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Spatial Analysis of PrEP Access via Public Transit and Car in Urban Areas Across Demographic Variables and Clinic Services

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Abstract

Spatial Analysis of PrEP Access via Public Transit in Urban Areas Across Demographic Variables and Clinic Services

By Justin Cubilo

Background:
New HIV diagnoses have declined over the past decade, but men who have sex with men (MSM) remain disproportionately impacted by new diagnoses. Disparities persist despite availability of oral pre-exposure prophylaxis (PrEP), with access being a major inhibitor to uptake. While previous studies have examined issues related to access to PrEP, this study expands on those findings by examining access to PrEP via public transportation.

Methods:
Census tract shapefiles and population weighted centroids for the cities of Washington, DC; Atlanta, GA; and Jackson, MS were obtained from the U.S. Census Bureau. Demographic information was collected for census tracts from the 2016 American Community Survey (ACS), and county-level MSM estimates were obtained through a data request to the ACS, which were assigned down to the census tract level. Information for PrEP-prescribing clinics was obtained from the National Prevention Information Network (NPIN). Data were imported into ArcGIS 10.6, which was used to produce neartables of the nearest clinic to each centroid. Coordinates from these neartables were then submitted to the Google Maps API, which determined public transit and driving times between each centroid and its nearest clinic. These times were then used to produce travel time maps while SAS 9.4 was used to conduct descriptive analyses using demographic data for each census tract.

Results:
While all three cities showed little difficulty in access via car, there were several PrEP deserts when examining access via public transportation. Suburban areas of each city displayed more areas with transit times greater than 50 minutes to the nearest clinic, and these areas became larger when only considering clinics with PrEP navigator services or accepting uninsured patients. Greater numbers of census tracts with higher rates of uninsured individuals or higher proportions of Hispanic individuals were associated with requiring greater than 50 minutes of transit time to their nearest clinic.

Conclusions:
PrEP deserts are just as much an issue in urban areas as they have been in rural areas when considering public transit. Structural interventions need to be taken to provide better access to PrEP clinics via public transportation, especially for uninsured and Black and Hispanic populations.

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Table of Contents

Introduction

The number of new HIV diagnoses has declined between 2010 and 2015, yet declines were not even across risk groups, with new diagnoses more prevalent in certain groups compared to others [1]. For instance, men who have sex with men (MSM) are the most affected, accounting for 67% of new diagnoses. Disparities also exist within the MSM population, with African American MSM accounting for nearly 38% of all new MSM HIV diagnoses, followed by diagnoses among Hispanic/Latino and White MSM, which both account for approximately 28% of new diagnoses [2].

These disparities exist even though effective preventative measures are available in the form of oral antiretroviral pre-exposure prophylaxis (PrEP), which has seen an 800% increase in prescriptions since 2012, resulting in a total of more than 77,000 PrEP users in the United States [3]. Clinical trials have found significant associations between the concentration of PrEP in an individual's blood plasma and protection against HIV acquisition, with medical efficacies of the medication in preventing HIV being greater than 99% [4, 5]. However, even with this high level of efficacy and the substantial increases in PrEP prescriptions seen since 2012, substantial numbers of new HIV cases continue to be diagnosed annually, indicating that other factors related to access and adherence to PrEP have a significant impact on HIV prevention.

Having access to a licensed physician who will conduct HIV testing and prescribe PrEP is necessary for patients to access PrEP, but easy access to such physicians is not always guaranteed. For one thing, not all physicians are aware of PrEP, and those physicians that are aware may not be willing to prescribe it for a host of potential reasons, such as concerns about medication toxicity or adherence [6]. This has led to a situation in

which PrEP-providing clinics are limited in number. One analysis examining the distribution of PrEP-prescribing providers in the U.S. found that most states have less than one PrEP-providing clinic per 100,000 population, indicating that patients who want to take PrEP may not be able to do so without substantial burden [7].

In addition to the scarcity of PrEP-prescribing providers, other factors have demonstrated effects that further limit access. For instance, race has been shown to impact access by being significantly associated with travel time to health care and also in provider willingness to prescribe PrEP. For instance, one study found that medical students were less likely to prescribe PrEP to African Americans in hypothetical scenarios due to assumptions that they would engage in more unprotected sex if prescribed PrEP [8]. Moreover, African Americans are more likely to have to travel a greater distance for medical care than their white counterparts even though they are disproportionately negatively affected by new HIV diagnoses [7].

Furthermore, income, access to insurance, and education level are also related to access to and use of medical providers. Those who lack high school or college educations have been shown to be more likely to live in areas where PrEP access is limited and dependent on their ability to drive longer distances [9]. Income and insurance are closely tied together as well. PrEP unfortunately comes at a high cost for those wishing to use it as a preventative measure against HIV, and areas with higher levels of poverty and lower levels of insurance coverage have poor coverage of PrEP-prescribing providers, making travel time much greater for people living in such areas since they often require clinics that offer PrEP navigation services (i.e., services that assist PrEP-eligible individuals in working with their insurance coverage and/or in applying to programs that assist with medication

co-payments[10]), which can be more limited in number [7, 9]. With CDC recommendations stating that individuals should have four yearly visits with providers for HIV testing in order to have their prescriptions refilled, many of these access issues also make it difficult for patients to maintain in PrEP care, making the medication less effective in preventing HIV [11].

Previous studies have examined the impact of these factors on access among MSM at the national level based on driving time distance to care. Yet many living in metropolitan areas do not have access to a care and instead rely on public transit systems. Therefore, this study seeks to expand on the previous literature by investigating access to PrEP providers among the MSM population, focusing specifically on how public transit utilization is associated with access to PrEP in three urban areas: Jackson, MS, Atlanta, GA, and Washington, DC.

Methods

PrEP Clinic Data

Data for PrEP-providing clinics was obtained from the CDC's National Prevention Information Network (NPIN)[12]. The initial dataset consisted of more than 1,800 clinics across all 50 states and U.S. territories, which was then limited to the 87 total clinics within the regions surrounding study assessment areas of Jackson, Atlanta, and Washington, DC. The database dataset includes variables for whether clinics serve those without insurance or offer PrEP financial services navigation. Information about clinics in this database is regularly verified by research staff to ensure that it is up-to-date and that each clinic has at least one provider who is professionally licensed to prescribe PrEP to patients and is accepting new patients. The data related to PrEP-providing clinics obtained from the NPIN database represents clinic data that was current as of January of 2019.

Demographic Data

Census tract level demographic data was obtained from results of the American Community Survey (ACS) 2016 estimates (Tables B01001, B02001, B03003, B08301, B17001, and B27001) through the IPUMS National Historical Geographic Information System (NHGIS) site sponsored by the University of Minnesota[13]. Census data obtained for the current study were used to determine the proportions of African-American, Hispanic, and uninsured individuals and those living at or below the Federal poverty line within a given census tract. Additionally, Census data related to the number of people who traveled by public transit to work was used as a proxy to determine the number of PrEP-eligible MSM within a given Census tract that relied on public transit. The NHGIS website provided national data for all 50 states, and these data were cut down only to include the census tracts relevant to the cities examined in this study using R version 3.5.3[14].

PrEP Eligibility Data

The PrEP-eligible MSM population estimates used in the present study were based on an estimate published by Smith, Van Handel, Wolitski et al.[15], which included MSM who were 18 years or older, had HIV-negative or unknow HIV status, were in serodiscordant or seroconcordant relationships, had one or more sexual partners in the past 12 months, and had STIs or condomless anal intercourse in the previous 12 months. Based on their results, they estimated that 24.7% of MSM in the United States have indications for PrEP. For the present study, the total number of PrEP-eligible MSM determined to reside in census tracts was determined by taking the 2016 county-level estimates for MSM and multiplying it by the estimate from Smith et al. to limit numbers only to those with indications for PrEP. After this calculation was made, the PrEP-eligible county-level MSM estimates were allocated to census tracts (e.g., if a census tract had 10% of the male population for a county, 10% of the overall MSM population was distributed to that census tract).

Geographic Data and Methods

Geographical shapefiles of the census tracts for Georgia, Mississippi, Virginia, Maryland, and Washington, DC were downloaded from the U.S. Census website [16] in addition to data files containing the population-weighted centroids for each census tract. These data were imported into ArcGIS 10.6 [17] where they were then altered to contain data only for the cities examined in this study. In order to determine which census tracts should remain for the final analyses and which should be removed, city public transit maps were examined to determine how far out the transit systems spread from the city centers. All census tracts falling under these transit systems were retained for the transit time queries, as were other census tracts within the same county that fell outside the transit system boundaries so that they could serve as a buffer to ensure that transit times would not be left out of the final analysis. PrEP clinics were imported into ArcGIS 10.6 and were layered onto the map with Census-provided population-weighted centroids. Using the clinic

and centroid data, a nearest neighbor analysis was performed to determine the single nearest PrEP-providing clinic for each population-weighted centroid in ArcGIS 10.6. Driving and public transit times between the centroid and the nearest clinic were then calculated using a Python-based call to the Google Maps API. These data, as well as the demographic data described above, were then joined to the census tract shapefile and displayed in a choropleth map. Census tract queries not returning values for public transit times were removed from the final analysis since these tracts did not have access to public transit.

Descriptive Analyses

Descriptive analyses were conducted for census tracts across each of the three cities, examining numbers and proportions of census tracts and PrEP-eligible MSM found within certain public transit and driving time categories (i.e., 25 minutes or less, greater than 25 minutes to 50 minutes, and greater than 50 minutes) and within tracts categorized according to proportions of uninsured, African-American race, Hispanic ethnicity, poverty, and public transit use. SAS 9.4 [18] was used to determine appropriate cut-offs in the tables based on quartiles of the proportions for each demographic category and to tabulate the MSM population residing within census tracts falling within each quartile and public transit times.

Results

Initial and Final Analysis Areas

The initial analysis area consisted of 1,739 census tracts across Jackson, MS, Atlanta, GA, and Washington, DC. Following the initial Python-based call to the Google Maps API, it was discovered that a total of 1,365 census tracts returned travel times to PrEP-prescribing clinics via public transit; therefore, these were the only tracts retained for the final analysis. Figure 1, Figure 2, and Figure 3 display the initial and final census tracts from this analysis, systems for Jackson, MS, Atlanta, GA, and Washington, DC, respectively, as well as the PrEP-prescribing clinics present in each city, and their public transit systems. The final analysis area in Jackson consisted of 48 census tracts, Atlanta's area contained 445 census tracts, and Washington, DC's area contained 872 tracts.

Population and Clinic Distributions

A total of 1,365 census tracts were included as part of the final analysis, with 48, 445, and 872 tracts located in the Jackson, MS, Atlanta, GA, Washington, DC metropolitan areas, respectively. Table 1 provides information about the distribution of the PrEP-eligible MSM population in each city by demographic attributes. Marked differences are observed across the cities in relation to how PrEP-eligible MSM are distributed according to each demographic category considered in this study. For instance, 1,120 (67.63%) and 34,210 (47.70%) of PrEP-eligible MSM reside in census tracts that had >20% of the population living below the poverty line in Jackson and Atlanta, respectively. In contrast, Washington, DC had 46,386 (54.86%) PrEP-eligible MSM living in tracts with <10% poverty.

When considering race and ethnicity, all three cities had a greater portion of their population living in counties with >20% of the population being African-American, with Jackson having 1,612 (97.34%), Atlanta having 49,645 (69.22%), and Washington, DC having 41,424 (48.99%) PrEP-eligible MSM living in such tracts. However, this pattern was opposite when considering Hispanic ethnicity, with all three cities showing that the vast majority of the PrEP-eligible MSM population living in tracts where the Hispanic population made up <10% of the total population. Additionally, Jackson had 1,032 (62.32%) PrEP-eligible MSM and Atlanta had 37,284 (51.98%) PrEP-eligible MSM residing within tracts where >20% of the population were uninsured, while 54,653 (64.64%) PrEP-eligible MSM live in tracts with <10% of the population being uninsured in Washington, D.C.

Differences were observed in public transit use as well. For Jackson, 1,588 (95.89%) PrEP-eligible MSM were in tracts with <5% of the population using public transit (based on use of public transit when commuting to work), with little variability for assessment. Atlanta exhibited slightly more variability in public transit use; however, 53.89% (N = 38,833) of the PrEP-eligible population lived within tracts with <5% public transit use. Washington, DC exhibited the greatest degree of public transit use, and in this case 68.88% (N = 58,245) of the PrEP-eligible MSM population lived in tracts with >20% public transit use.

In addition to examining the distribution of the PrEP-eligible MSM population according to population demographics, the distribution of PrEP-prescribing clinics and the services they provide was also investigated across each city (Table 2). Altogether, there were 83 PrEP-prescribing clinics within the analytical areas across the three cities.

When considering all clinics regardless of services provided, the number of clinics available rose as the number of PrEP-eligible MSM in a city increased, with Jackson having 4 clinics, Atlanta having 30, and Washington, DC having 49. When clinics were limited by services, this relationship essentially remained, though sharp decreases in the number of available clinics were observed for both Atlanta and Washington, DC.

Driving and Transit Times for All PrEP-Prescribing Clinics

The distribution of driving and public transit times to all PrEP-prescribing clinics, regardless of services offered, is displayed in Figure 4. In relation to driving times, each of the three cities exhibited driving times that were predominantly less than or equal to 25 minutes, with a small number of tracts around the edge of the maps for Atlanta and Washington, DC displaying driving times that were between 25 and 50 minutes. In contrast, transit times for each of the tracts were more varied, with transit times in the middle of the analysis areas exhibiting shorter transit times than those on the out edges. The maps also show that PrEP-prescribing clinics are much more clustered in Atlanta and Jackson, whereas they appear to be more spread out in Washington, DC. For example, in Atlanta, while there appear to be many clinics in the city center with some spreading out to the north, the southern portion of the metropolitan area has no clinics present.

Table 3 examines the distribution of the PrEP-eligible MSM population across transit times and demographic characteristics in order to provide denominators for the portion of the population found within a given transit time. In Jackson and Atlanta, the majority of the overall population of PrEP-eligible MSM can be found in tracts exhibiting a travel time of greater than 50 minutes on public transit, with 1,010 (60.99%) in tracts classified as such in Jackson and 33,909 (47.28%) in tracts classified as such in Atlanta.

This remains relatively constant across all categorizations of demographic variables, with the majority of each demographic categorization being found within the greater than 50 minutes transit time category. The opposite situation is observed in Washington, DC, with 46,168 (54.60%) of PrEP-eligible MSM found in tracts characterized as requiring 25 minutes or less on public transit to arrive at any nearest PrEP-prescribing clinic. The majority was consistently found in the 25 minutes or less category across each demographic categorization except for public transit utilization, in which the amount of travel time appears to increase for tracts in which less than 20% of the population utilizes public transit for their commute.

Driving and Transit Times for PrEP-Prescribing Clinics with PrEP Navigation Services

Figure 5 displays the distribution of driving and public transit times to the nearest PrEP-prescribing clinic with a PrEP navigator for each of the three cities examined in this study. Driving times in this map continue to be relatively consistent, with all three maps displaying driving times mostly less then 25 minutes to the nearest PrEP-prescribing clinic with a PrEP navigator. However, there are slightly more tracts exhibiting driving times between 25 and 50 minutes on the outer edges of Atlanta and Washington, DC. When examining the distribution of transit times, large portions of the outer census tracts of each of the cities exhibit travel times of greater than 50 minutes, with most clinics primarily focused within the city center for all three cities. For instance, while Atlanta and Washington, DC have some clinics in their Western and Northwestern suburbs, the vast majority of PrEP navigator services are found within the city center.

Denominators for transit time categories for clinics with PrEP navigator services across the three cities and the distribution of the PrEP-eligible MSM population across these and the other demographic categories are displayed in Table 4. Once again, for Jackson and Atlanta, the majority of the PrEP-eligible MSM population resides within census tracts requiring more than 50 minutes of travel time on public transit to the nearest PrEP clinic with navigation services. In Jackson, this number increased to 1,512 (91.30%), and in Atlanta this number increased to 39,385 (56.95%). In Washington, DC, the overall distribution of PrEP-eligible MSM across transit time categories was relatively similar, with slightly more residing in census tracts requiring less than 25 minutes of time on public transit to get to their nearest clinic with navigator services (N = 30,908, 36.80%). When examining census tract demographics, it is apparent that the majority of PrEP-eligible MSM live in tracts requiring greater than 50 minutes of time on public transit regardless of how much of a given population demographic makes up the population in a census tract. However, it appear that tracts with greater than 10% of the population being uninsured or Hispanic have a greater proportion of their MSM population living more than 50 minutes away from PrEP navigation services by transit in Atlanta. In Washington, DC, the distribution of PrEP-eligible MSM is more scattered. However, one particularly salient characteristic of this population is that as the proportion of the population that is uninsured increases within a tract, the more MSM are found within tracts requiring greater than 50 minutes of time on transit to the nearest PrEP navigator services, with a majority from each demographic split showing greater than 10% uninsured within the population being in this category.

Driving and Transit Times for PrEP-Prescribing Clinics Accepting Uninsured Patients

Figure 6 displays the distribution of driving and transit times across the three cities in this study while also showing the locations of the PrEP-prescribing cities in each city that accept patients without insurance. Compared to the previous two maps, driving times for Atlanta and Washington, DC are somewhat different, showing a greater number of tracts with greater than 25 minutes of travel time and lower travel times around the city centers for both and in the Western suburbs for Washington, DC. Public transit times to outside of the city centers for each city in the study, with the exception of one of the PrEP-prescribing clinics accepting uninsured patients are overall greater than 50 minutes more limited and more tightly clustered in western suburbs of Washington, DC where there is one clinic present that accepts uninsured patients. Compared to previous maps, the number of available clinics is much

Denominator data are displayed for transit time categories across the three cities in this study based on time to the closest clinic accepting uninsured patients in Table 5. For all three cities, a greater proportion of the PrEP-eligible MSM population lives within census tracts requiring greater than 50 minutes of travel time compared to other travel time categories, with 1,491 (90.04%) MSM in Jackson, 44,188 (64.20%) MSM in Atlanta, and 35,224 (41.80%) MSM in Washington, DC living in such a census tract. Within census tracts that have a proportion of the population that is more than 10% Hispanic or more than 10% uninsured, Atlanta and Washington, DC both show increasing proportions of the PrEP-eligible MSM living in tracts requiring greater than 50 minutes of time on transit as the proportion of Hispanic or uninsured individuals increase.

For instance, while 33.91% (N=18,462) of PrEP-eligible MSM in Washington, DC live in a census tract with less than 10% of the population uninsured and requiring a 50-minute transit time to a clinic, 73.22% of PrEP-eligible MSM living in a census tract with greater than 20% of the population uninsured require over 50 minutes of transit time to a clinic, indicating that as the uninsured rate increases, PrEP-eligible MSM in these census tracts with higher insurance rates are more likely to have to spend more time in transit to get to clinics they may need.

Median Travel Time by City

Finally, Table 6 displays the median travel time and interquartile range in travel for both driving and public transit by city and clinic service. Median driving times do not appear to differ markedly across cities for all clinics, but when PrEP-navigator services are specified, median driving times for Atlanta (18.00 minutes, IQR = 13.00) and Washington, DC (18.00 minutes, IQR = 11.00) appear to increase to a greater extent and exhibit a wider spread than what is witnessed in Jackson. A similar situation occurs to a slightly greater extent when clinics are restricted to those accepting uninsured patients, with Atlanta's median driving time being 23.00 minutes (IQR = 15.00) and Washington, DC's median driving time being 21.00 minutes (IQR = 13.00). In both cases, Jackson's median driving time remains lower at 12.00 minutes which likely due to the smaller area that needs to be covered in Jackson compared to what is seen in the other two cities.

Median transit times differ across city when all clinics are considered, with Washington, DC exhibiting the lowest median transit time, Jackson the second lowest, and Atlanta the highest. Clinics with PrEP navigator services result in a similar, but less pronounced pattern; however, in this instance Jackson and Atlanta switch places. When

considering only clinics that accept uninsured patients, there is no clear difference observed across the three cities, with all of them exhibiting median transit times close to 60 minutes.

Discussion

This study provides both a depiction of access to PrEP providers in urban areas as well as new methods for considering transit burden for individuals reliant on public transportation services for obtaining care. As stated previously, few studies have attempted to investigate the role of public transportation and access to care, and those that have employed different methods than those used here and have had several limitations. The present study attempts to address some of these limitations by providing a new potential methodology that can be used for assessing access to care, specifically access to PrEP-prescribing providers, that uses more accurate calculations of public transportation travel time and estimates of public transit usage. In particular, previous studies have estimated travel time on public transportation by utilizing a single speed and applying that speed to the distance needed to travel to a given clinic, leading to arguably inaccurate determinations of travel time via transit [19]. In contrast, the present study attempts to use real-time estimates obtained from the Google Maps API, which finds the fastest route through multiple public transit modalities. Using the Python code for these queries (see Appendix) makes this methodology easily reproducible while also allowing for the potential to put in multiple requests to Google Maps that examine transit times at different times of day when traffic patterns differ, thus allowing for the determination of an average travel time that is more representative of the true travel time to a given clinic. Such methodology for investigating access to care via public transit is currently not present in the literature and, therefore, this study makes a significant contribution to future research in this area by providing such a method for future use.

In addition to utilizing a new methodology for assessing access to PrEP-providing clinics via public transit, the present study also contributes to the current literature investigating the impact of factors such as race, ethnicity, poverty, and insurance coverage on access to care. Previous studies have identified disparities in access to general medical care via driving across racial and ethnic lines and among those in poverty [9, 20]. The results of the present study further confirm these disparities, with Black and Hispanic populations more affected by longer travel times on transit to PrEP-prescribing clinics for the three cities examined. Additionally, poverty also appeared to be associated with higher transit times in Atlanta and Jackson, but not in Washington, DC, which indicates that such populations are affected when both driving and transit are taken into account and that access needs to be significantly improved among these populations, especially since these populations tend to see higher rates of new HIV diagnoses and would therefore benefit from greater access to PrEP-prescribing providers.

PrEP deserts (considered to be regions in which travel to the nearest PrEP-prescribing provder takes greater than 25 minutes in the present study) have also been examined in previous studies, which have found that rural areas and MSM living in the southern United States tend to have the highest proportion of PrEP deserts when considering access by car. The present study adds to these findings by showing that even urban areas that have high levels of access by car can have PrEP deserts for those who are reliant upon public transit. The cities in this study were chosen based on the degree to which their public transit systems have been developed. The Washington, DC transit system is highly developed, having the second largest rail system and sixth largest bus system in the United States, and it extends over three states. In contrast, the Jackson

transit system is much smaller with a more limited number or routes that primarily serve the downtown portion of Jackson. Atlanta falls in between these two cities. While it has a developed bus and rail system, its system only provides services to two of its regions, with larger suburbs found in Gwinnett and Cobb counties required to develop their own bus systems that can connect their citizens to the city, which some have argued is a result of opposition to desegregation. Results across these three transit systems showed that when access to any PrEP-prescribing clinic is considered, those reliant on public transit for access can potentially face extensive barriers to access even within an urban area since the number of PrEP deserts markedly increases when comparing transit access to driving access. Additionally, the analyses here show that considering access in general is not enough and that considering specific services is perhaps a more useful method for determining the level of access that people have to these clinics. While general access to clinics, regardless of their services, provided a more favorable picture of access to PrEP-prescribing providers, the truth remains that many people are limited to finding PrEP-prescribing clinics with the proper services for their situation, especially those who are uninsured or who live in poverty. When considering only clinics that provide PrEP navigator services or that see the uninsured, significant impacts on time to care were observed, which can have extensive impacts on PrEP initiation and adherence. In particular, those who are uninsured are more proportionately affected by longer travel times on transit to PrEP-prescribing clinics that will accept them as patients in their practice (even in Washington, DC where the public transit system is most developed), signaling that there is a higher need for clinics accepting uninsured patients and that more of these clinics are needed in areas where there are potentially higher numbers of

uninsured MSM. This also suggests that even highly developed public transit systems cannot necessarily overcome issues related to access to specific services.

Limitations

The present study has several limitations that need to be considered when interpreting the results. First of all, MSM estimates were only available at the county level. Therefore, it was assumed that the distribution of MSM county level estimates across census tracts would be similar to the distribution of overall male county-level estimates across census tracts. This may have resulted in certain tracts having far larger or smaller numbers of MSM than is actually the case. Additionally, travel time estimates for this study were based on a single point estimate based on where the greatest numbers of people live within a census tract. While using this point as the only origin in a given census tract may provide an adequate estimate of travel time for the population within that tract, it is by no means representative of the reality that people face, and it does not adequately capture the variability in travel times that would be found if all potential origin points were mapped and tested. Although using every possible origin point is not feasible in a study like this, it may be worthwhile to consider testing multiple origin points within a census tract to get a potentially more accurate overall estimate that better accounts for variability in future iterations of this work. Furthermore, classifying census tracts on public transit reliance was based solely on ACS data indicating the number of people who use public transit on their commutes to work. While this may give a general estimate of census tracts where people rely more heavily on public transit, there are other factors that may influence whether transit would be used for visiting a healthcare provider. For instance, an individual may use public transit to commute to work in the

morning, but may use a car for other tasks. Additionally, some individuals may have less consistent access to a car but might be able to use one for a visit to a healthcare provider when they have an appointment. Finally, one last limitation regarding transit reliance is that it was assumed that the percentage of people using transit within a given census tract would be representative of the proportion of the MSM population using public transit in the same census tract. This, of course, may not be accurate as there is the possibility that far higher or far lower percentages of the MSM population may rely on public transit for commuting to work or for taking care of everyday tasks such as visiting a doctor.

Conclusion

Overall, the results of this study indicate that disparities exist in relation to access to PrEP and PrEP-related services via public transit within urban areas. Additionally, results indicate that PrEP deserts, largely identified as an issue in rural, Southern communities in previous work, also pose a major issue in urban areas when individuals seeking out PrEP services rely on public transit for access, and these deserts can be quite extensive if PrEP navigation services or clinics that accept the uninsured are needed. Based on these results, it is apparent that structural interventions need to be considered, especially when considering the uninsured and Black populations, though providing easier access to PrEP either via more clinics or better transit actions for these populations.

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Table 1. Distribution of census tracts and PrEP-eligible MSM across Jackson, MS, Atlanta, GA, and Washington, DC

	Jackson, MS		Atlanta, GA		Washington, DC	
	N	**%**	**N**	**%**	**N**	**%**
Total PrEP-Eligible Population	1,656	1.05	72,065	45.53	84,555	53.42
Poverty[1]						
< 10%	95	5.74	19,424	27.08	46,386	54.86
10% to < 15%	48	2.90	9,934	13.85	15,188	17.96
15% to < 20%	393	23.73	8,156	11.37	8,088	9.57
> 20%	1,120	67.63	34,210	47.70	14,893	17.61
Black Population						
< 10%	21	1.27	7,999	11.15	28,956	34.25
10% to < 15%	23	1.39	6,240	8.70	9,028	10.68
15% to < 20%	-	-	8,181	11.41	5,147	6.09
> 20%	1,612	97.34	49,645	69.22	41,424	48.99
Hispanic Population						
< 5%	1,124	67.87	26,850	37.26	16,372	19.36
5% to < 10%	489	29.53	15,147	21.02	24,948	29.51
10% to < 15%	43	2.60	7,415	10.29	14,932	17.66
> 15%	-	-	22,653	31.43	28,299	33.47
Uninsured Population						
< 10%	147	8.88	16,220	22.61	54,653	64.64
10% to < 15%	313	18.90	8,749	12.20	12,410	14.68
15% to < 20%	164	9.90	9,812	13.68	6,819	8.06
> 20%	1,032	62.32	37,284	51.98	10,673	12.62
Population Using Public Transit						
< 5%	1,588	95.89	38,833	53.89	4,182	4.95
5% to < 10%	68	4.11	15,464	21.46	11,254	13.31
10% to < 20%	-	-	6,771	9.40	10,874	12.86
> 20%	-	-	10,997	15.26	58,245	68.88

[1]*Note: The ACS was missing data on poverty for 7 census tracts in the analysis area.*

Table 2. Distribution of PrEP-prescribing clinics by city and services offered

	Jackson, MS		Atlanta, GA		Washington, DC	
	N	**%**	**N**	**%**	**N**	**%**
All Clinics	4	4.82	30	36.14	49	59.04
Clinics Accepting Uninsured Patients	1	5.88	7	41.18	9	52.94
Clinics with PrEP Navigator Services	1	4.00	7	28.00	17	68.00

Table 3. Distribution of PrEP-Eligible MSM population by public transit time to nearest PrEP-prescribing clinic by census tract demographics across Jackson, MS, Atlanta, GA, and Washington, DC

	Jackson, MS						Atlanta, GA						Washington, DC					
	<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes		<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes		<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total PrEP-Eligible Population	265	16.00	381	23.01	1,010	60.99	15,459	21.55	22,356	31.17	33,909	47.28	46,168	54.60	25,867	30.59	12,520	14.81
Poverty																		
< 10%	-	0.00	36	37.89	59	62.11	4,854	24.99	5,592	28.79	8,978	46.22	17,956	38.71	16,966	36.58	11,464	24.71
10% to < 15%	-	0.00	-	0.00	48	100.00	1,213	12.21	3,077	30.97	5,644	56.81	10,088	66.42	4,306	28.35	794	5.23
15% to < 20%	55	13.99	43	10.94	295	75.06	1,649	20.22	2,437	29.88	4,070	49.90	5,387	66.60	2,582	31.92	119	1.47
> 20%	210	18.75	302	26.96	608	54.29	7,743	22.63	11,250	32.89	15,217	44.48	12,737	85.52	2,013	13.52	143	0.96
Black Population																		
< 10%	-	0.00	-	0.00	3	100.00	2,488	31.10	3,016	37.70	2,495	31.19	11,560	39.92	11,795	40.73	5,601	19.34
10% to < 15%	23	100.00	-	0.00	-	0.00	2,063	33.06	1,553	24.89	2,624	42.05	4,788	53.04	3,236	35.84	1,004	11.12
15% to < 20%	-	0.00	-	0.00	-	0.00	2,480	30.31	2,219	27.12	3,482	42.56	2,631	51.12	1,571	30.52	945	18.36
> 20%	242	15.01	381	23.64	989	61.35	8,535	17.19	15,802	31.83	25,308	50.98	27,189	65.64	9,265	22.37	4,970	12.00
Hispanic Population																		
< 5%	265	23.58	381	33.90	478	42.53	8,105	30.19	7,949	29.61	10,796	40.21	11,606	70.87	3,095	18.90	1,675	10.23
5% to < 10%	-	0.00	-	0.00	489	100.00	5,302	35.00	4,303	28.41	5,542	36.59	13,437	53.86	7,014	28.11	4,497	18.03
10% to < 15%	-	0.00	-	0.00	43	100.00	287	3.87	2,040	27.51	5,088	68.62	6,775	45.37	5,184	34.72	2,973	19.91
> 15%	-	0.00	-	0.00	-	0.00	1,872	8.26	8,298	36.63	12,483	55.11	14,350	50.71	10,574	37.37	3,375	11.93
Uninsured Population																		
< 10%	23	15.65	79	53.74	45	30.61	6,783	41.82	5,105	31.47	4,332	26.71	33,357	61.03	13,209	24.17	8,087	14.80
10% to < 15%	-	0.00	23	7.35	290	92.65	2,160	24.69	2,013	23.01	4,576	52.30	5,785	46.62	4,488	36.16	2,137	17.22
15% to < 20%	9	5.49	23	14.02	132	80.49	1,271	12.95	2,321	23.65	6,220	63.39	3,179	46.62	2,749	40.31	891	13.07
> 20%	233	22.58	256	24.81	543	52.62	5,352	14.35	13,151	35.27	18,781	50.37	3,847	36.04	5,421	50.79	1,405	13.16
Population Using Public Transit																		
< 5%	246	15.49	351	22.10	991	62.41	5,823	14.99	11,633	29.96	21,377	55.05	282	6.74	1,384	33.09	2,516	60.16
5% to < 10%	19	27.94	30	44.12	19	27.94	4,493	29.05	4,646	30.04	6,325	40.90	1,926	17.11	4,412	39.20	4,916	43.68
10% to < 20%	-	0.00	-	0.00	-	0.00	1,363	20.13	2,136	31.55	3,272	48.32	2,094	19.26	6,224	57.24	2,556	23.51
> 20%	-	0.00	-	0.00	-	0.00	3,887	35.35	4,175	37.96	2,935	26.69	41,866	71.88	13,847	23.77	2,532	4.35

Table 4. Distribution of PrEP-eligible MSM population by public transit time to nearest PrEP-prescribing clinic with PrEP navigator services by census tract demographics across Jackson, MS, Atlanta, GA, and Washington, DC

	Jackson, MS						Atlanta, GA						Washington, DC					
	<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes		<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes		<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total PrEP-Eligible Population	23	1.39	121	7.31	1,512	91.30	9,738	14.08	20,040	28.98	39,385	56.95	30,908	36.80	26,989	32.14	26,087	31.06
Poverty																		
< 10%	-	0.00	-	0.00	95	100.00	1,583	8.66	3,310	18.10	13,391	73.24	11,314	24.69	13,952	30.45	20,549	44.85
10% to < 15%	-	0.00	-	0.00	48	100.00	785	8.80	2,098	23.51	6,041	67.69	7,452	49.07	4,319	28.44	3,417	22.50
15% to < 20%	23	5.85	32	8.14	338	86.01	1,206	15.57	2,259	29.17	4,280	55.26	4,316	53.36	2,721	33.64	1,051	12.99
> 20%	-	0.00	89	7.95	1,031	92.05	6,164	18.02	12,373	36.17	15,673	45.81	7,826	52.55	5,997	40.27	1,070	7.18
Black Population																		
< 10%	-	0.00	-	0.00	21	100.00	526	6.79	2,591	33.47	4,624	59.73	6,645	23.07	9,884	34.31	12,278	42.62
10% to < 15%	23	100.00	-	0.00	-	0.00	1,278	21.48	757	12.72	3,914	65.79	3,483	38.58	2,759	30.56	2,786	30.86
15% to < 20%	-	0.00	-	0.00	-	0.00	1,562	22.54	575	8.30	4,792	69.16	1,856	36.06	1,594	30.97	1,697	32.97
> 20%	-	0.00	121	7.51	1,491	92.49	6,469	13.24	16,351	33.46	26,054	53.31	18,924	46.15	12,752	31.10	9,326	22.75
Hispanic Population																		
< 5%	23	2.05	121	10.77	980	87.19	4,596	17.12	10,096	37.60	12,158	45.28	5,780	35.48	6,702	41.14	3,808	23.38
5% to < 10%	-	0.00	-	0.00	489	100.00	3,562	25.17	3,515	24.83	7,077	50.00	10,433	41.89	6,131	24.62	8,339	33.49
10% to < 15%	-	0.00	-	0.00	43	100.00	-	0.00	1,952	28.92	4,797	71.08	5,053	33.84	4,919	32.94	4,960	33.22
> 15%	-	0.00	-	0.00	-	0.00	1,687	7.76	4,711	21.66	15,353	70.59	9,642	34.61	9,237	33.16	8,980	32.23
Uninsured Population																		
< 10%	23	15.65	-	0.00	124	88.80	3,222	39.24	4,220	51.39	770	9.38	24,467	44.89	15,223	27.93	14,814	27.18
10% to < 15%	-	0.00	-	0.00	313	100.00	1,855	22.71	1,398	17.12	4,915	60.17	3,894	31.49	4,129	33.39	4,342	35.12
15% to < 20%	-	0.00	-	0.00	164	100.00	871	9.57	2,199	24.15	6,034	66.28	1,790	26.25	2,416	35.43	2,613	38.32
> 20%	-	0.00	121	11.72	911	88.28	3,897	10.53	12,457	33.67	20,646	55.80	757	7.35	5,221	50.71	4,318	41.94
Population Using Public Transit																		
< 5%	23	1.45	102	6.42	1,463	92.13	2,190	6.04	7,628	21.03	26,454	72.93	4	0.10	533	12.94	3,582	86.96
5% to < 10%	-	0.00	19	27.94	49	72.06	3,458	22.36	3,577	23.13	8,429	54.51	350	3.13	2,444	21.88	8,374	74.98
10% to < 20%	-	0.00	-	0.00	-	0.00	1,220	18.02	3,128	46.20	2,423	35.78	769	7.07	3,995	36.74	6,110	56.19
> 20%	-	0.00	-	0.00	-	0.00	2,977	37.06	2,977	37.06	2,079	25.88	29,785	51.51	20,017	34.62	8,021	13.87

Table 5. Distribution of PrEP-Eligible MSM population by public transit time to nearest PrEP-prescribing clinic accepting uninsured patients by census tract demographics across Jackson, MS, Atlanta, GA, and Washington, DC

	Jackson, MS						Atlanta, GA						Washington, DC					
	<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes		<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes		<= 25 Minutes		>25 to <= 50 Minutes		> 50 Minutes	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total PrEP-Eligible Population	23	1.39	142	8.57	1,491	90.04	8,375	12.17	16,269	23.64	44,188	64.20	26,548	31.51	22,486	26.69	35,224	41.80
Poverty																		
< 10%	-	0.00	-	0.00	95	100.00	2,533	14.12	3,187	17.76	12,223	68.12	8,782	19.05	10,932	23.72	26,375	57.23
10% to < 15%	-	0.00	-	0.00	48	100.00	970	10.66	1,457	16.01	6,674	73.33	6,171	40.63	4,248	27.97	4,769	31.40
15% to < 20%	23	5.85	32	8.14	338	86.01	1,190	15.36	1,625	20.98	4,930	63.65	3,924	48.52	2,078	25.69	2,086	25.79
> 20%	-	0.00	110	9.82	1,010	90.18	3,682	10.82	10,000	29.37	20,361	59.81	7,671	51.51	5,228	35.10	1,994	13.39
Black Population																		
< 10%	-	0.00	-	0.00	21	100.00	1,036	13.38	2,498	32.27	4,208	54.35	5,749	19.92	8,552	29.64	14,554	50.44
10% to < 15%	23	100.00	-	0.00	-	0.00	1,428	24.00	906	15.23	3,615	60.77	2,333	26.28	2,310	26.02	4,234	47.70
15% to < 20%	-	0.00	-	0.00	-	0.00	1,903	25.80	442	5.99	5,031	68.21	1,224	23.78	1,018	19.78	2,905	56.44
> 20%	-	0.00	142	8.81	1,470	91.19	4,115	8.55	12,657	26.31	31,334	65.14	17,242	41.67	10,606	25.63	13,531	32.70
Hispanic Population																		
< 5%	23	2.05	142	12.63	959	85.32	3,823	14.24	10,271	38.25	12,756	47.51	5,640	34.50	5,613	34.34	5,094	31.16
5% to < 10%	-	0.00	-	0.00	489	100.00	3,785	26.40	3,277	22.86	7,274	50.74	9,358	37.84	6,017	24.33	9,353	37.82
10% to < 15%	-	0.00	-	0.00	43	100.00	-	0.00	1,277	19.03	5,432	80.97	3,591	24.05	4,913	32.90	6,428	43.05
> 15%	-	0.00	-	0.00	-	0.00	874	4.11	1,678	7.89	18,726	88.01	7,959	28.17	5,943	21.04	14,349	50.79
Uninsured Population																		
< 10%	23	15.65	-	0.00	124	84.35	4,254	28.00	3,932	25.88	7,006	46.12	21,468	39.43	14,519	26.67	18,462	33.91
10% to < 15%	-	0.00	-	0.00	313	100.00	1,988	23.81	1,348	16.14	5,014	60.05	2,882	23.31	3,700	29.92	5,783	46.77
15% to < 20%	-	0.00	-	0.00	164	100.00	907	10.31	1,559	17.72	6,332	71.97	1,820	26.88	1,787	26.39	3,164	46.73
> 20%	-	0.00	142	13.76	890	86.24	1,333	3.62	9,664	26.24	25,836	70.14	378	3.54	2,480	23.24	7,815	73.22
Population Using Public Transit																		
< 5%	23	1.45	104	6.55	1,461	92.00	2,720	7.57	4,061	11.30	29,160	81.13	4	0.10	694	16.79	3,436	83.12
5% to < 10%	-	0.00	38	55.88	30	44.12	3,405	22.02	2,648	17.12	9,411	60.86	309	2.75	1,395	12.43	9,521	84.82
10% to < 20%	-	0.00	-	0.00	-	0.00	906	13.38	3,056	45.13	2,809	41.49	500	4.60	3,470	31.91	6,904	63.49
> 20%	-	0.00	-	0.00	-	0.00	1,451	13.19	6,738	61.27	2,808	25.53	25,735	44.35	16,927	29.17	15,363	26.48

Table 6. Medians and IQRs of travel time to PrEP-prescribing clinics across Jackson, MS, Atlanta, GA, and Washington, DC

	All Clinics			Clinics with PrEP Navigator Services			Clinics Accepting Uninsured Patients		
	Jackson	**Atlanta**	**DC**	**Jackson**	**Atlanta**	**DC**	**Jackson**	**Atlanta**	**DC**
Driving Times									
Median	9.83	13.38	10.39	12.00	18.00	18.00	12.00	23.00	21.00
IQR	7.11	11.03	8.20	4.50	13.00	11.00	5.00	15.00	13.00
Transit Times									
Median	42.61	51.99	30.96	64.00	51.00	48.00	61.50	59.00	58.00
IQR	33.88	37.05	30.75	20.50	55.00	48.00	20.00	62.00	46.00

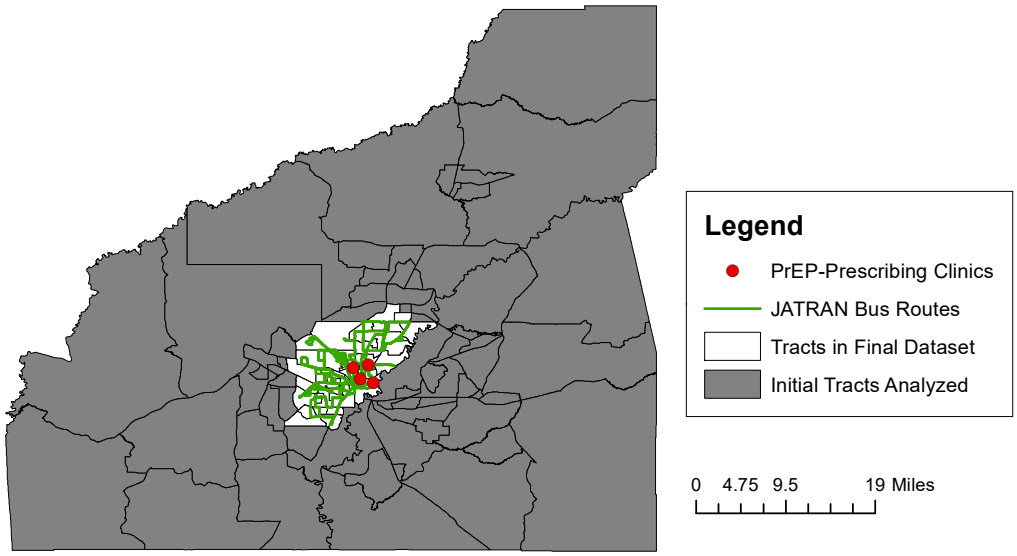

Figure 1. Initial and final analysis areas for the city of Jackson, MS with Jackson Transit (JATRAN) bus routes and all PrEP-prescribing clinics in the area.

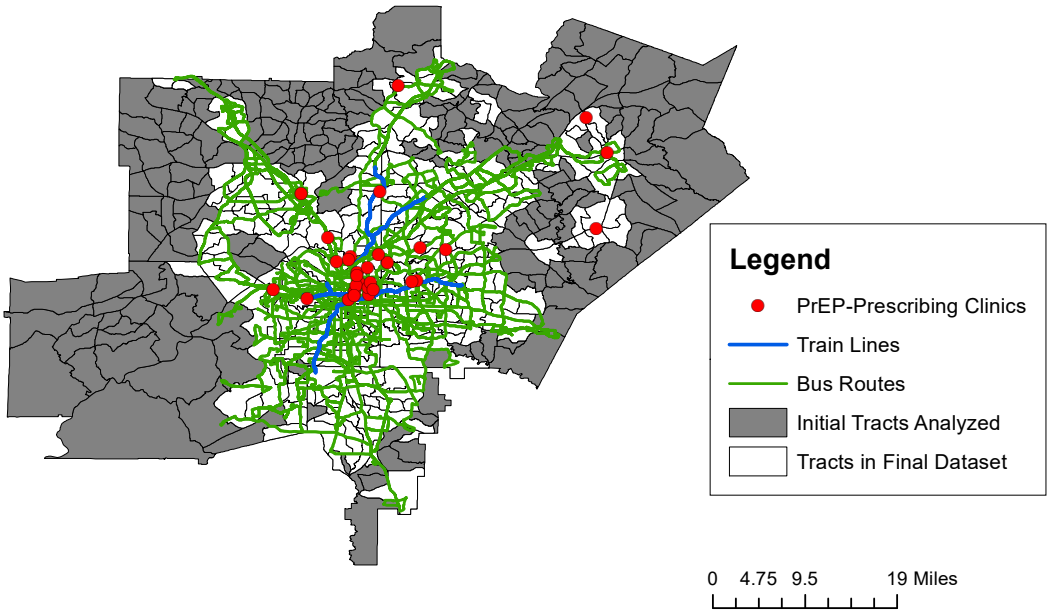

Figure 2. Initial and final analysis areas for the city of Atlanta, GA with Metropolitan Atlanta Rapid Transit Authority (MARTA), Gwinnett County, and Cobb County bus and train routes and all PrEP-prescribing clinics in the area.

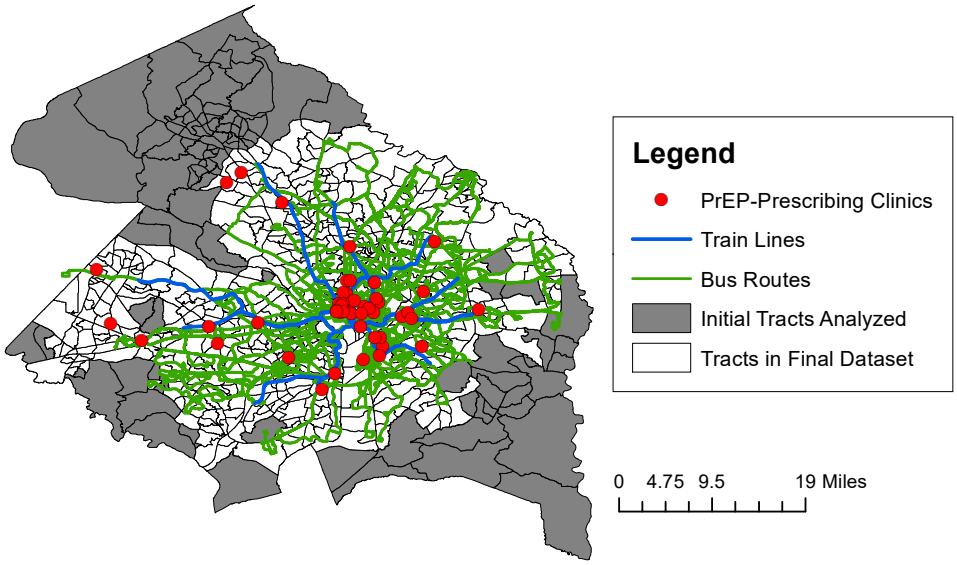

Figure 3. Initial and final analysis areas for Washington, DC and the surrounding metropolitan area with Washington Metropolitan Area Transit Authority (WMATA) bus and train routes and all PrEP-prescribing clinics in the area.

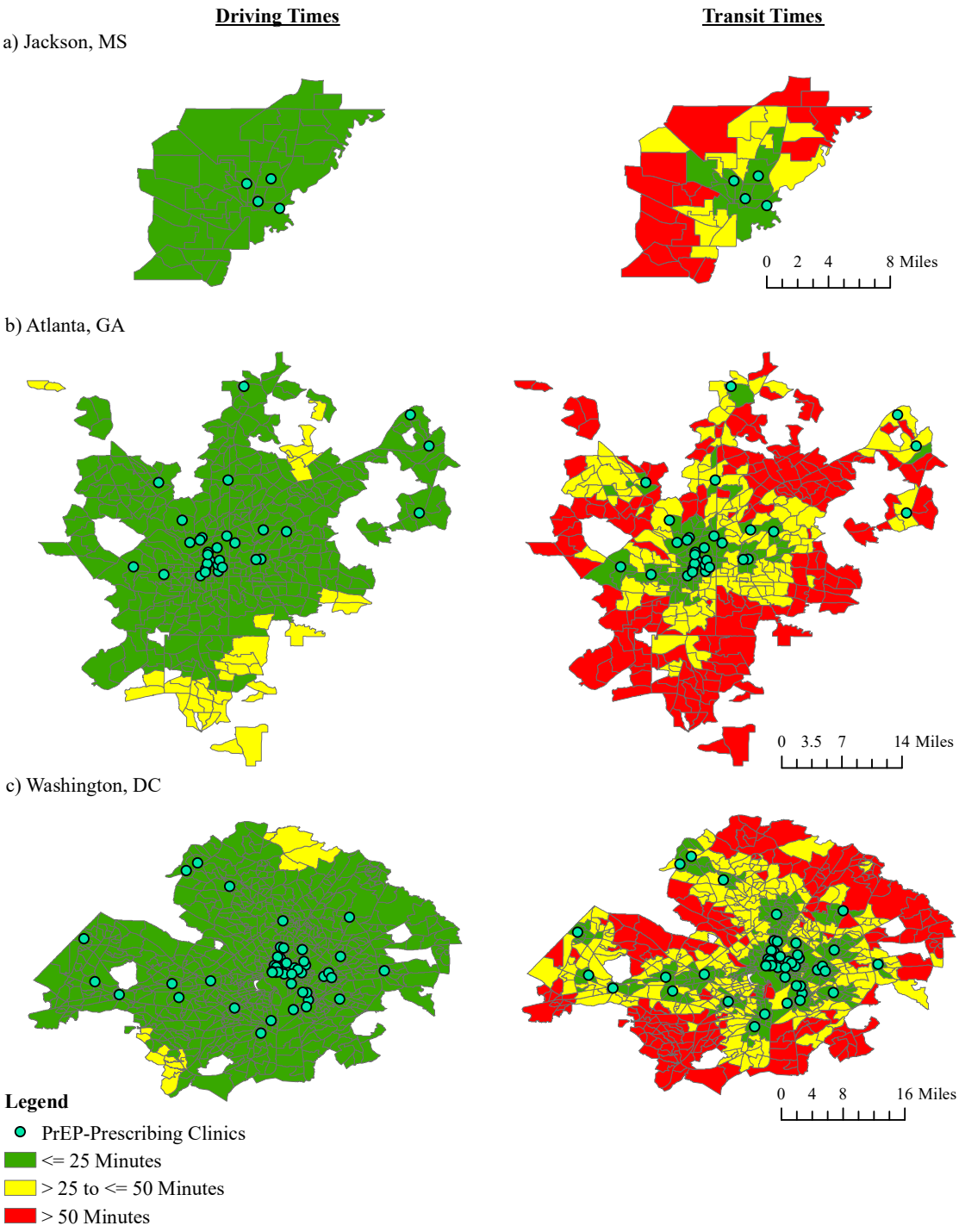

Figure 4. Distribution of average driving and public transportation times to all PrEP-prescribing clinics by census tract in Jackson, MS, Atlanta, GA, and Washington, DC.

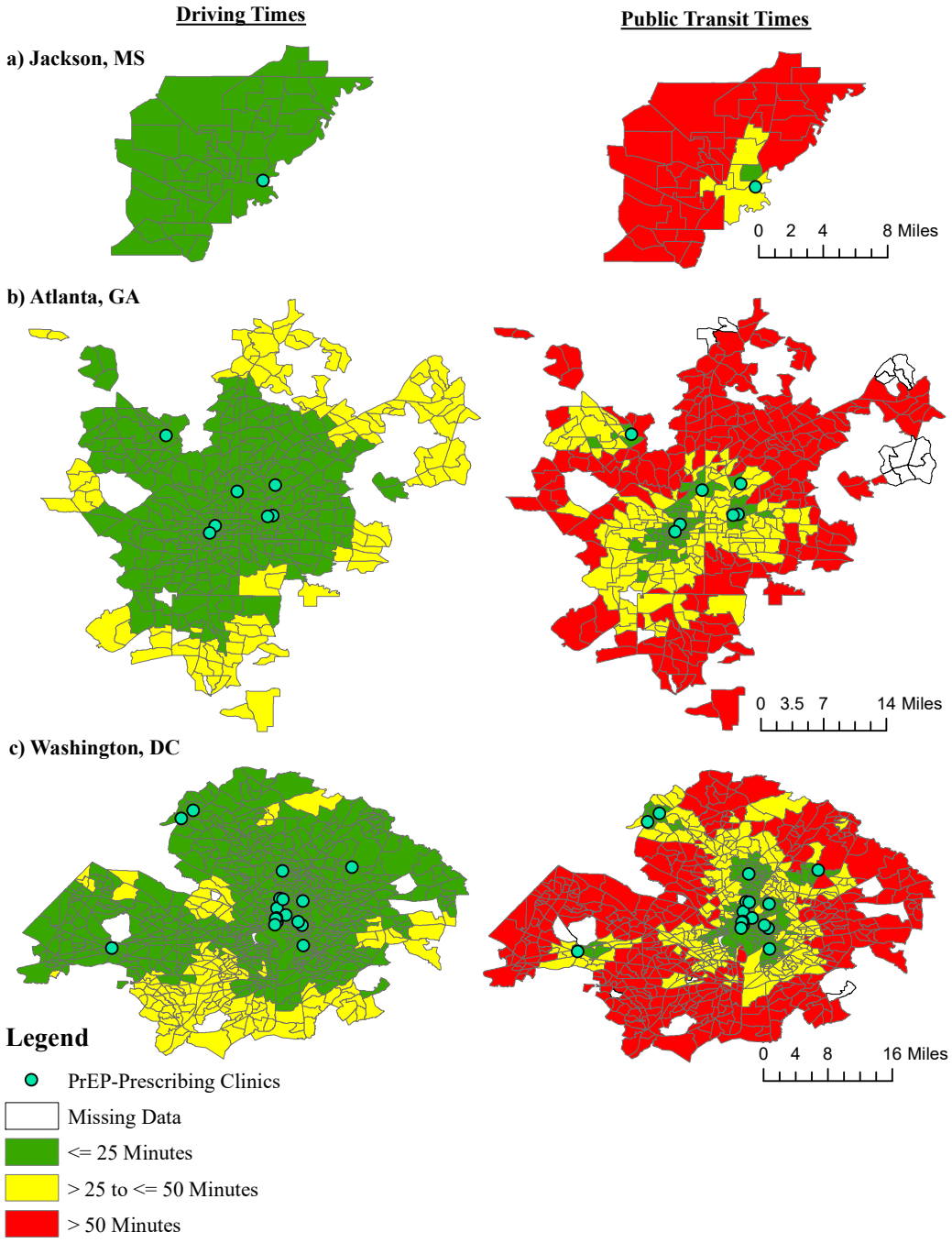

Figure 5. Distribution of average driving and public transportation times to PrEP-prescribing clinics with PrEP navigator services by census tract in (a) Jackson, MS, (b) Atlanta, GA, and (c) Washington, DC

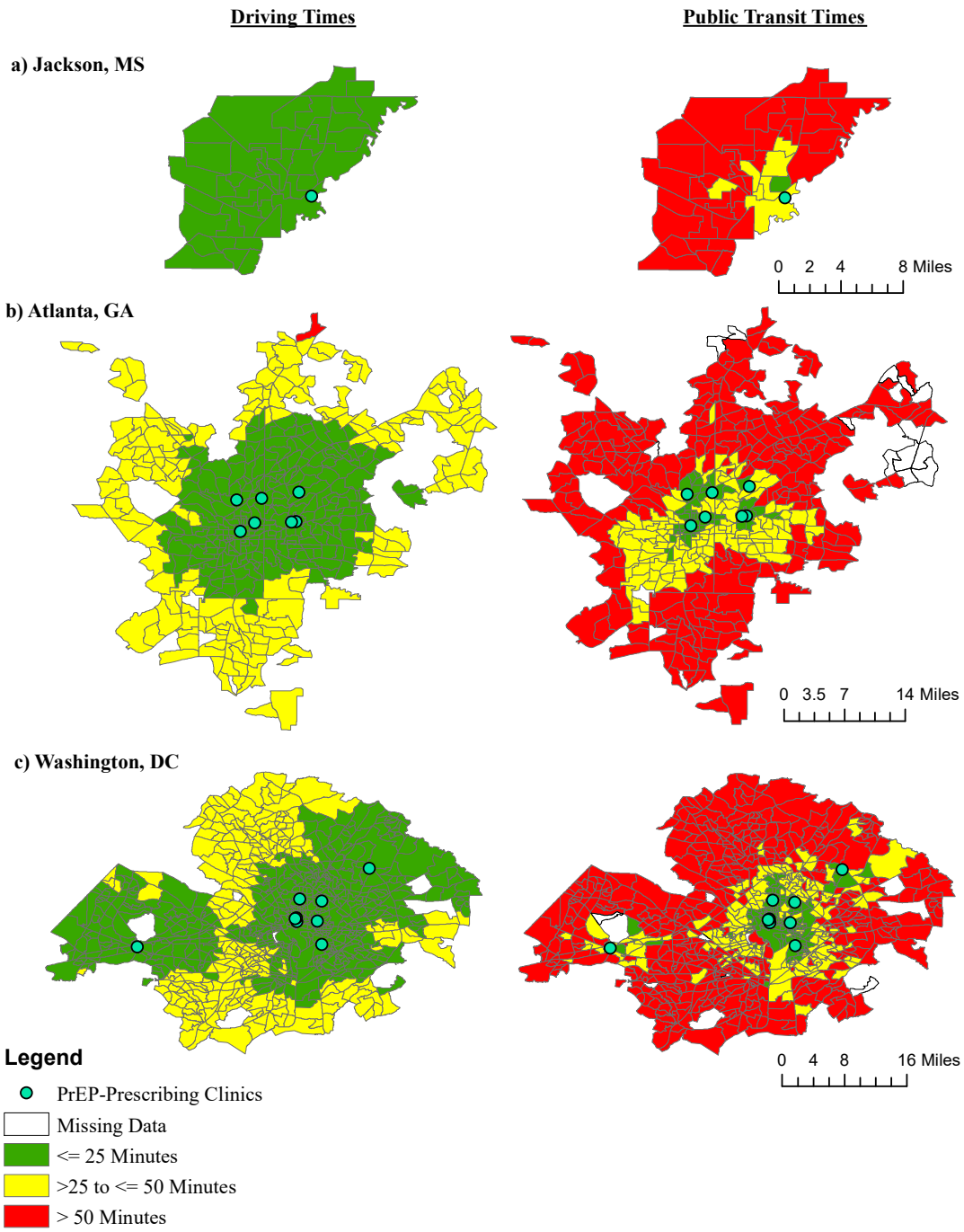

Figure 6. Distribution of average driving and public transportation times to PrEP-prescribing clinics accepting uninsured patients by census tract in (a) Jackson, MS, (b) Atlanta, GA, and (c) Washington, DC.