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Racial Disparities In Geographic Access To Primary Care In Philadelphia

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ABSTRACT Primary care is often thought of as the gateway to improved health outcomes and can lead to more efficient use of health care resources. Because of primary care's cardinal importance, adequate access is an important health policy priority. In densely populated urban areas, spatial access to primary care providers across neighborhoods is poorly understood. We examined spatial variation in primary care access in Philadelphia, Pennsylvania. We calculated ratios of adults per primary care provider for each census tract and included buffer zones based on prespecified drive times around each tract. We found that the average ratio was 1,073; the supply of primary care providers varied widely across census tracts, ranging from 105 to 10,321. We identified six areas of Philadelphia that have much lower spatial accessibility to primary care relative to the rest of the city. After adjustment for sociodemographic and insurance characteristics, the odds of being in a low-access area were twenty-eight times greater for census tracts with a high proportion of African Americans than in tracts with a low proportion of African Americans.

Access to health care is a long-standing research and policy priority.[1] Although the Affordable Care Act (ACA) focuses on reducing cost-related barriers through new insurance coverage, the projected increase in demand for care raises questions about whether the health care system has sufficient capacity to deliver services.[2,3] Access to primary care has been a particular concern because of primary care's importance for prevention and chronic disease management and its position as an entry point to the health care system overall.[4]

Access to care is multidimensional. More than three decades ago, Roy Penchansky and J. William Thomas[5] defined five key components of access to care: *affordability* (cost), *availability* (appropriate resources and supply), *accessibility* (geographic convenience), *accommodation* (hours of operation), and *acceptability* (patients' preferences about providers). Although affordability has dominated recent policy discussions, accessibility or geographic convenience might be uniquely important for primary care. A greater supply of primary care is associated with better health outcomes, including all-cause, heart disease, and cancer mortality.[6] Evidence also supports that patients living in areas with higher primary care supply have better outcomes at a lower cost compared to those living in other areas.[7,8]

However, these and other studies examining primary care supply have focused on rural areas[9] or used large units of analysis (that is, counties and states).[10] Few studies have examined variations in supply within more densely populated urban areas where there might be unique challenges. In large cities, people are less likely to own automobiles and are more likely to rely on alternative modes of transportation, including

walking.[11] Even with car ownership, high congestion can result in long travel times for relatively short distances. Thus, urban areas require different approaches to measuring primary care supply—in particular, approaches that allow for the geocoding of providers to small geographic areas.[12]

Prior studies in Chicago[13] and Washington, D.C.,[14,15] have found variation in geospatial access within each city and an association between improved access to primary care and a reduction in emergency department use for children. However, these studies are limited by the use of geographic units that might not correspond well to neighborhoods, are defined by straight-line distance instead of travel time, or have data limitations that prevent exact geocoding.

In this study our objective was to measure spatial access to primary care within an urban area, quantify differences in supply that might contribute to disparities, and determine population characteristics associated with variations in geographic access. We attempted to use an approach to measure access that local public health departments could replicate to meet the goal of monitoring local health care systems as called upon by the Institute of Medicine and Centers for Disease Control and Prevention.[16,17] This is particularly important as the focus of health reform implementation moves from insurance enrollment toward maximizing the health gains from new coverage.

The setting for this study was Philadelphia, Pennsylvania, the fifth-largest US city. The Schuylkill River divides the city into east and west, and a downtown core (Center City) divides the city into north and south. The population is diverse, with approximately 42 percent African American, 37 percent white, and 12 percent Hispanic.[18] Despite the diversity overall, racial and ethnic groups tend to be geographically concentrated: West and north Philadelphia have high African American populations, while whites make up majorities in the south and northeast parts of the city. The city's poverty rate is the highest of the ten largest cities in the United States.[18] Philadelphia is home to five medical schools and fourteen general acute care hospitals.

Study Data And Methods

OVERALL APPROACH We undertook a multistep process to measure spatial access to primary care for adults. First, we constructed a geocoded database of primary care providers from multiple data sources, which we verified by phone survey. Then we calculated ratios of adults per primary care provider for each census tract based on the providers and populations in and around that tract, as described in more detail below. Our goal was to measure geographic access using relatively short travel times given urban populations' reliance on mixed modes of transportation, determine whether our results were sensitive to modest increases in travel time, and identify population characteristics associated with differential levels of geographic access. The University of Pennsylvania's Institutional Review Board approved this study. We describe each step in further detail below.

PROVIDER INVENTORY We constructed a verified inventory of all primary care providers for adults—including physicians, nurse practitioners, and physician assistants—in Philadelphia and its neighboring ZIP codes in Pennsylvania. Because no single source could identify every potential provider, we compiled data from several provider directories. We then used a phone survey to verify each entry because provider lists might contain information that is not entirely accurate, up to date, or inside the scope of our study.

The primary provider directory came from a commercial health care practitioner database created and maintained by SK&A, a company that provides resources for medical marketing. We elected to use SK&A data instead of National Provider Identifier data as our primary source because we were interested in precise office location information and because the latter has been shown to have significant inaccuracies in practice addresses (up to one-third).[19] To check for providers not represented in the SK&A list, we used lists of primary care providers in Philadelphia provided by the largest commercial insurance plan and the largest Medicaid managed care plan. We then added previously unidentified federally qualified health centers (FQHCs) and FQHC look-alikes from lists provided by the Philadelphia Department of Public Health and two organizations representing health centers in Philadelphia.

We defined the scope of primary care providers for our inventory as physicians, nurse practitioners, and physician assistants practicing in or near Philadelphia with any of the following specialties: osteopathic medicine, family practice, geriatrics, general practice, internal medicine–pediatrics, and internal medicine (without an associated subspecialty). We excluded pediatricians because pediatric primary care was outside the scope of our study. We grouped individual providers into practices by matching on ZIP code and phone number. We then phone-verified office location and the number of practicing clinicians providing primary care (full-time and part-time physicians, nurse practitioners,

and physician assistants) by using a short survey administered by trained research assistants.

MEASURING SPATIAL ACCESS We measured spatial access by the ratio of the number of adults in an area relative to the number of providers who provided services and were accessible to those people. We defined full-time providers or equivalents at each practice based on survey responses. We considered physicians with fewer than four full days of clinical activity per week to be 0.5 full time or equivalent and the remaining physicians as 1.0 full time or equivalent. Following the precedent set by the Health Resources and Services Administration, we counted nurse practitioners' and physician assistants' efforts as 75 percent of full-time-equivalent to account for smaller panel sizes.[20] Therefore, those with fewer than four full days of clinical activity per week were counted as 0.375 full-time or equivalent providers and the remaining as 0.750 full time or equivalent. For practices without complete survey data, we predicted provider counts based on a linear regression of the estimated full-time or equivalent providers as a function of the provider counts from practices that responded to the survey. For practices that were not in the SK&A database (that is, were found in an insurer database) and did not respond to the survey, we used the average provider count reported in the survey for other practices not in the database.

We chose census tracts as the unit of analysis to best approximate neighborhoods in an urban area. We excluded census tracts in the lowest fifth percentile of population density in Philadelphia to avoid industrial or other nonresidential areas, which left a total of 363 tracts in our analysis. We defined adult population by census tract using American Community Survey (ACS) 2008–13 five-year estimates.

We calculated ratios of adults per primary care provider for the population in each tract based on a five-minute travel time radius in an automobile under optimal traffic conditions measured from the census tract centroid—the geographic center of the tract. This corresponded to an average of 1.4 street miles traveled. We retrieved all drive times using the Google Maps Distance Matrix API[21] in November 2014. The ratio for each tract included the providers and populations within each tract plus surrounding tracts whose geographic centroid could be reached within a five-minute drive time, including tracts in Pennsylvania but outside of Philadelphia. We considered the sensitivity of drive time with a sensitivity analysis based on an eight-minute drive time (results not shown). Measures of access were performed using R statistical software.

STATISTICAL ANALYSES OF LOW-ACCESS AREAS Because we were interested in identifying areas with less supply that might call for workforce development, for the analysis we aggregated contiguous census tracts into "low-access areas." These are defined as areas with five or more contiguous census tracts in the highest quintile of ratios of adults per primary care provider (lowest supply). This is a relative instead of absolute measure, as there is no agreed-upon definition of the optimal supply of primary care.

Census-tract characteristics of median age, percentage African American, percentage Hispanic, percentage of adults ages 18–64 without insurance, percentage of adults ages 18–64 with public insurance, and median household income were from the ACS 2008–13 five-year estimates. The primary outcome in our analyses was binary: whether or not a census tract was in a low-access area (defined above). Univariate logistic regression was used to examine the relationship between population characteristics of census tracts and being in a low-access area.

We modeled the association of census-tract demographic characteristics with being in a low-access area, using multivariate logistic regression. As a secondary analysis, we performed multivariate linear regression modeling, using the same combinations of census-tract demographics as above, with the continuous outcome of ratio of adults per primary care provider within a five-minute drive time (results not shown). As a sensitivity analysis to explore the effect using a larger geographic unit, we repeated the multivariate linear regression with the outcome of ratio of adults per primary care provider within an eight-minute drive time buffer (results not shown). Statistical analyses were performed using Stata statistical software, version 13.

LIMITATIONS There were some limitations inherent in the assumptions that we made in creating our access measure. Even with accurate practice location information and provider counts, provider supply is affected by percentage of time spent seeing patients; providers' experience, efficiency, and training status; and range of services offered, among other individual factors. Similarly, the demand for primary care depends not only on the size of the population but also health status and personal health care–seeking preferences. We assumed that most people obtain primary care near their home, instead of near a workplace or other frequented location.

The ideal maximum distance to primary care in urban areas is not known. We defined our unit of primary care access using a five-minute drive time radius, recognizing that actual travel time under less-than-ideal conditions would likely be much longer. In addition, we did not directly calculate walking or public transit access, which would result in different boundaries because of

different travel patterns. While further work to define how far is too far to travel for primary care in cities is needed, our five-minute drive time radius, corresponding to 1.4 street miles, is a reasonable proxy based on Philadelphia's geography, where all points in the city are less than three miles from the city limits.

The modifiable areal unit problem, or the error introduced into spatial analyses by arbitrarily drawing unit borders and by aggregating units, is also a limitation.[22] Although working at the individual patient level would eliminate some of the concern,[23] individual-level data are not available because of confidentiality and individual privacy concerns. Recognizing that, we chose an approach that allows for access calculations at a unit in which the data is available in the ACS but small enough to be meaningful and can approximate the neighborhood.

Study Results

Exhibit 1 shows the characteristics of the 363 census tracts in Philadelphia County included in our analysis. More than two-thirds of census tracts have a high degree of racial concentration (less than 20 percent, or 80 percent or more, African American). The latter is the case in more than a quarter of census tracts. Median household income is below the federal poverty level in 21.5 percent of tracts. In nearly a third of census tracts, the rate of public insurance among adults ages 18–64 exceeds 30 percent.

Exhibit 2 shows the distribution of census tracts by adults in that census tract per primary care provider within a five-minute drive. The distribution is skewed by those census tracts with poor access on the tail of the distribution. The mean ratio of adults per primary care provider was 1,073, but the supply of primary care varied widely across census tracts, ranging from 105 to 10,321 (interquartile range: 617, 1,252). When the drive-time radius was expanded to eight minutes, the mean ratio of adults per primary care provider declined to 760 (interquartile range: 566, 915; results not shown).

SPATIAL ACCESS When we mapped ratios of adults per primary care provider (quintiles) by census tract, six low-access areas emerged (Exhibit 3). Of the 363 census tracts in Philadelphia County, 17 percent ($n = 63$) met our definition of belonging to a low-access area—defined as five or more contiguous census tracts in the highest quintile of ratios of adults per primary care provider (meaning the lowest supply of providers). Exhibit 4 shows the census-tract sociodemographic and health insurance characteristics of low-access areas. Census tracts with high percentages of African Americans were most likely to be in low-access areas—32 percent of tracts whose populations were more than 80 percent African American were in low-access areas, compared to 6.1 percent of those with populations less than 20 percent African American. The likelihood of a census tract's having limited access to primary care increased as the rate of uninsurance increased as well.

Exhibit 4 also shows the adjusted association between census-tract characteristics and the probability of being in a low-access area. Unadjusted results are available in the online Appendix.[24] After adjustment for census tract–level insurance rates (public insurance, uninsurance), income, age, and population density, census tracts with high percentages of African Americans (80 percent or more) were more likely to be located in a low-access area compared to those with low percentages of African Americans (less

EXHIBIT 1

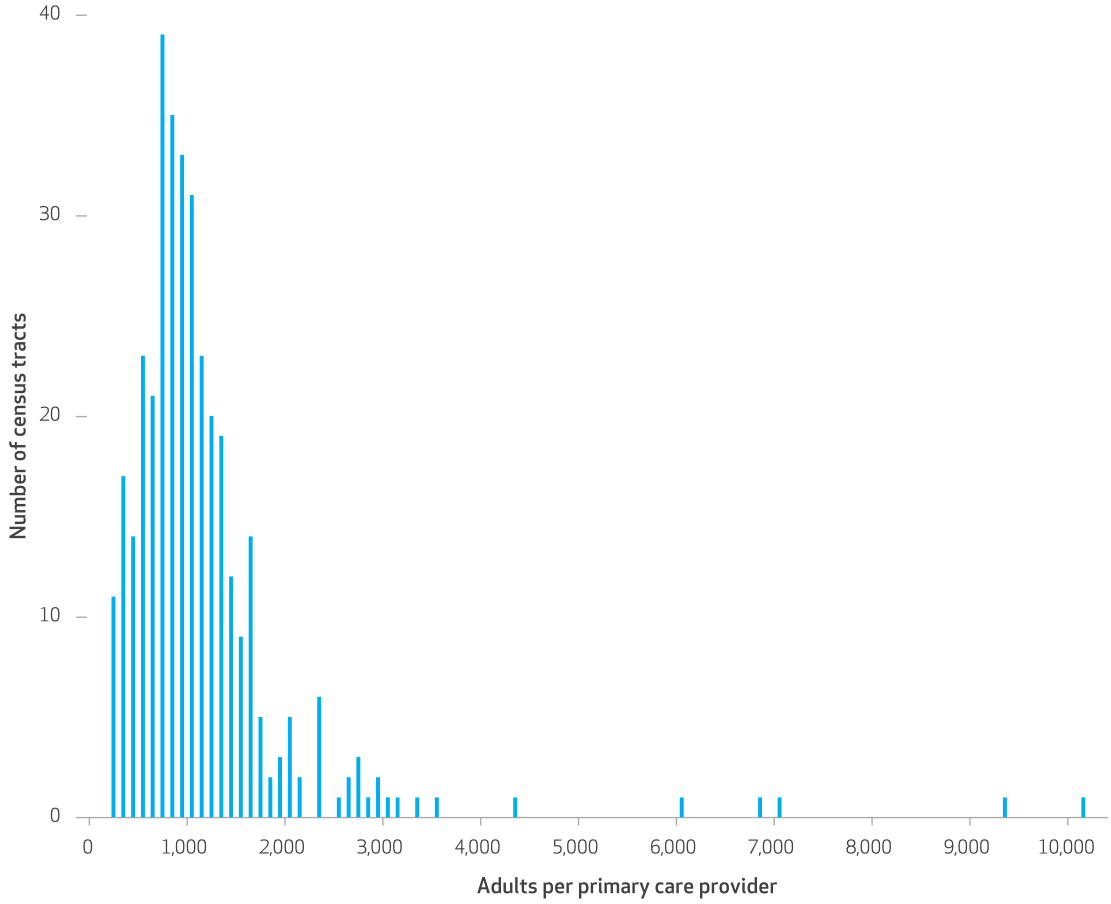
Characteristics of Philadelphia census tracts, 2008–13

Categorical variables	Percent of census tracts
AFRICAN AMERICAN	
Less than 20%	40.5
20–39%	14.1
40–59%	7.7
60–79%	10.2
80% or more	27.6
HISPANIC	
Less than 5%	54.6
5–10%	19.0
10–20%	12.7
20% or more	13.8
PUBLIC INSURANCE RATE[a]	
Less than 10%	21.8
10–19%	25.9
20–29%	20.4
30–39%	18.2
40% or more	13.8
UNINSURANCE RATE[a]	
Less than 10%	16.0
10–19%	38.3
20–29%	35.5
30% or more	10.2
MEDIAN HOUSEHOLD INCOME	
Less than 100% of poverty	21.5
100–200% of poverty	49.9
More than 200% of poverty	28.7
Continuous variables	**Mean/median**
Mean population density, log thousand people per square mile (SD)	2.55 (0.61)
Median age, years (SD)	34.6 (6.81)
Mean ratio of adults ages 18 and older: primary care providers within five-minute buffer zone (SD)	1,072.9 (1,016.3)

SOURCE Data from the American Community Survey, 2008–13. **NOTES** $N = 363$ census tracts. Excludes smallest 5 percent of census tracts by population. African American and Hispanic are not mutually exclusive. [a]Ages 18–64.

EXHIBIT 2

Distribution of ratio of adults per primary care provider across census tracts in Philadelphia



SOURCE Population data from the American Community Survey, 2008–13. **NOTES** Adult population (numerator) and primary care provider full time or equivalents (denominator) include data from any census tract whose centroid falls within a five-minute drive time radius of the centroid of the census tract of analysis. $N = 363$ census tracts.

than 20 percent) (odds ratio: 28.82; $p < 0.001$). Census tracts with a high percentage (more than 20 percent) of Hispanics also were more likely to be located in a low-access area compared to those with a low percentage of Hispanics (less than 5 percent) (OR: 6.21; $p < 0.001$). Multivariate linear regression, with the continuous outcome of adults per primary care provider, shows a similar result, which persists when the geographic area is increased from a five-minute drive time to an eight-minute drive time (results not shown).

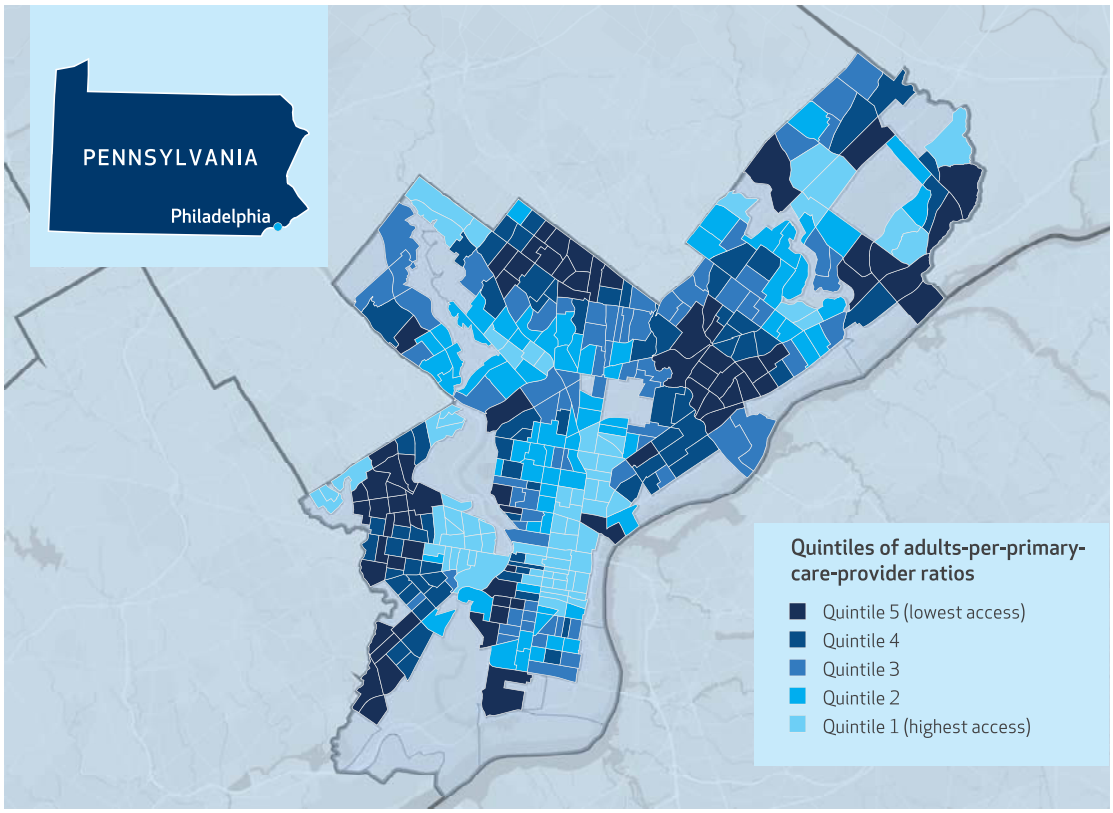
Discussion

Philadelphia, like many large cites, is a patchwork of neighborhoods with starkly different demographic characteristics, especially when it comes to racial composition. In this study we found wide variation in spatial accessibility of primary care among different neighborhoods. These characteristics appear to mirror each other: The areas of the city with high percentages of African Americans or Hispanics were likely to also be areas with poor primary care spatial accessibility. Census tracts where more than 80 percent of residents were African American have twenty-eight times higher odds of falling into the lowest-primary-care-access regions of the city. If there is a low supply of primary care providers relative to the population in neighborhoods where racial minorities are prevalent, people who live in those areas might be forced to travel farther or wait longer, which creates additional barriers to primary care. This could be exacerbated as minority populations make the largest gains in insurance coverage through the ACA if there are concentrated areas of increased demand.[25]

These differences in primary care accessibility at the census-tract level are in the setting of a city that has sufficient primary care supply overall, as indicated by the mean ratio of adults per primary

EXHIBIT 3

Philadelphia census tracts by quintile of ratio of adults per primary care provider



SOURCE Authors' analysis using Google Maps Distance Matrix API. **NOTES** Using a five-minute drive time calculation, the authors defined "low access" as areas with five or more contiguous census tracts in the quintile with the highest ratios of adults per primary care provider. Census tracts in the lowest fifth percentile of population density in Philadelphia were excluded.

care provider of 1,075:1. Although the ideal ratio is subject to debate, the ratio in Philadelphia is well below the definition of a Health Professional Shortage Area of 3,500:1, as established by the Health Resources and Services Administration.[26] When we increased potentially accessible primary care providers by increasing the travel time from five minutes to eight minutes, we saw a decrease in the ratio of adults per primary care provider of approximately one-quarter and a narrower interquartile range. With longer travel times, differences in access to primary care across the city were reduced but not eliminated. Travel on foot or by public transit were beyond the scope of this study but will be important areas to address in future work.

Racial disparities in both individual and population health are widely recognized. The effect of neighborhoods on health status is a growing area of research.[27] This can be seen in studies of neighborhoods looking at food deserts—having limited access to healthy food. Research has shown that food deserts are often located in areas with largely African American and Hispanic populations,[28,29] even after socioeconomic status variables are accounted for.[30] Other studies on neighborhoods have looked at differences in the built environment, including access to facilities that encourage physical activity[31] and safe walkable streets,[32] which might be contributing to racial differences in obesity rates. Although our work does not assess causality or directionality of the relationship among access to primary care, race, and socioeconomic status, further research could pursue whether primary care spatial accessibility is a potentially useful indicator of neighborhood health risk. Exploring the relationship to indicators such as food access and walkability will be an important step in determining how to use measures of spatial accessibility to primary care.

Primary care provider supply is not the only important element of access to primary care. In fact, some evidence suggests that provider supply in urban areas explains only some of the variation in some self-reported access-to-care measures and that variations in insurance status might be a primary driver of access differences.[33]

EXHIBIT 4

Characteristics of census tracts in low-access areas in Philadelphia, 2008–13

Census-tract characteristic	Percent of census tracts that are low-access areas	Odds ratio, adjusted
AFRICAN AMERICAN[a]		
Less than 20%	6.1	Ref
20–39%	15.7	2.49
40–59%	21.4	4.90**
60–79%	21.6	8.61****
80% or more	32.0	28.82****
HISPANIC[a]		
Less than 5%	19.7	Ref
5–10%	11.6	1.00
10–20%	10.9	1.30
20% or more	22.0	6.21***
PUBLIC INSURANCE RATE[b]		
Less than 10%	6.3	Ref
10–19%	20.2	1.17
20–29%	24.3	0.05
30–39%	21.2	0.31
40% or more	14.0	0.32
UNINSURANCE RATE[b]		
Less than 10%	5.2	Ref
10–19%	14.4	2.74
20–29%	24.0	5.65**
30% or more	24.3	4.38*
MEDIAN HOUSEHOLD INCOME		
Less than 100% of poverty	11.5	Ref
100–200% of poverty	23.8	2.75*
More than 200% of poverty	10.6	3.51*
CONTINUOUS VARIABLES		
Population density[c]	—[d]	0.56*
Median age	—[d]	1.02

SOURCE Data from the American Community Survey, 2008–13. **NOTES** $N = 63$ census tracts. Low-access areas are defined as five or more contiguous census tracts that are in the quintile with the highest ratios of adults per primary care provider. [a]African American and Hispanic are not mutually exclusive. [b]Adults ages 18–64. [c]Log thousand people per square mile. [d]Cell is empty because variable was included in the model as a continuous variable. *$p < 0.10$ **$p < 0.05$ ***$p < 0.01$ ****$p < 0.001$

Additional research is needed to examine how patients' experiences in accessing care are influenced by the local primary care supply. Objective data on the ability to get a new patient appointment and wait times to an appointment can be obtained by audit methodology, or "secret shopper" studies, where simulated patients attempt to schedule primary care appointments.[34] These types of studies can be useful for exploring variations in access by type of insurance as well. Medicaid acceptance rates tend to be lower in areas with a high degree of racial segregation,[35] such as Philadelphia, which places an already vulnerable low-income population potentially even more at risk for poor access. Narrow provider networks are also becoming more prevalent among insurance plans.[36] This narrowing of provider networks can shrink the available pool of primary care providers, making it even more important to consider geographic access to care. Beyond measuring access to care, the ultimate goal should be to understand the relationship between spatial accessibility of primary care and health outcomes. Studies producing evidence that associates improved health outcomes with a greater supply of primary care have used much larger geographic units of analysis than census tracts and show differences in the effect of supply in urban and rural areas.[37,38]

Conclusion

Until more evidence emerges, policy makers face the question of what actions are needed to ensure primary care access. Our findings show that even in densely populated cities with relatively high levels of primary care provider supply, geographic access can vary dramatically, with stark racial differences. Although our analysis does not determine the causes of these disparities, they do point to the opportunity to use spatial analyses to target investments in primary care such as decisions of where to locate federally qualified health centers in the future. State and local health departments could play an important role in measuring and monitoring access.[16,17] The combination of increasing data availability and geospatial methods in public health creates new opportunities for data-driven evaluation of local primary care access that can better direct local, state, and national policy decisions. ■

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