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Geographic Proximity Affects Adherence to Primary Care Facility Appointment in New York City

By

Genta Ishikawa

Degree to be awarded: MPH

Executive MPH (Applied Epidemiology)

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Michael R. Kramer PhD Date

Committee Chair

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By

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M.D.
Hokkaido University School of Medicine, Japan
2007

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2017

Abstract

Geographic Proximity Affects Adherence to Primary Care Facility Appointment in New York City

By Genta Ishikawa

Background: A missed primary care appointment is an independent predictor of acute care utilization and suboptimal primary care outcomes. However, the relationship between geographic proximity to the primary care facility (PCF) and the risk of no-shows has not been fully investigated in New York City. Objective of the study was (1) to investigate the relationships of geographic proximity to PCF with the risk of a no-show and (2) to explore/predict no-shows based on a host of environmental and health system factors.

Methods: This was a single-center, retrospective study at General Medical Associates (GMA)/Mount Sinai Beth Israel, a large, urban, general internal medicine outpatient practice in lower Manhattan, from January through December 2015. We calculated street network distance to GMA in miles and transit time by public transportation to GMA in minutes. A multivariable generalized estimating equation regression model was used to analyze the relationships of geographic proximity with missed facility appointments (i.e., no-show).

Results: A total of 11,881 patients over 18 years old who had appointments (total appointment = 36,144) at GMA from January through December 2015 were included. Missed facility appointments accounted for 21.2% of the total appointments. Median street network distance and transit time were 4.4 miles and 23.9 minutes, respectively. Fully adjusted models by multiple covariates showed positive coefficient values in primary exposure variables ([transit time] and [network distance]; 0.003 and 0.006, respectively) and negative coefficient values in quadratic terms ($[\text{transit time}]^2$ and $[\text{network distance}]^2$: -0.0001 and -0.0003, respectively) despite the lack of statistical significance but trend of positive correlation between transit time and risk of a no-show (p-values for coefficients of [transit time], [network distance], $[\text{transit time}]^2$, and $[\text{network distance}]^2$ in the full models were 0.052, 0.225, 0.053, and 0.581, respectively). The other significant predictors of no-shows were younger age, male, black race, Medicaid, resident/intern physician appointment, snowy weather, and low annual household income.

Conclusions: As the transit time by public transportation to a PCF increases in New York City, patients are more likely to have no-shows to facility appointments.

Length: 334 words

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Introduction

Missed appointments, or no-shows, are very common in all primary care facilities (PCFs). A no-show is an independent predictor of acute care utilization and suboptimal primary care outcomes such as incomplete cancer screening and suboptimal diabetes control[1]. A study of PCFs in Boston demonstrates that younger, Black, Hispanic, and Medicaid patients have an increased risk of no-shows[2]. Another single-center study of patients in an otolaryngology clinic in Detroit revealed that age, race, and income are significantly related to no-shows[3]. In 2015, General Medical Associates (GMA) at Mount Sinai Beth Israel, a large, urban, general internal medicine outpatient practice in lower Manhattan, New York City had a high no-show rate of 21.2%. GMA primarily serves a population with relatively low socioeconomic status (in 2015, patients' median annual household income was $43,316, whereas that of New York City as a whole was $58,878) mainly from the lower Manhattan and Brooklyn areas (Figure 1). Identifying a large at-risk population for no-shows and using a multi-method approach to address the issue showed persistent improvement in no-show rate in a prior study[4]. We assumed that identifying and addressing geographic factors of no-shows could contribute to improvement of clinic adherence by certain interventions (locating clinic closer, providing transportation support, etc). However, the relationship between the geographic proximity to the PCF and the risk of no-shows has not been fully investigated in prior literature. Therefore, this study mainly investigated the association between (1) street network distance and (2) transit time by public transportation with the risk of no-shows. We hypothesized that patients who live farther from the PCF or have poor transit access, as reflected by the street network distance and the transit time by public transportation (i.e., subway or bus), have an increased risk of no-shows. In metropolitan New York City, driving is not a common means of transportation owing to limited parking space, heavy traffic, and expensive tolls for tunnels into Manhattan: passing Bronx-Whitestone, Throgs Neck, & RFK Bridges; Hugh L Carey1 & Queens Midtown Tunnels by a car costs $8 each time[5]. Therefore, aside from those living within walking distance to PCFs, subway and bus are main means of transportation. Thus, we assumed that besides street network distance to the PCF, transit time to clinic by public transportation also strongly impacts adherence to clinic appointments.

Materials and Methods

Patients and Other Clinical Variables

This was a retrospective, single-center study at GMA, Mount Sinai Beth Israel, New York City. We reviewed the medical records of 11,881 consecutive patients aged ≥ 18 years who had at least one appointment with GMA and lived in New York City (for a total of 36,144 appointments) from January to December in 2015. Cancelled and rescheduled appointments were excluded from the analysis. Appointments with registered nurses and social workers were also excluded. Patient's residential street addresses were geocoded by Google Maps Geocoding API[6]. We also used Google Maps API to calculate the street network distance in miles and the transit time by public transportation in minutes, by using network data from the Metropolitan Transportation Authority bus/subway[7]. Several covariates were used in our study: age (18-40, 41-64, and 65-), gender, race (White, Black, Asian, and others), type of health insurance (commercial, managed Medicaid, Medicaid, managed Medicare, Medicare, and self-pay), annual household income ($0-$40,000, $40,001-$65,000, $65,001-$90,000, $90,001-$125,000, and $125,000-), provider type (attending physician, resident/intern, and nurse practitioner), and weather (clear, cloudy, rainy, and snowy). Age, gender, race, type of health insurance, and annual household income have been shown to be correlated with the risk of no-shows in the previous literatures[1,2]. Therefore, we included those variables as covariates in our full model. Further, provider type and weather were included in our model because these variables were deemed to be confounders although the correlation of these with no-shows have never been tested previously. Namely we assumed that the lack of continuity of care by resident/intern physicians who are employed for a maximum of 3 years in their training period and heavy snowy weather in New York City would hugely affect the risk of no-show. The annual household income of each patient was estimated from the median household income data by residential census tract as reported by the United States Census Bureau (American Community Survey, 2011-2015)[8]. Weather and temperature information were extracted from the *AccuWeather* website[9]. The main outcome measure was missed facility appointments. The primary independent variables were the street network distance to GMA in miles and the transit time by public transportation to GMA in minutes (both continuous variables).

Statistical Methods

All clinical data were collected from patients' medical records. Continuous variables are expressed as mean ± standard deviation or median with IQR unless stated otherwise. Categorical variables are presented as frequency and percentage. The ORs of a no-show (the main outcome measure) were calculated by multivariable logistic regression; the analysis was adjusted for age, gender, race, type of health insurance, provider type, weather, and annual household income in our final model. We chose a generalized estimating equation because individuals could have more than one appointment. Our final model was shown below.

Log Y = β1 [transit time (network distance)] + β2 [transit time (network distance)]^2 + β3 [age] + β4

[gender] + β5 [race] + β6 [type of health insurance] + β7 [provider type] + β8 [weather] + β9 [annual household income] (Y was primary dependent variable [1=missed appointment 0=kept appointment] and β1 – 9 were coefficient terms in each independent variable).

The variables of transit time and network distance were centered by subtracting their mean values from original values to mitigate multicollinearity. No clinically and statistically significant interactions among the independent variables were found. We assumed the error terms were independent and the predictor variables were independent from each other, and linearity of independent variables with log odds. The level of significance was set at $p < 0.05$. All analyses were performed by SAS version 9.4 (SAS Inc., Cary, NC, USA).

This study was approved by the Institutional Review Board of Mount Sinai Beth Israel (HS#: 15-01125 MSBI# 115-15).

Results

Patient and Appointment Characteristics

During the study period, we identified 11,881 consecutive patients with a total of 36,144 appointments (Tables 1). The vast majority of patients (88.9%) had 1–5 appointments at GMA during the study period. Mean patient age was 54.2 ± 16.8 years. There were 7,783 women (65.5%). The most common race/ethnicity was white (36.1%), followed by black (16.9%). The distribution of patients by census tract shows that the majority of patients came from either lower Manhattan or Brooklyn (Figure 1). The median (IQR) street network distance to GMA was 4.4 (1.7, 8.3) miles, and the median transit time by public transportation was 23.9 (16.1, 37.3) minutes. However, the modes of public transit (subway, bus, etc) and the number of transfers, used for each appointment, could not be distinguished due to technical limitation. The most common health insurance type was managed Medicaid (34.7%), followed by commercial insurance (27.0%), and managed Medicare (22.0%). Median annual household income was $43,316 ($27,829, $67,578).

Main Exposures of No-shows

Out of 36,144 appointments, 7,606 (21.2%) were missed (Table 1). Patients who lived further away from GMA were more likely to miss appointments visually (Figures 2, 3). Those who lived in Manhattan and along the belt of the L-line (between Chelsea, Brooklyn and Queens at Halsey Street) had a lower no-show rate than those who lived outside the belt (Figure 2). Figure 3 demonstrated quadratic (non-linear) associations, with a convex to the top, rather than simple linear associations between the main exposure variables and main outcome measure. Graphs of the non-linear association peaked approximately at 15 miles and 50 minutes where point OR ([Odds at X] / [Odds at (X-1)]) became less than 1. Namely, our results visually show that the no-show rate started to decrease for patients who lived farther than 15 miles from GMA or spent longer than 50 minutes to GMA by public transportation. Given probable non-linear associations (Figure 3), quadratic terms were included in multivariable generalized equation estimation regression model, investigating associations of (1) street network distance and (2) transit time by public transportation to GMA with a risk of no-show. Table 2 shows that unadjusted coefficient terms ($\beta 1$s) of these primary independent variables were both positive (0.0286 and 0.0099, respectively), whereas unadjusted quadratic terms ($\beta 2$s) were both negative (-0.0015 and -0.0002, respectively) and these values were all statistically significant (all p-values < 0.01). Fully adjusted coefficient terms in network distance and transit time were still both positive (0.225 and 0.052, respectively) but lost statistical significance after adjustment by covariates (p-values were 0.225 and 0.052, respectively). Likewise, fully adjusted quadratic terms were still both negative (-0.0003 and -0.0001, respectively) but lost statistical significance (p-values were 0.581 and 0.053, respectively).

Other Predictors of No-shows

Multivariate analysis (Table 2) showed that the other significant predictors of no-shows in adjusted models were male (OR: 1.09; p = 0.02), younger age, black race (OR: 1.34; $p < 0.01$), Medicaid (OR: 1.71; $p < 0.01$), resident/intern physician appointment (OR: 1.50; $p < 0.01$), snowy weather (OR: 1.21; $p < 0.01$), and lower annual household income. Appointments during the winter holiday season and hot or cold outside temperature, were visually missed more frequently (Figure 4).

Discussion

To our knowledge, the present study is the first to investigate whether geographic proximity to the PCF are associated with the risk of no-show in New York City. We assessed the associations not only of geographic proximity, as reflected by network distance to clinic, but also of transit time by public transportation with the risk of a no-show, since we thought that the complexity of public transportation in New York City could make it difficult for patients to keep clinic appointments. Contrary to our hypotheses, we could not show a strong correlation between street network distance and no-show but there is a possible positive correlation between transit time and no show, adjusted for multiple covariates. In other words, those who have further to travel via transit, as reflected by longer transit time by public transportation, were more likely to have no-shows. This implies that time is more important than distance in New York City where few people drive cars, so the distance by owned vehicle is not so predictive. Further, most people use transit by public transportation so that time indicator has stronger association. Another possible explanation for the association between transit time and no-show is that on average increased transit time is associated with increased cost of using transit, so cost could be a barrier to appointment compliance. However, our results contradict with a previous study which demonstrated that the rate of appointment keeping for a Midwestern, urban family practice residency clinic is higher for patients who have a longer distance to travel[10].

The insight provided by the present study is provocative because it suggests that transit access to the PCF, as reflected by transit time by public transportation, should be taken into account when choosing a primary care doctor, either by patients or insurance companies, in order to minimize the risk of missed appointments; various other factors contribute to choosing primary care providers. GMA is located just above "14th Street-Union Square Station" where L-line stops and those who lived along the belt of the L-line (between Chelsea, Brooklyn and Queens at Halsey Street) had a lower no-show rate (Figure 2) and this implies that less complicated transit access is related to less transit time, which may ultimately lead to lower no-show rate.

Most health plans provided by private health insurance companies negotiate special, discounted rates with certain doctors and hospitals with "in-network" insurance purposes. The present study suggests that transit access should be taken into consideration when private health insurance companies decide on an "in-network" PCF for each patient in order to improve clinic appointment adherence; this consideration could be monitored simultaneously by the state health department. At the same time, the efficacy of providing patients who live further away from clinic with transportation support (free subway/bus ticket for non-Medicaid patients, etc) should be evaluated.

The present study shows that the no-show rate started to decrease for patients who lived farther than 15 miles from GMA or spent longer than 50 minutes to GMA by public transportation (Figure 3). Contrary to our expectation, the results demonstrated non-linear (quadratic) associations of distance and time with the rate of a no-show despite a lack of precision, reflected by jagged shape of curves and wide 95% confidence interval, in the area of extremely far distance or long transit time. This might be because these patients have higher interest in specific healthcare providers or specialties at GMA although they live further away.

The other predictive factors for no-shows in New York City included younger age, male sex, black race, Medicaid, low annual household income, snowy weather, and appointment with resident/intern physicians shown by our fully adjusted models. Moreover, extremely warm or cold weather and appointment during the winter holiday season appear to be additional risk factors, shown in Figure 4. The study is informative in that it analyzed several other predictors of no-shows, some of which, including weather, outside temperature, and resident/intern physician appointment, have not been investigated previously. One previous study at a PCF in Boston demonstrates that younger, black, Hispanic, and Medicaid patients have an increased risk of no-shows[2]. Another study concludes that economically disadvantaged patients face barriers to accessing specialty surgical care[11]. We obtained similar results with regard to age, race/ethnicity, health insurance, and socioeconomic status. Patients on Medicare had a decreased risk of no-shows, presumably because the elderly people have greater interest in health maintenance than younger people. Concordantly, the no-show rate in geriatric clinics is reported to be lower than that in general primary care clinics[12].

Our study revealed that appointments with resident/intern physicians were missed more frequently than those with attending physicians. While another study reports that there is no significant difference in the rate of emergency department visits between faculty and resident practices at residents' primary care clinics[13], we were not able to investigate poor clinical outcome from poor clinic adherence to appointments with resident/intern physicians. In our medicine residency program at Mount Sinai Beth Israel, residents rotate on inpatient services for six weeks at a time without ambulatory responsibilities instead of moving to and from their ambulatory clinic once per week during inpatient rotations. Then, two dedicated weeks are spent in the ambulatory setting[14]. The continuity of care, which might be negatively affected by these intermittent resident/intern physician clinic days, may influence patients' adherence to clinic appointments. This may indicate inadequate continuity of care in resident/intern physician clinics, thus suggesting the need for improvements to the residency curriculum.

Snowy weather was another predictor of no-shows in the present study. This may be due to public transportation delays during snowy weather. In contrast, rainy weather did not increase the no-show rate, which implies that public transportation is less affected by rainy weather than snowy weather. Snowy weather may also negatively affect ease of access to transit station (e.g. if sidewalks are clear to walk from home to transit). Furthermore, extremely warm or cold outside temperature affected the no-show rate (Table 3) and the curve implied quadratic association with convex downward. This suggests extreme ambient temperature may affect patients' intent to keep appointments, possibly because transit access to the PCF is affected particularly during snowy weather.

Subsequent interventions are imperative to mitigate non-adherence to appointments. Identifying a large at-risk population for no-shows and using a multifaceted approach to address the issue can result in persistent improvement and could be used in other residency training and community clinic settings[4]. On the basis of the results of the present study, we aim to create a risk-scoring system in the whole Mount Sinai Health System to predict no-shows and identify the high-risk population. A multidisciplinary approach involving healthcare providers, registered nurses, social workers, and IT departments that includes a reminder letter system or a centralized phone system would improve non-adherence to clinic appointments, which would in turn tremendously decrease the overall cost of healthcare.

The present study has several limitations. First, the retrospective observational study design incurs an information bias. For example, although GMA accepts a huge Hispanic population, the majority of patients did not report their race/ethnicity and were categorized as "missing" (Table 1). Therefore, we could not accurately analyze differences in race/ethnicity. Moreover, we were unable to identify medical reasons for appointments (i.e., emergency visits or scheduled visits) because of limited information gathered retrospectively. The reason for no-shows (e.g., delayed arrival time, forgetfulness, etc.), another clinical factor that affects appointment adherence, was not investigated fully. Third, this was a single-center study of patients with relatively low socioeconomic status, limiting the generalizability of the results. New York City is known as a "melting pot." Therefore, our results might not be applicable to other parts of the US that have different demographic composition, or even other parts of New York City that have different socioeconomic and demographic structure. Well-developed public transportation system makes New York distinct from other parts of the US. Finally, despite having a large sample size, there was low precision of estimates at the extremes of distance and time in Figure 3.

Conclusions

As the transit time by public transportation to PCF increases, patients are more likely to miss appointments. While various factors contribute to choosing primary care providers, geographic proximity to the PCF should be taken into account when choosing primary care physicians in order to mitigate missed appointments.

Acknowledgements

Contributors: GI was the principal author, had full access to all data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis; CC, TS, SS, DC, and JA contributed substantially to the study design, and writing of the manuscript; MK contributed substantially to the data analysis and interpretation and writing the manuscript. ZevRoss Spatial Analysis (website: http://www.zevross.com/) contributed to spatial analysis.

Funders: none

Prior Presentations: none

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Table 1. Patient Characteristics

	Patient (n=11,881) mean (SD) median (IQR) n (%)
Demographic	
Age (years)	54.2 (16.3)
Female	7,783 (65.5)
Race/Ethnicity	
White	4,289 (36.1)
Black	2,008 (16.9)
Asian	410 (3.5)
Other	532 (4.5)
Missing	4,642 (39.1)
Transit time (min)	23.9 (16.1, 37.3)
Street network distance (mile)	4.4 (1.7, 8.3)
Insurance type	
Commercial	3,193 (27.0)
Managed medicaid	4,116 (34.8)
Medicaid	357 (3.0)
Managed medicare	2,599 (22.0)
Medicare	1,426 (12.0)
Self pay	107 (0.9)
Others	42 (0.4)
Annual household income	43,316 (27,829, 67,578)
$0-$40,000	5,465 (46.5)
$40,001-$65,000	2,907 (24.7)
$65,001-$90,000	1,703 (14.5)
$90,001-$125,000	1,216 (10.3)
$125,000-	471 (4.0)
Number of appointments	n=36,144
1-5	10,558 (88.9)
6-10	1,219 (10.3)
11-15	79 (0.66)
16-20	18 (0.2)
21-25	6 (0.1)
26-30	1 (0.0)
Missed appointments	7,666 (21.2)

SD: standard deviation.

Table 2. Risk Factors for No Show

		Unadjusted				Adjusted (transit time)				Adjusted (network distance)			
		OR	95% CI		p-value	OR	95% CI		p-value	OR	95% CI		p-value
Transit time (min)		1.010	1.007	1.012	< 0.001	1.003	1.000	1.006	0.052				
Transit time^squared (min)		1.000	1.000	1.000	< 0.001	1.000	1.000	1.000	0.053				
Network distance (miles)		1.029	1.020	1.039	< 0.001					1.006	0.996	1.016	0.225
Network distance^squared (miles)		0.999	0.998	0.999	0.002					1.000	0.999	1.001	0.581
Age													
	18-40	1.000			ref.	1.000			ref.	1.000			ref.
	41-64	0.630	0.580	0.685	< 0.001	0.630	0.580	0.685	< 0.001	0.630	0.580	0.684	< 0.001
	65-	0.495	0.441	0.555	< 0.001	0.495	0.441	0.555	< 0.001	0.496	0.442	0.556	< 0.001
Gender													
	Female	1.000			ref.	1.000			ref.	1.000			ref.
	Male	1.062	0.992	1.136	0.083	1.088	1.016	1.165	0.016	1.086	1.015	1.163	0.017
Race													
	White	1.000			ref	1.000			ref.	1.000			ref.
	Black	1.499	1.375	1.634	< 0.001	1.340	1.226	1.465	< 0.001	1.338	1.224	1.463	< 0.001
	Asian	1.030	0.866	1.226	0.737	0.987	0.829	1.175	0.881	0.985	0.828	1.173	0.868
	Other	1.618	1.394	1.878	< 0.001	1.328	1.145	1.541	< 0.001	1.326	1.143	1.538	< 0.001
Insurance type													
	Commercial	1.000			ref.	1.000			ref.	1.000			ref.
	Managed Medicaid	1.355	1.245	1.474	< 0.001	1.127	1.027	1.236	0.011	1.128	1.028	1.237	0.011
	Medicaid	1.729	1.442	2.072	< 0.001	1.500	1.246	1.806	< 0.001	1.503	1.248	1.810	< 0.001
	Managed Medicare	0.861	0.785	0.945	0.002	0.986	0.879	1.106	0.806	0.985	0.878	1.105	0.795
	Medicare	0.931	0.833	1.040	0.207	1.075	0.947	1.220	0.265	1.073	0.946	1.218	0.274
	Self Pay	1.833	1.253	2.682	0.002	1.564	1.103	2.217	0.012	1.567	1.105	2.222	0.012
Provider type													
	Attending	1.000			ref.	1.000			ref.	1.000			ref.
	Resident/Intern	1.524	1.418	1.637	< 0.001	1.409	1.304	1.523	< 0.001	1.407	1.302	1.520	< 0.001
	Nurse Practitioner	1.159	1.044	1.286	0.006	1.084	0.974	1.207	0.141	1.081	0.971	1.203	0.155
Weather													
	Clear	1.000			ref.	1.000			ref.	1.000			ref.
	Cloudy	0.970	0.908	1.035	0.356	0.976	0.913	1.043	0.477	0.976	0.913	1.043	0.472
	Rainy	1.041	0.966	1.122	0.291	1.047	0.970	1.130	0.235	1.047	0.971	1.130	0.234
	Snowy	1.182	1.046	1.335	0.007	1.205	1.064	1.364	0.003	1.206	1.065	1.366	0.003
Annual household income													
	$0-$40,000	1.000			ref.	1.000			ref.	1.000			ref.
	$40,001-$65,000	0.940	0.870	1.015	0.111	0.949	0.878	1.027	0.195	0.946	0.874	1.023	0.162
	$65,001-$90,000	0.832	0.754	0.919	< 0.001	0.890	0.811	0.997	0.045	0.882	0.797	0.976	0.015
	$90,001-$125,000	0.675	0.592	0.759	< 0.001	0.808	0.706	0.926	0.002	0.784	0.688	0.893	< 0.001
	$125,000-	0.610	0.504	0.738	< 0.001	0.722	0.592	0.879	0.001	0.694	0.574	0.839	< 0.001

SD: standard deviation

Figure Legends

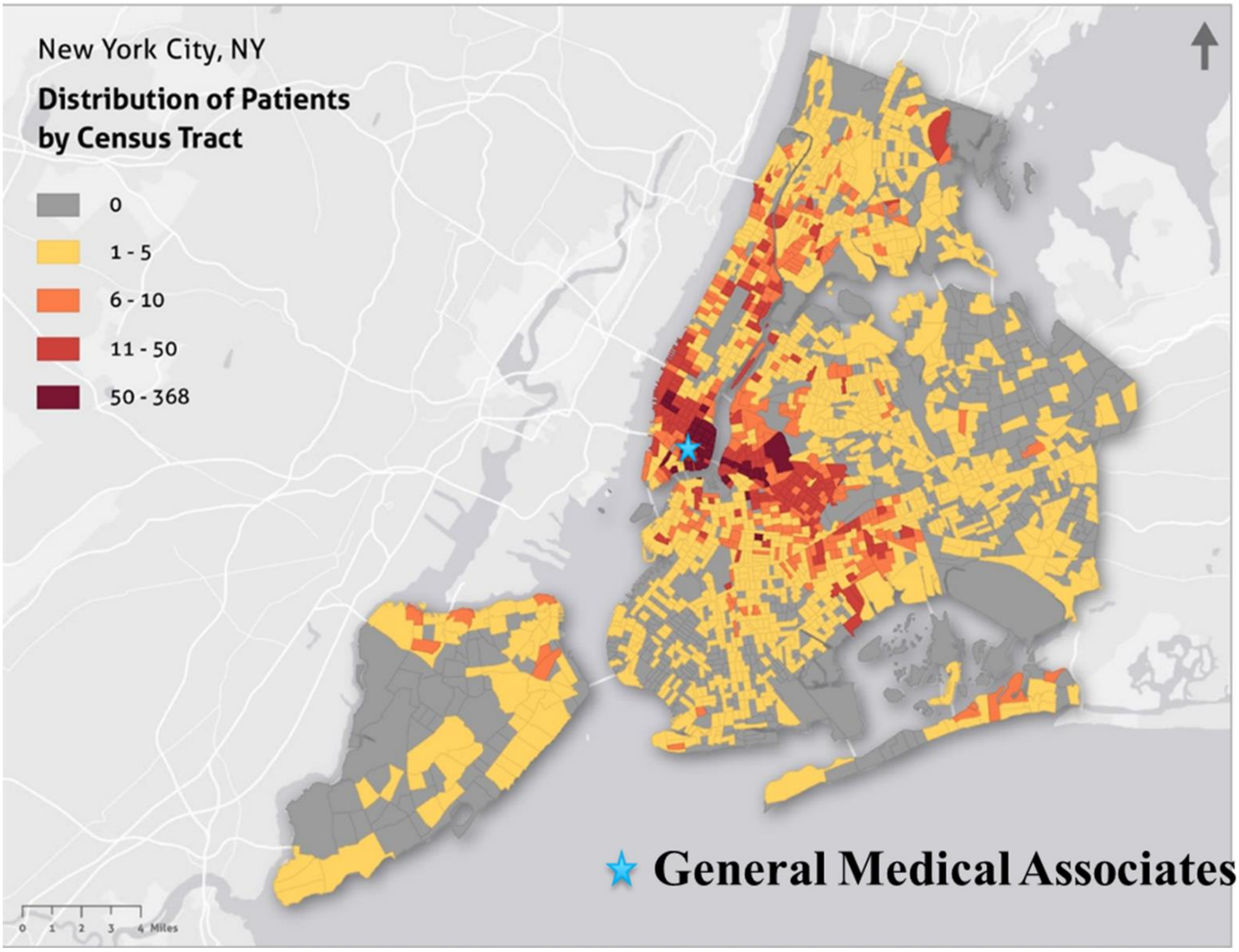
Figure 1. Distribution of Patients by Census Tract

Figure 2. Percentage of Missed Appointments by Census Tract

Figure 3. **(A)** Street Network Distance and Percentage of Missed Appointment **(B)** Street Network Distance and Estimate of Odds Ratio of Missed Appointment **(C)** Transit Time by Public Transportation and Percentage of Missed Appointment **(D)** Transit Time by Public Transportation and Estimate of Odds Ratio of Missed Appointment

Figure 4. **(A)** Age and Percentage of Missed Appointment **(B)** Outside Temperature and Percentage of Missed Appointment **(C)** Month and Percentage of Missed Appointment

Figure 1



New York City, NY
Distribution of Patients by Census Tract
0
1 - 5
6 - 10
11 - 50
50 - 368
General Medical Associates
0 1 2 3 4 Miles

Figure 2

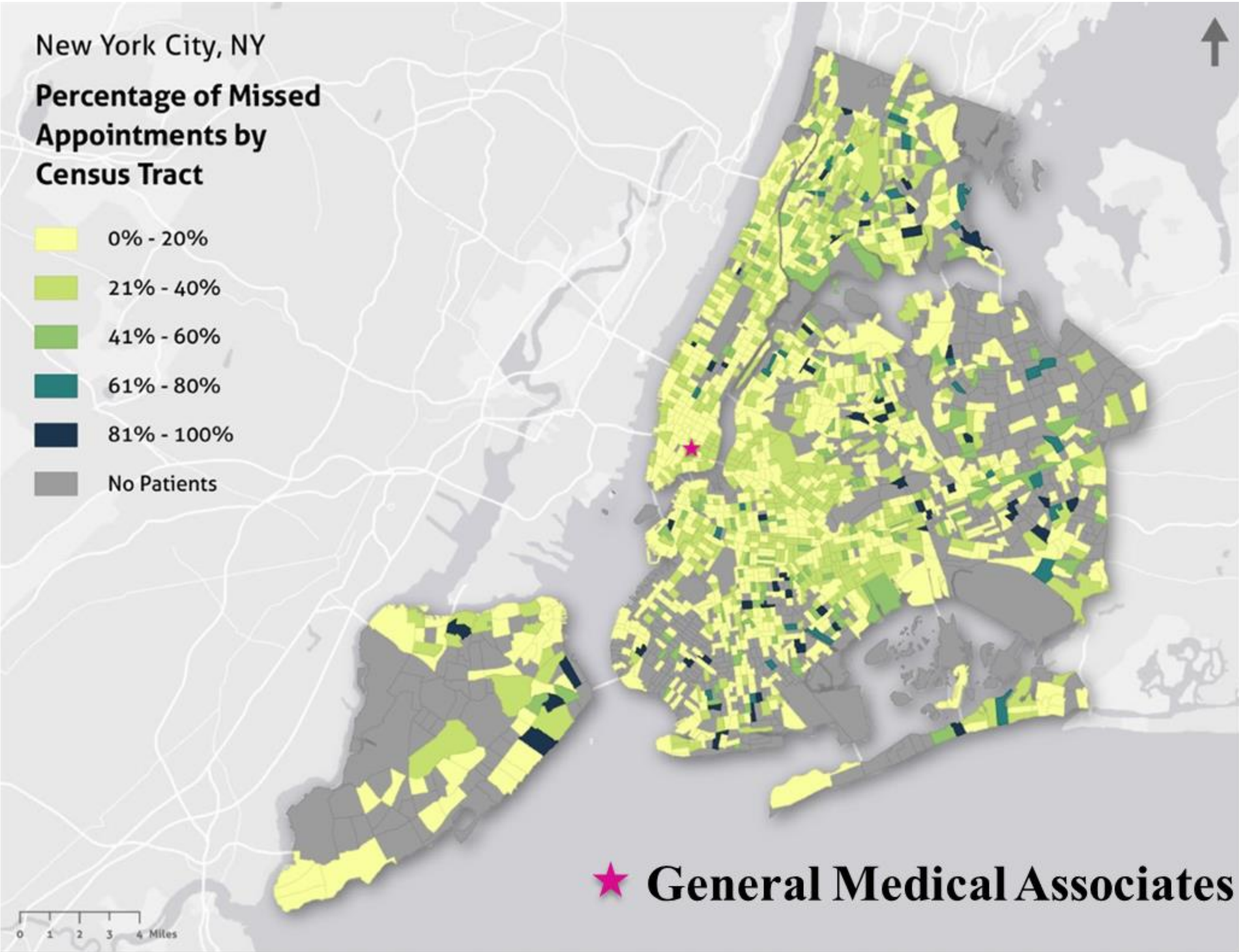
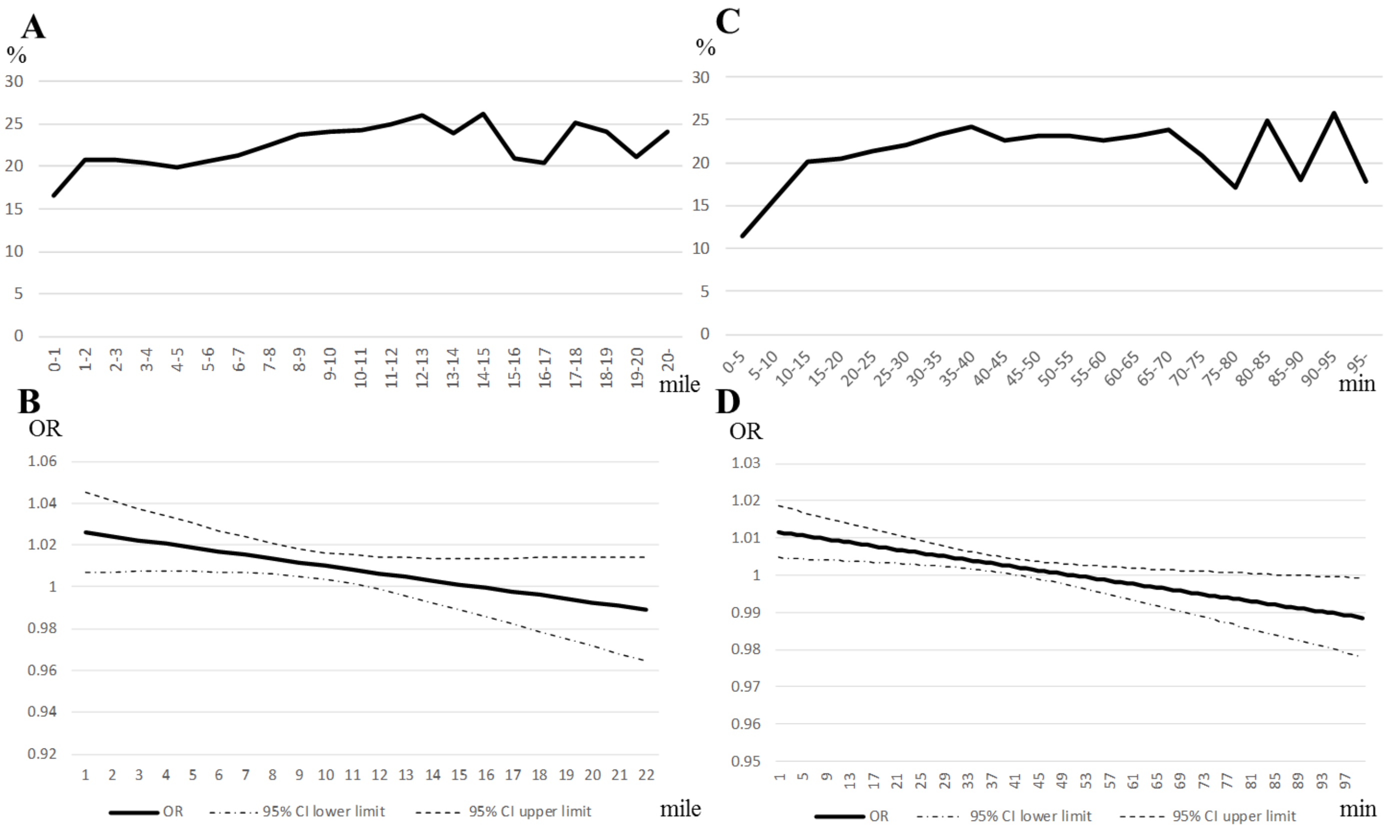
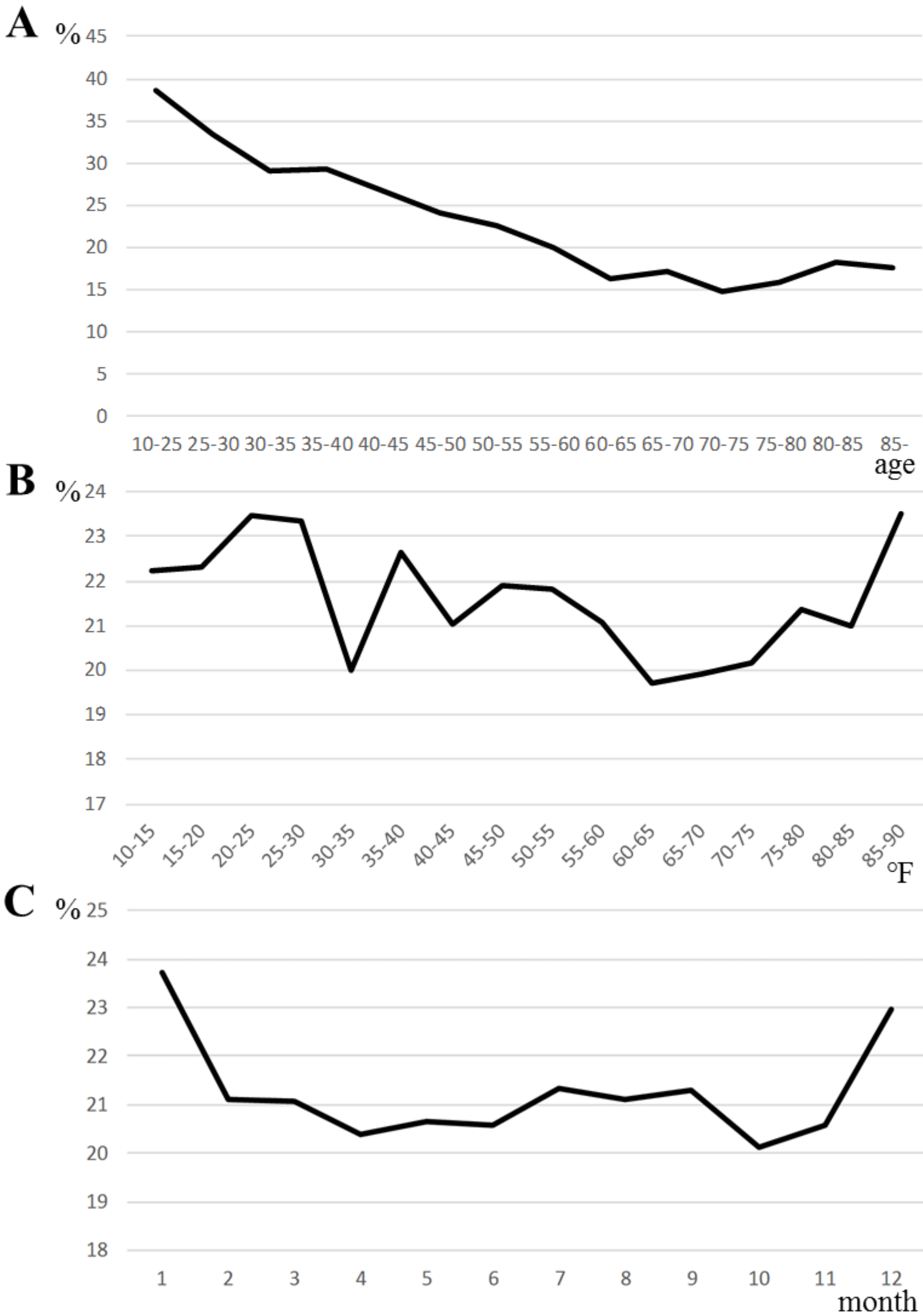

New York City, NY
Percentage of Missed Appointments by Census Tract
0% - 20%
21% - 40%
41% - 60%
61% - 80%
81% - 100%
No Patients
General Medical Associates
0 1 2 3 4 Miles

Figure 3



min: minutes OR: odds ratio

Figure 4


A
%
45
40
35
30
25
20
15
10
5
0
10-25 25-30 30-35 35-40 40-45 45-50 50-55 55-60 60-65 65-70 70-75 75-80 80-85 85-
age
B
%
24
23
22
21
20
19
18
17
10-15 15-20 20-25 25-30 30-35 35-40 40-45 45-50 50-55 55-60 60-65 65-70 70-75 75-80 80-85 85-90
°F
C
%
25
24
23
22
21
20
19
18
1 2 3 4 5 6 7 8 9 10 11 12
month