity spaces**				
Covariate	**CT**	**CL**	**CD**	**ML**	**MD**	**CT**	**CL**	**CD**	**ML**	**MD**
Age	Ref	0.07	0.08	0.02	0.12	0.08	0.06	0.28	0.36	0.60
Race	Ref	0.06	0.14	0.21	0.11	0.14	0.09	0.13	0.26	0.58
Education	Ref	0.04	0.13	0.22	0.17	0.28	0.24	0.07	0.22	0.38
Car as primary mode of transportation	Ref	0.00	0.01	-0.11	-0.01	-0.22	0.10	-0.25	0.14	-0.08
Any transportation instability	Ref	-0.04	0.05	0.04	0.02	0.02	0.00	-0.16	-0.17	-0.17
Moved to the city in the past 6 months	Ref	0.02	-0.14	-0.13	-0.09	-0.09	-0.11	-0.04	0.00	-0.43
Completely out	Ref	-0.16	-0.08	-0.03	-0.09	-0.09	-0.07	-0.18	-0.10	-0.15
Sex partners	Ref	0.03	0.09	0.03	0.05	0.19	0.08	0.39	0.15	0.24
Reported HIV Positive	Ref	0.00	-0.04	0.11	0.05	-0.37	-0.06	-0.10	-0.02	0.04

Modeling HIV Testing in the Past Year

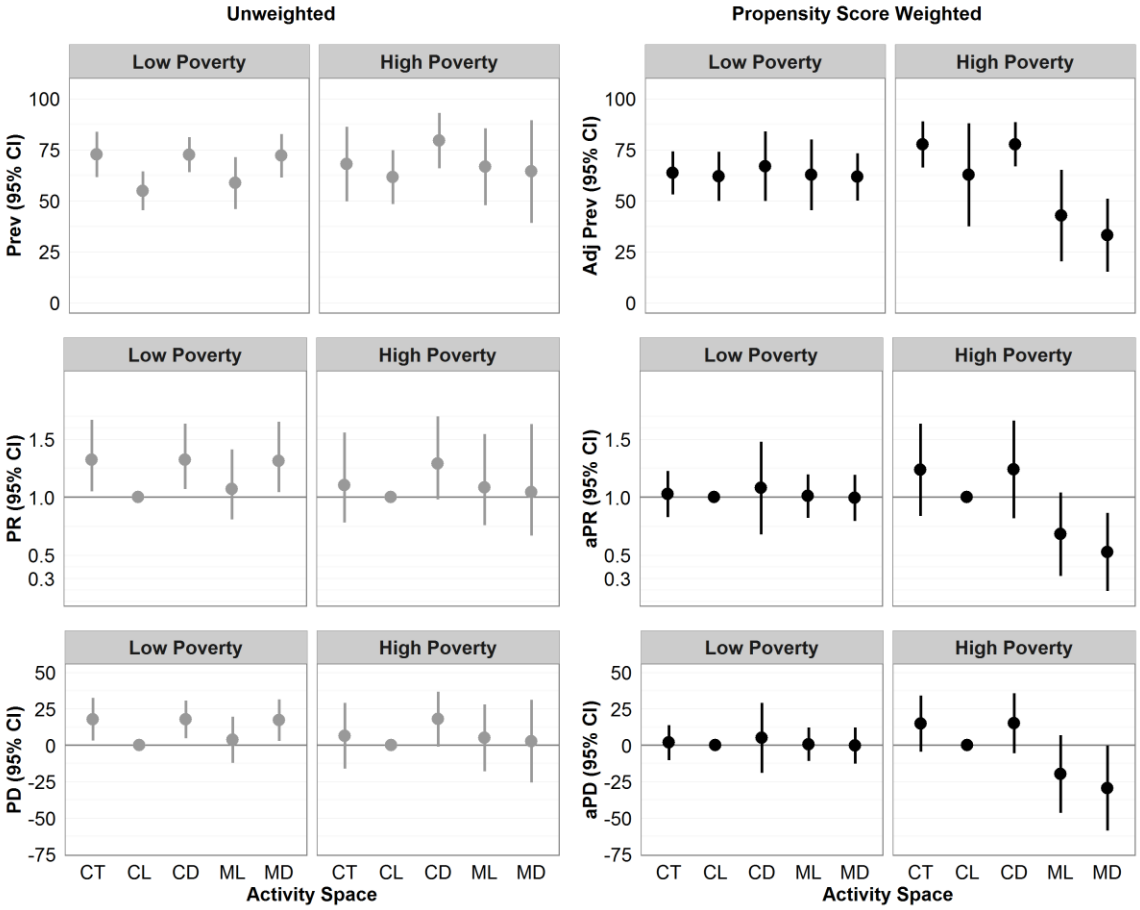
Associations with Activity Space within Levels of Residential Poverty

Among men living in low poverty areas, the unadjusted prevalence of reporting an HIV test in the past year was the lowest among men with activity spaces defined by local potential risk (prevalence (95% CI) for "county-concentrated, local potential risk" and "MSA-concentrated, local potential risk": 55% (45, 64), 59% (46, 72), respectively) (Figure 11). Compared to men in the "county-concentrated, local potential risk" category, men living in low poverty in the "census tract-concentrated", "county-concentrated, disperse potential risk", and "MSA-concentrated, disperse potential risk" categories were significantly more likely to report recent HIV testing (prevalence (95% CI): 18% (3, 32), 18% (5, 31), 17% (3, 32), respectively).

In crude analyses, men living in high poverty areas exhibited little difference in the prevalence of recent HIV testing across categories of activity space. However, men in the "county-concentrated, disperse potential risk" category who lived in high poverty areas reported slightly more HIV testing in the past year compared to men in the "county-concentrated, local potential risk" category (PD (95% CI): 18% (-1, 37)).

However, in weighted, adjusted analyses, the prevalence of reporting a recent HIV test did not differ across categories of activity space among men living in low poverty census tracts, but varied greatly for those men living in high poverty census tracts (Figure 11). Among these men, compared to men in the "county-concentrated, local potential risk" category, the prevalence of recent HIV testing in the two MSA-defined activity spaces were lower by 20 to 30% (PD (95% CI): "MSA-concentrated, local potential risk": -20% (-47, 7); "MSA-concentrated, disperse potential risk": -30% (-59, 0)).

Figure 11. Prevalence, prevalence ratios (PR), and prevalence differences (PD) for reporting an HIV Test within the past year by combined residential poverty and activity space in unweighted and propensity-score weighted online samples of 543 MSM not reporting to be HIV positive. The reference group for PR and PD is activity space category CL ("county-concentrated, local potential risk") within the given level of residential poverty.

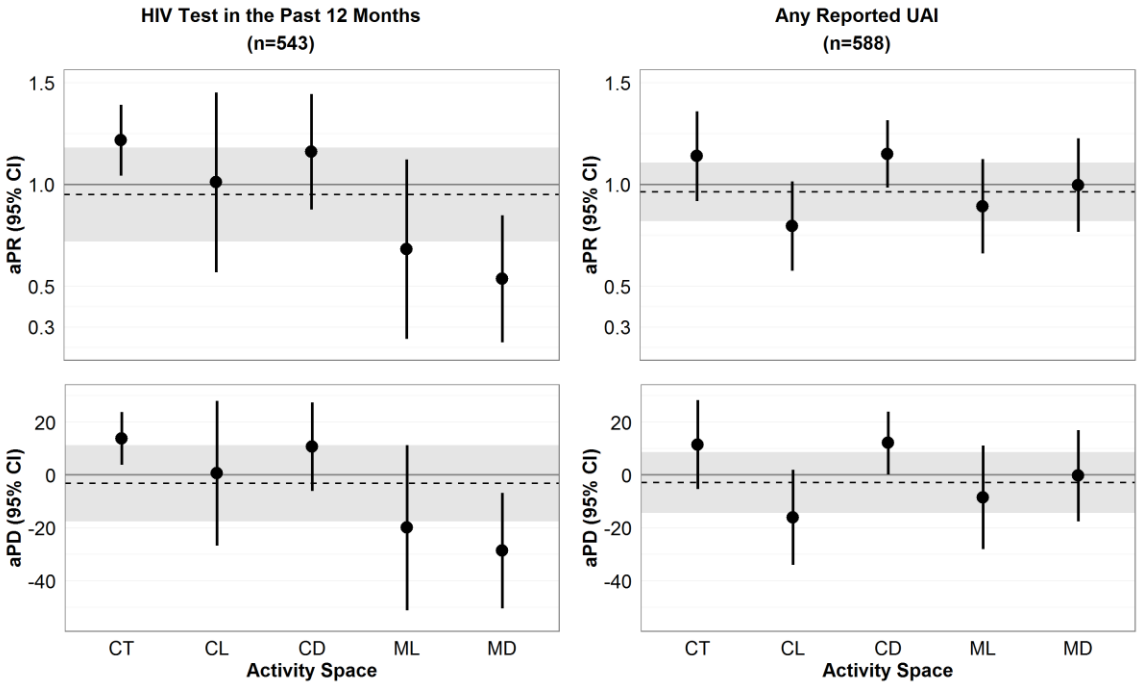


Associations with Residential Poverty within Activity Space Categories

We also considered associations within each activity space category, as opposed to within levels of poverty. The association between poverty and recent HIV testing moved from being directly associated among men with spatially concentrated activity spaces, to being inversely associated among men with spatially disperse activity spaces (Figure 12). Men living in high poverty in the "census tract-concentrated" category were more likely to report an HIV test in the past year than men in the same activity space category living in

low poverty tracts (PD (95% CI): 14% (4, 24)). Within the two county-concentrated activity spaces, we found no statistical differences comparing men living in high and low poverty. Finally, among men with MSA-concentrated activity spaces, those living in high poverty were less likely to report a recent HIV test than those living in low poverty (PD (95% CI): "MSA-concentrated, local potential risk": -20% (-47, 7); "MSA-concentrated, disperse potential risk": -30% (-59, 0)). These associations are markedly different than the comparison of high to low poverty that ignores activity space (aPR (95% CI): -3% (-18, 11)) (Figure 12).

Figure 12. Adjusted prevalence ratios (aPR) and prevalence differences (aPD) for the association between reporting specific behaviors and high residential poverty, by category of activity space, in propensity-score weighted online samples of MSM. The reference group for all aPR and aPD is low residential poverty. The horizontal dashed line and grey band represent the association and its 95% CI comparing high poverty to low poverty in the absence of considering activity space.

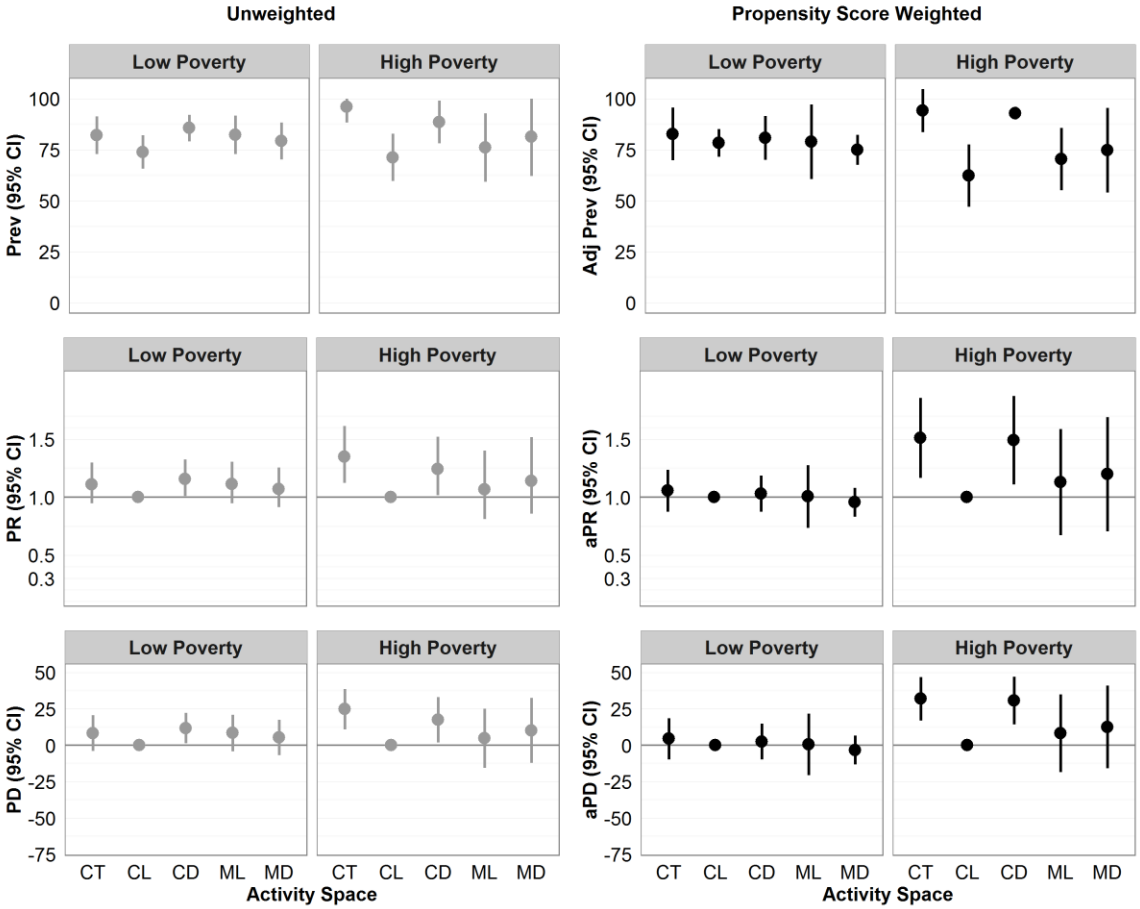


Modeling Any Reported UAI

Associations with Activity Space within Levels of Residential Poverty

Among men living in low poverty areas, the crude prevalence of reporting any UAI was similar across categories of activity space (Figure 13). However, among men living in high poverty areas, the unadjusted prevalence of reporting UAI was highest in the "census tract-concentrated" and "county-concentrated, disperse potential risk" activity spaces (prevalence (95% CI): 96% (88-100), 89% (78, 99), respectively).

Figure 13. Prevalence, prevalence ratios (PR), and prevalence differences (PD) for reporting any unprotected anal intercourse (UAI) by combined residential poverty and activity space in unweighted and propensity-score weighted online samples of 588 MSM. The reference group for PR and PD is activity space category CL ("county-concentrated, local potential risk") within the given level of residential poverty.



In adjusted analyses, the prevalence of reporting UAI did not vary across categories of activity space among men living in low poverty areas, but differed greatly for those men living in high poverty areas (Figure 13). Among men living in high poverty neighborhoods, compared to men in the "county-concentrated, local potential risk" category, the adjusted prevalence of UAI among men with "census tract-concentrated" and "county-concentrated, disperse potential risk" activity spaces were greater by roughly 30% (PD (95% CI): 32% (47, 17), 31% (47, 14), respectively).

Associations with Residential Poverty within Activity Space Categories

Comparing the prevalence of UAI among those living in high residential poverty to those living in low residential poverty within each category of activity space, the two activity spaces defined by local potential sexual risk were associated with reporting less UAI (Figure 12) (PD (95% CI): "county-concentrated, local potential risk": -16% (-34, 2); "MSA-concentrated, local potential risk": -8% (-28, 11)). Within the most spatially concentrated activity space and the two activity spaces defined by disperse potential sexual risk, more UAI was reported among men living in high poverty (PD (95% CI) for "census tract-concentrated", "county-concentrated, disperse potential risk", and "MSA-concentrated, disperse potential risk" categories: 11% (-5, 28), 12% (0, 24), 12% (0, 24), 0% (-18, 17), respectively). These associations deviate from the corresponding comparison that ignores possible effect modification by activity space (aPR (95% CI): -3% (-14, 9)) (Figure 12).

DISCUSSION

In this analysis, we examined associations between a combined measure of activity spaces and residential poverty with two behaviors (HIV testing and UAI) within an

online sample of MSM. Although neither behavior was associated with residential poverty alone, behaviors differed across activity spaces within levels of poverty. Among men living in low poverty census tracts, we found little difference in either recent HIV testing or reporting UAI across categories of activity space. However, among men living in high poverty census tracts, we observed decreasing prevalence of HIV testing with increasing spatial variation in non-residential locations and we observed significant and meaningful associations between activity spaces and UAI. Put simply, these results illustrate that activity spaces matter among MSM, especially among those living in high poverty census tracts.

As this analysis is an early examination of novel, complex relationships, we may suggest a number of possible hypotheses. Broadly, these observed associations between activity spaces and behaviors among MSM may reflect the push and pull of neighborhood contexts. Differences in transportation access, and the spatial distributions of testing locations, other healthcare resources, sex partners, stigma, and homophobia, may all lead to MSM engaging in certain behaviors within or outside their home neighborhoods [25,39,52,137,163]. As suggested by social ecological frameworks, these spatial patterns may in turn be driven by larger social structures that generate economic opportunity, develop services for MSM, reduce racial segregation, and promote acceptance among the community as a whole [19–21,55,164].

This push and pull may be distributed differently across high and low poverty neighborhoods, reflecting potential heterogeneity within these activity space categories. Geography appears to resonate among MSM living in high poverty areas in ways that may not be true of men living in low poverty neighborhoods. Men living in low poverty

areas may more easily overcome limitations to movement and unequal spatial distribution of resources. However, these limitations may lead MSM living in high poverty neighborhoods to experience a less uniform environment, and possibly one that is not wholly of his choosing [28]. Given the strong connections between poverty and race in the United States, MSM of color may be particularly constrained to specific neighborhoods and to certain places within those neighborhoods [29].

Our results with respect to recent HIV testing and UAI illustrate the importance of considering activity spaces. Recent funding supported by the Centers for Disease Control and Prevention (CDC) has promoted the geographic targeting of HIV interventions to specific neighborhoods with large burdens of HIV infection, which are also frequently high poverty neighborhoods [165–170]. Consequently, interventions have been guided by residence-based surveillance data and often targeted to areas of high residential poverty [139,171–179]. Our study may indicate the success of these programs, with MSM living in high poverty areas who also have spatially concentrated activity spaces near home reporting a higher prevalence of recent HIV testing than their counterparts living in low poverty areas. As these men's activities tend to be nearer their homes, they may be more likely to encounter these testing programs.

Such geographic targeting strategies may also have a previously unobserved limitation. Men living in high poverty neighborhoods with activity spaces that are highly geographically varied reported much less HIV testing than their spatially concentrated counterparts, suggesting that they may not have benefited from these geographically targeted programs. Since these men frequently travel outside their home neighborhood, they may not have encountered interventions designed to increase HIV testing in their

home neighborhoods. These results could also reflect differences in the relationship between these men and their neighborhoods. For example, men with geographically larger activity spaces may be less social connected to their neighborhoods or may be responding to greater stigma and homophobia within their neighborhoods, potentially decreasing the prevalence of recent HIV testing [29,54,58,147,180–182].

We also found that, compared to men living in low poverty census tracts, men living in high poverty census tracts with the most spatially compact activity space were more likely to report having UAI. Additionally, associations between UAI and residential poverty among men with county-focused activity spaces differed depending on whether potential risk locations were spatially concentrated or spatially dispersed. We did not observe the same pattern among MSM with MSA-focused activity spaces. These findings, which imply a spatial patterning of UAI, are novel. Since our models controlled for casual sex partnerships, these findings may reflect an underlying spatial structure of sex partners, of peer condom norms, or of condom availability [25,42,183]. Men in the "county-concentrated, local potential risk" category may live in neighborhoods with large populations of MSM, such that the low prevalence of UAI reflects peer norms for condom use among a spatially-concentrated pool of potential sex partners [42,62,63]. As with our findings about recent HIV testing, the high prevalence of UAI among men in the "census tract-concentrated" and "county-concentrated, disperse potential risk" categories may be associated with stigma and homophobia in these communities [19,57,59,61,163,181], which could lead these men to spatially constrain their activity space or to seek sex farther from home.

Study Limitations

This study has limitations. First, this analysis does not account for uncertainty in the assignment of LCA class. In this sample, probabilities of class membership were generally near 0 or 1, so the additional analytic complexity required to account for this variation would have little effect on results. Second, despite using well specified propensity score models, residual confounding by both measured and unmeasured factors may remain.

Generalizability of this online sample from select MSAs to all MSM in the United States, and especially MSM of color, is also a concern. The difficulties of reaching MSM of color through online surveys is well documented [101,117]. Finally, all data in this study are self-reported, so some degree of misclassification is likely. As we ask about recent locations, misidentification of locations may be low, provided that participants are able to correctly use the map. This concern may be minimized by the use of a familiar Google map in an online population. As a primary outcome, UAI is almost certainly misclassified for some participants in our sample, as has been universally observed in studies of UAI and HIV incidence [184–189]. Additionally, timing of the most recent HIV test is subject to recall bias.

Conclusions

This study focused on the complex relationships between residential poverty, activity spaces, and health behaviors among MSM. We found meaningful and statistically significant differences in recent HIV testing and reporting UAI by activity spaces among men living in high poverty areas, but not among men living in low poverty areas. These

results highlight the importance of accounting for both residential and non-residential locations in studies examining the role of context in HIV-related outcomes among MSM.

CHAPTER 6. CONCLUSION AND FUTURE DIRECTIONS

As the concept of activity spaces among MSM has only recently entered the scientific literature [71,72], this dissertation represents an early series of analyses in this area. In this dissertation, we have used novel methods to collect place-based data, to aggregate these data into a quantitative measure, and to use that measure to examine risk and preventive HIV-associated behaviors. Through this process, this dissertation has advanced both this research area and public health practice. In this chapter, we summarize major findings from the dissertation, present its innovation, relevance, and public health impact, and discuss future research directions.

REVIEW OF MAJOR FINDINGS

In the first aim, we examined the feasibility of collecting location-based data using an online, map-based tool among an online convenience sample of MSM. Overall, participants were willing and able to use this tool to accurately indicate the requested locations, suggesting that, within this online setting and MSM population (and with careful consideration of the potential biases associated with online research in this population), this method of data collection is feasible, and results in complete, good quality data. Additionally, for most locations, men who chose to not use the map tool were not significantly different from men who did use the tool with respect to demographic factors and HIV-related behaviors. The notable exception to this finding is that men were 20% less likely to report a sex location if that location was a partner's home, reflecting both confidentiality concerns and uncertainty in the exact location.

After establishing the feasibility of collecting these data, we then used the collected locations to describe the activity spaces of MSM from nine MSAs with high burdens of HIV. Using LCA, we categorized and described spatial variation in routine activities and potential HIV-related sexual risk and prevention behaviors among MSM. Specifically, this analysis reduced a large number of locations important in the lives of MSM into a single, concise measurement with significance to public health action. We then identified categories of activity spaces, ranging from those in which men remain near home for all behaviors to those in which behaviors span multiple counties. Overall in our study, the activity spaces of 84% of participants were defined by behaviors occurring outside of the home census tract. This analysis revealed two key factors defining the activity spaces of MSM: the spatial overlap of routine and prevention behaviors and the potential spatial segregation of sexual risk behaviors from routine and prevention behaviors.

Finally, after establishing different typologies of activity spaces among MSM, we examined associations between these activity spaces and behaviors. Specifically, we examined joint associations between activity spaces and residential poverty on two behaviors (HIV testing and UAI). Although neither outcome was associated with residential poverty alone, behaviors differed across activity spaces within levels of poverty. Among men living in low poverty, we found little difference in either recent HIV testing or reporting UAI across categories of activity space. However, among men living in high poverty, we observed decreasing prevalence of HIV testing with increasing spatial variation in non-residential locations and we observed significant and meaningful associations between activity spaces and UAI. Put simply, these results illustrate that activity spaces matter among MSM, especially among those living in high poverty.

INNOVATION

Within each aim, this dissertation incorporated innovation – through the application of a new concept within the MSM literature, through data collection, and through the applied analytic methods. Early in the development of this dissertation, the frameworks of activity spaces and spatial polygamy became obvious paths forward in considering the role of non-residential locations in the health-related behaviors of MSM [79]. However, given the novelty of applying these concepts within this literature, innovation was required at all stages to determine how to collect data, to quantify spatial patterns, and to analyze these data.

Although an online, map-based tool had been previously developed and validated in a limited population [98], its use in a broader sample of MSM for a larger number of locations was unclear. Consequently, we first examined the feasibility of using this tool in a different population with different locations. All analyses in this dissertation then rest on the foundation of this innovative online map tool.

Given these detailed location data, we then needed a method for condensing large amounts of data into a single, quantifiable, interpretable measure. Activity spaces have typically classified based on geometric measures [77,88,92,94,95] or using visual inspection of spatial patterns [90], but those methods lack clear relevance in terms of defining HIV-related interventions and policy. Consequently, we used LCA to classify the activity spaces of our online sample of MSM. By first using theory to inform the selection of variables for inclusion in the LCA [19–21,28], this method allowed the development of an empirically-based measure of activity spaces that was grounded in theory.

This dissertation's final aim required the analysis of small sample sizes within some activity space categories and a potentially large number of confounders. To address this potential analytic limitation, we used propensity scores [149]. Finally, this dissertation required the analysis of common outcomes (i.e., answering the map questions, UAI, recent HIV test), which would have resulted in an estimated prevalence odds ratio (POR) that was larger than the true prevalence ratio [114]. Consequently, we directly estimated adjusted prevalence, adjusted prevalence ratio (aPR), and adjusted prevalence difference (aPD) using predictive margins methods with logistic regression. This method also avoided statistical convergence issues that may occur when estimating PR using other methods, such as log-binomial regression [115].

RELEVANCE AND PUBLIC HEALTH IMPACT

This dissertation has relevance for both future research in this area and for public health interventions and policy. First, this dissertation expanded the population and locations types that may be feasibly collected using the online map-based tool. We included MSM, independent of HIV status, from urban, suburban, and rural locations, not only large urban areas that are the typical geographic focus of much HIV research. We also included a wide variety of non-residential locations that may be contextually important to the health of MSM. Online studies of MSM may now reasonably use this tool for similarly detailed geographic data collection. This tool may be especially useful in cases where the exact address may be unknown or where resources (including time, staff, and funding) are limited.

Additionally, we found that analyses using data collected with this tool will generally have minimal bias resulting from nonresponse to these questions, although bias may

remain due to non-participation. A first key exception to this finding was the observed educational gradient in which participants with no college education were less likely to provide all requested locations and sex locations. Missing data among these individuals may especially be a concern in online research, where MSM of color are more difficult to recruit [117].

A second key exception is the potential for bias in analyses using sex location when sex occurs at the partner's home (although a large majority still provided this location). Therefore, these missing data may bias analyses where either having sex at the partner's home or education is associated with both the exposure and outcome [118]. This finding may be critical for confounding by education since lower levels of education are frequently spatially patterned and associated with poorer health outcomes.

Given the feasibility of collecting these data, the LCA-derived measure of activity spaces may similarly be useful in research and public health practice. We found that the activity spaces of 84% of participants were defined by behaviors occurring outside of the home census tract. We also identified two key factors defining the activity spaces of MSM (the spatial overlap of routine and prevention behaviors and the potential spatial segregation of sexual risk behaviors from routine and prevention behaviors) and observed variation in sexual risk and prevention behaviors by activity spaces and residential poverty. We have successfully illustrated the utility of this measure of activity space as both an exposure and effect modifier. Research involving the activity spaces of MSM may now use and refine these typologies, further examining associations between socioeconomic contexts and HIV epidemiology.

These results also have direct application to public health practice. When collecting geographic data, the willingness of MSM to provide these data must be addressed. Men who did not provide the requested locations were generally unwilling, rather than unable, to provide the locations. Even in an anonymous online survey, privacy remained a concern among a small fraction of participants. Although most participants responded to these map questions, privacy concerns for these few individuals must be considered in the implementation and interpretation of future research. Providing participants with the opportunity to learn more about their data's security and reinforcing the acceptability of reporting approximate locations (e.g., the nearest intersection) may help to assuage these concerns.

Similarly, participants' inability to provide these locations could also be addressed within the online survey. This inability may stem from a lack of geographic knowledge or uncertainty in locations. Incorporating text search boxes to search for a given street name or emphasizing the acceptability of identifying an intersection or other landmark could potentially address this limitation. This recommendation could also reduce the observed educational gradient in responding to these questions.

These results also point to the need to collect more detailed location data as part of behavioral and disease surveillance systems [190]. Recent calls have been made for increased geographic targeting of interventions in order to reach most at-risk populations [139–141]. Federal funding mechanisms have also promoted the geographic targeting of HIV interventions to specific neighborhoods with large burdens of the disease [165–170]. Consequently, interventions have been guided by residence-based surveillance data and often targeted to areas of high residential poverty [139,171–177].

Our results show that, for most MSM, interventions targeted in this manner could miss key geographic opportunities. Men having activity spaces with large geographic variation may frequently travel outside their home neighborhood, thus not encountering these programs and interventions. Targeting interventions to locations where sexual risk and prevention behaviors occur, which are frequently outside the residential neighborhood in high-risk groups, could allow more MSM to benefit from these interventions.

However, this dissertation also illustrates the success of programs based on residential geographic targeting among MSM living in high poverty areas who also have small, spatially concentrated activity spaces. Geographically targeting based on residence-based data may have an unintended positive consequence. By visiting locations across his county or his MSA, MSM with geographically large activity spaces may have greater opportunity to encounter interventions that were not designed to reach him. MSM living in locations targeted by interventions may also diffuse interventions through their travels.

Additionally, more detailed location data could allow health departments to better understand spatial limitations to testing and prevention and the spatial distribution of the sexual networks of MSM [25,39,52]. Younger MSM, who are at highest risk of acquiring HIV, were more likely to engage in potential sexual risk behaviors across a county [10,14]. Additionally, partner types represented a key determinant of the activity space. Having only casual partners or concurrent casual and main partners may place MSM at greater sexual risk for HIV and STI acquisition [138]. The observed activity space categories may then be markers of sexual networks with elevated risk and could then be used by health departments to better identify MSM at high risk.

FUTURE DIRECTIONS

Given the formative nature of this work, this dissertation serves as a foundation for multiple future directions, including those focused on the methodology surrounding activity space research and those specifically focused on HIV research among MSM. First, a thorough validation of the use of the tool could be completed. This validation would require more detailed address data and would likely require some interaction between participants and study staff, leading to a more resource-intensive study. Additional work is also needed to ensure that MSM with lower levels of education are willing and able to accurately select locations on the map.

This dissertation represents an early exploration of the activity spaces of MSM and attempt to quantify the activity spaces for epidemiologic research. Future work should refine methods of categorization, including accounting for the variation in contextual exposures, the duration of attendance at each location, and acquiring a more complete set of visited locations [89]. All of these directions may first require qualitative research to guide quantitative research toward the most meaningful factors. Critically, the reasons behind these spatial patterns should be explored into order to establish the directions of pathways between these activity spaces and relevant behaviors. Examining the push and pull of neighborhood contexts (e.g. stigma, homophobia, testing resources, gay services, etc.) may reveal heterogeneity among these activity space categories and suggest why men spatially constrain or spatially expand their activity spaces [19,52,57,59,61,137,163,181,182]. Additionally, as suggested by social ecological frameworks, these spatial patterns may be driven by larger social structures that generate

economic opportunity, provide transportation options, develop services for MSM, and promote acceptance among the community as a whole [19–21,164].

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APPENDICES

APPENDIX A: THE SEX MARKS THE SPOT QUESTIONNAIRE

ID 579

ID 231

Welcome! You clicked on a Facebook ad for an Emory University research study. We want to see if you would like to participate. Your privacy is very important to us and we will keep all of your information confidential.

If you have any questions or concerns, please feel free to contact us at marksthespot@emory.edu or 404-727-2038.

On the next page, we will determine if you are eligible for the study. Thanks for your interest!

ID 580

ID 3

What is your gender? *

- ○ Male
- ○ Female
- ○ Transgender: male to female
- ○ Transgender: female to male

VALIDATION Min = 0 Max = 110 Must be numeric Whole numbers only Positive numbers only

ID 4

How old are you? *

ID 6

In the past 6 months, have you had sex with a man? *

- Yes
- No
- I don't know

ID 7

Can you read and write in English? *

- Yes
- No

VALIDATION Using custom RegEx pattern
ID 735

What is the ZIP code where you live now? *

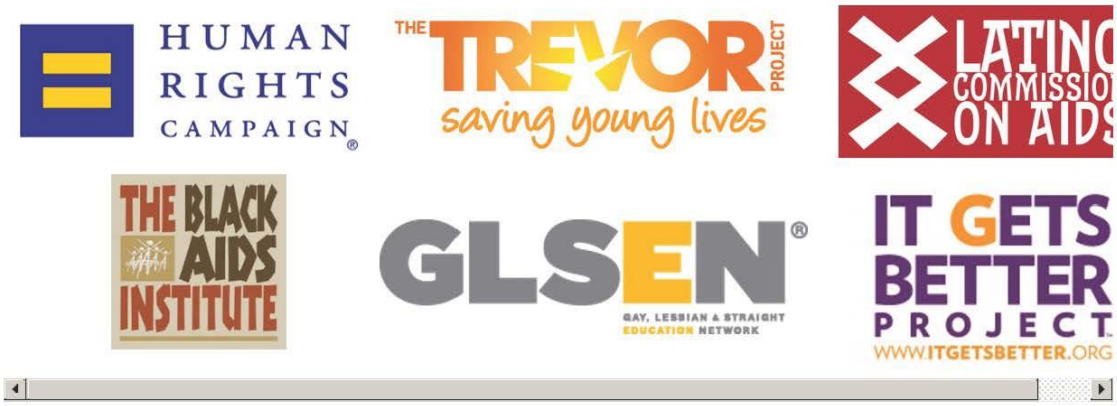
ID 583

ID 204

Based on your responses, you are eligible for this research study. We will ask you to take a short (20-25 minute) survey. For completing the survey, we will make a $3 charitable donation to the charity that you will later choose from the list below (up to a total of $3000 across all organizations).

Please read the information on the next page carefully before you decide to participate.

ID 576



ID 396

Emory University
Consent to be a Research Subject And HIPAA Authorization

Title: Assessing HIV Risk and Prevention Locations among Men who have Sex with Men

Principal Investigator: Adam Vaughan, MPH MS, Patrick Sullivan, DVM PhD; Department of Epidemiology, Rollins School of Public Health, Emory University

Sponsor: Emory University

Introduction
You are being asked to be in a research study. This form is designed to tell you everything you need to think about before you decide to consent (agree) to be in the study or not to be in the study. **It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study. You can skip any questions that you do not wish to answer, although you may be asked why you chose to skip certain questions.**

Before making your decision:

- Please carefully read this form or have it read to you
- Please ask questions about anything that is not clear

You can print a copy of this consent form, to keep. Feel free to take your time thinking about whether you would like to participate. By signing this form you will not give up any legal rights.

Study Overview
Some studies have shown that where you live may have an impact on your health. Emory University is doing a study to better understand how places, including where you live, are associated with HIV prevention and with risky behaviors. We expect that up to 1,000 men living in large cities across the United States will be in this study.

Procedures
If you decide to be in the study, you will be asked to answer questions in a one-time online survey. The survey will ask you to locate specific locations on a map. It will take you about 20 minutes to take the survey. You will need a computer or mobile device to answer the questions. You can leave the study at any time. If you agree to be in the study, you will be asked to check a box showing you have read and understood this consent form. You can fill out the survey after you check the box.

You can skip any questions you do not want to answer. You can end the survey at any time. After you finish the survey, you do not have to do anything else.

Risks and Discomforts
Some of the questions asking about your HIV status or about some locations may make you feel uncomfortable. If there is a question you do not want to answer, check the "Prefer not to answer" box and you will be able to move to the next question. You can also stop taking the survey any time by closing your internet browser.

We will also ask you about where you live, where you work, where you have sex, where you socialize, where you go to the doctor, where you go for HIV testing, and where you meet sex partners. Study researchers will also know your IP address. We will never attempt to locate you using this information.

The survey website is secure and any answers you give will be securely stored on a HIPAA compliant server. While there is little risk with the study, Emory cannot guarantee confidentiality (for example, if you take the survey on a public computer).

Benefits
This study is not designed to benefit you directly. The information from this study may help make HIV prevention programs better.

Compensation
After you have completed the survey, you will be offered $3 as a charitable donation to an organization that you select from a pre-determined list. The study will donate up to $3000 in total.

Confidentiality
We will do everything we can to keep others from learning about your participation in the research. We will not collect your name. A study number will be assigned to you and used on study records. No other identifying information will appear when we present or publish the study results. To further help protect your privacy, the investigators have obtained a Confidentiality Certificate.

You should understand that a Confidentiality Certificate does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. Note however, that if an insurer or employer, learns about your participation, and obtains your consent to receive research information, then the investigator may not use the Certificate of Confidentiality to withhold this information. This means that you and your family must also actively protect your own privacy.

Finally, you should understand that the investigator is not prevented from taking steps, including reporting to authorities, to prevent serious harm to yourself or others. The Certificate of Confidentiality will not be used to prevent disclosure to local authorities of child abuse and neglect, or harm to self or others.

What the Certificate of Confidentiality protects:
The National Institutes of Health has given this study a Certificate of Confidentiality. Emory would rely on it to not give out study information that identifies you. For example, if Emory received a subpoena for study records that identify you, we would say no. The Certificate gives Emory legal backup to say no. It covers information about you that could harm your image or finances. It also covers information about you that could harm your chances at a job or getting insurance.

What the Certificate of Confidentiality does not protect:
The Certificate does not prevent you or someone other than you from making disclosing your information. The Certificate also does not prevent Emory from releasing information about you:

- Information to state public health offices about certain infectious diseases
- Information to law officials if child abuse has taken place
- Information Emory gives to prevent immediate harm to you or others
- Information Emory gives to the study sponsor as part of the research

Authorization to Use and Disclose Protected Health Information

The privacy of your health information is important to us. We call your health information that identifies you, your "protected health information" or "PHI." To protect your PHI, we will follow federal and state privacy laws, including the Health Insurance Portability and Accountability Act and regulations (HIPAA). We refer to all of these laws as the "Privacy Rules." Here we let you know how we will use and disclose your PHI for the study.

PHI that will be Used/Disclosed:

The PHI that we will use and/or disclose (share) for the research study includes:

- Your home ZIP code
- Locations of your home, work, sexual encounters, primary doctor, pharmacy, socialization, HIV and STD testing, and meeting sex partners
- Month and year of your positive HIV test, if applicable
- IP address

Purposes for which your PHI will be Used/Disclosed:

We will use and disclose your PHI for the conduct and oversight of the research study.

Use and Disclosure of Your Information:

The investigators can use the Certificate of Confidentiality to refuse to disclose information (for example if there were a court subpoena) that may identify you in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. The Certificate of Confidentiality will not be used to prevent disclosure to local authorities of child abuse and neglect, or harm to self or others.

Authorization to Use PHI is Required to Participate:

By signing this form, you give us permission to use and share your PHI as described in this document. You do not have to sign this form to authorize the use and disclosure of your PHI. If you do not authorize the use and disclosure of your PHI for the study, then you may not participate in the research study.

People that will Use and/or Disclose Your PHI:

The following people and groups will use and disclose your PHI in connection with the research study:

- The Principal Investigator and the research staff
- The Principal Investigator may use other people and groups to help conduct the study. These people and groups will use your PHI to do this work.
- The Principal Investigator and research staff will share your PHI with other people and groups to help conduct the study or to provide oversight for the study, including the Emory Institutional Review Board, the Emory Office of Research Compliance, and the Office for Clinical Research.
- The Office for Human Research Protections

Expiration of Your Authorization:

This authorization will not expire because it is a research study.

Revoking Your Authorization:

You do not have to sign this form. Even if you do, at any time later on you may revoke (take back) your permission. If you want to do this, you must write to:

Adam Vaughan
Emory University Rollins School of Public Health
1518 Clifton Rd.
Atlanta, GA 30322

After that point, the researchers would not collect any more of your PHI. But they may use or pass along the information you already gave them so they can follow the law, protect your safety, or make sure the research was done properly. If you have any questions about this, please ask.

Other Items You Should Know:
Not all people and entities are covered by the Privacy Rules. HIPAA only applies to health care providers, health care payers or health care clearinghouses. If we disclose your information to people who are not covered by the Privacy Rules, including HIPAA, then your information won't be protected by the Privacy Rules. People who do not have to follow the Privacy rules can use or disclose your information with others without your permission if they are allowed to do so by the laws that cover them.

To maintain the integrity of this research study, you generally will not have access to your PHI related to this research until the study is complete. When the study ends, and at your request, you generally will have access to your PHI that collected in this study.

We may remove identifying information from your PHI. Once we do this, the remaining information will not be subject to the Privacy Rules. Information without identifiers may be used or disclosed with other people or organizations and/or for other purposes besides this study.

Costs
There will be no costs to you for participating in this study, other than basic expenses like internet access. You will not be charged for any of the research activities.

Voluntary Participation and Withdrawal from the Study
You have the right to leave a study at any time without penalty. You may refuse to answer any questions that you do not wish to answer. If you drop out of the study, your answers will still be used for the study. You cannot remove the answers you already gave, since your information is not tied to your personal information.

The researchers also have the right to stop your participation in this study without your consent if they believe it is in your best interest.

Contact Information
Contact Adam Vaughan at 404-727-2038 or marksthespot@emory.edu:

- if you have any questions about this study or your part in it,
- if you have questions, concerns or complaints about the research

Contact the Emory Institutional Review Board at 404-712-0720 or 877-503-9797 or irb@emory.edu:

- if you have questions about your rights as a research participant.
- if you have questions, concerns or complaints about the research.
- You may also let the IRB know about your experience as a research participant through our Research Participant Survey at http://www.surveymonkey.com/s/6ZDMW75.

Page exit logic: Consent
IF: Question "**Consent**
Please check the box below if you agree to be in the study. Please print a copy of this form for your records. If you agree to the above information and would like to be in this study, please click on "I agree" below." is not exactly equal to ("I agree. I have read the information above and I want to be in this study.") **THEN:** Disqualify and display:
By not clicking on "I agree," you have decided not to participate in this study. If you have any questions about the study or have reached this message in error, feel free to contact us at marksthespot@emory.edu or 404-727-2038. Thank you so much for your interest!

ID 232

Consent

Please check the box below if you agree to be in the study. Please print a copy of this form for your records. If you agree to the above information and would like to be in this study, please click on "I agree" below. *

- ○ I agree. I have read the information above and I want to be in this study.
- ○ I do not agree to participate in the study.

ID 397

Click here for a printable PDF copy of this consent form. This PDF will appear in a new window that you may need to close to return to the survey.

ID 651

Now, a few more important things before you begin the survey:

- This is a **forward-only** survey, which means you can't go back and change your answers. Proceed to the next page by clicking the "Next Page" button.
- All questions highlighted with an asterisk (*) are required questions.
- Please try to answer all questions.
- At any time, you can pause taking the survey by clicking the "Save and continue survey later" link at the top of the page
- If you have any questions while taking the survey, you can email us at marksthespot@emory.edu or call us at 404-727-2038.

Again, your privacy is very important to us. All of your responses in this survey will be confidential. Thank you for participating!

Page entry logic:
This page will show when: RandomNumber is exactly equal to "1"

ID 626

LOGIC Show/hide trigger exists.

ID 627

To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation. *

The Trevor Project

The Trevor Project

The Black AIDS Institute

The Black AIDS Institute

Latino Commission on AIDS

Latino Commission on AIDS

IT GETS BETTER PROJECT WWW.ITGETSBETTER.ORG

It Gets Better

HUMAN RIGHTS CAMPAIGN

Human Rights Campaign

GLSEN

GLSEN

ID 2

What is your race?

- White
- Black
- Hispanic
- Asian
- Native American
- Prefer not to answer
- Other

ID 9

Do you think of yourself as:

- ○ Heterosexual or straight
- ○ Homosexual or gay
- ○ Bisexual
- ○ Prefer not to answer
- ○ Other (Fill in the blank)

ID 10

How would you describe your current relationship status?

- ○ Single
- ○ Dating
- ○ Committed relationship (unmarried)
- ○ Married
- ○ Prefer not to answer
- ○ Other (Fill in the blank)

VALIDATION Min = 1 Max = 7

ID 664

Move the slider to show how "out" or open are you about your sexual orientation.

Completely hidden from others — Completely open to others

ID 11

What was your household income last year from all sources before taxes? (monthly/yearly)

- 0 to $833 (monthly) / 0 to $9,999 (yearly)
- $834 to $1667 (monthly) / $10,000 to $19,999 (yearly)
- $1668 to $2500 (monthly) / $20,000 to $29,999 (yearly)
- $2501 to $3333 (monthly) / $30,000 to $39,999 (yearly)
- $3334 to $4167 (monthly) / $40,000 to $49,999 (yearly)
- $4168 to $6250 (monthly) / $50,000 to $74,999 (yearly)
- $6251 or more (monthly) / $75,000 or more (yearly)
- Don't know
- Prefer not to answer

ID 12

What is the highest level in school that you completed?

- College, post graduate, or professional school
- Some college, associate's degree, and/or technical school
- High school diploma or GED
- Some or no high school
- Don't know
- Prefer not to answer

ID 411

Are you currently a college or university student?

- Yes
- No

ID 591

How do you normally get to places you need to go?

- Car
- Public transportation (bus, train)
- Walk
- Bike
- Other

*

ID 662

In the past 6 months, how often have you been unable to do something that you needed to do because you did not have a way to get there?

- Never
- 1 time
- 2 times
- 3 or 4 times
- 5 or 6 times
- 7 or 8 times
- At least once a month
- At least once a week
- Almost every day
- Don't know or don't remember

ID 592

How much do you worry about your current or future housing situation?

- Not at all
- A little
- Lots
- Don't know

LOGIC Show/hide trigger exists.

ID 595

When did you move to the place you stay/house/apartment where you live now?

- Less than 6 months ago
- More than 6 months ago
- Don't know or don't remember

LOGIC Hidden unless: Question "When did you move to the place you stay/house/apartment where you live now?" #13 is one of the following answers ("Less than 6 months ago","Don't know or don't remember")

ID 597

When did you move to the town or city where you live now?

- Less than 6 months ago
- More than 6 months ago
- I've always lived in this town/city
- Don't know or don't remember

ID 624

Are you currently homeless? (By homeless, we mean are you living on the street, in a shelter, a Single Room Occupancy hotel (SRO), temporarily staying with friends or relatives, or living in a car?)

- Yes
- No

ID 20

We're going to ask you about where you do certain activities. For each place, you'll be asked to provide a name or nickname. The nickname should be something that helps you remember the place. You will then use those names to answer other questions.

You will also enter some locations using a map. These locations will be kept confidential. We will not use these locations to identify you.

To use the map, feel free to zoom in and out of the map as you need to, just as you would using Google Maps. If you need to start over and re-enter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

ID 491

ID 548

Please click on the map on the town or city where you live now.

Feel free to zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 37

Enter a nickname for the place where you live now. You can change "Home" to something that makes sense to you. *

Home

LOGIC Hidden by default

ID 460

Please select a location on the map, or check that you would rather not select a location.

ID 492

ID 488

On the map, please click the location of your house or where you normally spend the night. You may also click the closest intersection to these places.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 34

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 35

Why did you not want to answer this question? (Mark all that apply.)

- [ ] I can't remember where this location is
- [ ] I'm not sure where that place is on a map
- [ ] I'm not comfortable using the map to select locations
- [ ] This place is in a different city
- [ ] Didn't feel comfortable giving that information
- [ ] Worried about a loss of privacy
- [ ] Worried about what friends, family, or coworkers would think
- [ ] Other

LOGIC Show/hide trigger exists.
ID 604

Which of the following best describes your work situation? *

- ○ Full time paid job (>30 hours/week)
- ○ Part time paid job (<30 hours/week)
- ○ Home duties/child care
- ○ Full time student
- ○ Part time student
- ○ Volunteer/charitable work
- ○ Unemployed
- ○ Disabled
- ○ None of these
- ○ Prefer not to answer

Page entry logic:
This page will show when: Question "Which of the following best describes your work situation?" #20 is one of the following answers ("Full time paid job (>30 hours/week)","Part time paid job (<30 hours/week)","Full time student","Part time student")

LOGIC Hidden unless: Question "Which of the following best describes your work situation?" #20 is one of the following answers ("Full time paid job (>30 hours/week)","Part time paid job (<30 hours/week)")
ID 605

Enter a nickname for the place where you work. You can change "Work" to something that makes sense to you. *

Work

LOGIC Hidden unless: Question "Which of the following best describes your work situation?" #20 is one of the following answers ("Full time student","Part time student")

ID 608

Enter a nickname for the place where you go to school. You can change "School" to something that makes sense to you.

School

Page entry logic:
This page will show when: Question "Which of the following best describes your work situation?" #20 is one of the following answers ("Full time paid job (>30 hours/week)","Part time paid job (<30 hours/week)","Full time student","Part time student")

LOGIC Hidden by default

ID 610

Please select a location on the map, or check that you would rather not select a location.

ID 611

ID 612

On the map, please click where [question("value"), id="609"] is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map

Clear map

ID 613

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 614

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

ID 114

Now we're going to ask you questions about two places outside of your home where you most often socialize or hang out.

These can be restaurants, bars, clubs, friends' houses, or anywhere else that you get together with friends or meet people.

LOGIC Show/hide trigger exists. Hidden unless: Question "Which of the following best describes your work situation?" #20 is one of the following answers ("Full time paid job (>30 hours/week)","Part time paid job (<30 hours/week)","Full time student","Part time student")

ID 251

Outside of your home, where is the place you most often socialize or hang out? *

- ○ Work/school: [question("value"), id="609"]
- ○ Another place (Enter a name.)

*

LOGIC Hidden unless: Question "Which of the following best describes your work situation?" #20 is not one of the following answers ("Full time paid job (>30 hours/week)","Part time paid job (<30 hours/week)","Full time student","Part time student")

ID 665

Enter a nickname for a place outside of your home where you often socialize or hang out. *

Page entry logic:
This page will show when: (Question "Outside of your home, where is the place you most often socialize or hang out?" #25 is one of the following answers ("Another place (Enter a name.)") OR Question "Enter a nickname for a place outside of your home where you often socialize or hang out. " #26)

LOGIC Hidden by default
ID 463

Please select a location on the map, or check that you would rather not select a location.

ID 493
ID 494

On the map, please click where [question("option value"), id="443"] is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map

Clear map

ID 123

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 124

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

Page entry logic:
This page will show when: (Question "Outside of your home, where is the place you most often socialize or hang out?" #25 is one of the following answers ("Another place (Enter a name.)") OR Question "Enter a nickname for a place outside of your home where you often socialize or hang out. " #26)

ID 255

Have you ever met someone at [question("value"), id="443"] who you later had sex with?

- ○ Yes
- ○ No
- ○ Prefer not to answer

ID 256

What kind of place is [question("value"), id="443"]?

- My boyfriend/partner/friend's house
- Somewhere else I normally stay
- Restaurant
- Coffee house
- Bar
- Club
- Mall or shopping center
- Park
- Other

LOGIC Hidden unless: Question "Outside of your home, where is the place you most often socialize or hang out?" #25 is one of the following answers ("Another place (Enter a name.)")

ID 252

Where is another place outside of your home that you often socialize or hang out? *

- Work/school: [question("value"), id="609"]
- Another place (Enter a name.)

*

LOGIC Hidden unless: (Question "Outside of your home, where is the place you most often socialize or hang out?" #25 is one of the following answers ("Work/school: [question(\"value\"), id=\"609\"]") OR Question "Which of the following best describes your work situation?" #20 is not one of the following answers ("Full time paid job (>30 hours/week)","Part time paid job (<30 hours/week)","Full time student","Part time student"))

ID 254

Enter a nickname for another place outside of your home where you often socialize or hang out. *

Page entry logic:
This page will show when: (Question "Where is another place outside of your home that you often socialize or hang out?" #31 is one of the following answers ("Another place (Enter a name.)") OR Question "Enter a nickname for another place outside of your home where you often socialize or hang out." #32)

LOGIC Hidden by default

ID 464

Please select a location on the map, or check that you would rather not select a location.

ID 499
ID 500

On the map, please click where [question("option value"), id="445"] is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 264

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location
ID 265

Why did you not want to answer this question? (Mark all that apply.)

- [ ] I can't remember where this location is
- [ ] I'm not sure where that place is on a map
- [ ] I'm not comfortable using the map to select locations
- [ ] This place is in a different city
- [ ] Didn't feel comfortable giving that information
- [ ] Worried about a loss of privacy
- [ ] Worried about what friends, family, or coworkers would think
- [ ] Other

Page entry logic:
This page will show when: (Question "Where is another place outside of your home that you often socialize or hang out?" #31 is one of the following answers ("Another place (Enter a name.)") OR Question "Enter a nickname for another place outside of your home where you often socialize or hang out." #32)

ID 259

Have you ever met someone at [question("value"), id="445"] who you later had sex with?

- ○ Yes
- ○ No
- ○ Prefer not to answer

ID 266

What kind of place is [question("value"), id="445"]?

- My boyfriend/partner/friend's house
- Somewhere else I normally stay
- Restaurant
- Coffee house
- Bar
- Club
- Mall or shopping center
- Park
- Other

ID 224

Now we're going to ask you about places you go for healthcare, such as your doctor and pharmacy.

LOGIC Show/hide trigger exists.
ID 587

Do you have a doctor who you normally see if you are sick or need medical care? *

- Yes
- No
- Don't know

LOGIC Hidden unless: Question "Do you have a doctor who you normally see if you are sick or need medical care?" #37 is one of the following answers ("Yes")
ID 148

Enter a nickname for where you normally go to the doctor. *

Page entry logic:
This page will show when: Question "Do you have a doctor who you normally see if you are sick or need medical care?" #37 is one of the following answers ("Yes")

LOGIC Hidden by default
ID 466

Please select a location on the map, or check that you would rather not select a location.

ID 508
ID 506

On the map, please click where your doctor, [question("value"), id="148"], is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 147

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location
ID 149

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

LOGIC Show/hide trigger exists.
ID 588

Do you have a pharmacy where you normally pick up prescriptions or medications? *

- ○ Yes
- ○ No
- ○ Don't know

LOGIC Hidden unless: Question "Do you have a pharmacy where you normally pick up prescriptions or medications?" #41 is one of the following answers ("Yes")
ID 151

Enter a nickname for where you normally go to pick up prescriptions or medications. *

Page entry logic:
This page will show when: Question "Do you have a pharmacy where you normally pick up prescriptions or medications?" #41 is one of the following answers ("Yes")

LOGIC Hidden by default
ID 467

Please select a location on the map, or check that you would rather not select a location.

ID 511
ID 509

On the map, please click where your pharmacy, [question("value"), id="151"], is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 152

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 153

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

ID 45

Have you ever been tested for HIV? *

- ○ Yes
- ○ No
- ○ Don't remember

LOGIC Hidden by default
ID 757

Please enter a valid date.

LOGIC Dynamically shown if "Have you ever been tested for HIV?" = Yes
ID 658

In what month and year did you have your most recent HIV test? If you don't remember the exact date, make your best guess.

Month

January
February
March
April
May
June
July
August
September
October
November
December

Year

2015
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
1996
1995
1994
1993
1992
1991
1990
1989
1988
1987
1986
1985

VALIDATION

LOGIC Show/hide trigger exists. Dynamically shown if "Have you ever been tested for HIV?" = Yes

ID 21

What was the result of your most recent HIV test?

- Negative
- Positive
- Indeterminant or inconclusive
- Didn't get the results of my last HIV test
- Prefer not to answer

LOGIC Hidden unless: Question "What was the result of your most recent HIV test?" #47 is one of the following answers ("Positive")

ID 666

Are you currently taking any antiretroviral medicines to treat your HIV? These medicines are also known as ART, HAART, or the AIDS cocktail.

- Yes
- No
- Prefer not to answer

LOGIC Hidden unless: Question "What was the result of your most recent HIV test?" #47 is one of the following answers ("Negative","Indeterminant or inconclusive","Didn\'t get the results of my last HIV test","Prefer not to answer")

ID 668

Do you take Pre-Exposure Prophylaxis (PrEP)? PrEP is a daily pill that you may prevent HIV infection from taking hold if you are exposed to the virus.

- Yes, I take PrEP regularly.
- Yes, I take PrEP when I think I might need it.
- No, but I've heard of PrEP.
- No, I've never heard of PrEP.

LOGIC Dynamically shown if "Have you ever been tested for HIV?" = Yes

ID 282

Where did you have your most recent HIV test? *

- Your home: [question("value"), id="37"]
- Work/school: [question("value"), id="609"]
- Place you hang-out: [question("value"), id="443"]
- Place you hang out: [question("value"), id="445"]
- Your doctor: [question("value"), id="148"]
- Your pharmacy: [question("value"), id="151"]
- Another place (Enter a name.)

*

Page entry logic:
This page will show when: (Question "Where did you have your most recent HIV test?" #50 is one of the following answers ("Another place (Enter a name.)") AND Question "Have you ever been tested for HIV?" #45 is one of the following answers ("Yes"))

LOGIC Hidden by default

ID 468

Please select a location on the map, or check that you would rather not select a location.

ID 515

ID 512

On the map, please click where you had your last HIV test, [question("option value"), id="282", option="11810"]. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 160

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 161

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

ID 413

In the past year, have you been tested for any STDs? *

- ○ Yes
- ○ No
- ○ Don't know/remember

LOGIC Dynamically shown if "In the past year, have you been tested for any STDs?" = Yes

ID 412

Where were you most recently tested for STDs? *

- ○ Your home: [question("value"), id="37"]
- ○ Work/school: [question("value"), id="609"]
- ○ Place you hang-out: [question("value"), id="443"]
- ○ Place you hang out: [question("value"), id="445"]
- ○ Your doctor: [question("value"), id="148"]
- ○ Your pharmacy: [question("value"), id="151"]
- ○ HIV testing: [question("option value"), id="282", option="11810"]
- ○ Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where were you most recently tested for STDs?" #54 is one of the following answers ("Another place (Enter a name.)")

LOGIC Hidden by default
ID 469

Please select a location on the map, or check that you would rather not select a location.

ID 518
ID 516

On the map, please click where you were last tested for STDs, [question("option value"), id="412", option="13195"]. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 162

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location
ID 163

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

ID 697

This is the last section of the survey. We're going to ask who, where, and what about your recent sexual experiences.

LOGIC Hidden by default
ID 707

Please enter at least one nickname.

ID 703

Please give a nickname for each of your most recent male sex partners in the last six months. This could be his name or something else to remember who this person is. We will use this nickname to ask you other questions.

If you had more than three male sex partners in the last six months, we would like nicknames for the most recent three.

Sex Partner 1

Sex Partner 2

Sex Partner 3

ID 709

We're going to ask you some questions about your first sex partner, [question("value"), id="706"].

ID 368

Have you had sex with [question("value"), id="706"] more than once in the past six months?

- Yes
- No
- Don't know

ID 369

Is/was [question("value"), id="706"] someone that you feel or felt committed to above all others (someone you might call your boyfriend, significant other, life partner, or husband)?

- Yes
- No
- Don't know

ID 689

Where did you first meet [question("value"), id="706"]? *

- Online or using an app (like Grindr or Scruff)
- Your home: [question("value"), id="37"]
- Work/school: [question("value"), id="609"]
- Place you hang-out: [question("value"), id="443"]
- Place you hang out: [question("value"), id="445"]
- Your doctor: [question("value"), id="148"]
- Your pharmacy: [question("value"), id="151"]
- HIV testing: [question("option value"), id="282", option="11810"]
- STD testing: [question("option value"), id="412", option="13195"]
- Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where did you first meet [question("value"), id="706"]?" #60 is one of the following answers ("Another place (Enter a name.)")

LOGIC Hidden by default

ID 691

Please select a location on the map, or check that you would rather not select a location.

ID 692

ID 693

On the map, please click where you first met [question("value"), id="706"], [question("option value"), id="689", option="14132"]. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 694

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 695

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

ID 686

Where did you most recently have sex with [question("value"), id="706"]? *

- ○ Your home: [question("value"), id="37"]
- ○ Work/school: [question("value"), id="609"]
- ○ Place you hang-out: [question("value"), id="443"]
- ○ Place you hang out: [question("value"), id="445"]
- ○ Your doctor: [question("value"), id="148"]
- ○ Your pharmacy: [question("value"), id="151"]
- ○ HIV testing: [question("option value"), id="282", option="11810"]
- ○ STD testing: [question("option value"), id="412", option="13195"]
- ○ Where you first met [question("value"), id="706"]: [question("option value"), id="689", option="14132"]
- ○ Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where did you most recently have sex with [question("value"), id="706"]?" #63 is one of the following answers ("Another place (Enter a name.)")

ID 414

What type of place is [question("option value"), id="686", option="14110"]?

- [question("value"), id="706"]'s house
- Somewhere else I normally stay
- Someone else's house
- Bar
- Bathhouse
- Club
- Park
- Other

LOGIC Hidden by default
ID 470

Please select a location on the map, or check that you would rather not select a location.

ID 521
ID 519

On the map, please click where [question("option value"), id="686", option="14110"] is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 39

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 40

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

LOGIC Show/hide trigger exists.

ID 366

What did you do the last time you had sex with [question("value"), id="706"] at [question("value"), id="350"]? (Mark all that apply.)

- ☐ Receptive anal sex (you were the bottom)
- ☐ Insertive anal sex (you were the top)
- ☐ Oral sex
- ☐ None of these
- ☐ Prefer not to answer

LOGIC Hidden unless: Question "What did you do the last time you had sex with [question("value"), id="706"] at [question("value"), id="350"]? (Mark all that apply.)" #67 is one of the following answers ("Receptive anal sex (you were the bottom)","Insertive anal sex (you were the top)") Dynamically shown if "What did you do the last time you had sex with [question("value"), id="706"] at [question("value"), id="350"]? (Mark all that apply.)" = Receptive anal sex (you were the bottom) or "What did you do the last time you had sex with [question("value"), id="706"] at [question("value"), id="350"]? (Mark all that apply.)" = Insertive anal sex (you were the top)

ID 367

Did you use a condom the last time you had sex with [question("value"), id="706"] at [question("value"), id="350"]?

- ○ Yes
- ○ No
- ○ Don't know/remember
- ○ Prefer not to answer

Page entry logic:
This page will show when: nSexPartners is greater than "1"

ID 710

Now we're going to ask you some questions about your second sex partner, [question("value"), id="423"].

ID 285

Have you had sex with [question("value"), id="423"] more than once in the past six months?

- Yes
- No
- Don't know

ID 291

Is/was [question("value"), id="423"] someone that you feel or felt committed to above all others (someone you might call your boyfriend, significant other, life partner, or husband)?

- Yes
- No
- Don't know

ID 702

Where did you first meet [question("value"), id="423"]? *

- Online or using an app (like Grindr or Scruff)
- Your home: [question("value"), id="37"]
- Work/school: [question("value"), id="609"]
- Place you hang-out: [question("value"), id="443"]
- Place you hang out: [question("value"), id="445"]
- Your doctor: [question("value"), id="148"]
- Your pharmacy: [question("value"), id="151"]
- HIV testing: [question("option value"), id="282", option="11810"]
- STD testing: [question("option value"), id="412", option="13195"]
- Where you first met [question("value"), id="706"]: [question("option value"), id="689", option="14132"]
- Place you had sex: [question("option value"), id="686", option="14110"]
- Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where did you first meet [question("value"), id="423"]?" #71 is one of the following answers ("Another place (Enter a name.)")

LOGIC Hidden by default
ID 711

Please select a location on the map, or check that you would rather not select a location.

ID 712
ID 713

On the map, please click where you first met [question("value"), id="423"], [question("option value"), id="702", option="14184"]. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 714

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location
ID 715

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

Page entry logic:
This page will show when: nSexPartners is greater than "1"

ID 717

Where did you most recently have sex with [question("value"), id="423"]? *

- ○ Your home: [question("value"), id="37"]
- ○ Work/school: [question("value"), id="609"]
- ○ Place you hang-out: [question("value"), id="443"]
- ○ Place you hang out: [question("value"), id="445"]
- ○ Your doctor: [question("value"), id="148"]
- ○ Your pharmacy: [question("value"), id="151"]
- ○ HIV testing: [question("option value"), id="282", option="11810"]
- ○ STD testing: [question("option value"), id="412", option="13195"]
- ○ Where you first met [question("value"), id="706"]: [question("option value"), id="689", option="14132"]
- ○ Place you had sex: [question("option value"), id="686", option="14110"]
- ○ Where you first met [question("value"), id="423"]: [question("option value"), id="702", option="14184"]
- ○ Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where did you most recently have sex with [question("value"), id="423"]?" #74 is one of the following answers ("Another place (Enter a name.)")

ID 421

What type of place is [question("option value"), id="717", option="14220"]?

- [question("value"), id="423"]'s house
- Somewhere else I normally stay
- Someone else's house
- Bar
- Bathhouse
- Club
- Park
- Other

LOGIC Hidden by default
ID 471

Please select a location on the map, or check that you would rather not select a location.

ID 530
ID 531

On the map, please click where [question("option value"), id="717", option="14220"] is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 375

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 376

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

Page entry logic:
This page will show when: nSexPartners is greater than "1"

ID 87

What did you do the last time you had sex with [question("value"), id="423"] at [question("value"), id="354"]?

- ☐ Receptive anal sex (you were the bottom)
- ☐ Insertive anal sex (you were the top)
- ☐ Oral sex
- ☐ None of these
- ☐ Prefer not to answer

LOGIC Dynamically shown if "What did you do the last time you had sex with [question("value"), id="423"] at [question("value"), id="354"]?" = Receptive anal sex (you were the bottom) or "What did you do the last time you had sex with [question("value"), id="423"] at [question("value"), id="354"]?" = Insertive anal sex (you were the top)

ID 88

Did you use a condom the last time you had sex with [question("value"), id="423"] at [question("value"), id="354"]?

- ○ Yes
- ○ No
- ○ Don't know/remember
- ○ Prefer not to answer

Page entry logic:
This page will show when: nSexPartners is exactly equal to "3"

ID 719

Now we're going to ask you some questions about your third sex partner, [question("value"), id="425"].

ID 392

Have you had sex with [question("value"), id="425"] more than once in the past six months?

- Yes
- No
- Don't know

ID 393

Is/was [question("value"), id="425"] someone that you feel or felt committed to above all others (someone you might call your boyfriend, significant other, life partner, or husband)?

- Yes
- No
- Don't know

ID 720

Where did you first meet [question("value"), id="425"]? *

- Online or using an app (like Grindr or Scruff)
- Your home: [question("value"), id="37"]
- Work/school: [question("value"), id="609"]
- Place you hang-out: [question("value"), id="443"]
- Place you hang out: [question("value"), id="445"]
- Your doctor: [question("value"), id="148"]
- Your pharmacy: [question("value"), id="151"]
- HIV testing: [question("option value"), id="282", option="11810"]
- STD testing: [question("option value"), id="412", option="13195"]
- Where you first met [question("value"), id="706"]: [question("option value"), id="689", option="14132"]
- Place you had sex: [question("option value"), id="686", option="14110"]
- Where you first met [question("value"), id="423"]: [question("option value"), id="702", option="14184"]
- Place you had sex: [question("option value"), id="717", option="14220"]
- Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where did you first meet [question("value"), id="425"]?" #82 is one of the following answers ("Another place (Enter a name.)")

LOGIC Hidden by default

ID 721

Please select a location on the map, or check that you would rather not select a location.

ID 722

ID 723

On the map, please click where you first met [question("value"), id="425"], [question("option value"), id="720", option="14234"]. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 724

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 725

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

Page entry logic:
This page will show when: nSexPartners is exactly equal to "3"

ID 727

Where did you most recently have sex with [question("value"), id="425"]? *

- Your home: [question("value"), id="37"]
- Work/school: [question("value"), id="609"]
- Place you hang-out: [question("value"), id="443"]
- Place you hang out: [question("value"), id="445"]
- Your doctor: [question("value"), id="148"]
- Your pharmacy: [question("value"), id="151"]
- HIV testing: [question("option value"), id="282", option="11810"]
- STD testing: [question("option value"), id="412", option="13195"]
- Where you first met [question("value"), id="706"]: [question("option value"), id="689", option="14132"]
- Place you had sex: [question("option value"), id="686", option="14110"]
- Where you first met [question("value"), id="423"]: [question("option value"), id="702", option="14184"]
- Place you had sex: [question("option value"), id="717", option="14220"]
- Where you first met [question("value"), id="425"]: [question("option value"), id="720", option="14234"]
- Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where did you most recently have sex with [question("value"), id="425"]?" #85 is one of the following answers ("Another place (Enter a name.)")

ID 427

What type of place is [question("option value"), id="727", option="14268"]?

- [question("value"), id="425"]'s house
- Somewhere else I normally stay
- Someone else's house
- Bar
- Bathhouse
- Club
- Park
- Other

LOGIC Hidden by default
ID 472

Please select a location on the map, or check that you would rather not select a location.

ID 540
ID 538

On the map, please click where [question("option value"), id="727", option="14268"] is. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 378

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location

ID 379

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

Page entry logic:
This page will show when: nSexPartners is exactly equal to "3"

ID 390

What did you do the last time you had sex with [question("value"), id="425"] at [question("value"), id="355"]?

- ☐ Receptive anal sex (you were the bottom)
- ☐ Insertive anal sex (you were the top)
- ☐ Oral sex
- ☐ None of these
- ☐ Prefer not to answer

LOGIC Dynamically shown if "What did you do the last time you had sex with [question("value"), id="425"] at [question("value"), id="355"]?" = Receptive anal sex (you were the bottom) or "What did you do the last time you had sex with [question("value"), id="425"] at [question("value"), id="355"]?" = Insertive anal sex (you were the top)

ID 391

Did you use a condom the last time you had sex with [question("value"), id="425"] at [question("value"), id="355"]?

- ○ Yes
- ○ No
- ○ Don't know/remember
- ○ Prefer not to answer

LOGIC Show/hide trigger exists.

ID 589

In the past 6 months, have you picked up free condoms? *

- Yes
- No
- Don't know

LOGIC Hidden unless: Question "In the past 6 months, have you picked up free condoms?" #91 is one of the following answers ("Yes")

ID 730

Where was the last place you got free condoms? *

- Your home: [question("value"), id="37"]
- Work/school: [question("value"), id="609"]
- Place you hang-out: [question("value"), id="443"]
- Place you hang out: [question("value"), id="445"]
- Your doctor: [question("value"), id="148"]
- Your pharmacy: [question("value"), id="151"]
- HIV testing: [question("option value"), id="282", option="11810"]
- STD testing: [question("option value"), id="412", option="13195"]
- Where you first met [question("value"), id="706"]: [question("option value"), id="689", option="14132"]
- Place you had sex: [question("option value"), id="686", option="14110"]
- Where you first met [question("value"), id="423"]: [question("option value"), id="702", option="14184"]
- Place you had sex: [question("option value"), id="717", option="14220"]
- Where you first met [question("value"), id="425"]: [question("option value"), id="720", option="14234"]
- Place you had sex: [question("option value"), id="727", option="14268"]
- Another place (Enter a name.)

*

Page entry logic:
This page will show when: Question "Where was the last place you got free condoms?" #92 is one of the following answers ("Another place (Enter a name.)")

LOGIC Hidden by default

ID 473

Please select a location on the map, or check that you would rather not select a location.

ID 534
ID 535

On the map, please click where you last got free condoms, [question("option value"), id="730", option="14284"]. You may also click the closest intersection to this place.

Zoom in and out of the map as you need to.

If you need to start over and reenter the location of where you currently live, DO NOT PRESS BACK on your browser. Just press "CLEAR MAP" at the bottom left-hand corner of the map, then click on the appropriate place on the map.

Clear map

ID 164

☐ Cannot or don't want to provide this location

LOGIC Dynamically shown if " " = Cannot or don't want to provide this location
ID 165

Why did you not want to answer this question? (Mark all that apply.)

- ☐ I can't remember where this location is
- ☐ I'm not sure where that place is on a map
- ☐ I'm not comfortable using the map to select locations
- ☐ This place is in a different city
- ☐ Didn't feel comfortable giving that information
- ☐ Worried about a loss of privacy
- ☐ Worried about what friends, family, or coworkers would think
- ☐ Other

ID 590

In this survey, how hard or easy was it for you to find places on the maps?

Very hard	A little hard	Not hard or easy	Easy	Very easy
○	○	○	○	○

VALIDATION %s format expected

ID 64

To learn more about this topic, we may also hold online focus groups. These focus groups occur over the internet, are anonymous and you will receive compensation of $25-30. If you would be interested in participating in these groups, please enter your email below. We will only contact you for these focus groups, and not for any other purpose.

ID 192

Is there anything else you'd like to tell us about the survey or about your responses?

Page entry logic:
This page will show when: RandomNumber is exactly equal to "0"

ID 581

ID 746

To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation. *

The Trevor Project

The Trevor Project

The Black AIDS Institute

The Black AIDS Institute

Latino Commission on AIDS

Latino Commission on AIDS

It Gets Better

Human Rights Campaign

GLSEN

Page entry logic:
This page will show when: RandomNumber is exactly equal to "1"

ID 630

ID 634

Thank you for completing the survey. To thank you for your time, we will donate $3 to the organization that you selected:

LOGIC Hidden unless: Question "To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation." #2 is one of the following answers ("The Trevor Project")

ID 636

LOGIC Hidden unless: Question "To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation." #2 is one of the following answers ("Latino Commission on AIDS")

ID 637

LOGIC Hidden unless: Question "To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation." #2 is one of the following answers ("The Black AIDS Institute")

ID 638

LOGIC Hidden unless: Question "To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation." #2 is one of the following answers ("Human Rights Campaign")

ID 747

LOGIC Hidden unless: Question "To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation." #2 is one of the following answers ("It Gets Better")

ID 748

LOGIC Hidden unless: Question "To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation." #2 is one of the following answers ("GLSEN")

ID 754

ID 646

Is this the organization that you want to donate to? *

- Yes, donate to this organization.
- No, I want to change organizations.

Page entry logic:
This page will show when: Question "Is this the organization that you want to donate to?" #99 is one of the following answers ("No, I want to change organizations.")

ID 647

ID 749

To thank you for your time, we will donate $3 to an organization you choose (up to a total of $3000 across all organizations).

Select which organization you would like to receive your donation. *

The Trevor Project

The Black AIDS Institute

Latino Commission on AIDS

IT GETS BETTER PROJECT
WWW.ITGETSBETTER.ORG

HUMAN RIGHTS CAMPAIGN

GLSEN

ID 582

ID 1

Thank you for taking our survey. We appreciate the time you have taken. Your response is very important to us. Remember that we value your privacy so all your answers will remain confidential.

Please contact the study team at marksthespot@emory.edu or 404-727-2038 if you have any questions.

ID 223