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On the geographic access to healthcare, beyond proximity

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Abstract

This study examined the incongruence of travel distance between the nearest provider and the provider that pregnant woman actually chose to visit. Using a dataset of South Carolina claims including rural and urban areas for the period 2014-2018 based on live births of 27,290 pregnant women, we compared the travel distance and travel time for two providers of health: the nearest facility and the main one for the area in question. The number of the former type was counted for every case. The mean travel distance/time to the nearest provider was 3.2 miles (5.2 km) and 5.0 minutes, while that to the main (predominant) provider was 23.0 miles (37.0 km) and 31.7 minutes. Only 21.6% of pregnant women chose one of the closest facilities as their provider. The mean travel distance and time to the nearest provider for women in rural areas were more than twice that for urban women but only 1.2 times for the main provider. Rural women had one third fewer providers situated closer than the main in comparison to number available for urban women. Thus, we conclude that proximity is not the only factor associated with access to healthcare. While evaluating geographic access, the number of available health providers within the mean travel distance or time would be a better indicator of proximate access.

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Introduction

When assessing physical access to essential healthcare resources, previous studies have utilized the distance from the patients' residences to the location of their nearest provider (Purser *et al.*, 2021). This intuitive method is a logical choice for assessing access, as it takes into account the fact that multiple providers can be available, even for some under-served populations seeking care from a specialist. The distance measure is also useful when information is lacking regarding actual visits and visit locations. However, this method assumes that the choice of a healthcare provider is primarily influenced by proximity – *i.e.* the spatial factor-and the client does therefore not consider other solutions (Kiani *et al.*, 2021). Furthermore, the selection of a primary care physician (PCP) impacts subsequent care through referrals and recommendations (Foy *et al.*, 2010; Fritz *et al.*, 2012). Consequently, the proximity method fails to account for non-spatial factors, such as the physicians' referring network, cost or patient preferences.

A predominant provider refers to a health facility that can offer the highest number of services to a patient within a specific timeframe (Rosenblatt *et al.*, 1998; Weiner *et al.*, 1995). This type of provider represents the one that a patient would be thought to visit most frequently. However, there remains uncertainty regarding travel patterns depending on whether or not the patient chooses the nearest provider or the predominant one. Recently, there has been increased attention to the travel burden faced by pregnant women due to the shrinking access to obstetricians/gynaecologists in the United States (U.S.) as announced by the U.S. Department of Health and Human Services, Health Resources and Services Administration (2021). This issue has affected rural population more significantly than their urban counterparts, primarily due to the increasing closures of obstetric units in the rural areas (Hung *et al.*, 2016). In a new study, an algorithm for prenatal care (PNC) aiming to enhance the identification of the predominant PNC provider by incorporating sequential visit information has been proposed (Deng *et al.*, 2023). The application of this algorithm should increase the percentage of identifiable predominant providers. To the best of our knowledge, no previous studies have investigated the concordance between the driving distance/time to the nearest provider and that to the predominant provider. Understanding this difference in travel burden for pregnant women is crucial in order to allocate resources effectively to better meet their needs and demands, particularly those residing in rural areas with less resources of this kind. This study utilized PNC claims data from pregnant women enrolled in the South Carolina Medicaid program to describe and compare travel access to the nearest provider and that regarding the predominant provider.

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Materials and Methods

This study utilized a South Carolina Medicaid claims dataset covering the period 2014 to 2018, specifically focusing on live births in health facilities. The selection of live births was motivated by the primary interest in low-risk pregnancies. The dataset encompassed all claims associated with live births during these years and it provided information about the utilization of PNC during pregnancy. We obtained exemption to use this information from the Institutional Review Board at the authors' institute as the secondary analysis involved administrative data that could not be identified as belonging to specific individuals.

A total of 108,441 live births, with 2,155,076 associated claims were included in the dataset. The release of full date of birth (DOB) was withheld to protect privacy. Instead, in compliance with agreements and using previously published algorithms as guidance (Gourevitch *et al.*, 2022; Sarayani *et al.*, 2020), the month of birth was estimated using the PNC dates, delivery service and the International Classification of Diseases (ICD) codes associated with these claims. The estimates were then appended to the provided year of birth. To apply the PNC algorithm for identifying the predominant provider, visit frequency and sequence information are crucial (Deng *et al.*, 2023). However, due to the inconsistent nature of Medicaid registration, with patients enrolling and 'unenrolling' during their pregnancies, the dataset was limited to individuals with continuous enrolment in Medicaid throughout their pregnancies. This restriction resulted in a total of 37,359 live births. Among those, only 33,057 had at least one PNC claim available in the data, allowing for the identification of predominant providers in 29,230 pregnancies.

A comprehensive list of all available PNC providers was complied and categorized by year. This list comprised physicians, midwives and others healthcare professionals providing PNC of any kind. Using these lists, a Cartesian product was generated encompassing all pregnant women, resulting in a total of 45,400,193 combinations. The distances from each woman to each provider were calculated. As only 5-digit zip codes were available for the residences in question and the provider facilities, the centroid of the zip code tabulation area (ZCTA) was utilized to estimate travel distances. Driving times for all combinations were calculated using this centroid-to-centroid method, employing SAS software (https://www.sas.com) and Google Maps. For each pregnant woman, the nearest provider was determined based either on the shortest centroid to centroid distance or the shortest centroid to centroid driving time among all available providers. As there could be multiple nearest providers for each pregnant woman using these criteria, the average travel distance and driving time were calculated and assigned to them. Subsequently, the percentage of pregnant women who preferentially visited one of their nearest providers was computed. The travel distance and driving time to the predominant provider were used to identify the number of more closely available providers (MCAP), excluding the predominant provider. Comparisons were made between the travel distance and time to the nearest provider and those with regard to the predominant provider.

The percentage of the nearest provider chosen as the predominant provider was analysed by the *Chi*-square test, while continuous variables such as the number of MCAPs, driving distance and time were analysed using the student *t*-test. Additionally, comparisons were conducted based on whether or not the pregnant women under study lived in a rural or an urban area. 'Rurality' was determined by using the 2010 rural-urban commuting area (RUCA) codes, with codes 1.0-3.0, 4.1, 5.1, 7.1, 8.1 and 10.1 classified as urban and the remaining ones as rural. The estimation of MCAPs was also performed according to rural or urban categories. All statistical analyses were carried out using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA) with 95% significance level.

Results

In this sample, a total of 395,677 providers were identified as the PNC providers for the 29,230 live births, involving 27,290 unique pregnant women and 27,328 unique resident zip codes. The average access measurement to the nearest provider was 3.2 miles (5.2 km) taking 5.0 minutes of driving on average. As seen in Table 1, significantly greater average access measurements were observed for the predominant providers, both in terms of miles/km (23.0/37.0, p<0.001) and driving time (31.7 minutes, p<0.001).

Table 1. Travel distance and driving time to the nearest and the predominant provider.

Measure	Nearest provider			Predominant provider		
	All	Rural*	Urban*	All	Rural*	Urban*
Number of pregnant women	29,230	2,727	26,503	29,230	2,727	26,503
Travel distance (miles/km)	3.2	6.1/9.8^{p}	2.9/4.7	23.0/37.0^{p}	26.4/42.5^{p}	22.6/36.4
Maximum	30.0/48.3	24.4/39.3	30.0/48.3	310.0/498.9	310.0/498.9	300.0/482.8
Upper quartile	6.0/9.7	12.9/20.9	3.1/5.0	26.8/43.1	32.3/52.0	26.0/41.8
Median	0.0$^{\#}$	0.0$^{\#}$	0.0$^{\#}$	15.4/24.8	21.3/34.3	14.7/23.7
Lower quartile	0.0$^{\#}$	0.0$^{\#}$	0.0$^{\#}$	8.8/14.2	12.0/19.3	8.4/13.5
Driving time (minutes)	5.0	9.2 ***	4.5	31.7 ***	34.2 ***	29.9
Maximum	42.3	30.0	42.3	303.5	303.5	283.3
Upper quartile	11.8	19.0	7.0	36.0	44.0	35.3
Median	0.0$^{\#\#}$	0.0$^{\#\#}$	0.0$^{\#\#}$	24.5	29.5	24.0
Lower quartile	0.0$^{\#\#}$	0.0$^{\#\#}$	0.0$^{\#\#}$	16.0	17.0	16.0
Predominant is the nearest (%)	N.A.	N.A.	N.A.	21.6	29.3^{p}	20.8
MCAPs (n)	N.A.	N.A.	N.A.	133	91^{p}	137

^{p}significance level, p<.001; $^{\#}$travel distance, ZCTA of women's residency and provider facility; $^{\#\#}$driving time, ZCTA of women's residency and provider facility; N.A., not applicable; MCAP, more closely available providers; The travel distance and driving time to the final chosen provider were used as the cut-off for each pregnant woman - the number of MCAPs within that cut-off was counted. The 2010 rural-urban commuting area (RUCA) codes (1.0-3.0, 4.1, 5.1, 7.1, 8.1 and 10.1) were counted as urban, with the rest as rural.

When comparing the travel measures for the nearest and the predominant providers, a further analysis was conducted based on 'rurality'. Women living in rural areas exhibited a mean time of access to the closest provider that was more than twice that of urban women (6.1/9.8 *vs* 2.9/4.7 miles/km and 9.2 *vs* 4.5 minutes, respectively, p<0.001), with differences of 3.2/5.1 miles/km and 4.7 minutes. Moreover, the mean time of access to the predominant provider for rural women was less than 1.2 times those of urban women (26.4/42.5 *vs* 22.6/36.4 miles/km and 34.2 *vs* 29.9 minutes, respectively, p<0.001), with differences of 3.8/6.1 miles/km and 4.3 minutes (Table 1).

Only 21.6% of pregnant women preferred to visit their closest provider, while the majority visited a predominant provider even if located at a greater distance. Interestingly, rural women exhibited a higher likelihood of visiting the nearest provider as compared to urban women (29.3% *vs* 20.8%, respectively, p<0.001). On average, pregnant women had 133 MCAPs, and rural women had approximately one third fewer MCAPs than urban women (91 *vs.* 137, respectively, p<0.001) (Table 1).

Discussion

This study revealed a significant and meaningful discrepancy of access (with respect to distance and driving time) between the closest and the predominant provider of support for pregnant women. Only 21.6% of them visited one of the nearest, available providers as their preferred source of prenatal care, indicating that a substantial proportion of women in the study area faced a greater travel burden due to their choice of provider. On average, these women had access to 133 other available providers with shorter or equivalent travel distances and driving times. These results indicate that proximity is not the sole determinant when seeking healthcare, not even the primary one, at least not with regard to pregnancy. This observation aligns with a previous study, which highlighted that relying solely on the spatial factor would underestimate the influence of all other factors, particularly among rural populations (Kiani *et al.*, 2017). Thus, women are willing to travel longer distances to seek care from alternative providers, even though it imposes a higher burden on them. This may be due to referrals from their PCPs (Geissler *et al.*, 2021; Victoor *et al.*, 2012). Additionally, a previous study (Mohammadi *et al.*, 2022) identified the interaction between travel distance and hospital capacity as a crucial factor in increasing the spatial gravity for emergency Cesarean section. These findings suggest that the spatial factor, when it becomes significant, may interact with other non-spatial factors.

Compared to urban women, rural women in South Carolina experienced a greater travel burden when assessing both the nearest and the predominant providers. However, the absolute mean differences between rural and urban women in terms of travel distance were relatively small. Rural women had to travel an additional 3.2/5.1 miles/km to reach the nearest provider, while the difference increased to 3.8/6.1 miles/km when considering the predominant provider. This indicates that the travel burden for rural women doubled when seeking the nearest provider, but only increased by one sixth when visiting the predominant provider.

To improve this study, several enhancements could be implemented. Firstly, instead of utilizing ZCTA centroids, which may have a larger impact on the distance estimation to the nearest provider, actual addresses of both patient and provider should be incorporated. The modifiable areal unit problem (MAUP), which is a well-recognized potential obstacle in research (Arcaya *et al.*, 2016; Buzzelli, 2019), could be addressed by adopting this approach. Furthermore, incorporating other data sources such as the National Ambulatory Medical Care Survey, which includes visit disposition variables, would further enhance the findings and utility of such measures. Accessing claims from the private sector could also provide valuable insight into the influence of non-spatial factors in the provider selection process.

The discrepancy of the travel burden between the nearest and the predominant provider has significant implications for how access to care is measured and evaluated. The assumption that proximity to a provider guarantees access as well as utilization does not hold true in this case as only a small proportion of pregnant women were found to seek care from the closest providers. As the predominant provider generally delivers most services most of the times, it would be more likely to be the chosen provider rather than the nearest one. Therefore, it is crucial to consider the distance to the predominant provider to avoid biased access disparities that could exacerbate treatments and outcomes.

Conclusions

The findings reported here suggest that the number of providers within a specific area would serve as a superior indicator of access to health support as this information provides an accurate representation of the travel burden that patients face when seeking care. These parameters should be considered alongside other relevant factors to gain a comprehensive understanding of the complex decision-making process involved in provider selection.

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