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Travel Distance to HIV Medical Care: A Geographic Analysis of Weighted Survey Data from the Medical Monitoring Project in Philadelphia, PA

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Abstract Decisions regarding where patients access HIV care are not well understood. The purpose of this analysis was to examine differences in travel distance to care among persons receiving care in Philadelphia. A multi-stage sampling design was utilized to identify 400 potential participants. 65 % (260/400) agreed to be interviewed. Participants were asked questions about medical care, supportive services, and geographic location. Distances were calculated between residence and care location. 46.3 % travelled more than three miles beyond the nearest facility. Uninsured travelled further (6.9 miles, 95 % CI 3.9–9.8) than persons with public insurance (3.3 miles, 2.9–3.6). In multivariate analyses, no insurance (20/260) was associated with increased distance ($p = 0.0005$) and Hispanic ethnicity was associated with decreased distance ($p = 0.0462$). Persons without insurance travel further but insurance status alone does not explain the variability in distance travelled to care. In Philadelphia, Hispanic populations, and providers that may be most accessible to them, are spatially contained.

Keywords HIV/AIDS · Travel distance · Medical care · Geographic information systems (GIS) · Survey data

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Background

Multiple studies have evaluated the relationship between proximity to medical care and healthcare utilization [1–8], generally focusing on either facility choice or the association between distance and frequency of visits. Although these studies varied by geographic location [6, 9], study population [1, 4, 6–8], and methodology [5, 10, 11], the general consensus is that distance is often a barrier to care [12]. More specifically, persons living in rural areas tend to travel greater distances than persons in urban areas [3, 10], and straight-line distances have been shown to be a reliable measure of actual distance travelled [10]. Geographic analyses have also been utilized to assess access to care by focusing on the distribution of medical care sites within a given jurisdiction or catchment area [2, 9, 11–17]. As a result, strategies that address equitable access to care often emphasize location in effort to reduce physical barriers [2, 14–18], when other factors may also impact where persons access care. Two factors commonly identified as influencing decisions regarding where to access medical care include race/ethnicity and socioeconomic status [1, 3, 5]. However, other factors which may be more difficult to measure and quantify, such as access to ancillary services, facility reputation, fear of unwanted disclosure, and geographic relationship to non-medical services, have also been identified [4, 6, 7].

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Allocations of heath care resources are often configured and analyzed with consideration for geographic proximity to the population at risk [11–15, 17], however there is little data to suggest that persons access care at the location nearest to their primary residence. Data regarding patient travel distance to HIV medical care in the United States is limited, and most focus either on rural populations [6, 10], where travelling longer distances may be necessary; a national sample where regional differences may be masked [7]; services designed to meet the needs of specific risk groups [4, 8, 16, 19]; or prevention services rather than care and treatment [8].

As of December 31, 2010, there were 19,005 persons living with HIV/AIDS in the city of Philadelphia [20]. Although exact figures of incident cases are difficult to estimate, there are approximately 800–900 newly diagnosed HIV cases in the city each year [20]. Nearly two-thirds of living cases are African-American (63 %), most are 40 years of age or older (72.9 %), and almost one-third are female (29.1). Although cases have been diagnosed in all geographic areas of the city, they tend to cluster in three specific areas: center-city, which has a large population of men who have sex with men, and both north Philadelphia and west Philadelphia, each characterized by high population density and low socioeconomic status [20]. The city of Philadelphia encompasses 134 square miles, and includes a high concentration of large teaching hospitals, several HIV-specific clinics that offer a variety of ancillary services, a large number of private providers, as well as a variety of Ryan White-funded providers and ten geographically dispersed public clinics that provide care regardless of a patient's ability to pay.

In the analysis presented here, we sought to identify differences in travel distances among persons receiving care for HIV in a high-morbidity, densely populated urban area. We compared distance travelled by various subgroups, as well as differences between travel distance to care location of choice and distance to the nearest source of care. Furthermore, we used in-depth survey data, collected as part of a national HIV surveillance project, and geographic location data in an attempt to identify possible predictors of travel distance beyond services located in patients' residential communities.

Methods

Data were collected as part of the medical monitoring project (MMP). MMP is a supplemental surveillance project which utilizes a population-based sample of persons living with HIV/AIDS to monitor clinical outcomes, standards of HIV medical care, and on-going risk factors of persons receiving HIV medical care. The project is funded and coordinated by the centers for disease control and prevention (CDC). MMP utilizes a three stage sampling process in order to select a representative sample of 400 persons receiving primary HIV medical care, and has been described elsewhere [21, 22]. Potential participants were recruited at subsequent medical care visits to conduct a face-to-face interview that includes questions regarding care and treatment for HIV, as well as access to needed services including outpatient care, ancillary services, housing and financial assistance. To establish geographic location, local questions included in the Philadelphia MMP interview elicited nearest cross streets to, and zip code of, primary residence. Interviews were conducted from June 2009 through April 2010 using a standardized instrument administered via a handheld assisted personal interview (HAPI) device. The HAPI devices contained fully-documented interviews programmed using the Nova research company questionnaire development system (QDS) software version 2.4, including scripted components, skip patterns and response sets for all survey questions, and created data files of participant responses. This process eliminated the need for secondary data entry, and reduced the potential for transcription errors.

MMP is considered part of routine HIV surveillance at both the national and local levels, and therefore is not subject to review and approval by the city of Philadelphia institutional review board (IRB). However, in order to ensure voluntary participation in the structured interview component of MMP, written informed consent was obtained for all persons agreeing to participate, and a $25 incentive was paid upon conclusion of the interview process. Of those randomly selected to participate, 65 % (260/400) agreed to be interviewed.

As part of the standard MMP interview, respondents were asked to self-identify their birth gender, racial/ethnic background, insurance status, highest level of education and sexual orientation. Age categories were assessed using calculations based on the patient reported date of birth and the date of interview, and type of healthcare facility was assessed based on the facility where respondents receive HIV medical care; defined as the provider location where laboratory tests are ordered and/or antiretroviral medications are prescribed.

Distance Calculation

Distances to care location were calculated using ArcMap 10.1, a geographic information system (GIS) software package designed for the storage, analysis and display of spatial data. Euclidean distances were calculated from coordinates for the patient's current residential location and current HIV medical care location. For this analysis, participants were asked to provide the nearest cross streets to their primary residence during the surveillance period; cross streets were utilized to maintain the confidentiality of interview respondents without having to rely on less specific geographic units such as zip code centroids. Cross streets were geocoded using an address locator created and maintained by the city of Philadelphia's Department of Technology (DOT), and the resulting coordinates were added to the interview data. Facilities providing care for interview subjects were geocoded using the street address of the facility and the same address locator. Facility addresses were compiled as part of the multi-stage sampling process. All facilities providing HIV care in Philadelphia were included in the initial sample, and facilities were selected using probability proportional to size methodology. Euclidean distances were calculated as the difference between point p (residence) and point q (HIV care facility) where.

$$d(p,q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2}$$

The distance between the nearest care provider and the provider of choice was dichotomized as either local (within 3.1 miles) or non-local (>3.1 miles). This distance was selected as a measure of locality for three reasons: (1) all participants were within 3.1 miles of the nearest medical provider; (2) one of the few published analyses of travel distance to HIV care in an urban area utilized the same measure [3], and (3) similar proximity measures have been described for non-HIV medical services in an urban environment [1].

Network distances were calculated using the Network Analyst extension of ArcGIS 10.1 and the city of Philadelphia's street centerline file. Coordinates for the geocoded residence and facility of care were combined into one file, and network distances were calculated using spatial data relevant to street direction and accessibility, natural boundaries such as park and rivers, and elements of the built environment, such as train tracks and interstate highways, which impact travel distances. The network distances were calculated to provide a more realistic indicator of travel distance. Both Euclidean distances and network distances were initially calculated in feet, the distance unit of the source data, and then converted to miles for analysis. Data analyses were conducted using SAS 9.2 using procedures suitable for weighted survey data.

Results

The demographic distribution of persons interviewed for this analysis is presented in Table 1. Participants were predominantly male (61.2), black (61.1 %), and between the ages of 35–54 (61.4 %) at time of interview. Most had some form of public insurance (70.4 %), and the majority had a high school education or greater (67.8 %).

Table 1 Sample characteristics of persons engaged in HIV medical care

Characteristic	Number (weighted %)	95 % CI
Gender		
Male	158 (61.2)	[54.7–67.7]
Female	98 (37.3)	[30.4–44.2]
Transgender	4 (1.5)	[0.0–3.0]
Race/ethnicity		
White	49 (19.0)	[12.0–26.0]
Black	159 (61.1)	[54.3–67.9]
Hispanic	45 (17.3)	[12.7–21.9]
Other	7 (2.6)	[0.8–4.4]
Age category		
18–34	60 (23.4)	[13.4–33.4]
35–44	70 (26.8)	[20.0–33.7]
45–54	90 (34.6)	[28.5–40.8]
55+	40 (15.2)	[9.7–20.6]
Insurance		
Public	185 (70.4)	[61.9–78.8]
None	20 (7.7)	[4.4–11.0]
Private	55 (21.9)	[12.9–30.9]
Education		
<High school	84 (32.3)	[26.3–38.2]
High school/GED	96 (36.4)	[29.8–42.9]
>High school	80 (31.4)	[25.7–37.0]

Average Travel Distance: Euclidean

Travel distances to current facility of care are presented in Table 2. Overall, the average travel distance to HIV care for this sample was 3.7 miles (95 % CI 3.2–4.3). Females had a slightly shorter travel distance than males (3.4 vs. 3.9 miles), and, though few in number ($n = 4$), transgender individuals had a longer average travel distance (7.2 miles) than either females or males, but the differences were not statistically significant. Similarly, whites travelled longer average distances than blacks (4.7 vs. 3.6 miles), and Hispanics had the shortest average travel distance at 3.1 miles. Based on the confidence intervals, these differences were also not significant. No significant differences were detected for level of education, sexual orientation, or age category. However, persons with no insurance travelled significantly longer average distances to care than persons with public insurance (6.9 vs. 3.3 miles).

Average Travel Distance: Network

The average network (driving) distance to care for the entire sample was 4.4 miles. As expected, this distance was slightly longer than the straight-line distance that does not take into account traffic patterns and environmental

Table 2 Travel distance to HIV medical care (and 95 % CI) by selected characteristics

Characteristic	Avg Euclidean distance (in miles)	95 % CI	Avg network distance (in miles)	95 % CI
Total	3.7	[3.2–4.3]	4.4	[3.7–5.0]
Gender				
Male	3.9	[3.3–4.4]	4.5	[3.8–5.1]
Female	3.4	[2.8–4.0]	4.0	[3.3–4.7]
Transgender	7.2	[1.3–13.1]	8.4	[1.4–15.4]
Race/ethnicity				
White	4.7	[3.1–6.4]	5.4	[3.6–7.3]
Black	3.6	[3.1–4.1]	4.3	[3.7–4.9]
Hispanic	3.1	[2.2–4.0]	3.6	[2.6–4.6]
Other	3.8	[−0.7 to 8.2]	4.1	[−0.6 to 8.9]
Insurance				
Public	3.3	[2.9–3.6]	3.8	[3.4–4.2]
None	6.9	[3.9–9.8]	7.7	[4.4–11.0]
Private	4.4	[2.8–6.0]	5.2	[3.3–7.2]
Education				
<High school	3.3	[2.6–4.1]	3.8	[3.0–4.7]
High school/GED	3.4	[2.8–4.0]	4.0	[3.3–4.7]
>High school	4.6	[3.3–5.8]	5.4	[3.9–6.8]
Sexual orientation				
Homosexual	3.6	[2.7–4.5]	4.2	[3.2–5.2]
Heterosexual	3.9	[3.1–4.6]	4.5	[3.6–5.5]
Bisexual/other	3.3	[2.0–4.6]	3.9	[2.4–5.3]
Age Category				
18–34	4.0	[3.3–4.7]	4.6	[3.8–5.5]
35–44	4.3	[3.2–5.3]	4.9	[3.7–6.1]
45–54	3.0	[1.7–4.4]	3.6	[2.1–5.2]
55+	3.8	[2.8–4.7]	4.4	[3.3–5.5]
Facility type				
Hosp. O/P	4.3	[3.4–5.1]	4.9	[4.0–5.8]
Other	3.6	[2.6–4.6]	4.3	[3.1–5.5]
HIV clinic	4.0	[3.2–4.9]	4.5	[3.7–5.4]
HC	2.7	[0.9–4.6]	3.2	[1.1–5.3]

obstacles. The observed patterns across gender, race/ethnicity and insurance status remained the same. Network distances were also shorter for females than males or transgender individuals (4.0 vs. 4.5 and 8.4 miles, respectively), and Hispanics travelled shorter network distances than whites (5.4 miles) or blacks (4.3 miles), and these differences were also not statistically significant. However, persons without insurance travelled significantly longer network distances to care than persons with public insurance (7.7 vs. 3.8 miles).

Distance to Nearest Care Site

The average distance to the nearest HIV care provider for this sample is 1.03 miles (95 % CI 0.91–1.16). Nearly half (46.3 %) of all respondents with valid distance data travelled more than three miles further than the nearest care provider. However, no significant differences in the proportion of persons accessing local versus non-local care were detected among insurance status ($\chi^2 = 2.8$, $p = 0.2$), type of provider ($\chi^2 = 2.0$, $p = 0.5$), socioeconomic factors such as income ($\chi^2 = 4.8$, $p = 0.8$) or level of education ($\chi^2 = 4.1$, $p = 0.1$), or the utilization of ancillary services such as case management ($\chi^2 = 0.2$, $p = 0.8$), mental health counselling ($\chi^2 = 0.9$, $p = 0.8$) or risk reduction services ($\chi^2 = 1.9$, $p = 0.2$).

Regression Analysis

The demographic factors described in the Euclidean distance results above were included in a regression model using the GENMOD procedure in SAS 9.2, and the results

Table 3 Regression parameter estimates

Variable	Category	Odds ratio	Standard error	95 % CI	χ^2	*P* value
Intercept		4.4351	0.7529	[2.96–5.91]	34.70	<0.0001
Insurance	None	3.7034	1.0630	[1.62–5.79]	12.14	0.0005
	Private	0.5921	0.6147	[−0.61 to 1.80]	0.93	0.3355
	Public	Referent				
Gender	Transgender	3.2777	2.0164	[−0.67 to 7.23]	2.64	0.1040
	Male	−0.2261	0.5223	[−1.25 to 0.80]	0.19	0.6651
	Female	Referent				
Race/ethnicity	Black	−1.0682	0.6814	[−2.40 to 0.27]	2.46	0.1169
	Hispanic	−1.6319	0.8187	[−3.24 to 0.03]	3.97	0.0462
	Other	−0.4544	1.7106	[−3.81 to 2.90]	0.07	0.7905
	White	Referent				

are presented in Table 3. When combined in a multivariate regression model, insurance status and race/ethnicity were the only factors determined to be significant predictors of travel distance to medical care. Specifically, persons with no insurance were more likely to travel greater distance to care than persons with public insurance (OR 3.7; $p = 0.0005$) and persons of Hispanic race were more likely to travel a shorter distance to care than whites (OR −1.6; $p = 0.046$).

Discussion

These findings highlight several factors associated with the provision of medical care in a large urban area. Persons choose medical care locations based on a number of factors, and relative distance may not be the most important consideration. Most of the subjects in this analysis travelled farther than the nearest available source of medical care, and nearly half (46.3 %) travelled more than three miles farther, indicating that proximity is not the driving factor in where people access HIV care in Philadelphia. Health Department staff in Philadelphia has consistently monitored geographic trends in newly-diagnosed cases to ensure that appropriate services are offered in areas of the city most impacted by an epidemic which has changed dramatically over the past 30 years. These findings suggest that geography may be just one of several considerations in deciding where to access care, particularly given the variety of care options available.

Insurance status likely plays some role in this decision process, but lack of insurance alone seems insufficient to explain increased travel distance. Philadelphia has ten district health centers, as well as many Ryan White-funded HIV care providers located throughout the city that provide care regardless of insurance, yet persons without insurance are more likely to travel greater distance. Persons with private insurance, who may have more freedom to choose amongst a larger pool of providers, also appear to travel greater distances than persons with public insurance. This has been reported by other researchers [3]. Again, this finding suggests that proximity may not be the most important factor in choice of care location.

The facilities sampled for this project provide a range of ancillary services. Smaller, private facilities may have limited resources to provide services such as transportation benefits and case management, and larger, hospital-based or publicly-funded HIV clinics may provide a wider array of services to meet the needs of patients confronting issues beyond HIV medication management. The absence of significant differences in local versus non-local care based on the ancillary services considered in this analysis is surprising, and may be influenced by minimum cell-size requirements of weighted survey data. These phenomena will be re-evaluated in future analyses using data combined from multiple cycles of MMP that will allow more nuanced examination, including subgroup comparisons and different combinations of services. The availability of specific services, perhaps in combination with access to non-HIV medical care and services, may also have an impact on distance to care.

The Hispanic population in Philadelphia is highly concentrated in one area of the city, and services designed to reach Hispanics also tend to be localized in the same area. This may account for some of the differences observed in the analysis, especially given that providers fluent in Spanish are more likely to be located within close proximity to the Hispanic population. Similar findings regarding Hispanics and linkage to care in Philadelphia have been published elsewhere [23]. The MSM population, once the main driver of the epidemic in Philadelphia, had been concentrated in a small geographic area as well, and services were established in that area of center city to address those needs. Over time, the MSM population has become less centralized, however HIV care practices with large numbers of MSM patients continue to be centrally located.

Our study has several limitations that should be acknowledged. The sample used for this analysis is limited to persons actively engaged in HIV medical care, and may not account for persons who change providers frequently or access care intermittently. The network distance calculated only the minimum driving distance between the two points. Though likely influential in where individuals travel for care, information regarding speed limits and actual travel time were not available for this analysis. Also, the distance calculations used in this analysis do not take into account factors associated with using public transportation, such as routing to central transportation hubs and multiple modes of travel, that have a tendency to increase actual travel distance and the time required to get from one location to another. In addition, this sample is limited to persons already linked to medical care, and therefore does not address the relationship between distance and access to care. Finally, the data collected for this project do not include respondent-identified reasons for travel distance to access care, such as physician referral or proximity to other services, and therefore do not specifically address reasons why individuals choose to access care at particular facilities. Questions are asked about needed services, utilized services, and reasons for unmet need, which may help to explain patients' willingness to travel greater distances for care, but they do not necessarily explain why persons choose a particular provider or location.

The Philadelphia MMP plans to include additional local questions in subsequent cycles that will specifically address why patients choose to access care outside their local area. Questions regarding specific modes of travel—public transit, personal vehicle, shared rides—will also improve the utility of network distance information. Answers to these questions, analyzed in conjunction with observed travel distances, may better explain patients' care seeking behaviour.

Access to medical care is critical in the management of HIV infection. With increasing focus on treatment as prevention, the issues surrounding access to and retention in care will continue to rise in importance. The data reported here suggest that geographic factors may play an important role in where people access care and can aid in understanding care delivery. Future research should focus on the role of geographic factors in retention in HIV care and viral suppression, in addition to access to care, to examine their influence in each of the steps of the HIV treatment cascade.

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