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Renee Y. Hsia
Yu-Chu Shen

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Do PCI Facility Openings Differentially Affect AMI Patients by Individual Race and Community Segregation?

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ABSTRACT

Percutaneous coronary intervention facility openings may have differential effects on treatment and health outcomes for Black versus White patients in residentially segregated versus integrated communities. This study looked at changes in patient treatment and health outcomes (same-day PCI, PCI during hospitalization, 30-day mortality, and 1-year mortality) after the opening of a PCI facility within a 15-minute drive of a community. Findings show that Black patients in integrated communities experienced the greatest benefits after a PCI opening for every outcome examined. Healthcare stakeholders may be able to use this data to prioritize PCI openings in communities that will derive the greatest benefits

Renee Y. Hsia
University of California at San Francisco
SFGH Medical Center
1001 Potrero Avenue
San Francisco, CA 94110
Renee.Hsia@emergency.ucsf.edu

Yu-Chu Shen
Department of Defense Management
Naval Postgraduate School
555 Dyer Road
Monterey, CA 93943
and NBER
yshen@nber.org

Introduction

Disparities in the cardiovascular health, treatment, and long-term mortality rates of patients with acute myocardial infarction (AMI) have been well-documented. The death rate from acute coronary syndrome (ACS) is 30% higher for Black individuals compared to non-Hispanic White individuals,[1] and post- myocardial infarction (MI) survival rates are significantly higher for White individuals when compared with Black individuals.[2,3] Sadly, these disparities in outcomes are expected to persist, despite hundreds of local and federal initiatives to address racial inequities in healthcare.[4]

Much of the current literature on inequities in cardiac care has focused on patient factors (e.g., race, education, willingness to seek care) or provider factors (e.g., unconscious bias).[3] A small but growing proportion of the disparities literature is devoted to systems or "built environment" issues of where healthcare services exist, and has found that more affluent areas tend to have more hospitals and specialized centers, including dedicated to cardiac centers.[5,6] Patients from racial and ethnic minorities are less likely to be admitted to specialized facilities[7] and face an increasing likelihood of undergoing cardiac procedures, such as percutaneous coronary intervention (PCI), at low-volume hospitals which have been associated with less favorable outcomes.[8]

One of the gaps in the literature is that many of these studies tend to be cross-sectional, examining a single point in time to determine the existence of disparities;[3] however, it remains unknown whether changes in the built environment, such as the opening of PCI-capable facilities, have widened or narrowed disparities over time. The second conspicuous gap in knowledge lies in a more precise identification of how changes in the provision of care have differentially affected patients at the individual level based on the social construction of race and

at the population level, when acknowledging that residential segregation may affect cardiac outcomes.

Our study focuses on the opening of PCI-capable facilities from 2006-2017 and the differential effects of these openings on the treatment and health outcomes of AMI patients based on individual race and degree of community segregation. A clearer understanding of how the proliferation of these specialized healthcare services affect historically disadvantaged communities and populations may help elucidate foundational issues about the way our healthcare system is structured and identify potential targets of intervention.

Methods

Patient population and data sources

Our analytical sample included all Medicare Fee-for-Service patients who were diagnosed with AMI between January 2006 and December 2017. In order to get a clean identification of the effects of PCI openings on patient outcomes, our main analysis excluded patients whose communities experienced a PCI closure during the study period. Our control group represented AMI patients in communities that experienced no PCI capacity change during the study period. As our main analysis focused on differences between White and Black patients, we also excluded 5% of the analytical sample that were neither Black nor White.

The primary individual patient data comes from the 100% Medicare Provider and Analysis Review (MedPAR), which contains Medicare beneficiary summary files and is linked to vital status. Relevant data elements include patients' mailing ZIP codes, admission dates, ICD-9 and 10 diagnostic and procedure codes, demographics (e.g., age, sex, race/ethnic group), and

date of death. We linked Medicare data with 2010 US Census data via each patient's mailing ZIP code to obtain the longitude and latitude coordinates of their community. This enabled us to construct segregation measures out of the Black and White populations in those communities. In addition, we used the Dartmouth Health Atlas to identify hospital service areas for each ZIP code.[9] To obtain the geographic locations of all hospitals, we used the American Hospital Association (AHA) annual surveys which contain hospital longitude and latitude coordinates, and further supplemented this data with the hospital's heliport coordinates (if existent).[10] Institutional review board approval was not required for this study because no patient-identifiable data was used.

Identifying PCI facility openings over time

We captured PCI openings within a 15-minute drive of a given community using the following steps. First, for every year we identified whether each hospital was considered PCI-capable using a volume-based approach from prior work in order to minimize self-reporting errors.[11,12] A hospital was considered PCI-capable if it had performed at least 4 PCI procedures (from both inpatient or outpatient settings) in a year. Second, for each hospital, we defined opening year as the first year of at least two consecutive years of operation for a PCI hospital, as done in previous literature.[11,13]

Third, in order to identify changes in PCI capacity for a given community, we first computed actual driving time between each community-hospital pair for every year using web-based maps queries, via HERE developer maps API key and automation software from Stata, based on the geographical coordinates of the pair.[14,15] Finally, having identified the set of PCI-capable hospitals operating within a 15-minute drive for each year, we evaluated year-to-year

changes and classified communities according to whether they experienced a PCI hospital opening within a 15-minute drive in a given year. We chose a threshold of 15 minutes based on thresholds reported in other studies,[16–18] and prior literature showing that the majority of hospital visits are within 15 minutes of a patient's residence.[19]

Patient categories based on individual race and residential segregation

We categorized our AMI patient population into four categories based on an individual's race and their community's degree of segregation: (1) White in racially segregated communities (reference group); (2) Black in segregated communities; (3) White in integrated communities; and (4) Black in integrated communities. Each individual patient's race was identified from the Medicare beneficiary summary file's race record. Each community's degree of residential segregation was measured at the Hospital Service Area (HSA) level using the dissimilarity index, as residents from ZIP code communities that belonged to the same HSA incurred most of their hospitalizations from hospitals in that area.[20]

The dissimilarity index is the most common measure of segregation that is easy to interpret and has been applied in other health analyses.[21,22] There is a large body of literature devoted to measures of residential segregation.[23–25] The dissimilarity index for the i^{th} HSA was computed as $D_i = \frac{1}{2}\sum_{k=1}^{N}\left|\frac{w_k}{W_i} - \frac{b_k}{B_i}\right|$, where W_i and B_i were the total White and Black population counts at the i^{th} HSA, respectively; and there were N ZIP codes in an HSA, where w_k and b_k were the White and Black population count of the k^{th} ZIP code. We chose ZIP code as the building block of our HSA dissimilarity index based on prior literature.[26,27] HSAs were classified as racially segregated if their White–Black dissimilarity index was in the top one-third of the overall dissimilarity index distribution. Otherwise, they were categorized as integrated. In

order to track communities consistently over time, these community measures were made time-invariant and based on 2010 Census data.

Designating Communities with High Baseline PCI Capacity

In one of our sensitivity analyses, we stratified the sample based on a patient's community baseline PCI capacity. We hypothesized that PCI opening might have smaller effect in patient health outcomes in communities with high PCI capacity at baseline due to possible duplication of services, and larger effect in communities with low PCI capacity, as the latter communities would have unmet needs.

For the purposes of this analysis, we measured PCI capacity as percent of patients who were admitted to PCI-capable hospitals (regardless of whether they received PCI) and classified communities as having "high capacity" if they ranked in the top quartile of PCI capacity measures based on their 2005-2006 status. To create a reliable and stable capacity metric, we considered 2 factors: the geographical coverage of each market and the market's PCI capacity. Following prior work,[28–30] we used Hospital Referral Regions (HRR) as the broad market definition to classify communities. The HRR measure accounts for patient flow and transfer patterns and contains a sufficient patient population for obtaining a reliable metric. Similar to prior work,[31] we used the following regression-based approach to rank markets' baseline PCI lab capacity. Using the 2005 and 2006 AMI population, this risk-adjusted metric was obtained by taking the HRR intercepts from a regression, where the dependent variable was whether the AMI patient was admitted to a hospital with a PCI lab that included separate HRR intercepts on the right-hand side, and controls for patient demographic and comorbid conditions. Rankings based on the HRR intercepts from this regression represented the relative PCI lab capacity for

comparable patient populations across all HRR markets. For example, if HRR A had a higher coefficient than HRR B, an identical AMI patient would be more likely to have access to a PCI lab in HRR A than in HRR B. We used two years of baseline data to increase the precision of the ranking. ZIP code communities in HRRs ranked in the upper quartile were classified as "high-capacity" markets. In a sensitivity analysis, we used raw PCI capacity to rank the HRRs instead of using the regression-based rank. Our results were robust to the alternate definition.

Statistical methods

Our analysis focused on changes in the following treatments and health outcomes for AMI patients who experienced a PCI opening within a 15-minute drive of their community: (1) whether the patient received PCI treatment on the day of admission; (2) whether the patient received PCI treatment during the care episode; (3) 30-day mortality; and (4) 1-year mortality. Treatments were identified using ICD-9 and ICD-10 procedure codes and procedure dates. In our analysis, we included receipt of coronary angiography in addition to receipt of PCI since this procedure represents a prelude to revascularization and accounts for the clinical realities of failed PCI and/or anatomy that is not suitable for PCI. Mortality outcomes were computed by linking a validated death date with an admission date. We focused on time-specific mortality rather than in-hospital mortality to detect effects on mortality not only in the acute phase but in the longer term as well.

Our study design began with a difference-in-differences (DD) framework, where we compared outcomes defined above between patients who experienced a PCI opening within a 15-minute drive from their community (treatment groups) and patients of the same race/segregation category who did not have any change in PCI capacity during the study period (control groups).

Take the category of Black patients who lived in segregated communities as an example, our DD framework compares changes in outcomes between a Black patient who lived in a segregated community that experienced a PCI opening and a Black patient who lived in a segregated community that did not experience a PCI opening during the study period. We subsequently implemented a difference-in-differences-in-differences (DDD) that allowed us to compare whether the effects of PCI openings on outcomes were statistically significantly different across the 4 patient categories.

Because we had binary outcomes, we estimated a linear probability model with community-fixed effects to control for any unobserved time-invariant heterogeneity across communities and heteroskedasticity-robust standard errors clustered at the community level.[32] We used two sets of key variables. The first set included indicators for whether a community experienced a PCI hospital opening within a 15-minute drive. PCI opening indicators took on a value of 1 on and after the year that a community experienced a PCI opening. The coefficient estimate from this indicator represents changes in outcomes when the reference treatment group (White patients in segregated communities) experienced a PCI opening relative to the control group (patients whose communities did not have a PCI opening during the study period). The second set of key variables included the interaction term between the PCI opening indicators and the patient race/segregation group indicators. The coefficient estimates from this second set represented *additional changes* in outcomes between each race/segregation group relative to the reference group when both groups of patients experienced an opening.

Other control variables in the model included year indicators to capture the macro-level trends, patient demographics (5-year age groups, race and ethnicity, sex), as well as a set of disease-related risk adjustments in accordance with prior work.[33,34] It should be noted that while

we controlled for individual race, the race/segregation group indicators and other community-level characteristics were not included in the model, since they were subsumed by the community-fixed effects that already controlled for observed and unobserved differences across communities.

We also stratified our analysis based on a community's baseline PCI capacity. This allowed us to examine whether PCI openings had a smaller effect on patient health outcomes in communities with high PCI capacity at baseline, due to the possible duplication of services, and/or if openings had a larger effect in communities with low PCI capacity, as these communities would have unmet needs. As described above, we classified communities as having "high capacity" if they ranked in the top quartile of regression-adjusted PCI capacity measures based on their 2005-2006 status. The study was deemed exempt by the UCSF Human Research Protection Program because it did not include human subjects.

Results

A total of 2,388,180 patients were included in our study. Figure 1 shows that 28% were White patients living in segregated communities, 4% were Black in segregated communities, 63% were White in integrated communities, and 4% were Black in integrated communities. Figure 1 also shows that Black patients in segregated communities were more likely to experience a PCI opening (26%) compared to patients in the other 3 groups (15-18%).

Table 1 shows that, demographically, Black patients in both integrated and segregated communities were younger than White patients (29% and 28% of Black patients in integrated and segregated communities were under the age of 70 versus 19% and 18% of White patients, respectively), with a higher proportion being female (over 55% of Black patients were female

versus under 48% among White patients). In terms of disease profile, Black patients had a much higher rate of diabetes (40% and 39% of Black patients in integrated and segregated communities versus 29% and 28% of White patients in integrated and segregated, respectively), renal failure (34% versus 21-22%, respectively) and hypertension (78% and 77% versus 67%). Patients who were White, regardless of whether they were living in integrated or segregated communities, had a higher likelihood of suffering from ST-elevation MI (STEMI) than Black patients (23% versus 17% and 16%). We controlled for these disease profile differences in the statistical models so we could compare the experiences of comparable patients when their communities experienced a PCI opening. When examining the percentage of patients in communities with high baseline PCI capacity, 18% and 26% of patients in White segregated and integrated communities, respectively, resided in communities with high baseline capacity; whereas 21% and 19% of patients in Black segregated and integrated communities, respectively, had high baseline capacity. Finally, Table 1 shows that patients who were Black, regardless of residential segregation, had a lower rate of receiving same-day PCI (37-38%) than White patients (46%). Unadjusted mortalities were similar across the four race and segregation groups.

The Figure 2 highlights results from the community fixed-effects models and illustrates the risk-adjusted percentage point changes in outcomes after a community experienced a PCI opening within a 15-minute drive, relative to a community with no PCI capacity change (full regression results in Appendix Table 1). Panel A shows that when White patients in segregated communities experienced a PCI opening, their probability of same-day PCI treatment increased by 0.98 (95% CI: 0.19, 1.77) percentage points relative to White patients in segregated communities who did not have PCI openings in their community. This change represents a 2.1% relative increase in same-day PCI (mean rate for this patient category is 46% per Table 1), the

smallest benefit of the four groups. Black patients in integrated communities experienced the largest increase in likelihood of receiving same-day PCI (3.92; 95% CI: 2.90, 4.95) relative to Black patients in integrated communities who did not have a PCI opening in their community (panel A). This is equivalent to an 11% relative increase given that the mean rate of same-day PCI was 37% for patients in this category.

To examine whether the effects of PCI openings observed in the Figure 2, panel A differed significantly across the 4 categories of patients, we tested the point estimate differences using the DDD framework discussed above. The asterisks in panel A indicates that the 3.92 percentage point improvement for Black patients in integrated communities, as the result of a PCI opening, was statistically significantly different from the 0.98 percentage point improvement for White patients in segregated communities at the 0.01 significance level. In other words, the benefit of a PCI opening on likelihood of receiving same-day PCI was more than five times higher for Black patients in integrated communities compared to White patients in segregated communities (11% relative benefit compared to a 2.1% relative benefit with no PCI openings within the same race/segregation category).

We observed the same pattern in panel B when examining changes in the probability of receiving PCI during a hospitalization. In general, patients in integrated communities had larger increases in their probability of receiving PCI during a hospitalization (6.62 and 5.28 percentage points for Black and White patients, respectively) than those in segregated communities (3.60 and 2.20 percentage points for Black and White patients, respectively). Overall, Black patients benefited more than White patients, conditional on the same type of community. These changes are equivalent to a 12% increase for Black patients in integrated communities, and a 4% increase

for White patients in segregated communities when each experienced a PCI facility opening near their respective communities.

When evaluating mortality, differential benefits across the four groups of patients were persistent. As shown in panels C and D, White patients in segregated communities had no statistically significant benefit in 30-day or 1-year mortality when they experienced a PCI opening compared to patients in the same race/segregation category with no PCI opening. Once again, Black patients in integrated communities had the greatest benefit, with a 1.30 (CI: -1.98, -0.63) percentage point decrease in 30-day mortality when the community experienced a PCI opening, representing an 11% drop in 30-day mortality (mean rate for this patient category was 12%). We had similar findings when looking at 1-year mortality. Black patients in integrated communities experienced a 1.86 (CI: -2.80, -0.93) percentage point decrease, or a 6% drop, in 1-year mortality with a PCI facility opening compared to patients in the same race/segregation category with no opening.

Finally, Table 2 shows that when limiting the sample to communities without high baseline PCI capacity, results were similar to our main analysis (Figure 2 and Appendix Table 1). Black patients in integrated communities experienced the greatest benefits across all four outcomes when a PCI facility opened in their community, compared with the other three community types. Even in communities with high baseline PCI capacity, Black patients in integrated communities continued to exhibit the greatest reduction in 1-year mortality (-2.42; 95% CI: -4.44,-0.41) and a significant increase in the probability of receiving in-hospital PCI (2.90; 95% CI: 0.25,5.54). Black patients in segregated communities also had a 4.20 (CI: 2.02,6.38) and 4.98 (CI: 2.49,7.46) percentage point increase in probability of same-day PCI and

in-hospital PCI, respectively. However, White patients in integrated communities did not benefit from PCI opening when baseline PCI capacity was high.

Discussion

Our study found differential benefits of PCI facility openings within a 15-minute drive based on patient race and community degree of segregation. The greatest benefits from PCI openings were observed for Black patients in integrated communities across all outcomes examined: same-day PCI; PCI during hospitalization; 30-day mortality; and 1-year mortality. Conversely, these benefits were least noticeable or non-existent for White individuals in segregated communities among the four race/segregation categories. For example, when looking at same-day PCI, Black patients in integrated communities experienced more than five times the benefit from a PCI opening compared with White patients in segregated communities.

It is important to keep in mind that on average, Black patients in either type of community had a lower probability of receiving PCI and higher long-term mortality rates compared to their White counterparts. It is therefore comforting to see that PCI openings are, in fact, allowing previously disadvantaged populations a chance to "catch up" and reduce disparities, although the acceleration of improved outcomes was not enough to achieve complete parity during the study period.

To our knowledge, there is no current literature that looks simultaneously at the impact of PCI center openings on disparities in patient outcomes and variation in outcomes based on residential segregation. Prior studies have shown disparities in access to other types of care for Black patients compared to White; specifically, majority-Black census tracts face disproportionate barriers in geographic access to trauma centers,[35] and decreased availability of

surgical services.[36] Other research has found that African Americans are more likely than other races to live in areas with a primary care physician (PCP) shortage and this likelihood increases as the degree of community segregation increases.[37]

Our findings contribute to the literature in three major ways. First, rather than examining cross-sectional disparities in access to or the existence of healthcare services across segregated and integrated communities, we focus on the dynamic and ongoing impact of PCI openings on patient outcomes. Our results reveal significant differences in the benefit of PCI openings between communities with varying degrees of residential segregation. Second, our stratified analysis by baseline capacity shows that despite increasing evidence of systematic duplication by new PCI facilities, Black patients in integrated, high baseline capacity communities continued to benefit from PCI facility openings while White patients in integrated, high capacity communities did not. Third, our study uses a multi-level approach to determine associations between PCI openings and patient outcomes. Rather than focus on Black individuals alone, for example, we were able to distinguish the differential impacts of PCI openings for Black patients living in segregated versus integrated communities. And fourth, we focus on the critical, time-sensitive condition of AMI, where outcomes have proven to be influenced by access to PCI,[38] rather than analyzing healthcare services without a pressing, time-sensitive component such as primary care.

Limitations

Our study has some important limitations. First, our patient records came from MedPAR, which only captures patients admitted to the inpatient setting. While the percentage of PCI procedures done as "outpatient" has increased over the years,[39] less than 1% of these outpatient PCIs[40] actually occur in ambulatory (ASC) or outpatient surgical centers. Further, Medicare only

began reimbursing PCI in ASCs in 2020,[41] so any significant changes from this legislation would not impact our findings. Second, our data included only Medicare FFS beneficiaries and therefore did not capture Medicare Advantage or privately insured patients. We would not expect PCI openings to affect Medicare Advantage or private patients differently from Medicare FFS patients for the outcomes we examined. It is possible that the geographic distribution of patients not enrolled in Medicare FFS is systematically different from those enrolled in Medicare FFS; however, such differences do not invalidate our estimated results because our results are identified based on comparing differences within-communities. Third, driving time and whether a community experienced a PCI opening within a 15-minute drive were measured with errors because we used the same geographical coordinates for all patients from the same community. This measurement error would introduce attenuation bias and make our results a conservative estimate. Fourth, we used administrative data which lacks clinical details for each patient. However, our population-level analysis would not be possible if we used data sources that contained richer clinical information, such as the CathPCI Registry®, since those data sources capture only patients who received PCI procedures in participating hospitals, and therefore precludes the evaluation of all AMI patients. Fifth, we do not know whether new PCI centers operated during limited hours nor can we capture the quality of each new PCI facility; therefore, our results should be interpreted as capturing the overall effect of PCI openings without differentiating by the quality of new PCI facilities. Finally, given these data limitations, we are not able to fully explore the possible mechanisms behind the differential benefits of PCI openings across patient and community types. For example, PCI openings might change patient profiles for those who received PCI treatments (such as severity and or location of infarction).

The lack of clinical granularity precluded us from investigating the extent to which such patient profile changes might contribute to the positive impact of PCI openings observed in our analysis.

Conclusions

Overall, our study found that Black patients in integrated communities benefited most significantly from PCI openings for each of the 4 outcomes examined, while White patients in segregated communities derived the least benefit. This information may provide healthcare stakeholders and planners with additional evidence on which to base the long-term efforts at structural reform targeting the "built environment" of healthcare services.

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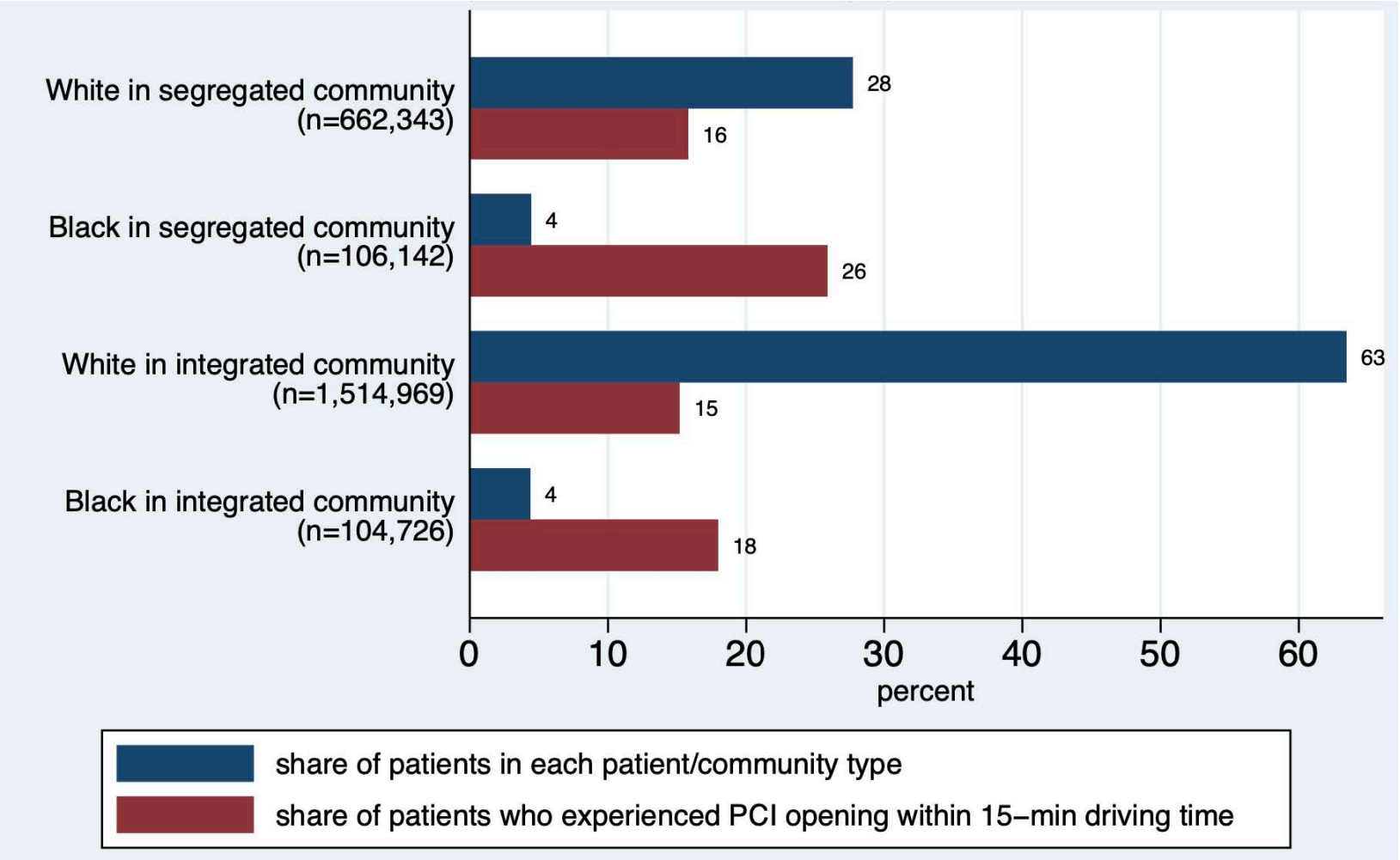

Figure 1. AMI patient distribution and share of patients experiencing PCI opening by patient and community type.
Total AMI patient size: N=2,388,180. PCI indicates percutaneous coronary intervention. AMI indicates acute myocardial infarction.

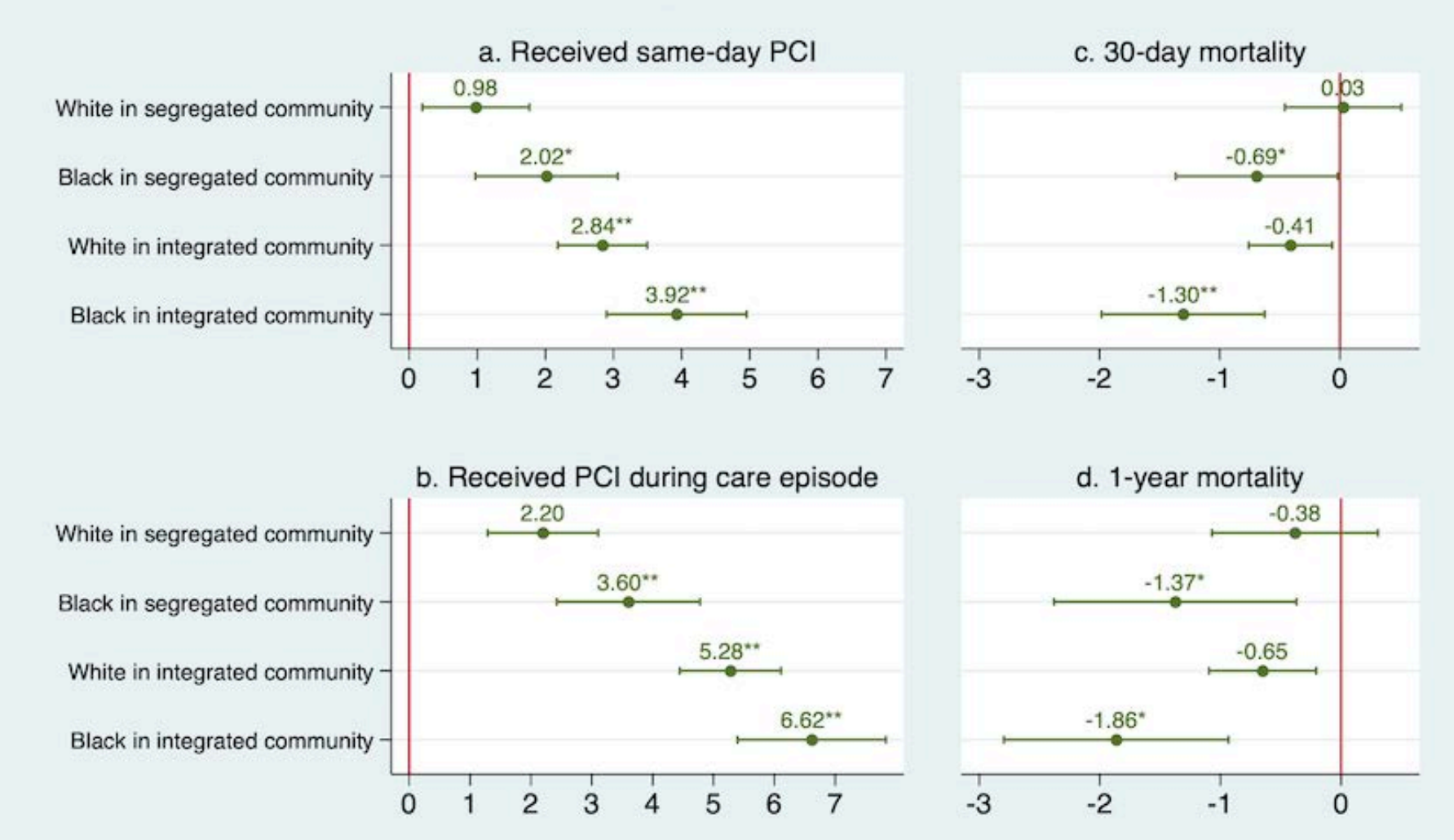

Figure 2. Risk-adjusted percentage point changes in outcomes from a PCI opening within a 15-minute drive.
Range plot represents 95% confidence intervals of the point estimates. Asterisks denote that changes in outcomes are statistically significantly different from White patients in segregated communities at *p<0.05 and **p<0.01 levels. Additional model results are presented in Appendix Table 1. PCI indicates percutaneous coronary intervention.

Table 1. Descriptive Statistics of Patient Characteristics

	Segregated community				Integrated community			
	White		Black		White		Black	
	N	%	N	%	N	%	N	%
N	662,343	28%	106,142	4%	1,514,969	63%	104,726	4%
Patient demographics and community								
White	662,343	100%	0	0%	1,514,969	100%	0	0%
Black	0	0%	106,142	100%	0	0%	104,726	100%
Female	317,257	48%	61,139	58%	703,628	46%	58,099	55%
Age distribution at time of admission								
65-69 years	122,360	18%	30,174	28%	292,664	19%	30,532	29%
70-74 years	117,211	18%	21,144	20%	284,309	19%	20,894	20%
75-79 years	117,235	18%	18,570	17%	277,140	18%	18,349	18%
80-84 years	120,149	18%	15,955	15%	269,021	18%	15,477	15%
85+ years	185,388	28%	20,299	19%	391,835	26%	19,474	19%
Community has high baseline PCI capacity	117,795	18%	21,823	21%	391,312	26%	20,132	19%
Patient conditions								
STEMI	149,241	23%	16,897	16%	342,971	23%	17,339	17%
Peripheral vascular disease	64,388	10%	10,743	10%	152,215	10%	11,133	11%
Pulmonary Circulation disorders	32,752	5%	7,467	7%	73,569	5%	6,674	6%
Diabetes	186,266	28%	41,254	39%	435,613	29%	42,063	40%
Renal failure	142,692	22%	36,195	34%	323,519	21%	36,093	34%
Liver	5,242	1%	1,140	1%	12,421	1%	960	1%
Cancer	24,120	4%	4,571	4%	54,430	4%	3,999	4%
Dementia	28,352	4%	5,758	5%	61,906	4%	5,682	5%
Valvular disease	90,811	14%	10,973	10%	202,723	13%	11,427	11%
Hypertension	441,048	67%	82,133	77%	1,014,912	67%	81,484	78%
Chronic pulmonary disease	135,533	20%	19,944	19%	322,651	21%	18,971	18%
Rheumatoid arthritis/collagen vascular	14,431	2%	1,987	2%	34,686	2%	2,069	2%

Coagulation deficiency	29,388	4%	5,221	5%	65,637	4%	4,865	5%
Obesity	44,443	7%	8,299	8%	110,635	7%	8,855	8%
Substance abuse	7,007	1%	2,322	2%	18,427	1%	1,972	2%
Depression	33,526	5%	2,878	3%	73,084	5%	2,923	3%
Psychosis	21,406	3%	2,715	3%	47,422	3%	2,686	3%
Hypothyroidism	76,833	12%	6,057	6%	177,887	12%	6,167	6%
Paralysis and other neurological disorder	51,384	8%	10,067	9%	115,074	8%	10,105	10%
Ulcer	1,337	0%	271	0%	3,092	0%	228	0%
Weight loss	18,916	3%	4,588	4%	41,657	3%	4,428	4%
Fluid and electrolyte disorders	142,965	22%	27,416	26%	311,734	21%	26,014	25%
Anemia (blood loss and deficiency)	81,514	12%	19,781	19%	188,490	12%	20,046	19%
Treatment and health outcomes								
Same-day PCI	307,892	46%	40,501	38%	702,360	46%	38,726	37%
In-hospital PCI	411,538	62%	60,755	57%	909,455	60%	56,449	54%
30-day mortality	87,329	13%	12,195	11%	198,336	13%	12,687	12%
1-year mortality	187,746	28%	31,212	29%	424,027	28%	31,204	30%

PCI = percutaneous coronary intervention. STEMI = ST-segment elevation myocardial infarction

Table 2. Risk-adjusted percentage point changes in outcomes when there is a PCI opening within a 15-minute drive, by baseline PCI capacity

	Same-day PCI	In-hospital PCI	30-day mortality	1-year mortality
Communities without high baseline PCI capacity (top quartile)				
Patient race and community segregation categories				
White in segregated communities	0.83	2.03**	-0.08	-0.58
	[-0.02,1.67]	[1.06,3.01]	[-0.61,0.44]	[-1.31,0.16]
Black in segregated communities	1.34*	3.00**	-0.81*	-1.44*
	[0.17,2.52]	[1.68,4.32]	[-1.58,-0.04]	[-2.59,-0.29]
White in integrated communities	3.41**	5.92**	-0.38	-0.75**
	[2.69,4.14]	[4.99,6.85]	[-0.77,0.00]	[-1.25,-0.25]
Black in integrated communities	4.09**	7.09**	-1.52**	-1.71**
	[2.94,5.24]	[5.72,8.45]	[-2.27,-0.77]	[-2.76,-0.66]
N	1,837,118			
Communities with high baseline PCI capacity (top quartile)				
Patient race and community segregation categories				
White in segregated communities	0.42	0.53	0.85	1.08
	[-1.61,2.45]	[-1.73,2.79]	[-0.38,2.08]	[-0.96,3.12]
Black in segregated communities	4.20**	4.98**	-0.13	-0.89
	[2.02,6.38]	[2.49,7.46]	[-1.37,1.11]	[-2.94,1.16]
White in integrated communities	-0.26	1.44	-0.50	-0.26
	[-1.62,1.09]	[-0.18,3.06]	[-1.31,0.32]	[-1.21,0.70]
Black in integrated communities	1.99	2.90*	-0.45	-2.42*
	[-0.26,4.23]	[0.25,5.54]	[-1.99,1.08]	[-4.44,-0.41]
N	551,062			

PCI = percutaneous coronary intervention

Values are coefficient [95% confidence interval]. *p<0.05 **p<0.01

Note: Community fixed-effects models adjusted for patient demographic (age, sex, race, ethnicity) and comorbid conditions, and controlled for yearly trend.

Appendix Table 1. Full regression results of the models presented in Figure 2

	Same-day PCI	In-hospital PCI	30-day mortality	1-year mortality
Changes in outcome by patient race and community segregation category				
White in segregated communities	0.98*	2.20**	0.03	-0.38
	[0.19,1.77]	[1.29,3.11]	[-0.46,0.51]	[-1.07,0.31]
Black in segregated communities	2.02**	3.60**	-0.69*	-1.37**
	[0.97,3.06]	[2.43,4.78]	[-1.37,-0.02]	[-2.38,-0.37]
White in integrated communities	2.84**	5.28**	-0.41*	-0.65**
	[2.18,3.49]	[4.45,6.11]	[-0.76,-0.06]	[-1.10,-0.21]
Black in integrated communities	3.92**	6.62**	-1.30**	-1.86**
	[2.90,4.95]	[5.40,7.84]	[-1.98,-0.63]	[-2.80,-0.93]
Patient demographics characteristics				
Black	-5.01**	-4.81**	-0.71**	0.55**
	[-5.28,-4.74]	[-5.09,-4.53]	[-0.91,-0.50]	[0.28,0.81]
Female	-4.15**	-4.24**	0.02	-0.43**
	[-4.27,-4.04]	[-4.35,-4.12]	[-0.07,0.11]	[-0.54,-0.32]
Ages 70-74	-1.41**	-1.17**	0.79**	0.30**
	[-1.59,-1.23]	[-1.33,-1.00]	[0.68,0.90]	[0.15,0.46]
Ages 75-79	-5.44**	-4.96**	2.91**	4.58**
	[-5.63,-5.26]	[-5.13,-4.78]	[2.79,3.03]	[4.42,4.74]
Ages 80-84	-11.99**	-12.74**	5.82**	10.59**
	[-12.19,-11.80]	[-12.94,-12.55]	[5.69,5.95]	[10.41,10.77]
Ages 85+	-27.85**	-35.94**	13.37**	24.81**
	[-28.05,-27.64]	[-36.16,-35.73]	[13.24,13.51]	[24.63,24.98]
Patient disease and comorbid conditions				
STEMI	34.26**	21.20**	5.46**	0.77**
	[34.07,34.45]	[21.01,21.38]	[5.35,5.57]	[0.64,0.90]

Peripheral vascular disease	0.75**	2.67**	0.46**	1.95**
	[0.55,0.95]	[2.47,2.87]	[0.32,0.60]	[1.76,2.13]
Pulmonary Circulation disorders	-7.52**	-4.11**	1.52**	6.17**
	[-7.79,-7.26]	[-4.40,-3.82]	[1.30,1.74]	[5.88,6.45]
Diabetes (uncomplicated and complicated)	-3.36**	-2.20**	-0.80**	0.78**
	[-3.49,-3.23]	[-2.33,-2.08]	[-0.89,-0.71]	[0.65,0.90]
Renal failure	-13.03**	-10.75**	5.15**	14.01**
	[-13.18,-12.88]	[-10.91,-10.59]	[5.04,5.27]	[13.85,14.16]
Liver disease	-7.95**	-8.66**	4.11**	8.54**
	[-8.57,-7.33]	[-9.29,-8.03]	[3.62,4.61]	[7.92,9.17]
Cancer	-12.27**	-15.31**	10.54**	26.85**
	[-12.56,-11.98]	[-15.62,-14.99]	[10.25,10.83]	[26.52,27.19]
Dementia	-12.15**	-16.80**	4.88**	10.71**
	[-12.42,-11.87]	[-17.11,-16.50]	[4.60,5.16]	[10.37,11.04]
Valvular disease	-1.75**	1.07**	-0.62**	2.50**
	[-1.93,-1.58]	[0.89,1.26]	[-0.76,-0.49]	[2.32,2.68]
Hypertension (uncomplicated and complicated)	5.33**	5.25**	-7.47**	-11.31**
	[5.20,5.46]	[5.11,5.38]	[-7.57,-7.37]	[-11.43,-11.18]
Chronic pulmonary disease	-7.48**	-5.56**	0.73**	5.86**
	[-7.63,-7.34]	[-5.71,-5.42]	[0.63,0.84]	[5.71,6.00]
Rheumatoid arthritis/collagen vascular	0.04	0.33	-1.47**	-0.25
	[-0.34,0.42]	[-0.04,0.69]	[-1.73,-1.22]	[-0.61,0.10]
Coagulation deficiency	0.38*	1.39**	2.83**	3.48**
	[0.08,0.67]	[1.10,1.69]	[2.59,3.06]	[3.19,3.77]
Obesity	2.85**	4.12**	-1.84**	-4.42**
	[2.61,3.08]	[3.91,4.33]	[-1.97,-1.71]	[-4.60,-4.23]
Substance abuse	-4.42**	-3.61**	-1.44**	-1.27**
	[-4.95,-3.90]	[-4.12,-3.11]	[-1.78,-1.10]	[-1.74,-0.79]

Depression	-0.84**	-1.37**	-1.15**	-1.12**
	[-1.14,-0.54]	[-1.67,-1.07]	[-1.36,-0.95]	[-1.40,-0.84]
Psychosis	-5.09**	-4.47**	0.30*	2.31**
	[-5.45,-4.72]	[-4.84,-4.10]	[0.03,0.56]	[1.95,2.67]
Hypothyroidism	0.29**	0.16	-2.81**	-3.79**
	[0.11,0.47]	[-0.02,0.34]	[-2.94,-2.69]	[-3.96,-3.62]
Paralysis and other neurological disorder	-9.07**	-10.74**	4.20**	7.79**
	[-9.28,-8.85]	[-10.97,-10.51]	[4.00,4.39]	[7.55,8.03]
Chronic Peptic ulcer disease	-6.53**	-1.14	-1.59**	-0.78
	[-7.78,-5.29]	[-2.43,0.16]	[-2.49,-0.70]	[-2.00,0.44]
Weight loss	-11.11**	-12.05**	8.69**	18.77**
	[-11.43,-10.80]	[-12.41,-11.70]	[8.34,9.03]	[18.40,19.15]
Fluid and electrolyte disorders	-9.65**	-8.14**	9.23**	11.66**
	[-9.79,-9.51]	[-8.29,-7.99]	[9.10,9.35]	[11.51,11.81]
Anemia (blood loss and deficiency)	-5.69**	-4.36**	-1.77**	2.10**
	[-5.86,-5.52]	[-4.54,-4.18]	[-1.90,-1.63]	[1.92,2.28]
Stroke	-6.23**	-5.31**	11.74**	14.02**
	[-6.61,-5.86]	[-5.71,-4.91]	[11.35,12.12]	[13.60,14.44]
Year indicators (reference year 2006)				
2007	1.58**	0.93**	-0.48**	-0.23
	[1.30,1.86]	[0.64,1.22]	[-0.71,-0.25]	[-0.52,0.05]
2008	2.69**	2.06**	-0.39**	-0.24
	[2.41,2.97]	[1.76,2.36]	[-0.61,-0.17]	[-0.52,0.03]
2009	4.97**	4.26**	-0.85**	-0.82**
	[4.68,5.26]	[3.96,4.57]	[-1.08,-0.63]	[-1.11,-0.54]
2010	7.10**	6.38**	-1.13**	-1.43**
	[6.81,7.39]	[6.08,6.69]	[-1.35,-0.90]	[-1.71,-1.15]
2011	8.75**	7.86**	-1.23**	-1.54**
	[8.45,9.04]	[7.55,8.17]	[-1.45,-1.01]	[-1.82,-1.26]

2012	10.40**	9.40**	-1.61**	-2.06**
	[10.10,10.71]	[9.09,9.72]	[-1.82,-1.39]	[-2.34,-1.78]
2013	11.95**	10.93**	-1.77**	-3.10**
	[11.64,12.25]	[10.61,11.25]	[-1.99,-1.55]	[-3.38,-2.82]
2014	12.93**	11.97**	-1.85**	-2.65**
	[12.62,13.25]	[11.64,12.29]	[-2.07,-1.63]	[-2.93,-2.37]
2015	17.03**	15.22**	-1.48**	-5.30**
	[16.72,17.34]	[14.89,15.54]	[-1.69,-1.26]	[-5.57,-5.02]
2016	18.28**	17.14**	-1.88**	-5.26**
	[17.97,18.60]	[16.81,17.47]	[-2.10,-1.67]	[-5.54,-4.98]
2017	18.76**	17.71**	-1.88**	-5.22**
	[18.44,19.08]	[17.37,18.05]	[-2.10,-1.67]	[-5.50,-4.94]
constant	48.32**	66.48**	9.15**	18.65**
	[48.03,48.61]	[66.18,66.78]	[8.95,9.35]	[18.39,18.91]
N	2,388,180	2,388,180	2,388,180	2,388,180

PCI = percutaneous coronary intervention. STEMI = ST-segment elevation myocardial infarction.

Values are coefficient [95% confidence interval]. *p<0.05 ** p<0.01

Note: Community fixed-effects models adjusted for patient demographic (age, sex, race, ethnicity) and comorbid conditions, and controlled for yearly trend.