12-16-2022 9:00 AM

Association of Socioeconomic, Racial, and Regional Factors with In-Hospital Management and Outcomes of Acute Myocardial Infarction Patients in the United States: National Analyses of 2.8 Million Admissions

Olivia Haldenby, *The University of Western Ontario*

Supervisor: Ali, Shehzad, *The University of Western Ontario*
Joint Supervisor: Garg, Pallav, *The University of Western Ontario*
A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Epidemiology and Biostatistics

Abstract

Social determinants of health contribute to variations in clinical outcomes among acute myocardial infarction (AMI) patients. Using the National Inpatient Sample, we conducted retrospective cohort analyses to evaluate the association of income, race, and geography with in-hospital mortality and revascularization procedures among AMI admissions in the United States from 2015 to 2019. Multilevel logistic regression models were used while accounting for hospital clustering and relevant predictors. A sequential model-building approach produced model 1 (unadjusted patient-level exposures), model 2 (lifestyle factors), model 3 (clinical characteristics), and model 4 (fully adjusted hospital-level factors). We identified 2,798,225 AMI hospitalizations (≥18 years) with 1,567,575 undergoing revascularization procedures. Lowest-income, White, Asian or Pacific Islander, Native American, and Southern residents had higher in-hospital mortality, while higher-income, White, Midwestern, Southern, and Western residents had greater use of revascularization procedures. System-level strategies that improve structural factors are recommended to reduce disparities in AMI outcomes.

Keywords

Acute myocardial infarction, social determinants of health, health inequities, socioeconomic status, mortality, revascularization

Summary for Lay Audience

Heart attacks, or acute myocardial infarctions (AMIs), are a leading cause of illness and death in the United States (US). As of 2020, there were approximately one million deaths due to AMI in the US annually. Existing studies have identified non-medical factors, or social determinants of health (SDH), among AMI patients in the US that cause variation in their management and outcomes while in hospital. However, these studies are limited in their scope, causing their results to not be representative of the US population. Our current study addressed these existing gaps by using the National Inpatient Sample, which represents approximately 98% of the US population, to examine the association between income groups, race, and geography with death in hospital and the use of revascularization procedures among AMI patients in the US from 2015 to 2019.

Using biostatistical methods, we assessed the association between AMI and select SDH while adjusting for the impact of external factors at the patient- (i.e., age, sex, existing medical conditions and histories) and hospital-level (i.e., hospital location/teaching status, bed size). We identified variation in in-hospital death where AMI patients in the lowest-income groups, White, Asian or Pacific Islander and Native American patients, and those from the South experienced greater odds of death during their hospital stay. We also identified that AMI patients in the highest-income groups, White patients, and those presenting to hospitals in the Midwest, South and West had greater odds of receiving revascularization procedures while hospitalized. Studying the association between SDH and in-hospital deaths allows us to better understand how poor health outcomes are distributed among income groups, race, and geographic regions in the US. There is also significance in understanding the variation in the revascularization procedure use and what features of certain SDH or social groups make one more or less likely to receive care. These findings aid in recommending health system-level strategies that aim to reduce resource barriers, provider biases, and other structural factors to diminish the disparities observed among AMI patients in the US.

Co-Authorship Statement

Olivia Haldenby (OH), Shehzad Ali (SA), and Pallav Garg (PG) were responsible for study conception, design, and the statistical analysis plan. OH operationalized all datasets, conducted the data analysis, and wrote the thesis. All authors (OH, SA, and PG) contributed to interpreting the data, editing the thesis, and providing final approval for thesis submission.

Acknowledgements

Thank you to my co-supervisors, friends, and family for their guidance and support throughout this process. This thesis would have not been possible without their constant and consistent encouragement, especially with all the challenges associated with pursuing a master's degree during the COVID-19 pandemic.

I am grateful for my co-supervisors, Drs. Shehzad Ali and Pallav Garg, for their patience, guidance, and mentorship during my time as their student and for their feedback on my thesis work. Your expertise has been invaluable throughout the development and completion of my research project's objectives. I also appreciate your genuine and continued interest in my academic and professional development. I would not have been able to complete this thesis without your constant support and reassurance.

I also want to extend my thanks to the mentors, colleagues, and friends I have gained in the Department of Epidemiology and Biostatistics. Your advice, camaraderie, and insights have been essential to the progression in both my coursework and throughout my research projects. Thank you all for the late-night Zoom study sessions, group chats, and laughs.

I appreciate my parents and siblings for their love, support, and belief in me. To my Mom, for providing thoughtful advice and even just listening to and reasoning me through my worries, I could not be more grateful. I would also like to thank my family's pets, Cinder, Rosie, Coda, Clementine, Tilly, Ellie, Willa, Penelope, Igor, and Lottie, for their constant comfort and companionship during my time working from home in this program.

Finally, I wish to acknowledge the Department of Epidemiology and Biostatistics for funding this research.

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations and Acronyms

ACS	Acute Coronary Syndrome
AHA	American Heart Association
AHRQ	Agency for Healthcare Research and Quality
AMI	Acute Myocardial Infarction
BIPOC	Black, Indigenous, and People of Colour
CABG	Coronary Artery Bypass Graft
CI	Confidence Interval
ECG	Electrocardiogram
HCUP	Healthcare Cost and Utilization Project
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
ICD-10-PCS	International Classification of Diseases, Tenth Revision, Procedure Coding System
NIS	National (Nationwide) Inpatient Sample
NSTEMI	Non-ST-Elevation Myocardial Infarction
OR	Odds Ratio
PCI	Percutaneous Coronary Intervention
SAVA	Substance Abuse, Violence, and HIV/AIDS
SD	Standard Deviation
SDH	Social Determinants of Health
SES	Socioeconomic Status
SID	State Inpatient Database
STEMI	ST-Elevation Myocardial Infarction
US	United States

Chapter 1

1 Thesis Introduction, Rationale, Objectives, and Organization

1.1 Background

Social determinants of health (SDH) are factors related to an individual's living, learning, and working environments.[1] SDH influence health inequities by interacting to create social groups where relatively worse health outcomes cluster among certain members.[2,3] There are evident differences in health outcomes among socioeconomic status (SES), race/ethnic, and geographic groups related to morbidity, mortality, and life expectancy.[2,4,5] Addressing SDH is essential for improving health within and between social groups as well as reducing the longstanding inequities observed in health outcomes.[1,6-8] As acute myocardial infarction (AMI) continues to be a leading cause of morbidity and mortality, globally, this condition allows for the evaluation of disparities within SDH across a broad population.[9]

Approximately one million deaths due to AMI occur in the United States (US) annually.[9] With this level of morbidity and mortality, there is a burden placed on population health and the healthcare system in terms of hospital admissions, cost of procedures, and adverse outcomes following AMI.[2,10] Although there have been major technical and clinical advances in acute cardiovascular care, disparities in health outcomes are still present among SDH factors and subsequent sociodemographic groups.[2,5] AMI clinical endpoints, such as in-hospital mortality and use of revascularization procedures, are well-documented in existing literature.[11-19] Examining in-hospital outcomes relative to SDH factors will allow us to better understand prevailing clinically significant disparities among AMI patients in the US.

Studies conducted in the US have reported that lower SES groups,[11,13,17,20-25] and those of Black, Indigenous, and People of Colour (BIPOC) race groups tend to experience higher odds of in-hospital mortality related to AMI and are less likely to undergo revascularization procedures.[12,26-40] Further, contemporary research indicates that those living in the Northeast regions of the US tend to experience lower odds of in-hospital mortality compared to other regions while those in the West and South experience greater odds.[29,41-43] However, AMI patients presenting to

hospitals in the Northeast region have also been noted to have lower odds of receiving revascularization procedures.[41,42,44-48] We have selected to study the outcomes of in-hospital mortality and revascularization procedures among AMI patients in the US. Although prior studies have investigated the association of SDH and AMI outcomes, limitations in study methodology and design are abundant. With this, we conducted two empirical analyses to investigate whether membership in certain sociodemographic groups is associated with higher or lower odds of in-hospital outcomes in patients with a principal diagnosis of AMI.

1.2 Rationale

There has been extensive research conducted on in-hospital mortality and the use of revascularization procedures among AMI patients in the US. Findings from existing literature indicate the association among people with AMI and their belonging to particular social groups or geographic locations, such that these individuals experience greater odds of in-hospital mortality and lower odds of receiving appropriate revascularization procedures.[10-31,33,35,37-42,44-73] However, these studies are limited in their scope. Research investigating patterns of association between SES, race, and geographic location of AMI patients relative to their in-hospital mortality and use of revascularization procedures tend to limit the study sample based on age,[19,21,31,42,44,62,68] type of insurance,[14,23,36,38,68,70] region of the US,[15,16,20,36,38,57,58,69,72,74] restricted to AMI patients presenting with complications,[12,41,47,63,64,73] AMI type,[16,29,64,65] and used a single year of data.[15,18,45,52,57] The current study seeking to explore patterns of association between SES, race, and geographic location and in-hospital outcomes among AMI patients in the US will enhance the knowledge base and address current gaps in the literature as it uses a nationally representative sample of AMI patients spanning over multiple years in a contemporary context.

1.3 Objectives

The specific aims of this research project were as follows:

1) To explore patterns in the association of SES, race, and regional disparities of in-hospital mortality among adult patients after a principal diagnosis of AMI; and

2) To evaluate the patterns in the association of SES, race, and regional disparities with the in-hospital use of revascularization procedures, percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG), after a principal diagnosis of AMI.

1.4 Structure

Chapter 1: This chapter provides a brief description of the preliminary background information related to the thesis, as well as its rationale, objectives, and structure.

Chapter 2: This chapter aims to provide a thorough literature review related to the current evidence behind conducting the studies presented in this thesis.

Chapter 3: This chapter aims to evaluate patterns related to socioeconomic status, race, and regional disparities in in-hospital mortality for patients $\geq$ 18 years with a principal diagnosis of acute myocardial infarction in federally funded United States hospitals.

Chapter 4: This chapter aims to evaluate trends related to socioeconomic status, race, and regional disparities in the use of revascularization procedures for patients $\geq$ 18 years with a principal diagnosis of acute myocardial infarction in federally regulated hospitals in the United States.

Chapter 5: This chapter includes the limitations related to the studies presented in this thesis, provides final thoughts and conclusions, and indicates areas for future research.

Chapter 2

2 Literature Review

The literature review aims to describe the theoretical models that act as the framework for this thesis. Further, this chapter outlines the condition of interest, AMI, in terms of its clinical classification, significance, and risk factors. Next, relevant literature related to select in-hospital outcomes among AMI patients in the US are presented. Finally, this chapter concludes by highlighting the existing literature related to the relevant SDH examined in this thesis in the context of in-hospital outcomes among AMI patients.

2.1 Theoretical models

Several theoretical models were adapted as the framework for this thesis. Namely, the SDH were used as the basis, while elements from Andersen's Model of Health Services Use and Syndemic Theory were also adopted to structure this thesis. This section of the literature review aims to outline the history of the previously mentioned theoretical models, their features and uses, as well as their application in the context of studying in-hospital disparities among AMI patients in the US.

2.1.1 Social determinants of health

2.1.1.1 Defining social determinants of health

The determinants of health include one's individual characteristics and behaviours as well as their social, economic, and physical environments.[75] As a subset of the determinants of health, the SDH are factors related to an individual's living, learning, and working environments that impact a wide range of risk factors related to life and quality of life.[1] These determinants include education, income and social status, employment, childhood experiences, connection to the land (e.g., land, water, environment), social supports and connections, diversity and inclusion (e.g., gender identity, race, culture), housing, food security, accessibility, and transportation.[2,3,6,75] SDH interact and combine to create social groups where membership has a profound impact on

health and well-being at both the individual- and population-level.[2,3] SDH have been well-studied and identified as having wide-ranging impacts across the life course.[6]

2.1.1.2 Inequities in social determinants of health, examples, and their significance

Health inequities are defined as "inequalities that are deemed to be unfair, unjust, avoidable, or unnecessary that can be reduced or remedied through policy action".[4] Such inequities in the SDH are conceptualized in terms of structural, economic, environmental, and social disparities that are associated with differences observed in health outcomes both between and within populations.[76,77] Inequities in SDH are quantified through measures such as life expectancy, unemployment, lack of insurance, poverty, comorbidities, mortality, prevalence of chronic conditions and risk factors, and access to healthcare services and their quality.[4]

It has been established that one experiences better health with increasing socioeconomic position, such that there is a social gradient of health.[2,7,78] This social gradient of health is not just present due to deprivation among the lowest socioeconomic groups.[8] Instead, a social gradient of health functions across the entire socioeconomic spectrum within societies and is apparent in a wide range of diseases.[8,78] With this, the steepness of the social gradient of health is impacted by the degree of inequality within a society.[8] Lower socioeconomic groups tend to have a greater number and more severe comorbidities, reduced health literacy or ability to navigate the healthcare system, and may receive inferior quality of care.[2,8] Although the social gradient of health dictates that health improves as income increases at all income levels, the greatest benefits are observed when additional income is experienced towards the lowest level.[6]

Although progress in health and well-being in the US has been documented, the existing inequities between different population groups and geographic locations have lingered.[4] Studies have identified that there are apparent differences in health outcomes for SES, race/ethnicity, and geographic disparities in morbidity, mortality, and life expectancy among particular social groups.[2,4,5] For instance, Singh et al. [4] examined temporal trends in SDH in the US from 1935 to 2016 National Vital Statistics System, National Health Interview Survey, National Survey of Children's Health, American Community Survey, and Behavioral Risk Factor Surveillance System. These researchers concluded that the Southern states, individuals who are BIPOC, and those in lower socioeconomic groups fared worse in SDH indicators, such as education, life

expectancy, income, and mortality.[4] In the context of AMI, Raparelli et al. [5] explored variations in the quality of care by sex and SDH of young AMI patients in the US and Canada from 2008 to 2013 and identified that higher SES indicators (i.e., employment) were associated with a greater quality of AMI care. Overall, as observed in previous research, utilizing SDH would provide a greater understanding of vulnerability within SES, race, and geographic location in terms of in-hospital outcomes among AMI patients in the US.[4,5]

There is great significance in studying inequities in SDH between and within population groups in the US.[6,7] From an economic perspective, Graham et al. [79] estimated the overall cost of health inequities in the US as 1.24 trillion US Dollars. Inequities in the SDH tend to be greater in the US compared to other industrialized countries with the US lagging in narrowing the gaps observed in notable health indicators (e.g., infant mortality, life expectancy at birth).[79] These findings are concerning as the US invests more in providing clinical services rather than addressing the social and behavioural factors related to health and mortality.[6] These factors exist at the patient- (e.g., lifestyle, genetics), provider- (e.g., unintentional bias, sensitivity to patient needs), and system-levels (e.g., access to care, cultural competency).[79] By studying the influence of these factors on the distribution of health outcomes, there is potential for policy change to enable all individuals to fulfil their social functioning and material, physical, spiritual, and psychosocial needs.[7]

2.1.2 Andersen's Model of Health Services Use

Healthcare utilization is the use of the healthcare system "by persons for the purpose of preventing and curing health problems, promoting maintenance of health and well-being, or obtaining information about one's health status and prognosis".[80] Andersen and colleagues initially developed the 1968 Behaviour Model of Families' Use of Health Services to illustrate the why and how of healthcare utilization by American families.[81] This initial model illustrated health services usage by families through a function of predisposing characteristics, enabling resources, and perceived need.[81] Over time, Andersen's model has undergone revisions and modifications to account for both family- and individual-level factors.[82,83] Particularly, in the 1970s, Andersen and colleagues modified the model with an emphasis on the individual patients and the healthcare system as a key driver that impacts access to healthcare.[82] The third iteration

was released in the 1990s where the healthcare system, external environment, and population-level characteristics were incorporated as primary determinants of health behaviour.[82] The latest version of the late 1990s and early 2000s includes all previous aspects with the addition of feedback loops to emphasize that health outcomes may impact future population characteristics.[83]

The present version of Andersen's Model of Health Services Use contains three key elements: (1) predisposing; (2) enabling; and (3) need-for-care factors that can either improve or impede healthcare utilization by vulnerable populations.[83] Predisposing factors include those that are related to a patient's socio-cultural experiences and identities that exist before the patient may need care, including attitudes, knowledge, social norms, and perceived control.[83,84] Enabling factors are related to relevant community- and individual-level resources required to access care, including distance to health services, wait times, and access to health insurance.[83,84] Finally, need factors describe how individuals perceive their own health or functional state or how someone else (i.e., healthcare provider) describes their health or functional state.[83,84] Newer iterations continue to add on the three core components to provide policymakers and stakeholders with a framework to monitor and evaluate the effectiveness and efficiency of health programs by highlighting factors that affect equitable access to healthcare services.[4,80,85-88]

Many versions of Andersen's Model of Health Services Use have been modified and applied to specific populations and health programs.[89] Notably, Bradley et al. [89] used Andersen's Model to understand what modifications can be made to enhance its applicability to empirical studies of race/ethnicity in the context of long-term care services use. As a result, these researchers expanded Andersen's Model by identifying psychosocial factors (e.g., social norms, perceived control, attitudes, and knowledge) as determinants of services use.[89] Andersen's Model of Health Services Use offers a theoretical framework for investigating potential disparities in in-hospital outcomes and services use among AMI patients in the US. Specifically, Andersen's model can be adapted to account for predisposing (i.e., age, sex, race/ethnicity), enabling (e.g., income), and need for care factors (e.g., comorbidities) for AMI patients seeking care in the US.[83,84] Overall, Andersen's model provides tools and a fundamental basis for examining the patterns of in-hospital outcomes among SES, race/ethnicity, and geographic groups

2.1.3 Syndemic theory

A syndemic or synergistic epidemic is defined as an accumulation of social and health problems by person, place, or time.[90] The syndemic theory of health, which has roots in medical anthropology, emphasizes the biosocial complex, which consists of "interacting, co-present, or sequential diseases and the social and environmental factors that promote and enhance the negative effects of disease interaction".[91,92] Syndemics are classified by three criteria: (1) two or more diseases or conditions cluster within a particular population; (2) contextual and social elements create conditions where two or more diseases or conditions cluster; and (3) the clustering of diseases results in either biological, social, or behavioural adverse disease interactions which then increase the burden experienced by impacted populations.[91] The syndemic theory requires two or more diseases or exposures related to disease (e.g., obesity, smoking) to be present within a particular population as well as the associated societal and social contributors to the disease.[91,93-95] This approach moves away from the historical clinical understanding of disease as distinct outcomes in nature which are separate from other diseases and independent of social contexts and environments.[91] Instead, a syndemic approach seeks to understand how factors interact synergistically to impact the health of individuals and entire populations.[91,94] Syndemics are typically viewed among populations that have been made vulnerable by the SDH.[96]

The syndemic theory was first used in 2000 by Singer [97] to describe the interaction between substance abuse, violence, and AIDS (SAVA) in inner cities. Singer posited that HIV/AIDS meets syndemic criteria as it is often a necessary component in disease interactions and is impacted by social and structural factors (i.e., poverty, gender inequality, stigma, marginalization).[97] Specifically, Singer indicated that increased risk of HIV transmission and progression was linked to substance use which was also associated with domestic violence.[97] Together, these factors were found to exacerbate disease progression when linked with homelessness, poverty, poor healthcare access, and stigma from family members.[97] Singer's investigation of the SAVA syndemic emphasized how SDH and inequities can advance violence, substance use, and transmission of infectious diseases like HIV.[97]

Since Singer's work, syndemic frameworks have been applied to an array of research studies that involve other public health conditions and scenarios.[91,93,94,98] Syndemic theory aids in the identification and improvement of emerging medical interventions and can be a tool for social justice in health.[92] Syndemic theory has the potential to lend a theoretical basis to the current study exploring inequities related to SES, race, and geography as well as their impact on in-hospital outcomes and the use of interventions among AMI patients in the US.[92] Use of syndemic theory may explain why AMI may impact certain individuals and how interactions with the SDH and their inequities can worsen in-hospital outcomes.[91,92] Ultimately, syndemic theory provides tools for understanding why AMI may cluster, the pathways in which they interact in individuals and populations, and thereby multiply their disease burden, and how social environments of inequity and injustice contribute to clustering, interaction, and vulnerability.[98]

2.1.4 Implementation of theoretical models

Using the SDH model, we selected the relevant social conditions that impact individual and group differences in health status among hospitalized AMI patients in the US. Specifically, key areas of SDH have been cited as economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context.[99] Based on the data elements available in our chosen dataset, we selected SES, race/ethnicity, and geography as the SDH evaluated among AMI patients hospitalized in the US. Following this, we adapted Andersen's Model of Health Services Use to aid in the selection of appropriate predictors and potential confounders in the analysis.[89] Predisposing factors (i.e., age, sex, race/ethnicity), enabling factors (i.e., income), and need factors (i.e., comorbidities) related to AMI hospitalization were identified and implemented using this model (Appendix 10: Covariates selected based on Andersen's Model of Health Services Use) .[89] Syndemic theory was adopted to structure our understanding of the mechanisms related to the potential adverse interactions between AMI and the primary social conditions (i.e., SES, race/ethnicity, geography) that were examined in this thesis.[91,95]

2.2 Acute myocardial infarction

The following section provides an overview of acute myocardial infarction as well as its incidence, prevalence, risk factors, and in-hospital outcomes.

2.2.1 Acute myocardial infarction definition, clinical presentation, and management strategies

AMI is pathologically defined as when part of the heart muscle supplied by the coronary artery experiences tissue or cell death due to the severe reduction of blood flow and oxygen as the artery is occluded or almost occluded.[100,101] AMI can be differentiated as two clinical presentations: (1) ST-segment elevation myocardial infarction (STEMI); or (2) non-ST-segment elevation myocardial infarction (NSTEMI).[102] STEMI is distinct in its extended and entire occlusion of an epicardial coronary blood vessel which is recognized through elevation of the ST-segment on an electrocardiogram (ECG).[102,103] Conversely, NSTEMI typically results from a partial occlusion or severe narrowing of the coronary artery, or micro-embolism of the thrombus and/or atheromatous material.[104] NSTEMIs are recognized through the absence of an elevated ST-segment as well as through the presence of positive cardiac biomarkers (i.e., troponin) on an ECG.[102,104,105]

Clinical presentation and symptomology of STEMI and NSTEMI AMI sub-types are documented as being nearly identical.[100] The most common symptoms of AMI include chest pain with or without dyspnea, nausea, diaphoresis, anxiety, fatigue, sweating, and other manifestations.[100,106] Approximately 20%-40% of AMIs are silent, which means individuals are asymptomatic or experience symptoms mild enough such that they are not recognized as disordered by the individual.[100,107] Immediate treatment for AMI involves administering oxygen, anticoagulants, antiplatelet drugs, and antianginals.[100,106] The most common intervention strategies include reperfusion therapies involving primary PCI or fibrinolysis for STEMI, and early invasive angiography with a view to revascularization with PCI or CABG for NSTEMI.[100] Rehabilitation, antiplatelet drugs, beta-blockers, angiotensin-converting enzyme inhibitors, and/or statins are recommended following recovery.[100]

2.2.2 Incidence and prevalence of acute myocardial infarction

AMI is a leading cause of morbidity, disability, and mortality worldwide.[102] As of 2021, AMI has an estimated prevalence approaching three million people worldwide.[9] Every 40 seconds, it is estimated that an individual in the US experiences an AMI.[108] Annually, the incidence of AMI is approximated as 605,000 new cases and 200,000 recurrent cases in the US.[102,108] Prevalence of AMI approximates 3.0% for US adults aged 20 years and older during 2013 to 2016.[108,109] Of these cases, the vast majority appear to suffer with NSTEMI rather than STEMI diagnoses.[102] Specifically, nearly 40% of patients who present with AMI will have diagnostic indicators of STEMI.[102,110]

Temporal analyses performed by Chi et al. [110] using 18,630,776 person-years of observation from US California hospitals indicate a decline in the age- and sex-standardized incidence rate (per 100,000 person-years) of AMI hospitalizations from 349 in 2000 to 179 in 2014. These researchers also noted a relative decline in the incidence rate of patients hospitalized with NSTEMI from 219 in 2000 to 144 in 2014.[110] The incidence rate for STEMI hospitalizations followed a similar trend with an incidence rate of 159 in 2000 and 48 in 2014.[110] Although the incidence and prevalence of AMI in the US are well-documented, it is estimated that 20% of AMI are silent or asymptomatic such that they are not recognized by the individual, and subsequently, not documented as the individual does not seek care.[100]

2.2.3 Acute myocardial infarction risk factors

Risk factors that are associated with AMI include those that are modifiable and non-modifiable. Modifiable risk factors are defined as those that can be treated or controlled through medications or lifestyle changes, whereas non-modifiable risk factors are those that cannot be controlled through intervention or person-level changes.[9,102] Traditional modifiable AMI risk factors include smoking, hypertension, obesity, sedentary lifestyle, poor oral hygiene, diabetes mellitus, dyslipidemia, presence of vascular disease, and elevated levels of homocysteine.[9,79,102,111,112] Conversely, non-modifiable risk factors include SES, age, family history of coronary heart disease in first-degree relatives, and sex.[9,79,102,111,112]

The INTER-HEART study [112] conducted by Yusuf et al. explored the prevalence of nine potentially modifiable risk factors in more than 14,000 AMI cases that were matched based on age and sex with 16,000 asymptomatic cases or controls. The nine risk factors included smoking, diabetes, hypertension, obesity, psychosocial stressors, irregular consumption of fruits and vegetables, sedentary lifestyle, no alcohol consumption, and raised plasma lipids and were strongly associated with AMI in the 52 countries included in the study.[111,112] The researchers concluded that the modifiable risk factors included in this study represent over 90% of the risk for AMI in men and 94% of the risk in women.[112] Ultimately, AMI is posited as being a result of a complex interaction of both non-modifiable and modifiable risk factors existing at the individual- and societal-level.[9,112]

2.3 In-hospital outcomes related to acute myocardial infarction

2.3.1 In-hospital mortality

AMI is one of the leading causes of mortality in the world with 15% of all deaths being attributed to AMI.[102,113] In the US, AMI mortality was 27.0 per 100,000 people in 2018 with the highest rate observed in Arkansas and the lowest in Alaska.[108] Several existing studies indicate that due to advancements in cardiovascular care technologies and management, a decreasing trend in in-hospital mortality for AMI has been observed over the last several decades.[29,46] Specifically, Krumholz et al. [49] conducted a 20-year temporal analysis to explore health outcomes among 4.3 million older adults with AMI in the US. In this study, the researchers concluded that 30-day in-hospital mortality declined from 20.0% in 1994 to 12.4% in 2014.[49] Additional research conducted by Sugiyama et al. [50] used the National Inpatient Sample (NIS) to explore 10-year temporal trends in in-hospital mortality among AMI patients aged 30 years and older in the US. These researchers reported that from 2001 to 2011, in-hospital mortality improved for NSTEMI patients.[50] However, this study concluded that STEMI patients did not experience a significant change in their odds of in-hospital mortality during this study period.[50]

The significance of studying AMI-related in-hospital mortality in the US pertains to the distribution of poor health outcomes both between and within particular social groups and geographic locations. Although previous temporal trends indicate that in-hospital mortality has

declined among AMI patients in the US,[29,46,49,50] it is important to understand the distribution of this outcome in a contemporary context. Particularly, the current study seeks to understand whether the burden of in-hospital mortality is associated with population groups (i.e., SES, race, geographic location). Such analyses may quantify current disparities in in-hospital outcomes among AMI patients in the US. Additionally, the current study may provide an understanding of in-hospital mortality for future studies related to quality of care, hospital costs, and length of stay to help shape decision-making and policy-related strategies.

2.3.2 Revascularization procedures

In patients presenting with AMI, prompt and timely revascularization procedures can improve survival and long-term patient outcomes.[10,34] Common revascularization procedures include PCI and CABG among AMI patients. CABG procedures involve taking an existing blood vessel from another area of the body (i.e., chest, leg, arm) and attaching it to the coronary artery above and below the artery causing the AMI.[114] The new blood vessel created from this procedure is referred to as a graft.[114] PCI procedures, formally referred to as coronary angioplasties, are non-surgical interventions that use a small metallic stent that is inserted in a blocked blood vessel to help widen it and enhance blood flow to the heart.[115]

Among patients with STEMI diagnosis, timely access to primary PCI is essential to achieve optimal in-hospital outcomes.[116,117] NSTEMI patients are risk stratified by cardiac catheterization followed by revascularization (with either PCI or CABG as appropriate) and/or medical therapy alone.[51] Although the need for each previously mentioned revascularization procedure exists, research has highlighted that since the emergence of PCI during the 1990s, there has been a significant decrease in the volume of CABG procedures performed.[118-120] Due to the technological advancements over the last 40 years, PCI offers improved success rates and lower complication rates for AMI patients when compared to CABG.[51] However, Alkhouli et al. [10] investigated the use of CABG and PCI among in-hospital AMI patients in the US from 2003 to 2016. These researchers reported that, during this study period, there was a decrease in the volume of both procedures with CABG decreasing from 159 to 82 per 100,000 US adults per year and PCI decreasing from 366 to 180 per 100,000 US adults.[10] An explanation for these trends has been provided by Concannon et al. [121] and Wang and Yearly [122] in that PCIs are

still resource intensive and only 37% of all adult acute care hospitals in the US offer any PCI lab capability with little round-the-clock availability.

Studying inpatient revascularization procedures within the context of AMI patients in the US may offer insight into how care is distributed and what features of a population group may make individuals more or less likely to receive appropriate interventions. Existing literature indicates that understanding the association between patient characteristics (i.e., SES, race, geographic location) and the use of revascularization procedures may provide a means of quantifying disparities in the US context.[10,123] Further, research has indicated that US hospitals with revascularization capabilities are not evenly distributed between and within population groups.[123] With this, understanding revascularization use among AMI patients in the US may provide information for policy strategies related to the quality of and access to timely care.

2.4 Social determinants of health among acute myocardial infarction patients

2.4.1 Socioeconomic status

SES commonly refers to the combined measure of an individual's social and economic standing based on their education, income, and occupation.[124] In health services research, SES tends to be associated with one's health outcomes.[124] Specifically, individuals with membership in lower SES groups tend to have, on average, poorer health outcomes and greater premature mortality rates compared to those in higher SES groups.[124,125] In the context of AMI patients, individuals belonging to lower SES groups tend to have a higher prevalence of traditional cardiovascular risk factors, including smoking, obesity, diabetes, dyslipidemia, hypertension, poor working and living conditions, stress, and reduced access to health services.[126] AMI patients belonging to the lowest SES groups also experience worse in-hospital outcomes compared to their higher SES counterparts.[126]

Studies in historical and more contemporary contexts highlight a similar pattern of inequity based on SES for both in-hospital mortality and revascularization procedure use among AMI patients in the US.[11,13,25] Udell et al. [11] explored whether SES was associated with in-hospital

mortality or adverse cardiovascular events among AMI patients in the US from 2008 to 2013. These researchers identified that AMI patients presenting from lower SES neighbourhoods were at a higher risk of in-hospital mortality when compared to those from higher SES neighbourhoods.[11] Using the State Inpatient Database (SID), Yong et al. [13] examined the use of revascularization procedures, CABG and PCI, among patients hospitalized with acute coronary syndrome (ACS) (i.e., STEMI, NSTEMI, or unstable angina) in the US from 2008 to 2011. This study concluded that those in the highest SES categories were more likely to receive any kind of revascularization procedure when compared to those in the lowest SES categories.[13] More recently, Matetic et al. [25] used the NIS to investigate the impact of SES on the management strategies and in-hospital outcomes of AMI patients in the US from 2004 to 2014. These researchers also indicated that patients in the lowest SES quartile were more likely to experience in-hospital mortality and were less likely to receive PCI procedures when compared to those in the higher SES categories.[25]

2.4.2 Race/ethnicity

In health services research, race has historically been referred to as a scientific biological variable that can be used to predict health outcomes.[127,128] However, more recent methodological considerations highlight that race is a social construct and does not qualify as a scientific indicator.[127-129] In terms of our current studies, the concept of race will follow the updated and more appropriate interpretation as a social construct.[127-129] General trends related to race in historical and more contemporary health services research include that individuals belonging to BIPOC race groups tend to experience a greater burden of cardiovascular disease in the US.[36,130] Specifically, BIPOC individuals have greater disparities in the risk factors and outcomes related to time-sensitive conditions, such as AMI.[36]

Studies examining differences in in-hospital mortality among AMI patients in the US have reported that those belonging to BIPOC race groups tend to experience higher odds of in-hospital mortality.[28,31,52,53] Skinner et al. [53] examined differences in in-hospital mortality among fee-for-service Medicare patients with AMI from 1997 to 2001 and reported that, compared with white patients, black patients had greater odds of in-hospital mortality. However, more recent studies have indicated a shift in the distribution of in-hospital mortality across different race

groups.[19,26,54-56] Specifically, Patlolla et al. [54] investigated differences in in-hospital mortality among AMI patients using the NIS from 2007 to 2017 and concluded that Black race was associated with lower odds of in-hospital mortality when compared to White race. These researchers also noted that those in the Hispanic, Asian or Pacific Islander, and Native American race groups had comparable odds of in-hospital mortality when compared to those in the White race group.[54] For revascularization procedures, studies consistently reported that AMI patients with membership in BIPOC race groups had lower rates of receiving revascularization procedures during their hospital stay when compared to White patients.[12,15,33-39,57-60] Further, researchers also highlighted that when compared to White patients, patients in BIPOC race groups presented emergently, to lower volume hospitals, had lower uptake of newer or more costly interventions, and experienced greater barriers to procedure access.[12,14,31,36,37,39]

2.4.3 Geographic region

Risk factors for particular health outcomes have been noted to vary geographically across the US.[131-133] Studies have highlighted that where a person lives matters in terms of the quality of and their ability to access health services.[75-77] Based on 43 health services access indicators (e.g., insurance status, mortality amenable to health care, potentially avoidable ED visits, adults who went without care because of cost), Radley et al. [134] reported that the poorest access to and quality of care was clustered among individuals residing in the Southern and Western US states in 2019. However, those in the Northeast and Midwest states had more favourable indicators reported for overall healthcare access and quality.[134] Additionally, existing studies highlight those individuals who live in the Southeastern states, termed the “stroke belt”, of the US tend to have poorer overall cardiovascular health and a higher prevalence of significant risk factors related to AMI, including hypertension, high blood pressure, diabetes, and obesity.[77,135-137] Researchers have also reported that the majority of AMI hospitalizations occur in the Southern states of the US.[30,41,46,47,61]

Existing studies have highlighted disparities in in-hospital mortality among AMI patients relative to their geographic location in the US.[30,41,42,44-48,61,62,73] Specifically, Vallabhajosyula et al. [47] used the NIS database to examine geographic variation in in-hospital outcomes among AMI patients and found that in-hospital mortality was lower in the Midwest and West regions while

being higher in the South region when compared to the Northeast region. Atreya et al. [41] used the NIS database to investigate regional variation in in-hospital outcomes among AMI patients and reported that survival outcomes were best among patients hospitalized in the Midwest hospital census region. Prior research has also indicated that the Northeast hospital region tends to have overall lower AMI-related in-hospital mortality,[42,43] while patients presenting to hospitals in the West region tend to have the poorest in-hospital outcomes.[29,41] When considering the use of revascularization procedures among AMI patients, the existing literature is consistent in its findings where those in the Northeast region have lower odds of undergoing revascularization procedures when compared to other regions.[41,42,44-48]

Chapter 3

3 Association of Socioeconomic, Racial, and Regional Factors With In-hospital Mortality Among Acute Myocardial Infarction Patients in the United States: A National Analysis of 2.8 Million Admissions

3.1 Background

Despite clinical and technical advances in acute cardiovascular care, AMI continues to be a leading cause of morbidity and mortality globally.[9,71] Every 39 seconds, an American will experience an AMI with approximately 15% of those dying from their condition.[9,138] In 2020, there were approximately 1 million deaths due to AMI in the US.[9,42] From 2004 to 2014, nearly 5% to 7% of all in-hospital mortality in the US was due to AMI.[36]

Significant disparities exist in outcomes among patients presenting with AMI.[30,41,47,108] Prior research has identified patient-level clinical and sociodemographic heterogeneity as well as geographic variation in available resources and in-hospital management as potential determinants of in-hospital outcomes.[16-19] In-hospital outcomes tend to be worse for patients in lower SES groups,[11,20,21,24,28,53,139] and those of BIPOC race identities when compared to those of higher SES and White patients.[18,62,140] These disparities may be explained by several potential mechanisms that highlight interactions between SES, race, comorbidities, and other individual and environmental factors.[11] Prior studies suggest that these characteristics interact in a bidirectional manner to reinforce conditions, environments, and lifestyles that lead to poor health outcomes among those belonging to underserved groups.[31,53,64,68]

Existing studies examining the SDH of outcomes in patients presenting AMI have used sub-cohorts based on patient or clinical characteristics and have not been representative of the broader population of AMI patients. For instance, prior studies have used inclusion criteria based on age,[19,21,31,62,68] type of AMI,[16,29,64,65] type of insurance,[23,68,70] region of the country,[14,19,34] restricted to complicated AMI patients,[47,63,64] or have a study period limited to a single

year.[18,45,52] To our knowledge, no prior study has investigated multiple domains of social disparity in in-hospital mortality in patients presenting with AMI.

Using a retrospective cohort study design, we examined the impact of SES, racial, and regional disparities on in-hospital mortality in a nationally representative cohort of 2.8 million AMI hospitalizations in the US from 2015 to 2019.

3.2 Methods

3.2.1 Data source

We conducted a retrospective cohort study using NIS data from October 1, 2015, through December 31, 2019. The NIS is the largest publicly available all-payer inpatient database that contains data on hospital admissions for a wide range of clinical diagnoses and outcomes in the US. NIS data was sourced from the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ).[141] NIS sampling strata are based on hospital characteristics (e.g., bed size, urban or rural location and teaching status) and US census regions and divisions. Data were weighted relative to the NIS sampling frame to generate national estimates. The NIS database includes a 20% stratified sample from all HCUP hospitals and holds data for approximately 7 million hospital discharges per year. Due to its sampling strategy, data from the NIS is representative of approximately 98% of the US population.[141-143]

3.2.2 Study population

We included NIS data from October 1, 2015, through to December 31, 2019, as these years use the *International Classification of Diseases and Related Health Problems, Tenth Edition, Clinical Modification* (ICD-10-CM) coding structure. A weighted total of 151,293,520 patient discharge records were identified and screened. Admissions aged 18 years or older with a principal diagnosis of AMI were identified using the ICD-10-CM codes I21.x and I22.x. ICD-10-CM diagnostic codes used to define the cohort are available in Appendix 2: ICD-10-CM codes for condition of interest (AMI), and Figure 1 depicts the study sample inclusion criteria and selection process.

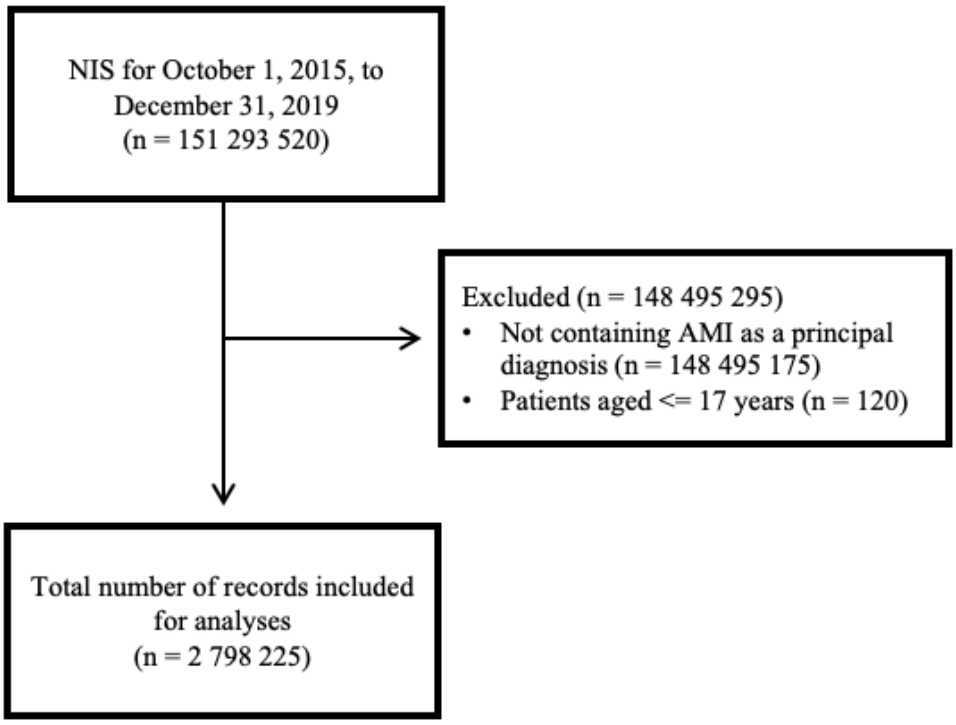


Figure 1: Study sample inclusion criteria and selection process for patients 18 years and older hospitalized with acute myocardial infarction

3.2.3 Exposure and outcome measures

Patient demographic characteristics included age, sex, race, and SES, all derived from HCUP-coded data elements. Patients with ages ranging from 18 to 90 years were included. Race was defined according to the following categories: White, Black, Hispanic, Asian or Pacific Islander, Native American, and Unspecified. SES was derived as quartiles established by the estimated household income of residents living in a patient's ZIP code as recorded on the discharge record (with quartile 1 being the lowest income category, and quartile 4 being the highest) (Appendix 13: Quartile ranges by year for estimated median household income of residents in the patient's ZIP code (USD) based on the National Inpatient Sample database variable definition from 2015 to 2019).

The primary outcome was all-cause in-hospital mortality. The Elixhauser Comorbidity Software Refined for ICD-10-CM was used to identify pre-existing clinical conditions based on secondary diagnoses (i.e., comorbidities) listed on hospital administrative data (Appendix 11: Elixhauser Comorbidity Software variables and ICD-10-CM codes).[10,17,25,26] Other select comorbidities were coded based on ICD-10-CM diagnostic codes (Appendix 12: Other comorbid conditions ICD-10-CM code).

Hospital-level characteristics included hospital census region, bed size, and hospital location/teaching status, derived from the American Hospital Association (AHA) Annual Survey of Hospitals. US hospital regions were coded in the following categories: Northeast, Midwest, South, and West (Figure 2) (Appendix 14: States by year in each hospital region based on the National Inpatient Sample database variable definition from 2015 to 2019). Hospital size was based on the number of short-term acute care beds and coded as: Small, Medium, and Large (Appendix 15: Number of patients by year in each hospital bedsize category based on the National Inpatient Sample database variable definition from 2015 to 2019). Hospital location and/or teaching status included the categories: Rural, Urban Non-Teaching, and Urban Teaching.

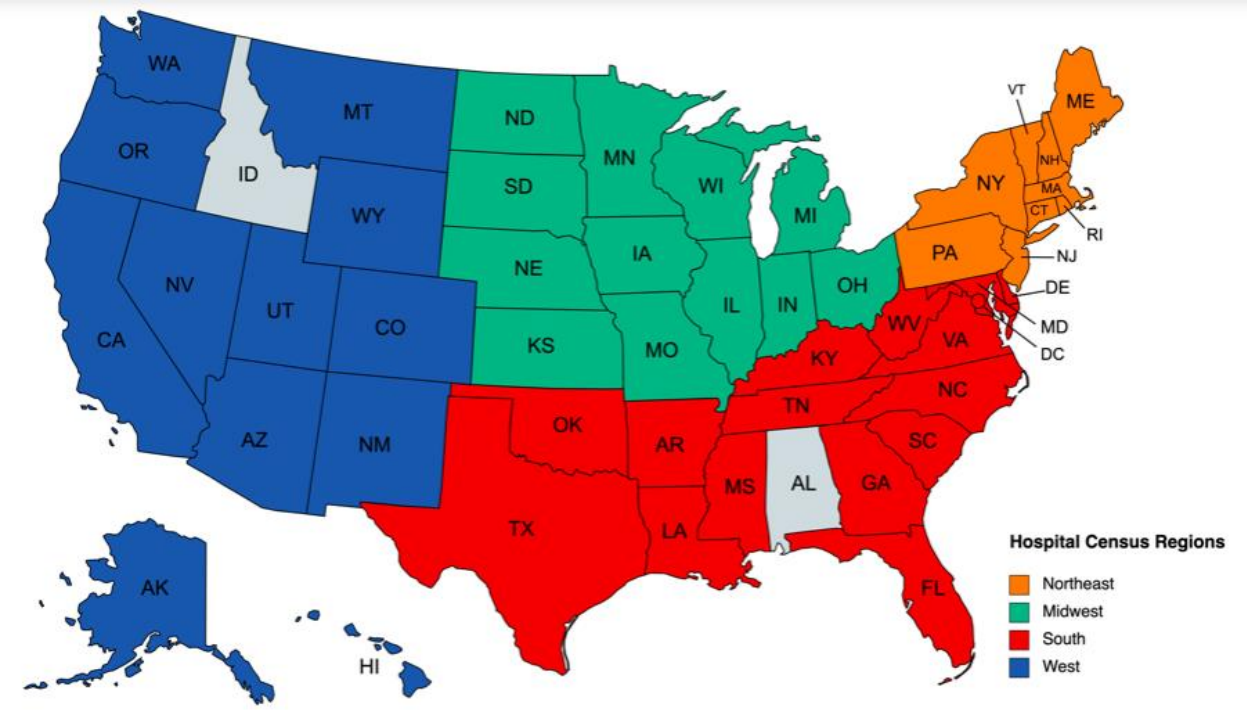


Figure 2: States included in each of the National Inpatient Sample Hospital Census Regions from 2015 to 2019

3.2.4 Statistical analysis

Weighted data were used for all statistical analyses. Descriptive statistics are presented as means (SDs) for continuous variables and as percentages for categorical and binary variables. As the percentage of missing data was small (<5%), we did not employ imputation methods.

Multilevel logistic regression models were used to estimate the relationship between in-hospital mortality in AMI patients and their SES, race, and geography while controlling for potential confounding variables and accounting for clustering of patients at the hospital level. To better understand the source of disparities, we used a model building approach which sequentially added covariates. Covariates were selected based on Andersen's Behavioural Model of Health Services Use which includes the following: predisposing factors (e.g. age, sex, race/ethnicity), enabling factors (e.g. income), and need factors (e.g. comorbidities) (Appendix 10: Covariates selected based on Andersen's Model of Health Services Use).[83] Additional covariates were added to control for the following categories: lifestyle factors, patient clinical characteristics, and finally hospital-level characteristics (hospital census region, bed size, and location/teaching status) and fixed effects for calendar years (Appendix 5: Covariates selected for model building). The resulting four models include (1) patient-level characteristics (age, sex, race, and quartiles of median household income by patient's ZIP code) (Appendix 6: Covariate definitions for model 1: sociodemographic characteristics); (2) model 1 + lifestyle-related factors (smoking, alcohol abuse, drug abuse, and obesity) (Appendix 7: Covariate definitions for model 2: model 1 + lifestyle-related factors); (3) model 2 + clinical history and comorbidities (Appendix 8: Covariate definitions for model 3: model 2 + clinical history and comorbidities); and (4) model 3 + hospital-level characteristics (hospital bed size, hospital location/teaching status, and hospital region) (Appendix 9: Covariate definitions for model 4: model 3 + hospital-level characteristics). Variable selection was informed by previously published clinical and health disparities literature research related to AMI hospitalizations in the US.[10,17,25,26] Recommendations for methodological standards in using the NIS datasets for research were followed (Appendix 1: Checklist for working with the National Inpatient Sample database).[144,145] All statistical analyses were performed using Stata software, version 17.0 (StataCorp). A *P*-value of 0.05 was considered significant.

3.3 Results

3.3.1 Demographics and baseline characteristics

From October 1, 2015, to December 31, 2019, we identified 2,798,225 admissions aged 18 years or older with AMI as a principal diagnosis on their discharge record. Of these admissions, 30.7% were in the lowest SES quartile, while 18.3% were in the highest quartile (Table 1). With regards to race/ethnicity, 73.5% of admissions were White, 11.4% were Black, 8.7% were Hispanic, 2.8% were Asian or Pacific Islander, 0.6% were Native American, and 3.0% were Unspecified (Table 1). Most admissions (40.9%) were in the South census region, 17.5% in the Northeast, 22.5% in the Midwest, and 19.1% in the West. Of the records identified, 4.6% had a discharge disposition of in-hospital death during the current admission (Table 1).

Table 1: Baseline characteristics by quartiles of median household income for patient's ZIP code

	Overall (Weighted N = 2 798 225)	0-25th percentile (Lowest) (Weighted n = 843 600)	26th-50th percentile (Weighted n = 752 535)	51st-75th percentile (Weighted n = 649 210)	76th-100th percentile (Highest) (Weighted n = 501 920)
Patient-level characteristics, No. (%)					
Age, mean ± SD (years)	70.0 ± 13.5	65.9 ± 13.5	67.1 ± 13.5	67.4 ± 13.4	68.3 ± 13.4
Sex					
Male	1 741 090 (62.2%)	502 325 (59.6%)	464 930 (61.8%)	412 070 (63.5%)	327 380 (65.2%)
Female	1 056 650 (37.8%)	341 110 (40.4%)	287 490 (38.2%)	237 040 (36.5%)	174 480 (34.8%)
Race					
White	1 984 150 (73.5%)	526 775 (64.3%)	563 325 (78.0%)	486 695 (78.0%)	373 540 (77.0%)
Black	307 775 (11.4%)	163 420 (20.0%)	64 985 (9.0%)	45 965 (7.4%)	28 210 (5.8%)
Hispanic	235 305 (8.7%)	90 170 (11.0%)	59 330 (8.2%)	49 645 (8.0%)	30 935 (6.4%)
Asian or Pacific Islander	75 370 (2.8%)	9 720 (1.2%)	13 460 (1.9%)	20 355 (3.3%)	30 870 (6.4%)
Native American	15 850 (0.6%)	7 285 (0.9%)	3 730 (0.5%)	2 375 (0.4%)	1 415 (0.3%)
Unspecified	80 690 (3.0%)	21 715 (2.7%)	17 510 (2.4%)	19 310 (3.1%)	20 015 (4.1%)
Expected primary payer					
Medicare	1 602 050 (57.3%)	484 190 57.5%)	437 755 (58.3%)	370 540 (57.2%)	283 860 (23.5%)
Medicaid	262 985 (9.4%)	106 995 (12.7%)	69 570 (9.3%)	51 365 (7.9%)	28 850 (5.8%)
Private insurance	709 275 (25.4%)	169 480 (20.1%)	182 535 (24.3%)	181 940 (28.1%)	162 320 (32.4%)
Self-pay	129 635 (4.6%)	50 600 (6.0%)	35 755 (4.8%)	25 120 (3.9%)	14 725 (2.9%)
No charge	11 330 (0.4%)	4 510 (0.5%)	3 120 (0.4%)	2 190 (0.3%)	1 265 (0.3%)
Other	78 870 (2.8%)	26 415 (3.1%)	22 480 (3.0%)	17 210 (2.7%)	10 615 (2.1%)
In-hospital mortality					
Yes	129 755 (4.6%)	39 290 (4.7%)	34 990 (4.7%)	29 315 (4.5%)	23 630 (4.7%)
No	2 666 615 (95.4%)	803 890 (95.3%)	716 770 (95.4%)	619 565 (95.5%)	478 005 (95.3%)
Comorbidities, No. (%)					
AIDS	12 370 (0.4%)	4 850 (0.6%)	3 065 (0.4%)	2 290 (0.4%)	1 705 (0.3%)
Alcohol abuse	101 325 (3.6%)	33 550 (4.0%)	27 415 (3.6%)	22 890 (3.5%)	15 175 (3.0%)
AMI type					
NSTEMI	1 976 555 (70.6%)	609 375 (72.2%)	532 745 (70.8%)	454 015 (69.9%)	345 250 (68.8%)
STEMI	821 670 (29.4%)	234 225 (27.8%)	219 790 (29.2%)	195 195 (30.1%)	156 670 (31.2%)
Arthropathies	81 740 (2.9%)	23 475 (2.8%)	21 980 (2.9%)	19 020 (2.9%)	15 895 (3.2%)
Chronic blood loss anemias	18 225 (0.7%)	5 710 (0.7%)	4 845 (0.6%)	4 165 (0.6%)	3 175 (0.6%)
Chronic pulmonary disease	585 050 (20.9%)	199 980 (23.7%)	164 760 (21.9%)	125 235 (19.3%)	84 335 (16.8%)
Coagulopathies	180 675 (6.5%)	52 445 (6.2%)	47 340 (6.3%)	43 185 (6.7%)	34 255 (6.8%)
Congestive heart failure	1 074 355 (38.4%)	343 435 (40.7%)	288 990 (38.4%)	241 400 (37.2%)	180 870 (36.0%)
Deficiency anemias	461 630 (16.5%)	151 970 (18.0%)	120 640 (16.0%)	102 335 (15.8%)	78 695 (15.7%)
Diabetes with chronic complications	586 760 (21.0%)	191 450 (22.7%)	158 310 (21.0%)	132 440 (20.4%)	94 575 (18.8%)
Diabetes without chronic complications	417 745 (14.9%)	135 645 (16.1%)	114 575 (15.2%)	93 015 (14.3%)	66 890 (13.3%)
Drug abuse	90 375 (3.2%)	35 315 (4.2%)	23 430 (3.1%)	18 135 (2.8%)	11 050 (2.2%)
Hypertension, complicated	909 475 (32.5%)	290 910 (34.5%)	244 815 (32.5%)	205 335 (31.6%)	152 325 (30.4%)
Hypertension, uncomplicated	1 105 845 (39.5%)	333 330 (39.5%)	297 885 (39.6%)	257 650 (39.7%)	196 910 (39.2%)

Hypothyroidism	341 160 (12.2%)	97 290 (11.5%)	94 305 (12.5%)	80 070 (12.3%)	63 585 (12.7%)
Liver disease, mild to moderate	85 260 (3.1%)	29 435 (3.5%)	22 055 (2.9%)	18 575 (2.9%)	13 320 (2.6%)
Liver disease, severe	12 485 (0.5%)	4 035 (0.5%)	3 510 (0.5%)	2 635 (0.4%)	2 015 (0.4%)
Lymphoma	16 180 (0.6%)	4 235 (0.5%)	4 005 (0.5%)	4 195 (0.7%)	3 490 (0.7%)
Metastatic cancer	37 910 (1.4%)	10 750 (1.3%)	9 955 (1.3%)	8 755 (1.4%)	7 805 (1.6%)
Obesity	515 880 (18.4%)	159 930 (19.0%)	143 320 (19.0%)	120 775 (18.6%)	83 020 (16.5%)
Other neurological disorders	124 180 (4.4%)	37 870 (4.5%)	33 110 (4.4%)	28 525 (4.4%)	22 540 (4.5%)
Paralysis	68 625 (2.5%)	24 620 (2.9%)	17 600 (2.3%)	14 390 (2.2%)	10 705 (2.1%)
Peptic ulcer with bleeding	22 425 (0.8%)	7 285 (0.9%)	5 960 (0.8%)	4 840 (0.8%)	3 900 (0.8%)
Peripheral vascular disease	272 050 (9.7%)	81 180 (9.6%)	73 580 (9.8%)	64 230 (9.9%)	48 300 (9.6%)
Previous cerebrovascular accident	35 015 (1.3%)	11 105 (1.3%)	9 025 (1.2%)	8 060 (1.2%)	6 110 (1.2%)
Previous coronary artery bypass graft	284 545 (10.2%)	88 415 (31.6%)	80 265 (10.7%)	64 255 (9.9%)	46 920 (9.4%)
Previous myocardial infarction	444 830 (15.9%)	136 855 (16.2%)	120 315 (16.0%)	103 535 (16.0%)	76 365 (15.2%)
Previous percutaneous coronary intervention	486 405 (17.4%)	149 540 (17.7%)	134 015 (17.8%)	111 500 (17.2%)	83 090 (16.6%)
Pulmonary circulation disease	152 735 (5.5%)	47 705 (5.7%)	40 995 (5.5%)	35 185 (5.4%)	26 165 (5.2%)
Renal failure, moderate	432 010 (15.4%)	132 095 (15.7%)	117 950 (15.7%)	99 390 (15.3%)	75 270 (15.0%)
Renal failure, severe	214 790 (7.7%)	73 500 (8.7%)	56 210 (7.5%)	47 080 (7.3%)	34 615 (6.9%)
Any smoking history	1 347 790 (48.2%)	431 045 (51.1%)	374 440 (49.8%)	306 065 (47.1%)	211 965 (42.2%)
Solid tumor without metastasis, malignant	53 890 (1.9%)	15 535 (1.8%)	14 430 (1.9%)	12 620 (1.9%)	10 445 (2.1%)
Valvular disease	411 475(14.7%)	116 375 (13.8%)	112 290 (14.9%)	97 930 (15.1%)	77 875 (15.5%)
Weight loss	94 355 (3.4%)	31 435 (3.7%)	24 865 (3.3%)	20 680 (3.2%)	15 585 (3.1%)
Procedures, No. (%)					
Coronary artery bypass graft (CABG)	245 385 (8.8%)	72 195 (8.6%)	67 365 (9.0%)	58 310 (9.0%)	43 065 (8.6%)
Percutaneous coronary intervention (PCI)	1 339 155 (47.9%)	384 095 (45.5%)	360 695 (47.9%)	321 575 (49.5%)	248 265 (49.5%)
Revascularization procedures	1 567 575 (56.0%)	451 385 (53.5%)	423 270 (56.3%)	375 845 (57.9%)	288 415 (57.5%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	494 820 (17.7%)	123 555 (14.7%)	135 835 (18.1%)	127 470 (19.6%)	99 240 (19.8%)
Medium	853 335 (30.5%)	248 725 (29.5%)	222 990 (29.6%)	197 715 (30.5%)	168 385 (33.6%)
Large	1 450 070 (51.8%)	471 320 (55.9%)	393 710 (52.3%)	324 025 (49.9%)	234 295 (46.7%)
Hospital region					
Northeast	489 745 (17.5%)	87 255 (10.3%)	113 155 (15.0%)	130 845 (20.2%)	151 365 (30.2%)
Midwest	629 455 (22.5%)	171 590 (20.3%)	203 910 (27.1%)	161 600 (24.9%)	87 080 (17.4%)
South	1 145 370 (40.9%)	475 550 (56.4%)	308 190 (41.0%)	209 950 (32.3%)	128 915 (25.7%)
West	533 655 (19.1%)	109 205 (13.0%)	127 280 (16.9%)	146 815 (22.6%)	134 560 (26.8%)
Hospital location/teaching status					
Rural	214 265 (7.7%)	116 425 (13.8%)	69 430 (9.2%)	20 140 (3.1%)	3 040 (0.6%)
Urban non-teaching	648 755 (23.2%)	168 455 (20.0%)	187 825 (25.0%)	158 250 (24.4%)	122 675 (24.4%)
Urban teaching	1 935 205 (69.2%)	558 720 (66.2%)	495 280 (65.8%)	470 820 (72.5%)	376 205 (75.0%)

3.3.2 Association between socioeconomic status and in-hospital mortality

To study the differences in in-hospital mortality and SES among AMI patients, we used multilevel logistic regression models, with cumulative addition of potential confounders and covariates of interest (Table 2). Model 1 included SES quartiles, race, age, and sex, and found that the odds of in-hospital mortality were higher for patients in the lowest (odds ratio (OR) = 1.11 [95% CI: 1.09–1.13] $P<0.001$) and second lowest (OR = 1.06 [1.04–1.08] $P<0.001$) income quartiles when compared to those in the highest quartile. Models 2-4 cumulatively added lifestyle factors (model 2), clinical history (model 3) and hospital characteristics (model 4). The fully adjusted model (model 4) found that patients in the lowest (OR = 1.10 [1.08–1.13] $P<0.001$) and second lowest (OR = 1.07 [1.05–1.09] $P<0.001$) income quartiles had greater odds of in-hospital mortality when compared to those in the highest quartile. The odds ratio for the second highest quartile (OR = 1.02 [1.00–1.04] $P=0.055$) was only significant at the 10% error threshold (Table 2).

Table 2: Odds ratios [95% confidence intervals] and *P* values for exposures of interest (quartiles of median household income for patient's ZIP code, race, and hospital region) in stepwise model building for in-hospital mortality

VARIABLES	Model 1 Sociodemographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]
Quartiles of median household income for patient's ZIP code				
Highest	*Reference Level*			
Second highest	1.01 [0.99-1.03] *P*=0.219	1.02 [1.00-1.04] *P*<0.05	1.02 [1.00-1.04] *P*=0.080	1.02 [1.00-1.04] *P*=0.055
Second lowest	1.06 [1.04-1.08] *P*<0.001	1.07 [1.05-1.09] *P*<0.001	1.07 [1.04-1.09] *P*<0.001	1.07 [1.05-1.09] *P*<0.001
Lowest	1.11 [1.09-1.13] *P*<0.001	1.13 [1.10-1.15] *P*<0.001	1.10 [1.07-1.12] *P*<0.001	1.10 [1.08-1.13] *P*<0.001
Race				
White	*Reference Level*			
Black	0.99 [0.97-1.01] *P*=0.431	0.98 [0.96-1.00] *P*=0.084	0.89 [0.87-0.91] *P*<0.001	0.89 [0.87-0.91] *P*<0.001
Hispanic	1.01 [0.98-1.03] *P*=0.508	0.97 [0.95-0.99] *P*<0.005	0.91 [0.89-0.93] *P*<0.001	0.91 [0.88-0.93] *P*<0.001
Asian or Pacific Islander	1.28 [1.24-1.32] *P*<0.001	1.22 [1.17-1.26] *P*<0.001	1.07 [1.03-1.11] *P*<0.001	1.07 [1.03-1.11] *P*<0.05
Native American	1.15 [1.06-1.25] *P*<0.05	1.13 [1.05-1.23] *P*<0.05	1.11 [1.02-1.21] *P*<0.05	1.11 [1.02-1.21] *P*<0.05
Unspecified	1.27 [1.22-1.31] *P*<0.001	1.23 [1.19-1.27] *P*<0.001	1.10 [1.06-1.14] *P*<0.001	1.09 [1.05-1.13] *P*<0.001
Hospital region				
Northeast	*Reference Level*			
Midwest				0.97 [0.91-1.03] *P*=0.276
South				1.06 [1.00-1.12] *P*<0.05
West				1.00 [0.94-1.06] *P*=0.919

[a] Age, sex, race, quartile of median household income for ZIP code

[b] Smoking, alcohol abuse, drug abuse, obesity

[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease

[d] Hospital bed size, hospital location/teaching status, hospital region

Additional analyses were performed to examine the relationship between SES and hospital region as well as SES and race (Table 3). AMI patients in the lowest income quartile admitted to hospitals in the West region (OR = 1.10 [1.03-1.17] $P<0.05$) as well as patients in the second lowest income quartile admitted to hospitals in the South (OR = 1.12 [1.06-1.19] $P<0.001$) and West hospital census regions (OR = 1.12 [1.06-1.19] $P<0.001$) had greater odds of in-hospital mortality when compared to patients in the highest income quartile who were admitted to hospitals in the Northeast census region. When compared to White AMI patients in the highest income quartile, those who were Black (OR = 0.87 [0.81-0.93] $P<0.001$) or Asian or Pacific Islander in the lowest income quartile (OR = 0.69 [0.62-0.77] $P<0.001$) as well as those who were Black (OR = 0.85 [0.78-0.93] $P<0.001$) or Asian or Pacific Islander (OR = 0.90 [0.83-0.98] $P<0.001$) in the second highest income quartile were less likely to experience in-hospital mortality.

Table 3: Odds ratios [95% Confidence Intervals] and *P* values for hospital region and quartiles of median household Income for patient's ZIP code and race and quartiles of median household income for patient's ZIP Code with in-hospital mortality as the outcome

VARIABLES	**Quartiles of median household income for patient's ZIP code**			
	Lowest	Second Lowest	Second Highest	Highest
Hospital region				
Northeast	*Reference Level*			
Midwest	0.97 [0.91-1.04] *P*=0.411	1.04 [0.97-1.09] *P*=0.255	0.95 [0.89-1.00] *P*=0.069	
South	1.02 [0.97-1.09] *P*=0.321	1.12 [1.06-1.19] P<0.001	1.04 [0.98-1.10] *P*=0.160	*Reference Level*
West	1.10 [1.03-1.17] *P*<0.05	1.12 [1.06-1.19] P<0.001	1.03 [0.98-1.09] *P*=0.238	
Race				
White				
Black	0.87 [0.81-0.93] *P*<0.001	1.00 [0.92-1.07] *P*=0.822	0.85 [0.78-0.93] *P*<0.001	
Hispanic	1.04 [0.97-1.12] *P*=0.283	1.05 [0.97-1.14] *P*=0.220	1.07 [0.99-1.16] *P*=0.108	
Asian or Pacific Islander	0.69 [0.62-0.77] *P*<0.001	0.91 [0.82-1.00] *P*=0.054	0.90 [0.83-0.98] *P*<0.05	*Reference Level*
Native American	0.90 [0.67-1.21] *P*=0.486	1.17 [0.85-1.60] *P*=0.331	0.87 [0.62-1.24] *P*=0.447	
Unspecified	0.97 [0.88-1.07] *P*=0.554	0.97 [0.87-1.07] *P*=0.501	0.96 [0.87-1.06] *P*=0.461	

3.3.3 Association between race category and in-hospital mortality

After adjusting for SES quartiles, race, age, and sex (Model 1, Table 2), Asian or Pacific Islander (OR = 1.28 [1.24–1.32] $P<0.001$), Native American (OR = 1.15 [1.06–1.25] $P<0.05$), and Unspecified (OR = 1.27 [1.22–1.31] $P<0.001$) race groups had higher odds of in-hospital mortality when compared to admissions among the White race group. Conversely, there were no observable differences in in-hospital mortality in admissions among Black (OR = 0.99 [0.97–1.01] $P=0.431$) or Hispanic (OR = 1.01 [0.98–1.03] $P=0.508$) race groups when compared to those in the White race group. After adjusting for lifestyle factors (model 2), clinical history (model 3), and hospital characteristics (model 4), the final model (model 4) showed greater odds of in-hospital mortality among admissions belonging to the Asian or Pacific Islander (OR = 1.07 [1.03–1.11] $P<0.05$), Native American (OR = 1.11 [1.02–1.21] $P<0.05$), and Unspecified (OR = 1.09 [1.05–1.13] $P<0.001$) race groups with the White race group as the reference. Additionally, those in the Hispanic (OR = 0.91 [0.88–0.93] $P<0.001$) and Black (OR = 0.89 [0.87–0.91] $P<0.001$) race groups had lower odds of in-hospital mortality when compared to those in the White race category (Table 2).

3.3.4 Association between hospital census region and in-hospital mortality

After adjusting for demographic, lifestyle, and clinical characteristics (model 4), AMI admissions in the South region (OR = 1.06 [1.00–1.12] $P<0.05$) had higher odds of in-hospital mortality when compared to admissions in the Northeast census region. Coefficients for other regions (Midwest: OR = 0.97 [0.91–1.03] $P=0.276$ and West: OR=1.00 [0.94–1.06] $P=0.919$) were not statistically significant (Table 2). Of AMI patients in the lowest SES income quartile, 56.4% reported to hospitals in the South census region while 10.3% were in the Northeast, 13.0% in the West, and 20.3% in the Midwest census regions. Further, AMI patients in the South had the greatest prevalence (41.0%) of at least one comorbidity when compared to patients in the Northeast (17.5%), West (19.0%), and Midwest (22.6%) regions.

3.3.5 Sensitivity analyses

Following the primary analyses examining the association between quartiles of median household income for patient's ZIP code, race, and hospital region and in-hospital mortality, additional analyses were performed to adjust for insurance status based on 'expected primary payer', as recorded in the NIS database (Table 4). As an enabling factor in Andersen's Model of Health Services Use,[146] insurance status is of interest in this study since having the means to afford health services may be associated with lower odds of in-hospital mortality. Relative to the fully adjusted model (model 4), the inclusion of the expected primary payer variable (model 5) provided similar results for income whereby AMI admissions in the poorest (OR = 1.09 [1.09 – 1.11] P<0.001) and second poorest (OR = 1.06 [1.04 – 1.08] P<0.001) quartiles had lower odds of in-hospital mortality compared to those in the highest quartile. This implies that after adjusting for insurance status, income remains an independent and statistically significant determinant of in-hospital mortality. Race categories also followed a similar pattern where those in the Black (OR = 0.88 [0.86 – 0.90] P<0.001) or Hispanic (OR = 0.89 [0.86 – 0.91] P<0.001) race groups had lower odds while those in the Asian or Pacific Islander (OR = 1.05 [1.01 – 1.09] P<0.05), Native American (OR = 1.09 [1.00 – 1.19] P<0.05), and Unspecified (OR = 1.07 – 1.11] P<0.001) race groups had higher odds of in-hospital mortality relative to White admissions. However, the inclusion of expected primary payer in model 5 resulted in the hospital census region to be not statistically significant at the 5% level.

We conducted an additional sensitivity analysis with the inclusion of 'revascularization during the current admission' variable (model 6). This procedure covariate is included as a sensitivity analysis since revascularization is associated with better survival and long-term outcomes among AMI patients.[10,34] Similar patterns of association were found between income quartiles, race, and hospital region and in-hospital mortality as in model 5 (Table 4). Relative to the highest income quartile, those in the lowest (OR = 1.07 [1.05 – 1.10] P<0.001) and second lowest (OR = 1.06 [1.03 – 1.08] P<0.001) quartiles had higher odds of in-hospital mortality. Among the race categories, AMI admissions in the Black (OR = 0.82 [0.80 – 0.83] P<0.001) and Hispanic (0.87 [0.85 – 0.89] P<0.001) race groups had lower odds while those in the Asian or Pacific Islander (OR = 1.05 [1.01 – 1.09] P<0.05), Native American (OR = 1.09 [1.00 – 1.19] P<0.05), and Unspecified (OR = 1.08 [1.04 – 1.12] P<0.001) groups had higher odds of in-hospital mortality

compared to those in the White race category. The results for hospital regions are similar to those reported in model 4 where AMI admissions to hospitals in the Southern census region (OR = 1.11 [1.05 – 1.18] $P<0.001$) had higher odds of in-hospital mortality relative to those in the Northeast.

Table 4: Odds ratios [95% confidence intervals] and *P* values for exposures of interest (quartiles of median household income for patient's ZIP code, race, and hospital region) for in-hospital mortality including expected primary payer and revascularization use as covariates

VARIABLES	Model 5 Model 4 + Expected Primary Payer	Model 6 Model 5 + Revascularization Use
Quartiles for median household income for patient ZIP code		
Richest	*Reference Level*	
Second richest	1.02 [0.99-1.04] *P*=0.146	1.02 [1.00-1.04] *P*=0.127
Second poorest	1.06 [1.04-1.08] *P*<0.001	1.06 [1.03-1.08] *P*<0.001
Poorest	1.09 [1.06-1.11] *P*<0.001	1.07 [1.05-1.10] *P*<0.001
Race		
White	*Reference Level*	
Black	0.88 [0.86-0.90] *P*<0.001	0.82 [0.80-0.83] *P*<0.001
Hispanic	0.89 [0.86-0.91] *P*<0.001	0.87 [0.85-0.89] *P*<0.001
Asian or Pacific Islander	1.05 [1.01-1.09] *P*<0.05	1.05 [1.01-1.09] *P*<0.05
Native American	1.09 [1.00-1.19] *P*<0.05	1.09 [1.00-1.19] *P*<0.05
Unspecified	1.07 [1.03-1.11] *P*<0.001	1.08 [1.04-1.12] *P*<0.001
Hospital region		
Northeast	*Reference Level*	
Midwest	0.97 [0.91-1.02] *P*=0.239	1.02 [0.97-1.09] *P*=0.414
South	1.05 [1.00-1.11] *P*=0.070	1.11 [1.05-1.18] *P*<0.001
West	1.00 [0.94-1.06] *P*=0.887	1.03 [0.97-1.10] *P*=0.328

3.4 Discussion

In this contemporary nationwide study using a representative database, we reported that there are significant SES, racial, and regional variations in in-hospital mortality among AMI patients across the US. AMI patients in the highest SES quartile were less likely to experience in-hospital mortality when compared to those in the lowest and second-lowest quartiles. Further, patients in the Black or Hispanic race groups had lower odds of experiencing in-hospital mortality relative to those who were White. However, patients in the Asian or Pacific Islander, Native American, and Unspecified race groups had greater odds of in-hospital mortality when compared to admissions in the White race group. AMI admissions in the South also had greater odds of in-hospital mortality than those from the Northeast or New England hospital census region.

3.4.1 Socioeconomic disparities in in-hospital mortality among acute myocardial infarction patients

Studies in historical and contemporary contexts note a similar pattern of disparity based on SES quartiles in AMI patient outcomes.[22] This could be due to a host of factors. For instance, those living in lower SES neighbourhoods tend to have a higher prevalence of cardiovascular risk factors, including smoking history, hypertension, diabetes, and obesity compared to their higher SES counterparts.[17,25,147] In our analysis, we adjusted for these factors but the association with SES quartiles remained significant. This may be because individuals in lower SES neighbourhoods experience barriers in accessing care which causes individuals to seek care much later than those in more advantaged social groups.[126,148] There is also evidence suggesting that poor individuals may seek care in smaller hospitals with limited acute cardiovascular care capacities, resources, and imperfect histories of utilizing evidence-based treatments.[11,16,17,24,25,28] Studies also cite that when low SES individuals gain access to therapies and interventions, they experience a greater delay in interventions and are less likely to be prescribed guideline-based therapies at follow-up.[24] Also, the lack of health insurance in low SES groups and its association with poor health outcomes has been well-documented in the literature.[148,149] Udell et al. [11] illustrated these trends in their study exploring AMI outcomes among different SES groups, where poorer SES groups had more comorbidities, fewer resources, and longer delays in medications and treatments.

Disparities in AMI in-hospital mortality among SES groups remain multifactorial. A complex interaction of individual-level factors, such as level of education, income, comorbid conditions, and insurance status, and broader aspects, including access to healthcare resources and social awareness, continue to drive the division in outcomes among AMI patients across SES quartiles.[11]

3.4.2 Racial disparities in in-hospital mortality among acute myocardial infarction patients

In our study, we found significant disparities in in-hospital mortality across several race groups. This is in line with recent studies that have reported that those who belong to historically under-resourced race groups experience greater odds of in-hospital mortality when compared to White patients.[27,28,53,150] Interestingly, our analyses also found that Black or Hispanic patients had lower odds of in-hospital mortality when compared to those who were White. Although an explanation for these complex interactions has not been fully elucidated, several studies have found that once all relevant confounders are adjusted, Black patients had lower odds of in-hospital mortality when compared to White patients.[19,26,54-56] This was observed after adjusting for clinical characteristics (i.e., comorbidities), suggesting that the comorbidity profile partly explains differences in in-hospital mortality. Patlolla et al. [54] illustrated these trends in their study examining disparities in in-hospital outcomes. Despite Black AMI patients having a greater number of comorbidities, they were less likely to experience in-hospital mortality when compared to their White counterparts after adjusting for comorbidities.[54]

Causes of disparities in cardiovascular care involve complex interactions between the health system and patient sociodemographic characteristics, cultural background, and underlying comorbidities. This is likely the result of disparities in timely access to care and the quality and quantity of care received in the hospital.[27,29,66,70,151] Matetic et al. [25] examined disparities in management strategies and in-hospital outcomes among US patients with AMI. Although these researchers indicated that Black patients with AMI had lower adjusted odds of in-hospital mortality, these patients still experienced lower rates of guideline-directed interventions, a longer length of hospital stay, and fewer discharges to home.[25] Lin et al. [[152]] noted that these

differences may be associated with variation in unobserved patient severity among patients of minority races, such that average patient acuity may be lower relative to other patients.

Reducing disparities in in-hospital mortality is a complex issue that requires multifactorial strategies. Socially disadvantaged groups may present with more severe conditions and comorbidities since they may experience delays in seeking care and often receive care that is of poorer quality.[126,148,149] Improving access to primary care to support early identification and timely intervention may reduce the observed disparities.[153] Existing literature also indicates that implementation of culturally competent care, rigorous protocols, and adherence to guidelines aid in the mitigation of treatment disparities in BIPOC patients with AMI.[154-157]

3.4.3 Regional variation in in-hospital mortality among acute myocardial infarction patients

The analyses in our study found that AMI admissions to hospitals in the South hospital census region are associated with higher odds of in-hospital mortality when compared to those in the Northeast region. This finding is consistent with existing literature that has found that AMI patients in Southern US states tend to have greater odds of in-hospital mortality compared to other regions.[30,41,47] This is partly explained by the higher prevalence of coronary risk factors for AMI, including hypertension, diabetes and obesity in the Southeastern or "stroke belt" states of the US.[30,139] Other studies emphasize that localizing public health policies and programs to certain state and county levels contributes to the regional variation in in-hospital outcomes for patients requiring acute cardiovascular care.[47,139] Liu et al. [139] identified regional variation in in-hospital outcomes among patients hospitalized for acute hypertension. These researchers highlighted the regionalization for developing and implementing health policies and programs as a potential factor since one's health behaviours and sociopolitical environment interact to impact their health outcomes.[139] Overall, regional variation in AMI-related in-hospital mortality may be attributable to a higher prevalence of cardiovascular risk factors, the differences in the healthcare organization, access, spending, and delivery that cause relatively worse outcomes to cluster in certain regions.

3.4.4 Strengths and limitations

Our study has a number of strengths. First, in contrast to many existing studies that used data at the regional- or state-level,[22,23,158] we used representative national-level data from nearly all states in the US. Second, we used contemporary data over multiple years which allowed us to understand the sociodemographic determinants of in-hospital mortality in AMI patients. Finally, we used consistent definitions and ICD-10 codes across years to define health conditions in the analysis.

Despite the strengths of this research, our study has several limitations. First, administrative databases are prone to coding errors. To mitigate the potential underreporting of diagnoses, we used validated ICD-10-CM codes from literature or those provided by AHRQ or HCUP to identify select diagnoses. Second, the NIS data does not identify repeated AMI events for the same patient. While this is unlikely to have a significant impact on the results, it is nevertheless a limitation of the way data are recorded. Third, while we controlled for potential confounders in our analysis, residual confounding may exist in this observational analysis. Further, the variable definitions provided by the NIS do not capture the granularity present in lived experiences. The SES variable was based on median household income for patient's ZIP code. However, this is a common limitation associated with the use of administrative data. Also, the race group definitions were broad which limited our ability to assess the heterogeneity present within each level. Our study is also subject to underreporting of age as the NIS classified all admissions aged 90 years and above into a 90-year-old age category. Finally, to increase the specificity of the studied AMI cohort, we included all patients with a primary diagnosis of AMI in our study sample which may have resulted in an under-representation of AMI admissions as those with secondary AMI diagnoses were not included. Despite the above limitations, this study addresses a knowledge gap related to the socioeconomic, racial, and geographic disparities in the in-hospital outcomes of AMI in a contemporary population.

3.5 Conclusion

In-hospital mortality following admission with AMI was higher among those in lower SES groups and those identifying as Asian or Pacific Islander, Native American, and AMI patients

presenting to hospitals in the South, while being lower in Black and Hispanic groups, compared with those in the highest SES and Whites, respectively. Additional quantitative and qualitative studies are needed to explore potential individual-level and population-level risk factors to understand the underlying causes of these prevailing disparities and the strategies that can be implemented to improve in-hospital outcomes.

Chapter 4

4 Who is likely to have a revascularization procedure after acute myocardial infarction? A national analysis of 2.8 million admissions in the United States

4.1 Background

Revascularization procedures, PCI and CABG are the mainstay of restoring blood flow after an AMI event.[10,34] Approximately one million revascularization procedures are conducted in the US annually.[42,71,138] Although there has been much clinical and technical advancement in these procedures, significant disparities exist in the rate of revascularization procedures following AMI.[123] Prior research has identified patient-level sociodemographic, clinical heterogeneity, and geographic variation in patients accessing and undergoing cardiac interventions,[11-13,36,42] where use of revascularization is lower among lower SES groups and those of BIPOC race groups relative to those of higher SES and White patients.[11-15,36-39] These disparities may be explained by several mechanisms, including potential bias in clinical decision-making and inequality in availability of health system resources.[14,36,38] Study samples in existing literature may not represent the broader AMI population as they are limited based on age,[11,42,44,69] type of insurance,[14,36,38] region of the country,[15,36,38,57,58,69,72,74] presence of complications at the time of admission,[12,41,73] including only a single year of study,[36,45,52] or not using a nationally representative database.[16,19,21,30,31,62]

To address current gaps in the literature, we examined the association of SES, racial, and regional disparities with the likelihood of receiving revascularization procedures in a nationally representative contemporary cohort of patients hospitalized with AMI in the US from October 1, 2015, through to December 31, 2019.

4.2 Methodology

4.2.1 Data source

We conducted a retrospective cohort study using NIS data from October 1, 2015, through December 31, 2019. The NIS is the largest publicly available all-payer inpatient database that contains data on hospital admissions for a range of clinical diagnoses and outcomes in the US. NIS data was sourced from the HCUP which is sponsored by the AHRQ.[159] NIS sampling strata are based on hospital characteristics (e.g., bed size, urban or rural location and teaching status) and US census regions and divisions. The database includes a stratified sample from all HCUP hospitals and contains data for approximately 7 million hospital discharges per year. Due to its sampling strategy, data from the NIS is representative of approximately 98% of the US population.[141-143]

4.2.2 Study population

We included data from the NIS spanning from October 1, 2015, through to December 31, 2019, as these years use consistent coding structures of the ICD-10-CM. A weighted total of 51,293,520 hospital discharge records was available over the study period. Admissions aged 18 years or older with a principal diagnosis of AMI were retained using the ICD-10-CM codes I21.x and I22.x. Appendix 2: ICD-10-CM codes for the condition of interest (AMI) displays all ICD-10-CM diagnostic codes used to define the cohort, Appendix 3: ST-segment elevation myocardial infarction and non-ST-segment elevation myocardial infarction ICD-10-CM codes defines the AMI sub-types (STEMI and NSTEMI), and Figure 3 illustrates the study sample inclusion criteria and selection process.

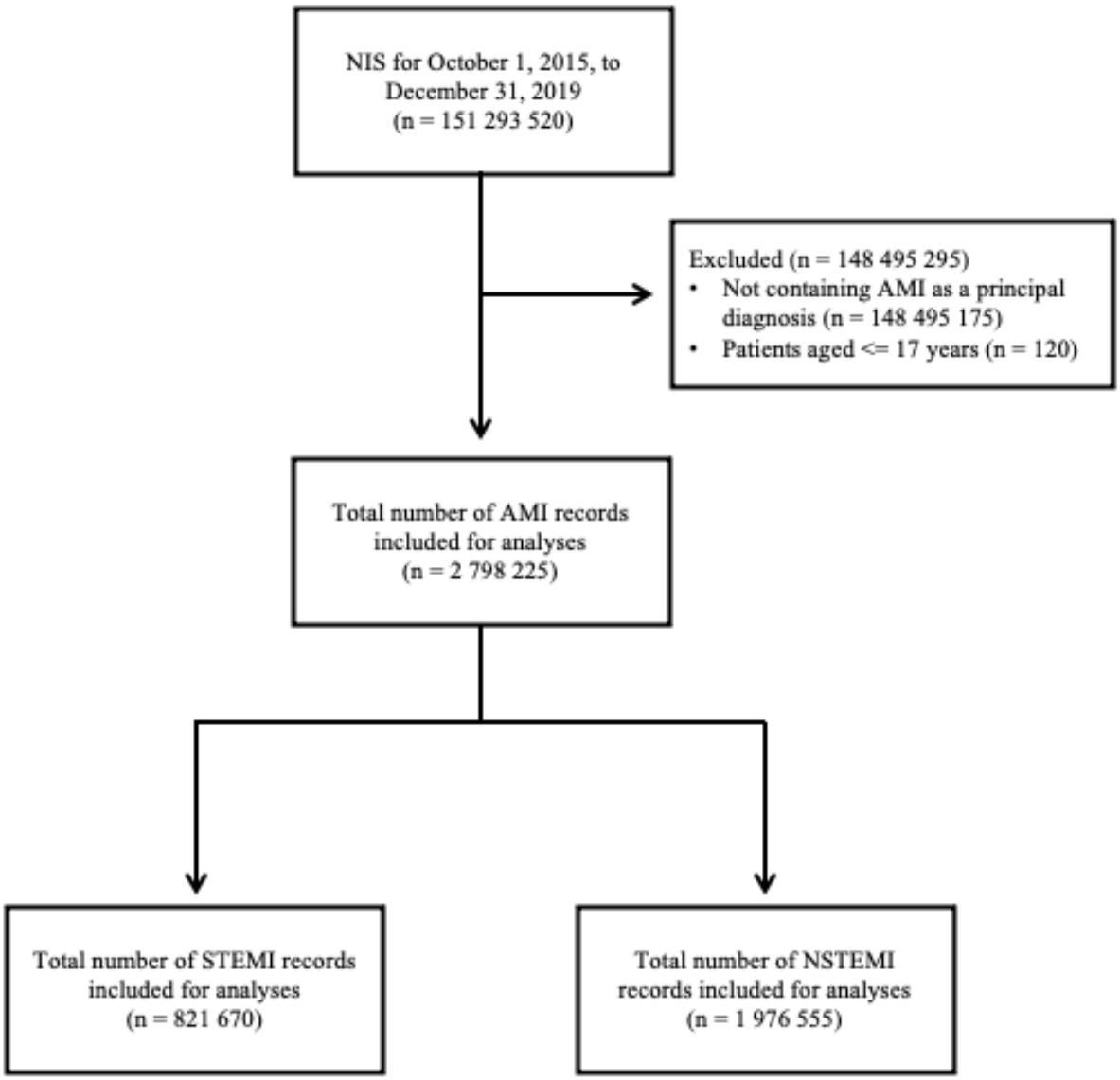


Figure 3: Study sample inclusion criteria and selection process for patients 18 years and older hospitalized with acute myocardial infarction and by diagnosis type

4.2.3 Exposure and outcome measures

The primary outcome covered in this study was the use of revascularization procedures which were defined by the procedure data elements in the NIS database that used the *ICD-10 Procedure Coding System* (ICD-10-PCS) to identify admissions that had undergone CABG and/or PCI procedures. Using validated codes from existing literature CABG was coded using ICD-10-PCS codes 02100x, 02104x, 02110x, 02114x, 02120x, 02124x, 02130x, and 02134x while PCI was coded using ICD-10-PCS codes 02703x, 02713x, 02723x, 02733x, 02H03x, 02H23x, and 02H33x (Appendix 4: Revascularization procedure variable definition [percutaneous coronary intervention and coronary artery bypass graft ICD-10-PCS codes]). Primary exposure variables included the SES and race of the patient, and census region of the hospital. SES quartiles are included in the NIS dataset and are based on the estimated household income of residents living in the patient's ZIP code on record (with quartile 1 being the lowest income category and quartile 4 being the highest) (Appendix 13: Quartile ranges by year for estimated median household income of residents in the patient's ZIP code (USD) based on the National Inpatient Sample database variable definition from 2015 to 2019). Race is defined in the NIS dataset in terms of the following categories: White, Black, Hispanic, Asian or Pacific Islander, Native American, and Unspecified. Hospital region is defined in the NIS dataset based on the American Hospital Association (AHA) Annual Survey of Hospitals and was coded as Northeast, Midwest, South, and West (Figure 4) (Appendix 14: States by year in each hospital region based on the National Inpatient Sample database variable definition from 2015 to 2019).

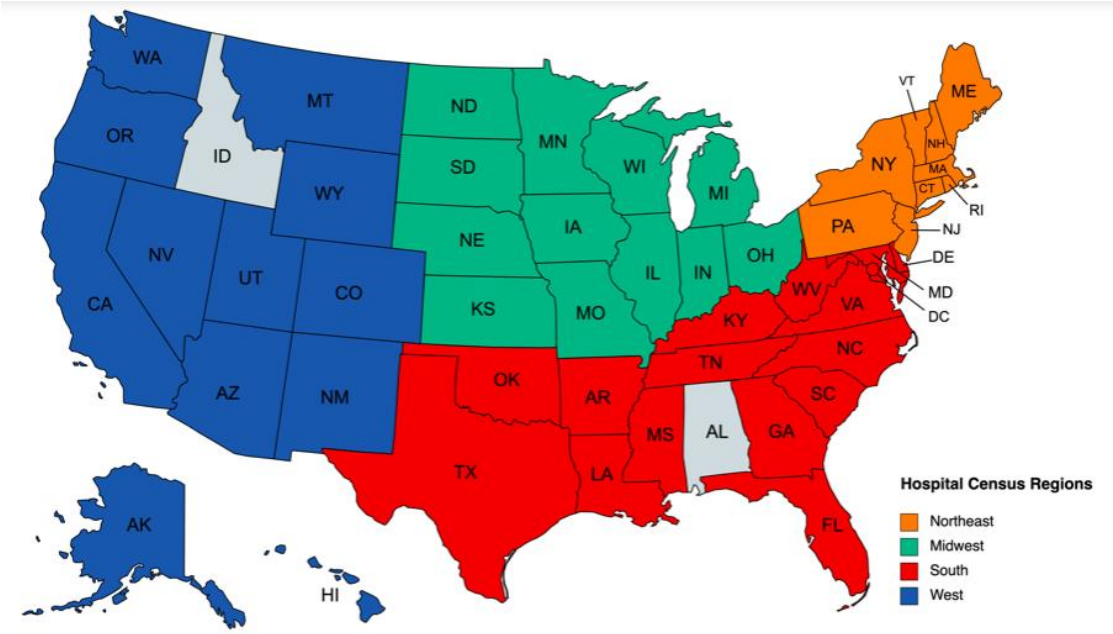


Figure 4: States included in each of the National Inpatient Sample Hospital Census Regions from 2015 to 2019

Secondary exposure variables included patient demographic characteristics (i.e., age and sex) and hospital characteristics (i.e., hospital bed size and rurality and teaching status). Sex was defined as male and female in NIS data. Hospital bed size was based on the number of short-term acute care beds from the AHA Annual Survey of Hospitals and coded as: Small, Medium, and Large (Appendix 15: Number of patients by year in each hospital bedsize category based on the National Inpatient Sample database variable definition from 2015 to 2019). Hospital location/teaching status included the categories: Rural, Urban Non-Teaching, and Urban Teaching. We also controlled for comorbidities using the Elixhauser Comorbidity Software refined for ICD-10-CM to identify pre-existing clinical conditions based on secondary diagnoses listed on hospital administrative data (Appendix 11: Elixhauser Comorbidity Software variables and ICD-10-CM codes).[10,17,25,26] Other comorbidities were coded based on ICD-10-CM diagnostic codes (Appendix 12: Other comorbid conditions ICD-10-CM codes).

4.2.4 Statistical analysis

Sample weights were used for all statistical analyses. Descriptive statistics are reported as percentages for categorical and binary variables and as means (SDs) for continuous variables. As the percentage of missing data was relatively small (<5%), we did not use imputation methods. Covariates were selected based on previously published clinical and health inequalities research related to AMI hospitalizations in the US.[10,17,25,26] We also used Andersen's Behavioural Model of Health Services Use as our theoretical basis for covariate selection with the identification and classification of predisposing (e.g., age, sex, race/ethnicity), enabling (e.g., income), and need for care variables (e.g., comorbidities) (Appendix 10: Covariates selected based on Andersen's Model of Health Services Use).[83]

Multilevel logistic regression modelling was used with revascularization procedure as the binary outcome. A sequential approach to model building was used by cumulatively adding exposure variables and potential confounders (Appendix 5: Covariates selected for model building). Model 1 (unadjusted) included only patient-level exposure variables (i.e., SES quartiles, race, age, and sex) (Appendix 6: Covariate definitions for model 1: sociodemographic characteristics), model 2 added lifestyle factors (i.e., any smoking history, alcohol abuse, drug abuse, obesity) (Appendix 7: Covariate definitions for model 2: model 1 + lifestyle-related factors), model 3 added patient-

level clinical characteristics and history (i.e., comorbidities) (Appendix 8: Covariate definitions for model 3: model 2 + clinical history and comorbidities), and model 4 added hospital characteristics (i.e., hospital location/teaching status, hospital bed size) (Appendix 9: Covariate definitions for model 4: model 3 + hospital-level characteristics). All models accounted for clustering of admissions at the hospital level. Recommendations for methodological standards in using the NIS datasets for research were followed (Appendix 1: Checklist for working with the National Inpatient Sample database).[144,145] All statistical analyses were performed using Stata software, version 17.0 (StataCorp).

4.3 Results

4.3.1 Demographic and baseline characteristics

Between October 1, 2015, and December 31, 2019, there were 2,798,225 hospital admissions with AMI as a principal diagnosis. Of these records, 30.7% were for patients in the lowest income quartile and 18.3% were in the highest. 73.5% of patients were White, 11.4% Black, 8.7% Hispanic, 2.8% Asian or Pacific Islander, 0.6% Native American, and 3.0% were Unspecified. Most admissions (40.9%) were in the South census region, 22.5% in the Midwest, 19.1% in the West, and 17.5% in the Northeast. Of the admissions identified, 8.8% received a CABG procedure, 47.9% underwent a PCI, 56.0% underwent at least one revascularization procedure, and 8.8% received both CABG and PCI (Table 5).

Of the AMI records, 821,670 admissions had a principal diagnosis of STEMI and 1,976,555 were NSTEMI. Both STEMI and NSTEMI admissions followed a similar pattern for the number of patients present in the lowest income quartile and the highest income quartile, as well as those in the White, Black, Hispanic, Asian or Pacific Islander, Native American, and Unspecified race groups. Additionally, the geographical distribution of STEMI and NSTEMI patients followed a similar pattern of summary statistics as those reported for AMI patients. Of the STEMI patients identified, 75.7% STEMI and 47.8% NSTEMI underwent at least one revascularization procedure. Complete descriptive and univariate data are presented in Appendix 28: Baseline characteristics by socioeconomic status among patients with ST-segment elevation myocardial

infarction and Appendix 31: Baseline characteristics by socioeconomic status among patients with non-ST-segment elevation myocardial infarction.

Table 5: Baseline characteristics by quartiles of median household income by patient's ZIP code with revascularization procedure use as the outcome

	Overall (Weighted N = 2 798 225)	0-25th percentile (Lowest) (Weighted n = 843 600)	26th-50th percentile (Weighted n = 752 535)	51st-75th percentile (Weighted n = 649 210)	76th-100th percentile (Highest) (Weighted n = 501 920)
Patient-level characteristics, No. (%)					
Age, mean ± SD (years)	70 ± 13.5	65.9 ± 13.5	67.1 ± 13.5	67.4 ± 13.4	68.3 ± 13.4
Sex					
Male	1 741 090 (62.2%)	502 325 (59.6%)	464 930 (61.8%)	412 070 (63.5%)	327 380 (65.2%)
Female	1 056 650 (37.8%)	341 110 (40.4%)	287 490 (38.2%)	237 040 (36.5%)	174 480 (34.8%)
Race					
White	1 984 150 (73.5%)	526 775 (64.3%)	563 325 (78.0%)	486 695 (78.0%)	373 540 (77.0%)
Black	307 775 (11.4%)	163 420 (20.0%)	64 985 (9.0%)	45 965 (7.4%)	28 210 (5.8%)
Hispanic	235 305 (8.7%)	90 170 (11.0%)	59 330 (8.2%)	49 645 (8.0%)	30 935 (6.4%)
Asian or Pacific Islander	75 370 (2.8%)	9 720 (1.2%)	13 460 (1.9%)	20 355 (3.3%)	30 870 (6.4%)
Native American	15 850 (0.6%)	7 285 (0.9%)	3 730 (0.5%)	2 375 (0.4%)	1 415 (0.3%)
Unspecified	80 690 (3.0%)	21 715 (2.7%)	17 510 (2.4%)	19 310 (3.1%)	20 015 (4.1%)
Expected primary payer					
Medicare	1 602 050 (57.3%)	484 190 57.5%)	437 755 (58.3%)	370 540 (57.2%)	283 860 (23.5%)
Medicaid	262 985 (9.4%)	106 995 (12.7%)	69 570 (9.3%)	51 365 (7.9%)	28 850 (5.8%)
Private insurance	709 275 (25.4%)	169 480 (20.1%)	182 535 (24.3%)	181 940 (28.1%)	162 320 (32.4%)
Self-pay	129 635 (4.6%)	50 600 (6.0%)	35 755 (4.8%)	25 120 (3.9%)	14 725 (2.9%)
No charge	11 330 (0.4%)	4 510 (0.5%)	3 120 (0.4%)	2 190 (0.3%)	1 265 (0.3%)
Other	78 870 (2.8%)	26 415 (3.1%)	22 480 (3.0%)	17 210 (2.7%)	10 615 (2.1%)
Comorbidities, No. (%)					
AIDS	12 370 (0.4%)	4 850 (0.6%)	3 065 (0.4%)	2 290 (0.4%)	1 705 (0.3%)
Alcohol abuse	101 325 (3.6%)	33 550 (4.0%)	27 415 (3.6%)	22 890 (3.5%)	15 175 (3.0%)
AMI type					
NSTEMI	1 976 555 (70.6%)	609 375 (72.2%)	532 745 (70.8%)	454 015 (69.9%)	345 250 (68.8%)
STEMI	821 670 (29.4%)	234 225 (27.8%)	219 790 (29.2%)	195 195 (30.1%)	156 670 (31.2%)
Arthropathies	81 740 (2.9%)	23 475 (2.8%)	21 980 (2.9%)	19 020 (2.9%)	15 895 (3.2%)
Chronic blood loss anemias	18 225 (0.7%)	5 710 (0.7%)	4 845 (0.6%)	4 165 (0.6%)	3 175 (0.6%)
Chronic pulmonary disease	585 050 (20.9%)	199 980 (23.7%)	164 760 (21.9%)	125 235 (19.3%)	84 335 (16.8%)
Coagulopathies	180 675 (6.5%)	52 445 (6.2%)	47 340 (6.3%)	43 185 (6.7%)	34 255 (6.8%)
Congestive heart failure	1 074 355 (38.4%)	343 435 (40.7%)	288 990 (38.4%)	241 400 (37.2%)	180 870 (36.0%)
Deficiency anemias	461 630 (16.5%)	151 970 (18.0%)	120 640 (16.0%)	102 335 (15.8%)	78 695 (15.7%)
Diabetes with chronic complications	586 760 (21.0%)	191 450 (22.7%)	158 310 (21.0%)	132 440 (20.4%)	94 575 (18.8%)
Diabetes without chronic complications	417 745 (14.9%)	135 645 (16.1%)	114 575 (15.2%)	93 015 (14.3%)	66 890 (13.3%)
Drug abuse	90 375 (3.2%)	35 315 (4.2%)	23 430 (3.1%)	18 135 (2.8%)	11 050 (2.2%)
Hypertension, complicated	909 475 (32.5%)	290 910 (34.5%)	244 815 (32.5%)	205 335 (31.6%)	152 325 (30.4%)
Hypertension, uncomplicated	1 105 845 (39.5%)	333 330 (39.5%)	297 885 (39.6%)	257 650 (39.7%)	196 910 (39.2%)
Hypothyroidism	341 160 (12.2%)	97 290 (11.5%)	94 305 (12.5%)	80 070 (12.3%)	63 585 (12.7%)
Liver disease, mild to moderate	85 260 (3.1%)	29 435 (3.5%)	22 055 (2.9%)	18 575 (2.9%)	13 320 (2.6%)
Liver disease, severe	12 485 (0.5%)	4 035 (0.5%)	3 510 (0.5%)	2 635 (0.4%)	2 015 (0.4%)
Lymphoma	16 180 (0.6%)	4 235 (0.5%)	4 005 (0.5%)	4 195 (0.7%)	3 490 (0.7%)
Metastatic cancer	37 910 (1.4%)	10 750 (1.3%)	9 955 (1.3%)	8 755 (1.4%)	7 805 (1.6%)
Obesity	515 880 (18.4%)	159 930 (19.0%)	143 320 (19.0%)	120 775 (18.6%)	83 020 (16.5%)

Other neurological disorders	124 180 (4.4%)	37 870 (4.5%)	33 110 (4.4%)	28 525 (4.4%)	22 540 (4.5%)
Paralysis	68 625 (2.5%)	24 620 (2.9%)	17 600 (2.3%)	14 390 (2.2%)	10 705 (2.1%)
Peptic ulcer with bleeding	22 425 (0.8%)	7 285 (0.9%)	5 960 (0.8%)	4 840 (0.8%)	3 900 (0.8%)
Peripheral vascular disease	272 050 (9.7%)	81 180 (9.6%)	73 580 (9.8%)	64 230 (9.9%)	48 300 (9.6%)
Previous cerebrovascular accident	35 015 (1.3%)	11 105 (1.3%)	9 025 (1.2%)	8 060 (1.2%)	6 110 (1.2%)
Previous coronary artery bypass graft	284 545 (10.2%)	88 415 (31.6%)	80 265 (10.7%)	64 255 (9.9%)	46 920 (9.4%)
Previous myocardial infarction	444 830 (15.9%)	136 855 (16.2%)	120 315 (16.0%)	103 535 (16.0%)	76 365 (15.2%)
Previous percutaneous coronary intervention	486 405 (17.4%)	149 540 (17.7%)	134 015 (17.8%)	111 500 (17.2%)	83 090 (16.6%)
Pulmonary circulation disease	152 735 (5.5%)	47 705 (5.7%)	40 995 (5.5%)	35 185 (5.4%)	26 165 (5.2%)
Renal failure, moderate	432 010 (15.4%)	132 095 (15.7%)	117 950 (15.7%)	99 390 (15.3%)	75 270 (15.0%)
Renal failure, severe	214 790 (7.7%)	73 500 (8.7%)	56 210 (7.5%)	47 080 (7.3%)	34 615 (6.9%)
Any smoking history	1 347 790 (48.2%)	431 045 (51.1%)	374 440 (49.8%)	306 065 (47.1%)	211 965 (42.2%)
Solid tumor without metastasis, malignant	53 890 (1.9%)	15 535 (1.8%)	14 430 (1.9%)	12 620 (1.9%)	10 445 (2.1%)
Valvular disease	411 475(14.7%)	116 375 (13.8%)	112 290 (14.9%)	97 930 (15.1%)	77 875 (15.5%)
Weight loss	94 355 (3.4%)	31 435 (3.7%)	24 865 (3.3%)	20 680 (3.2%)	15 585 (3.1%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	494 820 (17.7%)	123 555 (14.7%)	135 835 (18.1%)	127 470 (19.6%)	99 240 (19.8%)
Medium	853 335 (30.5%)	248 725 (29.5%)	222 990 (29.6%)	197 715 (30.5%)	168 385 (33.6%)
Large	1 450 070 (51.8%)	471 320 (55.9%)	393 710 (52.3%)	324 025 (49.9%)	234 295 (46.7%)
Hospital region					
Northeast	489 745 (17.5%)	87 255 (10.3%)	113 155 (15.0%)	130 845 (20.2%)	151 365 (30.2%)
Midwest	629 455 (22.5%)	171 590 (20.3%)	203 910 (27.1%)	161 600 (24.9%)	87 080 (17.4%)
South	1 145 370 (40.9%)	475 550 (56.4%)	308 190 (41.0%)	209 950 (32.3%)	128 915 (25.7%)
West	533 655 (19.1%)	109 205 (13.0%)	127 280 (16.9%)	146 815 (22.6%)	134 560 (26.8%)
Hospital location/teaching status					
Rural	214 265 (7.7%)	116 425 (13.8%)	69 430 (9.2%)	20 140 (3.1%)	3 040 (0.6%)
Urban non-teaching	648 755 (23.2%)	168 455 (20.0%)	187 825 (25.0%)	158 250 (24.4%)	122 675 (24.4%)
Urban teaching	1 935 205 (69.2%)	558 720 (66.2%)	495 280 (65.8%)	470 820 (72.5%)	376 205 (75.0%)
Procedures, No. (%)					
Coronary artery bypass graft (CABG)	245 385 (8.8%)	72 195 (8.6%)	67 365 (9.0%)	58 310 (9.0%)	43 065 (8.6%)
Percutaneous coronary intervention (PCI)	1 339 155 (47.9%)	384 095 (45.5%)	360 695 (47.9%)	321 575 (49.5%)	248 265 (49.5%)
Revascularization procedures	1 567 575 (56.0%)	451 385 (53.5%)	423 270 (56.3%)	375 845 (57.9%)	288 415 (57.5%)

4.3.2 Association between socioeconomic status and revascularization procedures

Multilevel logistic regression analysis (model 1, unadjusted) found that, compared to those in the highest income quartile, the odds of undergoing revascularization were lower in the lowest (OR = 0.80 [0.79-0.81] *P*<0.001), second lowest (OR = 0.87 [0.86-0.88] *P*<0.001) and second highest (OR = 0.94 [0.94-0.95] *P*<0.001) income quartiles. The fully adjusted model (model 4) found that patients in the lowest (OR 0.91 [0.90-0.92] *P*<0.001) and second lowest (OR = 0.97 [0.96-0.98] *P*<0.001) income quartiles had lower odds of undergoing revascularization procedures than those in the highest quartile (Table 6).

Table 6: Odds ratios [95% confidence intervals] and *P* values for exposures of interest in stepwise model building with revascularization procedures as the outcome

VARIABLES	Model 1 Sociodemographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]
Quartiles for median household income for patient ZIP code				
Highest	*Reference Level*			
Second highest	0.94 [0.94-0.95] *P*<0.001	0.94 [0.93-0.95] *P*<0.001	0.98 [0.97-0.98] *P*<0.001	1.00 [0.99-1.00] *P*=0.337
Second lowest	0.87 [0.86-0.88] *P*<0.001	0.87 [0.86-0.88] *P*<0.001	0.92 [0.91-0.93] *P*<0.001	0.97 [0.96-0.98] *P*<0.001
Lowest	0.80 [0.79-0.81] *P*<0.001	0.80 [0.79-0.80] *P*<0.001	0.86 [0.85-0.87] *P*<0.001	0.91 [0.90-0.92] *P*<0.001
Race				
White	*Reference Level*			
Black	0.55 [0.54-0.55] *P*<0.001	0.56 [0.55-0.56] *P*<0.001	0.62 [0.61-0.62] *P*<0.001	0.58 [0.57-0.58] *P*<0.001
Hispanic	0.83 [0.82-0.84] *P*<0.001	0.84 [0.84-0.85] *P*<0.001	0.86 [0.85-0.87] *P*<0.001	0.81 [0.80-0.82] *P*<0.001
Asian or Pacific Islander	0.93 [0.91-0.94] *P*<0.001	0.94 [0.92-0.96] *P*<0.001	0.98 [0.96-1.00] *P*<0.05	0.94 [0.92-0.96] *P*<0.001
Native American	0.83 [0.80-0.86] *P*<0.001	0.83 [0.80-0.86] *P*<0.001	0.91 [0.88-0.95] *P*<0.001	0.94 [0.91-0.98] *P*<0.05
Unspecified	1.07 [1.06-1.09] *P*<0.001	1.08 [1.07-1.10] *P*<0.001	1.07 [1.05-1.09] *P*<0.001	0.99 [0.98-1.01] *P*=0.486
Hospital region				
Northeast	*Reference Level*			
Midwest				1.71 [1.57-1.86] *P*<0.001
South				1.78 [1.64-1.94] *P*<0.001
West				1.46 [1.33-1.60] *P*<0.001

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

The secondary analysis by AMI type found that the unadjusted model (model 1) reported that those in the lowest (STEMI: OR = 0.78 [0.76-0.80] *P*<0.001; NSTEMI: OR = 0.84 [0.83-0.84] *P*<0.001), second lowest (STEMI: OR = 0.85 [0.84-0.87] *P*<0.001; NSTEMI: OR = 0.91 [0.90-0.92] *P*<0.001), and second highest quartiles (STEMI: OR = 0.95 [0.94-0.97] *P*<0.001; NSTEMI: OR = 0.96 [0.95-0.97] *P*<0.001) had lower odds of undergoing revascularization procedures when compared to those in the highest quartile (Table 7). The final model (model 4) found that STEMI patients in the lowest (OR = 0.88 [0.86-0.90] *P*<0.001), second lowest (OR = 0.92 [0.90-0.94] *P*<0.001), and second highest (OR = 0.98 [0.96-1.00] *P*<0.05) income quartiles had lower odds of revascularization while only NSTEMI patients in the lowest quartile (OR = 0.93 [0.92-0.94] *P*<0.001) had lower odds than the highest quartile (Table 7).

Table 7: Odds ratios [95% confidence intervals] and *P* values for exposures of interest in stepwise model building for AMI subtype with revascularization procedure use as the outcome

	STEMI				NSTEMI			
VARIABLES	Model 1 Socio-demographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]	Model 1 Socio-demographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]
Quartiles for median household income for patient ZIP code								
Highest	*Reference Level*				*Reference Level*			
Second highest	0.95 [0.94-0.97] *P*<0.001	0.95 [0.93-0.97] *P*<0.001	0.97 [0.95-0.99] *P*<0.05	0.98 [0.96-1.00] *P*<0.05	0.96 [0.95-0.97] *P*<0.001	0.96 [0.95-0.97] *P*<0.001	0.98 [0.97-0.99] *P*<0.001	1.00 [0.95-1.01] *P*=0.421
Second lowest	0.85 [0.84-0.87] *P*<0.001	0.85 [0.83-0.86] *P*<0.001	0.88 [0.86-0.90] *P*<0.001	0.92 [0.90-0.94] *P*<0.001	0.91 [0.90-0.92] *P*<0.001	0.90 [0.89-0.91] *P*<0.001	0.94 [0.93-0.95] *P*<0.001	0.99 [0.98-1.00] *P*=0.148
Lowest	0.78 [0.77-0.80] *P*<0.001	0.78 [0.76-0.79] *P*<0.001	0.83 [0.82-0.85] *P*<0.001	0.88 [0.86-0.90] *P*<0.001	0.84 [0.83-0.84] *P*<0.001	0.83 [0.82-0.84] *P*<0.001	0.87 [0.86-0.88] *P*<0.001	0.93 [0.92-0.94] *P*<0.001
Race								
White	*Reference Level*				*Reference Level*			
Black	0.50 [0.49-0.51] *P*<0.001	0.51 [0.50-0.52] *P*<0.001	0.57 [0.56-0.58] *P*<0.001	0.54 [0.53-0.55] *P*<0.001	0.59 [0.59-0.60] *P*<0.001	0.60 [0.60-0.61] *P*<0.001	0.64 [0.63-0.64] *P*<0.001	0.60 [0.58-0.60] *P*<0.001
Hispanic	0.83 [0.81-0.85] *P*<0.001	0.85 [0.83-0.87] *P*<0.001	0.87 [0.85-0.89] *P*<0.001	0.83 [0.81-0.85] *P*<0.001	0.85 [0.84-0.86] *P*<0.001	0.86 [0.85-0.87] *P*<0.001	0.87 [0.86-0.88] *P*<0.001	0.81 [0.80-0.82] *P*<0.001
Asian or Pacific Islander	0.93 [0.90-0.97] *P*<0.001	0.95 [0.91-0.98] *P*<0.05	1.00 [0.97-1.04] *P*=0.897	0.98 [0.94-1.01] *P*=0.217	0.92 [0.91-0.94] *P*<0.001	0.94 [0.92-0.96] *P*<0.001	0.97 [0.95-0.99] *P*<0.05	0.92 [0.90-0.94] *P*<0.001
Native American	0.69 [0.64-0.74] *P*<0.001	0.69 [0.64-0.75] *P*<0.001	0.73 [0.67-0.79] *P*<0.001	0.74 [0.69-0.81] *P*<0.001	0.92 [0.88-0.96] *P*<0.001	0.93 [0.89-0.97] *P*<0.001	0.98 [0.94-1.02] *P*=0.398	1.02 [0.97-1.06] *P*=0.456
Unspecified	1.01 [0.98-1.05] *P*=0.396	1.03 [0.99-1.06] *P*=0.111	1.07 [1.03-1.11] *P*<0.001	1.02 [0.98-1.05] *P*=0.352	1.06 [1.04-1.08] *P*<0.001	1.08 [1.06-1.10] *P*<0.001	1.08 [1.06-1.10] *P*<0.001	1.00 [0.98-1.02] *P*=0.749
Hospital region								
Northeast	*Reference Level*				*Reference Level*			
Midwest				1.64 [1.49-1.80] *P*<0.001				1.90 [1.74-2.07] *P*<0.001
South				1.64 [1.50-1.79] *P*<0.001				1.92 [1.77-2.09] *P*<0.001
West				1.26 [1.14-1.39] *P*<0.001				1.57 [1.43-1.73] *P*<0.001

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity

[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease

[d] Hospital bed size, hospital location/teaching status, hospital region

4.3.3 Association between race groups and revascularization procedures

Among hospitalized AMI patients, model 1 reported that the Black (OR = 0.55 [0.54-0.55] *P*<0.001), Hispanic (OR = 0.83 [0.82-0.84] *P*<0.001), Asian or Pacific Islander (OR = 0.93 [0.91-0.94] *P*<0.001), and Native American (OR = 0.83 [0.80-0.86] *P*<0.001) race groups had lower odds while those in the Unspecified race group (OR = 1.07 [1.06-1.09] *P*<0.001) had greater odds of undergoing revascularization procedures when compared to those in the White race group (Table 6). The fully adjusted model (model 4) reported that those in the Black (OR = 0.58 [0.57-0.58] *P*<0.001), Hispanic (OR = 0.81 [0.80-0.82] *P*<0.001), Asian or Pacific Islander (OR = 0.94 [0.92-0.96] *P*<0.001), and Native American (OR = 0.94 [0.91-0.98] *P*<0.05) race groups still had lower odds of undergoing revascularization procedures when compared to the White race group (Table 6).

Our secondary analysis using the unadjusted model 1 reported that STEMI and NSTEMI patients in the Black (OR = 0.50 [0.49-0.51] *P*<0.001); NSTEMI: OR = 0.59 [0.59-0.60] *P*<0.001), Hispanic (STEMI: OR = 0.83 [0.81-0.85] *P*<0.001); NSTEMI: OR = 0.85 [0.84-0.86] *P*<0.001), Asian or Pacific Islander (STEMI: OR = 0.93 [0.90-0.97] *P*<0.001); NSTEMI: OR = 0.92 [0.91-0.94] *P*<0.001), and Native American (STEMI: OR = 0.69 [0.64-0.74] *P*<0.001; NSTEMI: OR = 0.92 [0.88-0.96] *P*<0.001) race groups had lower odds while NSTEMI patients in the Unspecified race group (OR = 1.06 [1.04-1.08] *P*<0.001) had greater odds of undergoing revascularization procedures when compared to the White race group (Table 7). The final model (model 4) reported that, compared to the White race group, patients in the Black (STEMI: OR = 0.54 [0.53-0.55] *P*<0.001; NSTEMI: OR = 0.60 [0.58-0.60] *P*<0.001) and Hispanic (STEMI: OR = 0.83 [0.81-0.85] *P*<0.001; NSTEMI: OR = 0.81 [0.80-0.82] *P*<0.001) race groups had lower odds of revascularization. Patterns of association differed where only STEMI Native American patients (OR = 0.74 [0.69-0.81] *P*<0.001) and NSTEMI Asian or Pacific Islander race groups (OR = 0.92 [0.90-0.94] *P*<0.001) had lower odds of receiving revascularization procedures when compared to those in the White race group (Table 7).

4.3.4 Association between hospital census regions and revascularization procedures

We employed sequences of multilevel multivariable logistic regression models that include covariate and confounding variables of interest to understand disparities present among US census regions and revascularization procedure use among AMI patients. Following this array of models, hospital-level characteristics were not incorporated until the final model (model 4). In this final model, AMI admissions from hospitals in the Midwest (OR = 1.71 [1.57-1.86] *P*<0.001), South (OR 1.78 [1.64-1.94] *P*<0.001), and West (OR 1.46 [1.33-1.60] *P*<0.001) census regions had greater odds of undergoing revascularization procedures when compared to admissions in hospitals in the Northeast census region (Table 6).

In the secondary analysis using fully adjusted multilevel logistic regression model accounting for regional variation for STEMI and NSTEMI patients, the Midwest (STEMI: OR = 1.64 [1.49-1.80] *P*<0.001; NSTEMI: OR = 1.90 [1.74-2.07] *P*<0.001), South (STEMI: OR = 1.64 [1.50-1.79] *P*<0.001; NSTEMI: OR = 1.92 [1.77-2.09] *P*<0.001), and West (STEMI: OR = 1.26 [1.14-1.39] *P*<0.001; NSTEMI: OR = 1.57 [1.43-1.73] *P*<0.001) regions had greater odds of undergoing revascularization procedures when compared to patients hospitalized in the Northeast region (Table 7).

4.3.5 Sensitivity analyses

Following the primary analyses exploring the association between quartiles of median household income for patient's ZIP code, race, and hospital region and in-hospital mortality, additional analyses were performed to adjust for insurance status as expected primary payer (Table 8). The inclusion of insurance status is of interest as it is categorized as an enabling factor in Andersen's Model of Health Services Use such that having insurance may increase one's chance of receiving revascularization as they have the means to afford these health services.[146] Relative to the fully adjusted model (model 4), the inclusion of expected primary payer (model 5) provided similar results for income where AMI admissions in the poorest (OR = 0.93 [0.92 – 0.94] *P*<0.001) and second poorest (OR = 0.99 [0.98– 1.00] *P*<0.05) quartiles had lower odds of revascularization use compared to those in the highest quartile. These results indicate that income remains an

independent and statistically significant predictor of revascularization use among AMI patients. Race categories also followed a similar pattern where those in the Black (OR = 0.59 [0.58 – 0.59] $P<0.001$), Hispanic (OR = 0.83 [0.82 – 0.84] $P<0.001$), and Asian or Pacific Islander (OR = 0.96 [0.94 – 0.97] $P<0.001$) race groups had lower odds of undergoing revascularization procedures compared to those in the White race group. However, when including insurance status as a covariate, those in the Native American race group did not have statistically significant results at the 5% level compared to model 4. Hospital admissions in the Midwest (OR = 1.70 [1.56 – 1.85] $P<0.001$), South (OR = 1.77 [1.63 – 1.91] $P<0.001$), and West (OR = 1.46 [1.34 – 1.60] $P<0.001$) had higher odds revascularization use when compared to those presenting to hospitals in the Northeast.

Table 8: Odds ratios [95% confidence intervals] and *P* values for exposures of interest in stepwise model building for with revascularization procedures as the outcome including expected primary payer as a covariate

VARIABLES	Model 5 Model 4 + Expected Primary Payer
Quartiles for median household income for patient ZIP code	
Richest	*Reference Level*
Second richest	1.01 [1.00-1.02] *P*=0.202
Second poorest	0.99 [0.98-1.00] *P*<0.05
Poorest	0.93 [0.92-0.94] *P*<0.001
Race	
White	*Reference Level*
Black	0.59 [0.58-0.59] *P*<0.001
Hispanic	0.83 [0.82-0.84] *P*<0.001
Asian or Pacific Islander	0.96 [0.94-0.97] *P*<0.001
Native American	0.97 [0.93-1.00] *P*=0.069
Unspecified	1.01 [1.00-1.03] *P*=0.110
Hospital region	
Northeast	*Reference Level*
Midwest	1.70 [1.56-1.85] *P*<0.001
South	1.77 [1.63-1.91] *P*<0.001
West	1.46 [1.34-1.60] *P*<0.001

4.4 Discussion

In this national study using a representative database in a contemporary era, we reported that revascularization procedure use was associated with differences in SES, race/ethnicity, and regions among AMI admissions. Overall, AMI admissions in the lowest and second lowest income quartiles, those who were Black, Hispanic, Asian or Pacific Islander, or Native American had lower odds of receiving revascularization procedures. Admissions to hospitals in the Midwest, South, and West census regions all had higher odds of undergoing revascularization. STEMI admissions in the lowest, second lowest and second highest income quartiles, those who were in the Black, Hispanic, and Native American race groups, and admissions to hospitals in the Northeast census region were less likely to undergo revascularization procedures. For NSTEMI admissions, those in the lowest income quartile, admissions belonging to the Black, Hispanic, and Asian or Pacific Islander race groups, and those presenting to hospitals in the Northeast census region were less likely to receive revascularization procedures.

4.4.1 Socioeconomic associations in revascularization procedures among acute myocardial infarction patients

In our study, we reported significant differences in the likelihood of undergoing revascularization procedures among AMI admissions among the lower income quartiles when compared to those in the highest quartile. Historical and more recent studies indicate a similar pattern of disparity based on SES conditions in AMI patients undergoing revascularization procedures.[11-13,67] Yong et al. [13] illustrated these trends in their study exploring AMI outcomes among different SES groups, where poorer SES groups were less likely to receive revascularization procedures of any kind, experience poorer quality of care, have longer delays in receiving interventions, and were less likely to receive more costly and innovative procedures during their inpatient stay. By using more current years of NIS data, our study offers an understanding of these existing patterns of disparities observed among lower-income groups in a more contemporary and representative context.

Causes of socioeconomic disparities in cardiovascular care involve several factors. For instance, those living in and presenting to hospitals in lower SES neighbourhoods tend to experience

worse quality of care, fewer cardiac procedural capabilities and resources, and health system capacity and budget constraints.[11,13] In addition, when patients of lower SES gain access to therapies and interventions, they experience a longer delay in interventions when compared to those who are of higher SES.[13] Strategies for mitigating disparities in SES groups include targeting more timely revascularization procedures to lower SES groups when appropriate.[13,14]

4.4.2 Racial disparities in revascularization procedures among acute myocardial infarction patients

In our study, we reported significant disparities in the provision of revascularization procedures across several race groups. Our findings reflect recent studies that have found patients who are BIPOC experienced lower odds of undergoing revascularization procedures when compared to White patients.[12,15,33-40,57-60] The current study contributes to the evidence base as our findings provide an understanding of what factors may cause an AMI patient to be more or less likely to receive appropriate procedures during their inpatient stay using a contemporary and representative dataset. These results could be due to a host of factors, including the system-level mechanisms related to patient presentations to minority-serving hospitals.[31,36] Minority-serving hospitals are defined as those with the top 10% of Medicare patient volume who were Black and those who provided care to more than double the number of Black patients compared with competing hospitals.[36] Minority-serving hospitals are more likely to have patients who are transported by ambulance to be diverted to neighbouring hospitals than non-minority-serving hospitals, resulting in BIPOC patients experiencing reduced access to hospitals with cardiac care facilities, a lower probability of receiving cardiac interventions, and poorer uptake of newer and more costly therapies.[36] BIPOC patients also tend to be admitted to hospitals emergently and to lower volume hospitals which resulted in suboptimal systems of care.[14] Existing studies reinforce that BIPOC patients tend to have poorer uptake of newer or more costly interventions during their inpatient stay.[12,36,37,39] Dani et al. [31] investigated disparities among AMI patients and reported that, when compared to White patients, Black patients had greater barriers to procedure access and reduced procedural success with the underuse of guideline-recommended therapies.

Other explanations for these associations among race groups include the lower overall quality of services available in facilities where patients seek care. Particularly, hospitals with a

predominant Hispanic patient population have reported similar primary outcomes, quality of care, and performance markers when compared to hospitals with a mainly White patient population, but with similar quality of cardiac care services.[15] Disparities may also be due to hospital capacity where hospitals with higher procedural rates tended to have a reduced gap in patients' appropriate interventions.[38] The factors underlying these disparities may reflect clinical presentation and medical decision-making, environmental barriers that limit access to quality healthcare, and challenges around care coordination.[37-39]

Reducing disparities in the use of revascularization procedures in hospitals is a complex issue requiring multifactorial strategies. Disadvantaged groups may present to hospitals with reduced capacity for cardiac care and interventions, experience greater challenges related to medical decision-making and care coordination, and endure systematic and environmental barriers to accessing care.[31,36-39] Existing literature indicates that the implementation of quality improvement programs as well as improving access to primary care for monitoring processes of care and outcomes may reduce observed disparities.[14,31,36-39] Studies have emphasized the importance of understanding and being conscious of the variations of cardiovascular event outcomes by race to develop socially sensitive care plans that better serve under-resourced groups.[71,79]

4.4.3 Regional variation in revascularization procedures among acute myocardial infarction patients

Once adjusting for potential confounders and covariate variables of interest, AMI admissions to hospitals in the Midwest, South, and West census regions had greater odds of undergoing revascularization procedures when compared to admissions to hospitals in the Northeast region. Our findings are consistent with existing literature that has identified AMI patients in the Northeast US region to have lower odds of undergoing revascularization procedures when compared to other regions.[41,42,44-48] Our findings emphasize the significance of the disparities present in geographic location among patients presenting to hospitals with AMI. Further, this study aids in understanding which regions of the US are more or less likely to provide revascularization procedures to AMI patients by using a study sample that is contemporary and representative of the broader US population. These results may be partly explained by variation

in clinical practice patterns identified across the US.[42,46] The treatment of AMI in the Northeast region is characterized by greater use of medical therapies and lower use of cardiac procedures.[42,73] Existing literature emphasizes that clinical practice is influenced by differences in cardiovascular incidence and risk factors in the local population, available resources, and the medical community's perceptions of available treatments and treatment guidelines.[41,42,46] National quality improvement initiatives for systems of care to guide clinical management of revascularization procedures have been recommended to mitigate the regional disparities observed in procedure use.[45,46]

4.4.4 Strengths and limitations

Our study has several strengths. First, we used representative national-level data from nearly all states in the US which contrasts with many existing studies that used data at a regional- or state-level.[15,36,38] Second, we used contemporary data over multiple years which allowed us to consider the sociodemographic determinants of AMI patients receiving revascularization procedures. Third, we used consistent definitions and ICD-10 codes across multiple years to define health conditions in the analysis. Finally, while previous studies examined disparities in AMI-related outcomes while including a secondary or concomitant diagnoses, our study incorporated patients with a principal diagnosis of AMI to gain a fuller understanding of the disparities among patients undergoing revascularization procedures.

Despite the strengths of this study and the NIS database's attempts to mitigate potential errors through internal and external quality control measures, this study has several limitations. First, administrative databases are prone to coding errors. To mitigate the potential underreporting of diagnoses, we used validated ICD-10-CM codes from literature or those provided by AHRQ or HCUP to identify select diagnoses. Second, data available in the NIS do not identify repeated AMI events for the same patient. Although this is unlikely to have a significant impact on the results of our study, it is nevertheless a limitation of the way data are recorded. Third, despite controlling for potential confounders in our analysis, all observational studies can potentially suffer from residual confounding. Further, the variable definitions provided by the NIS may not capture the granularity present in lived experiences. For instance, the SES variable was based on median household income by patient ZIP code. However, this is a common limitation associated

with the use of administrative data. Additionally, the race group definitions were broad and limited our ability to assess the heterogeneity present within each level. Our study is also subject to underreporting of age as the NIS classified all admissions aged 90 years and above into a 90-year-old age category. The NIS includes a binary male or female sex variable that does not fully acknowledge gender identity. Finally, as the current study is examining associations in revascularization procedure use among patients who made it to the hospital, there are gaps in understanding likely disparities among those who died prior to their hospital encounter. Despite the above limitations, this study addresses a knowledge gap related to the socioeconomic, racial, and geographic disparities in the in-hospital management of AMI in a contemporary population.

4.5 Conclusion

Several factors were associated with lower odds of undergoing revascularization procedures. For the overall AMI population, admissions among the lowest and second lowest income quartiles, those who were Black, Hispanic, Asian or Pacific Islander and Native American had lower odds of receiving revascularization procedures while patients reporting to hospitals in the Midwest, South and West census regions experienced higher odds of revascularization. STEMI patients in the lowest, second lowest and second highest income quartiles, those who were Black, Hispanic and Native American, and those reporting to hospitals in the Northeast census region had lower odds of undergoing revascularization procedures. Finally, NSTEMI admissions among the lowest income quartile, those who were in the Black, Hispanic and Asian or Pacific Islander race groups, and patients reporting to hospitals in the Northeast census region had lower odds of receiving revascularization procedures during their hospital stay. Disparities in AMI in-hospital outcomes among sociodemographic groups and US regions remain multifactorial. Further studies are needed to investigate potential individual- and health system-level domains to understand the underlying causes of these prevailing disparities and what strategies can be implemented to improve equitable access to appropriate interventions.

Chapter 5

5 Integrated Summary & Conclusion

The objective of this chapter is to provide a summary and contextualize the findings presented in this thesis. Further, this chapter will discuss future directions for research in this area.

5.1 Summary of findings

5.1.1 Existing literature

Existing literature highlights variation among SES, race, and geographic location groups when considering in-hospital outcomes for AMI patients in the US.[11-13,25,35,36,41,42,44-48,67] Evaluating the outcome of in-hospital mortality allows for the understanding of how disparities are distributed both between and within social groups and geographic locations in the context of their SDH conditions.[160,161] Further, examining the use of revascularization procedures among AMI patients provides insight into how interventions are distributed in terms of their access and implementation.[162,163] Overall, the significance of studying in-hospital mortality and use of revascularization procedures among hospitalized AMI patients in the US allows for a better understanding of what aspects of the SDH conditions may make individuals more or less likely to experience these outcomes.[160-163]

Studies have concluded that AMI patients in the lowest SES groups had higher odds of in-hospital mortality when compared to the higher SES groups.[11,16,17,20-25,158] When considering race groups, analysis results appeared to vary for associations related to in-hospital mortality. Particularly, historical studies indicated that AMI patients with membership to the Black race group had higher odds of in-hospital mortality when compared to those in the White race group.[28,31,52,53,130] However, more contemporary studies have reported that AMI patients in the Black race group tend to have lower odds of in-hospital mortality relative to White patients.[19,26,54-56] Further, most existing literature highlighted that AMI patients in the Hispanic, Asian or Pacific Islander, or Native American race groups had greater odds of in-hospital mortality when compared to White patients.[11,16,17,20-25,158] In terms of geographic location in the

US, studies have noted that AMI patients presenting to hospitals in the Northeast had lower odds of in-hospital mortality compared to other regions.[42,43] However, more recent literature has indicated that patients presenting to the Midwest and West regions had lower odds of in-hospital mortality[41,47] while patients in the South region had higher odds when compared to the Northeast region.[30,47,139,164]

Studies reporting on the use of revascularization procedures among patients hospitalized for AMI in the US have also revealed associations among SES, race, and geographic location groups.[11-13,25,35,36,41,42,44-48,67] Existing literature has indicated that AMI patients in the lowest SES groups are less likely to undergo revascularization procedures during their hospital stay.[11-13,25,67] Research studies have reported that AMI patients belonging to Black, Hispanic, Asian or Pacific Islander, Native American, or Unspecified race groups had lower odds of receiving revascularization procedures when compared to White patients.[12,35,36] Finally, researchers have consistently highlighted that AMI patients presenting to hospitals in the Northeast US states tend to have lower odds of undergoing revascularization procedures relative to any other US region.[41,42,44-48]

Although existing literature is abundant, it is limited in terms of the study sample inclusion criteria based on age,[11,19,21,31,62,68,69] type of AMI,[16,29,64,65] type of insurance,[14,23,36,38,68,70] region of the country,[14,15,16,20,36,38,57,58,69,72,74] presence of complications at the time of admission,[12,41,47,63,64,73] including only a single year of study,[15,18,45,52,57] or not using a nationally representative database.[16,19,21,30,31,62] This thesis provided analyses that addressed existing gaps by including a broader study sample using a contemporary multi-year nationally representative database.

5.1.2 Association between SES, race, and geographic location and in-hospital mortality

The current study performed multilevel logistic regression models to understand the association between SES, race, and geographic location as well as in-hospital mortality among 2.8 million AMI patients in the US from 2015 to 2019. The results of this analysis indicated that AMI patients belonging to the lowest SES quartile had greater odds of in-hospital mortality when

compared to those in the highest SES quartiles. Additionally, AMI patients who were Black or Hispanic experienced lower odds of in-hospital mortality relative to White patients. However, AMI patients who were in the Asian or Pacific Islander, Native American, or Unspecified race groups had greater odds of in-hospital mortality when compared to White patients. Finally, this analysis indicated that AMI patients presenting to hospitals in the South region had higher odds when compared to AMI patients in the Northeast. These findings are related to the complex interaction of individual- and broader-level factors, such as education, income, comorbidities, access to healthcare resources, and regionalization of health programs and policies that continue to drive disparities in SDH among the outcomes of AMI patients.[164]

5.1.3 Association between SES, race, and geographic location and undergoing revascularization procedures

The current research study conducted multilevel logistic regression analyses to understand potential associations between SES, race, and geographic location as well as a patient's odds of undergoing revascularization procedures. This study indicated that AMI patients within the lowest SES quartile had the lowest odds of undergoing a revascularization procedure after AMI when compared to the second lowest, second highest, and highest. For race, AMI patients in the Black, Hispanic, Asian or Pacific Islander, or Native American race groups had lower odds of undergoing revascularization procedures when compared to patients in the White race group. AMI patients presenting to hospitals in the Midwest, West, and South regions had greater odds of undergoing revascularization procedures when compared to patients in hospitals in the Northeast. These results align with existing literature where those with the SDH previously mentioned experience overall worse quality of care, fewer cardiac procedural care resources, longer delays in interventions, and a poorer uptake of newer or more costly interventions during their inpatient stays.[11-13,67]

5.2 Strengths and limitations

The analyses provided in this thesis have several strengths compared to the existing knowledge base. First, relative to previous studies that used data at the regional- or state-level, we used national-level data representative of nearly all states in the US. Second, we consistently used

diagnostic definitions and ICD-10 codes across all analysis years to define health conditions in the studies presented in this thesis. Finally, we used a contemporary database over multiple years which allowed insight into the SDH of hospital outcomes among AMI patients in the US.

Although the analyses in this thesis offer several strengths, the current studies have several limitations. First, administrative databases are prone to coding errors which may result in the underreporting of diagnoses or procedures. We used validated ICD-10 codes from the literature or those provided by HCUP to identify the select procedures and health conditions. Second, the NIS data does not identify repeated AMI events or readmissions for the same patients. Third, residual confounding may be present in the observational analyses despite our controlling for potential confounders. Finally, the variable definitions provided in the NIS database by HCUP do not depict the same granularity present in lived experiences. Specifically, each hospital region category is composed of multiple states such that we cannot recognize which states have relatively worse outcomes among AMI patients.

5.3 Future directions

Future research is needed to better understand the disparities present among SES, race, and geographic location with AMI in-hospital outcomes and procedure use in the US. Additional studies that include quantitative and qualitative data elements would clarify other potential individual-level (i.e., level of education, employment status, more granular race groups) and population-level (i.e., presence of cardiac care facilities in hospitals) to better assess the underlying causes and mechanisms of these prevailing disparities. Prior research has also indicated that the use of multiple different data sources, in addition to health services data, increases accuracy when assessing contextual aspects of in-hospital outcomes.[165] Future research should also consider the use of longer-term studies to better understand the temporal trends associated with in-hospital outcomes among AMI patients in the US. Especially when considering the current studies provided in this thesis report novel findings not previously observed in the existing literature. Consideration around out-of-hospital and ambulatory care settings should be accounted for in future studies to better understand the association between the factors and outcomes of interest. Finally, future research should consider the use of additional

indicators, such as length of stay, hospital costs, and data elements related to quality of life and illness severity to better assess the impact of AMI on these populations.

5.4 Conclusions

The primary objective of this thesis was to investigate the association of the SDH, SES, race groups, and geographic location with in-hospital mortality and the use of revascularization procedures among AMI patients in the US. The first study examining SDH, including SES, race/ethnicity, and geographic locations in in-hospital mortality among AMI patients found that those in the lowest SES quartile, Asian or Pacific Islander, Native American or Unspecified patients, and those reporting to hospitals in the South had higher odds of in-hospital mortality. Further, AMI patients in the Black or Hispanic race group had lower odds of in-hospital mortality during their stays. The second study examining disparities present in SES, race groups, or geographic location among AMI patients undergoing revascularization procedures concluded that those in the lowest SES quartile and Black, Hispanic, Asian or Pacific Islander or Native American patients had lower odds of receiving revascularization procedures. However, this study also identified that AMI patients in the Unspecified race group and those presenting to hospitals in the Midwest, West, or South had greater odds of undergoing revascularization procedures. The findings from this thesis emphasize the need to consider disparities within SES, race groups, and geographic location among AMI patients in in-hospital outcomes and use of procedures which has implications at the patient, provider, and healthcare system levels.

References

1. Marmot M, Allen JJ. Social determinants of health equity. *American Journal of Public Health*. 2014;104(4)
2. Hoyler MM, Abramovitz MD, Ma X, et al. Social determinants of health affect unplanned readmissions following acute myocardial infarction. *Journal of Comparative Effectiveness Research*. 2021;10(1)doi:https://doi.org/10.2217/cer-2020-0135
3. (CDC) CfDCaP. Social Determinants of Health: Know What Affects Health. https://www.cdc.gov/socialdeterminants/index.htm
4. Singh GK, Daus GP, Allender M, et al. Social determinants of health in the United States: Addressing major health inequality trends for the nation, 1935-2016. *International Journal of Maternal and Child Health and AIDS*. 2017;6(2):139-164. doi:https://doi.org/10.21106%2Fijma.236
5. Raparelli V, Pilote L, Dang B, et al. Variations in quality of care by sex and social determinants of health among younger adults with acute myocardial infarction in the US and Canada. *JAMA Network Open*. 2021;4(10):e2128182. doi:10.1001/jamanetworkopen.2021.28182
6. Adler NE, Glymour MM, Fielding J. Addressing social determinants of health and health inequalities. *JAMA*. 2016;316(16):1641-1642. doi:10.1001/jama.2016.14058
7. Marmot M. Social determinants of health inequalities. *The Lancet*. 2005;365(9464):1099-1104. doi:https://doi.org/10.1016/S0140-6736(05)71146-6
8. Daniels N, Kennedy BP, Kawachi I. Why justice is good for our health: the social determinants of health inequalities. *Bioethics and Beyond*. 1999;128(4):215-251.
9. Mechanic OJ, Gavin M, Grossman SA. Acute Myocardial Infarction. StatPearls Publishing; 2021. https://www.ncbi.nlm.nih.gov/books/NBK459269/
10. Alkhouli M, Alqahtani F, Kalra A, Gafoor S, Alhajji M, Alreshidan M. Trends in Characteristics and Outcomes of Hospital Inpatients Undergoing Coronary Revascularization in the United States, 2003-2016. *JAMA*. 2020;3(2):e1921326. doi:10.1001/jamanetworkopen.2019.21326
11. Udell JA, Desai NR, Li S, Thomas L, de Lemos JA, Wright-Slaughter P. Neighbourhood socioeconomic disadvantage and care after myocardial infarction in the national cardiovascular data registry. *Circulation*. 2018;11:e004054. doi:https://doi.org/10.1161/CIRCOUTCOMES.117.004054
12. Nee R, Yan G, Yuan CM, Agodoa LY, Norris KC. Use of percutaneous coronary intervention among Black and White patients with end-stage renal disease in the United States. *Journal of the American Heart Association*. 2019;8:e012101. doi:10.1161/JAHA.119.012101
13. Yong CM, Abnousi F, Asch SM, Heidenreich PA. Socioeconomic inequalities in quality of care and outcomes among patients with acute coronary syndrome in the modern era of drug eluting stents. *Journal of the American Heart Association*. 2014;3:e001029. doi:10.1161/JAHA.114.001029
14. Lucas FL, Stukel TA, Morris AM, Siewers AE, Birkmeyer JD. Race and surgical mortality in the United States. *Annals of Surgery*. 2006;243(2):281-286. doi:10.1097/01.sla.0000197560.92456.32
15. Romero T, Greenwood KL, Glaser D. Update on quality of care in Hispanics and other racial-ethnic groups in the United States discharged with the diagnosis of acute myocardial infarction in 2013. *International Journal of Cardiology*. 2017;248:28-33. doi:http://dx.doi.org/10.1016/j.ijcard.2017.07.004

16. Kim C, Roux AVD, Hofer TP, Nallamothu BK, Bernstein SJ, Rogers MAM. Area socioeconomic status and mortality after coronary artery bypass graft surgery: The role of hospital volume. *American Heart Journal*. 2007;54(2):385-390. doi:https://doi.org/10.1016/j.ahj.2007.04.052
17. Agarwal S, Garg A, Parashar A, Jaber WA, Menon V. Outcomes and resource utilization in ST-elevation myocardial infarction in the United States: evidence for socioeconomic disparities. *Journal of the American Heart Association*. 2014;3(6):e001057. doi:10.1161/JAHA.114.001057
18. Shen JJ, Wan TT, Perlin JB. An exploration of the complex relationship of socioecologic factors in the treatment and outcomes of acute myocardial infarction in disadvantaged populations. *Health Services Research*. 2001;36(4):711-732.
19. Downing NS, Wang C, Gupta A, Wang Y, Nuti SV, Ross JS. Association of racial and socioeconomic disparities with outcomes among patients hospitalized with acute myocardial infarction, heart failure, and pneumonia: An analysis of within- and between-hospital variation. *JAMA*. 2018;1(5):e182044. doi:10.1001/jamanetworkopen.2018.2044
20. Foraker RE, Patel MD, Whitsel EA, Suchindran CM, Heiss G. Neighbourhood socioeconomic disparities and 1-year case fatality after incident myocardial infarction: The Atherosclerosis Risk in Communities (ARIC) Community Surveillance (1992-2002). *American Heart Journal*. 2013;165(1):102-107. doi:https://doi.org/10.1016/j.ahj.2012.10.022
21. Lindenauer PK, Lagu T, Rothberg MB, Avrunin J, Pekow PS, Wang Y. Income inequality and 30-day outcomes after acute myocardial infarction, heart failure, and pneumonia: retrospective cohort study. *BMJ*. 2013;346:521. doi:https://doi.org/10.1136/bmj.f521
22. Pedigo A, Seaver W, Odoi A. Identifying unique neighbourhood characteristics to guide health planning for stroke and heart attack: Fuzzy cluster and discriminant analyses approaches. *BMC Public Health*. 2011;6(7):e22693. doi:https://doi.org/10.1371/journal.pone.0022693
23. Bradley EH, Herrin J, Curry L, Drye EE, Normand SLT, Krumholz HM. Variation in-hospital mortality rates for patients with acute myocardial infarction. *The American Journal of Cardiology*. 2010;106(8):1108-1112. doi:https://doi.org/10.1016/j.amjcard.2010.06.014
24. Gerber Y, Weston SA, Killian JM, Therneau TM, Jacobsen SJ, Roger VL. Neighbourhood income and individual education: Effect on survival after myocardial infarction. *Mayo Clinic Proceedings*. 2008;83(6):663-669. doi:https://doi.org/10.4065/83.6.663
25. Matetic A, Bharadwaj A, Mohamed MO, Chugh Y, Chugh S, Minissian M. Socioeconomic status and differences in the management and outcomes of 6.6 million US patients with acute myocardial infarction. *The American Journal of Cardiology*. 2020;129:10-18. doi:https://doi.org/10.1016/j.amjcard.2020.05.025
26. Subramaniam AV, Patlolla SH, Cheunpasitporn W, Sundaragiri PR, Miller PE, Barsness GW. Racial and ethnic disparities in management and outcomes of cardiac arrest complicating acute myocardial infarction. *Journal of the American Heart Association* 2021;10:e019907. doi:https://doi.org/10.1161/JAHA.120.019907
27. Ya'quoub L, Lemor A, Dabbagh M, O'Neill W, Khandelwal A, Martinez SC. Racial, ethnic, and sex disparities in patients with STEMI and cardiogenic shock. *JACC: Cardiovascular Interventions*. 2021;14(6):653-660. doi:https://doi.org/10.1016/j.jcin.2021.01.003
28. Gad MM, Elgendy IS, Mahmoud AN, Saad AM, Isogai T, Mathias IS. Disparities in cardiovascular disease outcomes among pregnant and post-partum women. *Journal of the American Heart Association*. 2020;10:e017832. doi:https://doi.org/10.1161/JAHA.120.017832

29. Kolte D, Khera S, Aronow WS, Mujib M, Palaniswamy C, Sule S. Trends in incidence, management, and outcomes of cardiogenic shock complicating ST-Elevation myocardial infarction in the United States. *Journal of the American Heart Association*. 2014;3:e000590. doi:https://doi.org/10.1161/JAHA.113.000590
30. Ariss W, Minhas AMK, Issa R, Michos ED, Fudim M, Nazir S. Demographic and regional trends of mortality in patients with acute myocardial infarction in the United States, 1999 to 2019. *The American Journal of Cardiology*. 2022;164:7-13. doi:https://doi.org/10.1016/j.amjcard.2021.10.023
31. Dani SS, Lone AN, Javed Z, Khan MS, Khan MZ, Kaluski E. Trends in premature mortality from acute myocardial infarction in the United States, 1999 to 2019. *Journal of the American Heart Association*. 2021;11:e021682. doi:https://doi.org/10.1161/JAHA.121.021682
32. Maynard C, Ritchie JL. Racial differences in outcomes of Veterans undergoing coronary artery bypass grafting. *The American Journal of Cardiology*. 2001;88(8):893-895. doi:10.1016/s0002-9149(01)01900-2.
33. Kawsara A, El Shaer A, Khalouf A, Almakadma AK, Alkhouli M. Differences in risk profile, management, and outcome of ST-elevation myocardial infarction between Asian versus White patients in contemporary United States practice. *The American Journal of Cardiology*. 2021;160(2021):132-133. doi:https://doi.org/10.1016/j.amjcard.2021.09.001
34. Khera R, Secemsky EA, Wang Y. Revascularization practices and outcomes in patients with multivessel coronary artery disease who presented with acute myocardial infarction and cardiogenic shock in the US, 2009-2018. *JAMA Internal Medicine*. 2020;180(10):1317-1327. doi:10.1001/jamainternmed.2020.3276
35. Bricker RS, Glorioso TJ, Jawaid O, et al. Temporal trends and site variation in high-risk coronary intervention and the use of mechanical circulatory support: Insights from the Veterans Affairs Clinical Assessment Reporting and Tracking (CART) Program. *Journal of the American Heart Association*. 2019;(2019):e014906. doi:10.1161/JAHA.119.014906
36. Shen Y-C, Hsia RY. Do patients hospitalised in high-minority hospitals experience more diversion and poorer outcomes? A retrospective multivariate analysis of Medicare patients in California. *BMJ Open*. 2016;6:e010263. doi:10.1136/bmjopen-2015-010263
37. Mathews R, Chen AY, Thomas L, et al. Differences in short-term versus long-term outcomes of older Black versus White patients with myocardial infarction: Findings from the Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes With Early Implementation of American College of Cardiology/American Heart Association Guidelines (CRUSADE). *Circulation*. 2014;130(8):659-667. doi:10.1161/CIRCULATIONAHA.113.008370
38. Li S, Chen A, Mead K. Racial disparities in the use of cardiac revascularization: Does local hospital capacity matter? *PLoS ONE*. 2013;8(7):e69855. doi:10.1371/journal.pone.0069855
39. Sonel AF, Good CB, Mulgund J, et al. Racial variations in treatment and outcomes of Black and White patients with high-risk non-ST-elevation acute coronary syndromes: Insights from CRUSADE (Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes With Early Implementation of the ACC/AHA Guidelines?). *Circulation*. 2005;111:1225-1232. doi:10.1161/01.CIR.0000157732.03358.64
40. Gillum RF, Gillum BS, Francis CK. Coronary revascularization and cardiac catheterization in the United States: Trends in Racial Differences. *Journal of the American College of Cardiology*. 1997;29:1557-1562. doi:https://doi.org/10.1016/s0735-1097(97)00089-2

41. Atreya AR, Patlolla SH, Devireddy CM, Jaber WA, Rab ST, Nicholson WJ. Geographic variation and temporal trends in management and outcomes of cardiac arrest complicating acute myocardial infarction in the United States. *Resuscitation*. 2022;170:339-348. doi:https://doi.org/10.1016/j.resuscitation.2021.11.002
42. Kolte D, Khera S, Aronow WS, Mujib M, Palaniswamy C, Ahmed A. Regional variation across the United States in management and outcomes of ST-Elevation Myocardial Infarction: Analysis of the 2003 to 2010 Nationwide Inpatients Sample Database. *Clinical Cardiology*. 2014;37(4):204-212. doi:https://dx.doi.org/10.1002%2Fclc.22250
43. Krumholz HM, Wang Y, Chen J, Drye EE, Spertus JA, Ross JS. Reduction in acute myocardial infarction mortality in the United States. *JAMA*. 2009;302(7):767-773. doi:https://dx.doi.org/10.1001%2Fjama.2009.1178
44. Yeh RW, Normand S-LT, Wang Y, Barr CD, Dominici F. Geographic disparities in the incidence and outcomes of hospitalized myocardial infarction: Does a rising tide lift all boats? *Circulation: Cardiovascular Quality Outcomes*. 2012;5:197-204. doi:10.1161/CIRCOUTCOMES.111.962456
45. Smilowitz NR, Shah B, Lorin J, Berger JS. Patterns and outcomes of invasive management of type 2 myocardial infarction in the United States. *Coronary Artery Disease*. 2021;33:269-276. doi:10.1097/MCA.0000000000001122
46. Lemor A, Gorgis S, Villablanca PA, et al. Regional variation in procedural and clinical outcomes among patients with ST-elevation myocardial infarction with cardiogenic shock. *The American Journal of Cardiology*. 2020;125(11)doi:https://doi.org/10.1016/j.amjcard.2020.02.033
47. Vallabhajosyula S, Patlolla SH, Dunlay SM, Prasad A, Bell MR, Jaffe AS. Regional variation in the management and outcomes of acute myocardial infarction with cardiogenic shock in the United States. *Circulation*. 2020;13:e006661. doi:https://doi.org/10.1161/CIRCHEARTFAILURE.119.006661
48. Menon V, Rumsfeld JS, Roe MT, et al. Regional outcomes after admission for high-risk non-ST-segment elevation acute coronary syndrome. *The American Journal of Medicine*. 2006;2006(119):584-590. doi:10.1016/j.amjmed.2006.01.018
49. Krumholz HM, Normand ST, Wang Y. Twenty-year trends in outcomes for older adults with acute myocardial infarction in the United States. *JAMA Network Open*. 2019;2(3):e191938. doi:https://doi.org/10.1001%2Fjamanetworkopen.2019.1938
50. Sugiyama T, Hasegawa K, Kobayashi Y, Takahashi O, Fukui T, Tsugawa Y. Differential time trends of outcomes and costs of care for acute myocardial infarction hospitalizations by ST elevation and type of intervention in the United States, 2001-2011. *Journal of the American Heart Association*. 2015;4(3):e001445. doi:10.1161/JAHA.114.001445
51. Patlolla SH, Kanwar A, Cheungpasitporn W, et al. Temporal trends, clinical characteristics, and outcomes of emergent coronary artery bypass grafting for acute myocardial infarction in the United States. *Journal of the American Heart Association*. 2021;10:e020517. doi:https://doi.org/10.1161/JAHA.120.020517
52. Pippins JR, Fitzmaurice GM, Haas JS. Hospital characteristics and racial disparities in hospital mortality from common medical conditions. *Journal of the National Medical Association*. 2007;99(9):1030-1036.
53. Skinner J, Chandra A, Staiger D, Lee J, McClellan M. Mortality after acute myocardial infarction in hospitals that disproportionately treat black patients. *Circulation*. 2005;112(17):2634-2641. doi:https://doi.org/10.1161/CIRCULATIONAHA.105.543231

54. Patlolla SH, Shankar A, Sundaragiri PR, Cheungpasitporn W, Doshi RP, Vallabhajosyula S. Racial and ethnic disparities in the management and outcomes of cardiogenic shock complicating acute myocardial infarction. *American Journal of Emergency Medicine*. 2021;51(2022):202-209. doi:https://doi.org/10.1016/j.ajem.2021.10.051
55. LaVeist T, Pollack K, Thrope R, Fesahazion R, Gaskin D. Place, not race: disparities dissipate in Southwest Baltimore when Blacks and White live under similar conditions. *Agenda for Fighting Disparities*. 2011;30(10):1880-1887. doi:https://doi.org/10.1377/hlthaff.2011.0640
56. Spertus JA, Jones PG, Masoudi FA, Rumsfeld JS. Factors associated with racial differences in myocardial infarction outcomes. *Annals of Internal Medicine*. 2009;150:314-324. doi:https://doi.org/10.7326/0003-4819-150-5-200903030-00007
57. Bao Y, Kamble S. Geographical distribution of surgical capabilities and disparities in the use of high-volume providers: The case of coronary artery bypass graft. *Medical Care*. 2009;47(7):794-802.
58. Mukamel DB, Weimer DL, Buchmueller TC, Ladd H, Mushlin AI. Changes in racial disparities in access to coronary artery bypass grafting surgery between the late 1990s and early 2000s. *Medical Care*. 2007;45(7):664-671.
59. Hsia RY, Krumholz H, Shen Y-C. Evaluation of STEMI regionalization on access, treatment, and outcomes among adults living in nonminority and minority communities. *Journal of the American Medical Association*. 2020;3(11):e2025874. doi:10.1001/jamanetworkopen.2020.25874 (Repri
60. Kobayashia T, Glorioso TJ, Armstrong EJ, et al. Comparative outcomes after percutaneous coronary intervention among Black and White patients treated at US Veterans Affairs Hospitals. *Journal of the American Medical Association Cardiology*. 2017;2(9):967-975. doi:10.1001/jamacardio.2017.2180: 10.1001/jamacardio.2017.2180
61. Khan MZ, Munir MB, Khan MU, et al. Trends, outcomes, and predictors of revascularization in cardiogenic shock. *American Journal of Cardiology*. 2021;125(3):328-335. doi:https://doi.org/10.1016%2Fj.amjcard.2019.10.040
62. Loccoh EC, Maddox KEJ, Wang Y, Kazi DS, Yeh RW, Wadhera RK. Rural-urban disparities in outcomes of myocardial infarction, heart failure, and stroke in the United States. *Journal of the American College of Cardiology*. 2022;79(3):267-279. doi:https://doi.org/10.1016/j.jacc.2021.10.045
63. Vallabhajosyula S, Vallabhajosyula S, Burstein B, Ternus BW, Sundaragiri PR, White RD. Epidemiology of in-hospital cardiac arrest complicating non-ST-segment elevation myocardial infarction receiving early coronary angiography. *American Heart Journal*. 2020;223:59-64. doi:https://doi.org/10.1016/j.ahj.2020.01.016
64. Rashid M, Fischman DL, Gulati M, Tamman K, Potts J, Kwok CS. Temporal trends and inequalities in coronary angiography utilization in the management of non-ST-Elevation acute coronary syndromes in the US. *Scientific Reports*. 2019;9:240. doi:https://doi.org/10.1038/s41598-018-36504-y
65. Patel N, Gupta A, Doshi R, Kalra R, Bajaj NS, Arora G. In-hospital management and outcomes after ST-Elevation myocardial infarction in Medicaid Beneficiaries compared with privately insured. *Circulation*. 2019;12(1):e004971. doi:https://dx.doi.org/10.1161%2FCIRCOUTCOMES.118.004971
66. Yandrapalli S, Nabors C, Goyal A, Aronow WS, Frishman WH. Modifiable risk factors in young adults with first myocardial infarction. *Journal of the American College of Cardiology*. 2019;73(5):573-584. doi:https://doi.org/10.1016/j.jacc.2018.10.084

67. Rodriguez F, Foody JM, Wang Y, Lopez L. Young Hispanic women experience higher in-hospital mortality following an acute myocardial infarction. *Journal of the American Heart Association*. 2015;4:e002089. doi:10.1161/JAHA.115.002089
68. Chaudry SI, Khan RF, Chen J, Dharmarajan K, Dodson JA, Masuodi FA. National trends in recurrent AMI hospitalizations 1 year after acute myocardial infarction in Medicare Beneficiaries: 1999-2010. *Journal of the American Heart Association*. 2014;3:e001197. doi:https://doi.org/10.1161/JAHA.114.001197
69. Romero T, Velez P, Glaser D, Romero CX. Do gender and race/ethnicity influence acute myocardial infarction quality of care in a hospital with a large Hispanic patient and provider representation? *Cardiology Research and Practice*. 2013;2013:1-7. doi:http://dx.doi.org/10.1155/2013/975393
70. Barnato AE, Lucas FL, Staiger D, Wennberg DE, Chandra A. Hospital-level racial disparities in acute myocardial infarction treatment and outcomes. *Medical Care*. 2005;43(4):308-319. doi:http://www.jstor.org/stable/3768433
71. Desai R, Singh S, Fong HK, et al. Racial and sex disparities in resource utilization and outcomes of multi-vessel percutaneous coronary interventions (a 5-year nationwide evaluation in the United States). *Cardiovascular Diagnosis and Therapy*. 2018;9(1):18-29.
72. Manjunath L, Chung S, Li J, Shah H, Palaniappan L, Yong CM. Heterogeneity of treatment and outcomes among Asians with coronary artery disease in the United States. *Journal of the American Heart Association*. 2020;2020(9):e014362. doi:10.1161/JAHA.119.014362
73. Pilote L, Califf RM, Sapp S, et al. Regional variation across the United States in the management of acute myocardial infarction. *The New England Journal of Medicine*. 1995;333(9):565-572. doi:10.1056/NEJM199508313330907
74. Werner RM, Asch DA, Polsky D. Racial profiling: The unintended consequences of coronary artery bypass graft report cards. *Circulation*. 2005;111:1257-1263. doi:10.1161/01.CIR.0000157729.59754.09
75. (WHO) The World Health Organization. Determinants of health. https://www.who.int/news-room/questions-and-answers/item/determinants-of-health
76. Arcaya MC, Arcaya AL, Subramanian SV. Inequalities in health: definitions, concepts, and theories. *Global Health Action*. 2015;8doi:10.3402/gha.v8.27106
77. Baciu A, Negussie Y, Geller A. The Root Causes of Health Inequity. *Communities in Action: Pathways to Health Equity*. National Academies Press; 2017.
78. Bambra C, Gibson M, Sowden A, Wright K, Whitehead M, Petticrew M. Tackling the wider social determinants of health and health inequalities: Evidence from systematic reviews. *Journal of Epidemiology & Community Health*. 2010;64(4):284-291. doi:10.1136/jech.2008.082743
79. Graham G. Disparities in cardiovascular disease risk in the United States. *Current Cardiology Reviews*. 2015;11:238-245. doi:https://doi.org/10.2174/1573403x11666141122220003
80. Lederle M, Tempes J, Bitzer EM. Application of Andersen's behavioural model of health services use: A scoping review with a focus on qualitative health services research. *BMJ Open*. 2021;11(5)doi:10.1136/bmjopen-2020-045018
81. Andersen RM. *Families' use of health services: A behavioral model of predisposing, enabling, and need components*. Purdue University; 1968. https://www.lib.uwo.ca/cgi-bin/ezpauthn.cgi?url=http://search.proquest.com/dissertations-theses/families-use-health-services-behavioral-model/docview/302351484/se-2

82. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *The Milbank Memorial Fund Quarterly Health and Society*. 1973;51(1):95-124.
83. Andersen RM. Revisiting the behavioral model and access to medical care: Does it matter? *Journal of Health and Social Behavior*. 1995;36(1):1-10.
84. Aday LA, Andersen R. A framework for the study of access to medical care. *Health Services Research*. 1974;9(3):208-220.
85. Seidu A. Using Andersen's model of health service utilization to assess the use of HIV testing services by sexually active men in Ghana. *Frontiers in Public Health*. 2020;8:512. doi:https://doi.org/10.3389/fpubh.2020.00512
86. Travers JL, Hirschman KB, Naylor MD. Adapting Andersen's expanded behavioural model of health services use to include older adults receiving long-term services and support. *BMC Geriatrics*. 2020;20doi:https://doi.org/10.1186/s12877-019-1405-7
87. Smith GH, Scheid TL. An application of the Andersen model of health utilization to the understanding of the role. In: Kronenfeld JJ, ed. *Research in the Sociology of Health Care*. Emerald Group Publishing Limited; 2013:187-214.
88. Bhuyan SS, Lu N, Chandak A, Kim H, Wyant D. Use of mobile health applications for health-seeking behaviour among US adults. *Journal of Medical Systems*. 2016;40(6):1-8. doi:10.1007/s10916-016-0492-7
89. Bradley EH, McGraw SA, Curry L, et al. Expanding the Andersen Model: The role of psychosocial factors in long-term care use. *Health Services Research*. 2002;37(5):1221-1242. doi:https://doi.org/10.1111%2F1475-6773.01053
90. Davis CP. Definition of syndemic. RxList. https://www.rxlist.com/syndemic/definition.htm
91. Singer M, Bulled N, Ostrach B, Mendenhall E. Syndemics and the biosocial conception of health. *The Lancet*. 2017;389(10072):941-950. doi:https://doi.org/10.1016/S0140-6736(17)30003-X
92. Rudd KE, Mair CF, Angus DC. Applying syndemic theory to acute illness. *JAMA*. 2021;327(1):33-34. doi:10.1001/jama.2021.22583
93. Clearfield M, Davis G, Weis J, Gayer G, Shubrook JH. Cardiovascular disease as a result of the interactions between obesity, climate change, and inflammation: The COCCI syndemic. *Journal of Osteopathic Medicine*. 2018;118(11):719-729. doi:https://doi.org/10.7556/jaoa.2018.157
94. Shrestha S, Bauer CXC, Hendricks B, Stopka TJ. Spatial epidemiology: An empirical framework for syndemics research. *Social Science & Medicine*. 2022;295doi:https://doi.org/10.1016/j.socscimed.2020.113352
95. Singer M. *Introduction to syndemics: A critical systems approach to public and community health*. John Wiley & Sons; 2009.
96. Freedland KE, Skala JA, Carney RM, Steinmeyer BC, Rich MW. Psychosocial syndemics and multimorbidity in patients with heart failure. *Journal of Psychiatry and Brain Science*. 2021;6:e210006. doi:https://doi.org/10.20900%2Fjpbs.20210006
97. Singer M. A dose of drugs, a touch of violence, a case of AIDS: Conceptualizing the SAVA syndemic. *Free Inquiry in Creative Sociology*. 2000;28(1):13-24.
98. Rodriguez VJ, Chahine A, Parrish MS, et al. The contribution of syndemic conditions to cardiovascular disease risk. *AIDS Care*. 2021;33(5):585-593. doi:https://doi.org/10.1080/09540121.2020.1761518

99. US Department of Health and Human Services. Social Determinants of Health. https://health.gov/healthypeople/priority-areas/social-determinants-health
100. Sweis RN, Jivan A. Acute Myocardial Infarction (MI). Merck Manual. https://www.merckmanuals.com/en-ca/professional/cardiovascular-disorders/coronary-artery-disease/acute-myocardial-infarction-mi
101. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth Universal Definition of Myocardial Infarction. *Circulation*. 2018;138(20):e618-e651. doi:https://doi.org/10.1161/CIR.0000000000000617
102. Jayaraj JC, Davatyan K, Subramanian SS, Priya J. Epidemiology of Myocardial Infarction. In: Pamukcu B, ed. *Myocardial Infarction*. IntechOpen; 2019.
103. Daga LC, Kaul U, Mansoor A. Approach to STEMI and NSTEMI. *Journal of the Association of Physicians of India*. 2011;59
104. Basit H, Malik A, Huecker MR. *Non ST Segment Elevation Myocardial Infarction*. StatPearls Publishing; 2022.
105. Stark M, Kerndt CC, Sharma S. *Troponin*. StatPearls. StatPearls Publishing; 2022.
106. Lu L, Min L, Sun R, Zheng Y, Zhang P. Myocardial Infarction: Symptoms and Treatments. *Cell Biochemistry and Biophysics*. 2015;72(3)doi:https://doi.org/10.1007/s12013-015-0553-4
107. Sheifer SE, Manolio TA, Gersh BJ. Unrecognized Myocardial Infarction. *Annals of Internal Medicine*. 2001;135:801-811. doi:https://doi.org/10.7326/0003-4819-135-9-200111060-00010
108. Yu B, Akushevich I, Tashkin AP, Kravchenko J. Epidemiology of geographic disparities of myocardial infarction among older adults in the United States: Analysis of 2000-2017 Medicare data. *Frontiers in Cardiovascular Medicine*. 2021;8:707102. doi:https://doi.org/10.3389/fcvm.2021.707102
109. Virani SS, Alonso A, Aparicio HJ, et al. Heart Disease and Stroke Statistics - 2021 Update. *Circulation*. 2021;143:e254-e743. doi:https://doi.org/10.1161/CIR.0000000000000950
110. Chi GC, Kanter MH, Li BH, et al. Trends in acute myocardial infarction by race and ethnicity. *9*. 2020:e013542. doi:https://doi.org/10.1161/JAHA.119.013542
111. Ounpuu S, Negassa A, Yusuf S. INTER-HEART: A global study of risk factors for acute myocardial infarction. *American Heart Journal*. 2001;141(5):711-721. doi:https://doi.org/10.1067/mhj.2001.114974
112. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364(9438):937-952. doi:10.1016/S0140-6736(04)17018-9
113. Shah AM, Pfeffer MA, Hartley LH, et al. Risk of all-cause mortality, recurrent myocardial infarction, and heart failure hospitalization associated with smoking status following myocardial infarction with left ventricular dysfunction. *The American Journal of Cardiology*. 2010;106(7)doi:https://doi.org/10.1016/j.amjcard.2010.05.021
114. Service NH. Coronary Artery Bypass Graft. https://www.nhs.uk/conditions/coronary-artery-bypass-graft-cabg/#:~:text=The%20procedure,is%20known%20as%20a%20graft.
115. Heart and Stroke Foundation. Percutaneous coronary intervention (PCI or angioplasty with stent). https://www.heartandstroke.ca/heart-disease/treatments/surgery-and-other-procedures/percutaneous-coronary-intervention

116. Hsia RY, Shen Y-C. Percutaneous coronary intervention in the United States: Risk factors for untimely access. *Health Services Research*. 2016;51(2):592-609. doi:10.1111/1475-6773.12335
117. Voudris KV, Feldman DN. Complete revascularization in patients with STEMI and multivessel coronary artery disease: Is it beneficial? *Current Treatment Options in Cardiovascular Medicine*. 2021;23(15)doi:https://doi.org/10.1007/s11936-020-00887-x
118. Gogo PB, Dauerman HL, Mulgund J. Changes in patterns of coronary revascularization strategies for patients with acute coronary syndromes (from the CRUSADE Quality Improvement Initiative). *American Journal of Cardiology*. 2007;99(9):1222-1226. doi:http://dx.doi.org/10.1016/j.amjcard.2006.12.037
119. Gerber Y, Rihal CS, Sundt TM. Coronary revascularization in the community: a population-based study, 1990 to 2004. *Journal of the American College of Cardiology*. 2007;50(13):1223-1229. doi:http://dx.doi.org/10.1016/j.jacc.2007.06.022
120. Mack MJ, Brown PP, Kugelmass AD. Current status and outcomes of coronary revascularization 1999 to 2002. *Annals of Thoracic Surgery*. 2004;77(3):761-766. doi:http://dx.doi.org/10.1016/j.athoracsur.2003.06.019
121. Concannon TW, Nelson J, Goetz J, Griffith JL. A percutaneous coronary intervention lab in every hospital? *Circulation: Cardiovascular Quality and Outcomes*. 2012;5(1):14-20. doi:10.1161/circoutcomes.111.963868
122. Wang HE, Yearly DM. Distribution of specialized care centers in the United States. *Annals of Emergency Medicine*. 2012;60(5)doi:10.1016/j.annemergmed.2012.02.020
123. Fang J, Negassa A, Gern RW, Alderman MH. Access to revascularization among patient with acute myocardial infarction in New York City - Impact of hospital resources. *Journal of Urban Health*. 2006;83(6):1085-1094. doi:https://doi.org/10.1007%2Fs11524-006-9093-y
124. Baker EH. Socioeconomic Status, Definition. *The Wiley Blackwell Encyclopedia of Health, Illness, Behaviour, and Society*. 2014;doi:https://doi.org/10.1002/9781118410868.wbehibs395
125. Darin-Mattsson A, Fors S, Karenholt I. Different indicators of socioeconomic status and their relative importance as determinants of health in old age. *International Journal for Equity in Health*. 2017;16doi:https://doi.org/10.1186/s12939-017-0670-3
126. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic status and cardiovascular outcomes: Challenges and interventions. *Circulation*. 2018;137:2166-2178. doi:https://doi.org/10.1161/CIRCULATIONAHA.117.029652
127. Dordunoo D, Abernethy P, Kayuni J, McConkey S, Aviles ML. Dismantling "Race" in Health Research. *Canadian Journal of Nursing Research*. 2022;54(3)doi:https://doi.org/10.1177/08445621221074849
128. Ford ME, Kelly PA. Conceptualizing and categorizing race and ethnicity in health services research. *Health Services Research*. 2005;40:1658-1675. doi:https://doi.org/10.1111%2Fj.1475-6773.2005.00449.x
129. Lee C. "Race" and "ethnicity" in biomedical research: How do scientists construct and explain differences in health? *Social Science & Medicine*. 2009;68(6):1183-1190. doi:https://doi.org/10.1016/j.socscimed.2008.12.036
130. Mensah GA, Brown DW. An overview of cardiovascular disease burden in the United States. *Health Affairs*. 2007;26:38-48. doi:http://dx.doi.org/10.1377/hlthaff.26.1.38
131. Rickets TC. Geography and disparities in health care. In: Swift EK, ed. *Guidance for the National Healthcare Disparities Report*. National Academics Press (US); 2002.

132. Disparities Institute of Medicine US Roundtable on Health. The Impact of Geography on Health Disparities in the United States: Different Perspectives. *Challenges and Successes in Reducing Health Disparities: Workshop Summary*. National Academies Press (US); 2008.
133. Baum A, Wisnivesky J, Basu S, Siu AL, Schwartz MD. Association of geographic differences in prevalence of uncontrolled chronic conditions with changes in individuals' likelihood of uncontrolled chronic conditions. *JAMA*. 2020;324(14):1429-1438. doi:10.1001/jama.2020.14381
134. Radley DC, Collins SR, Hayes SL. 2019 Scorecard on State Health System Performance. The Commonwealth Fund. https://2019scorecard.commonwealthfund.org/files/Radley_State_Scorecard_2019.pdf
135. Canto JG, Kiefe CI, Rogers WJ, et al. Number of coronary heart disease risk factors and mortality in patients with first myocardial infarction. *JAMA*. 2015;306(19):2120-2127 doi:https://doi.org/10.1001%2Fjama.2011.1654
136. Baciu A, Negussie Y, Geller A. The State of Health Disparities in the United States. *Communities in Action: Pathways to Health Equity*. National Academies Press (US); 2017.
137. Howard G, Howard VJ. Twenty years of progress toward understanding the stroke belt. *Stroke*. 2020;51:742-750. doi:https://doi.org/10.1161/STROKEAHA.119.024155
138. Epstein AM, Weissman JS, Schneider EC, Gatsonis C, Leape LL, Piana RN. Race and gender disparities in rates of cardiac revascularization: do they reflect appropriate use of procedures or problems in quality of care? *Medical Care*. 2003;41(11):1240-1255. doi:10.1097/01.MLR.0000093423.38746.8C
139. Liu L, Yin X, Chen M, Jia H, Eisen HJ, Hofman A. Geographic variation in heart failure mortality and its association with hypertension, diabetes, and behavioural-related risk factors in 1,723 counties of the United States. *Frontiers in Public Health Epidemiology*. 2018;6:132. doi:https://doi.org/10.3389/fpubh.2018.00132
140. Mensah GA, Mokdad AH, Ford ES, Greenlund KJ, Croft JB. States of disparities in cardiovascular health in the United States. *Circulation*. 2005;111:1233-1241. doi:https://doi.org/10.1161/01.CIR.0000158136.76824.04
141. (HCUP) Healthcare Cost and Utilization Project. 2018 Introduction to the NIS. Agency for Healthcare Research and Quality. www.hcup-us.ahrq.gov/db/nation/nis/NIS_Introduction_2018.jsp
142. (HCUP) Healthcare Cost and Utilization Project. HCUP Databases. Agency for Healthcare Research and Quality. www.hcup-us.ahrq.gov/nisoverview.jsp
143. (HCUP) Healthcare Cost and Utilization Project. HCUP Tools and Software. Agency for Healthcare Research and Quality. www.hcup-us.ahrq.gov/tools_software.jsp
144. Khera R, Angraal S, Couch T, et al. Adherence to methodological standards in research using the National Inpatient Sample. *JAMA*. 2017;318(20):2011-2018. doi:10.1001/jama.2017.17653
145. (HCUP) Healthcare Cost and Utilization Project. Checklist for working with the NIS. Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/db/nation/nis/nischecklist.jsp
146. Andersen RM. Revisiting the behavioural model and access to medical care: Does it matter? *Journal of Health and Social Behaviour*. 1995;36(1):1-10. doi:https://doi.org/10.2307/2137284
147. Biswas S, Andrianopoulos N, Duffy SJ, Lefkovitz J, Brennan A, Walton A. Impact of socioeconomic status on clinical outcomes in patients with ST-segment-elevation myocardial

infarction. *Circulation: Cardiovascular Quality and Outcomes*. 2019;12:e004979. doi:https://doi.org/10.1161/CIRCOUTCOMES.118.004979
148. McMaughan DJ, Oloruntoba O, Smith ML. Socioeconomic status and access to healthcare: Interrelated drivers for healthy aging. *Frontiers in Public Health*. 2020;8:231. doi:https://doi.org/10.3389%2Ffpubh.2020.00231
149. Becker G, Newsom E. Socioeconomic status and dissatisfaction with health care among chronically ill African Americans. *American Journal of Public Health* 2003;93(5):742-748. doi:https://doi.org/10.2105%2Fajph.93.5.742
150. Vallabhajosyula S, Ya'Qoub L, Singh M, Bell MR, Gulati R, Cheungpasitporn W. Sex disparities in the management and outcomes of cardiogenic shock complicating acute myocardial infarction in the young. *Circulation*. 2020;13:e007154. doi:https://doi.org/10.1161/CIRCHEARTFAILURE.120.007154
151. Anstey DE, Li S, Thomas L, Wang TY, Wiviott SD. Race and sex differences in management and outcomes of patients after ST-elevation and non-ST-elevation myocardial infarct: results from the NCDR. *Clinical Cardiology*. 2016;39(10):585-595. doi:https://doi.org/10.1002/clc.22570
152. Lin M, Kressin NR, Paasche-Orlow MK, et al. Is 30-day post-hospitalization mortality lower among racial/ethnic minorities? A re-examination. *Medical Care*. 2018;56(8):665-672. doi:https://doi.org/10.1097%2FMLR.0000000000000938
153. Ndumele CD, Baer HJ, Shaykevich SS, Lipsitz SR, Hicks LS. Cardiovascular disease and risk in primary care settings in the United States. *The American Journal of Cardiology*. 2011;109(4):P521-P526. doi:https://doi.org/10.1016/j.amjcard.2011.09.047
154. Trivedi AN, Nsa W, Hausmann LRM, Lee JS, Ma A, Bratzler DW. Quality and Equity of Care in US Hospitals. *The New England Journal of Medicine*. 2014;371:2298-2308. doi:10.1056/NEJMsa1405003
155. Arora S, Stouffer GA, Kucharska-Newton A, Vaduganathan M, Qamar A, Matsushita K. Fifteen-Year trends in management and outcomes of non-ST-segment-elevation myocardial infarction among black and white patients: The ARIC community surveillance study, 2000-2014. *Journal of the American Heart Association*. 2018;7:e010203. doi:https://doi.org/10.1161/JAHA.118.010203
156. Basir MB, Kapur NK, Patel K, Salam MA, Schreiber T, Kaki A. Improved outcomes associated with the use of shock protocols: Updates from the National Cardiogenic Shock Initiative. *Coronary Artery Disease*. 2019;93(7):1173-1183. doi:https://doi.org/10.1002/ccd.28307
157. Handran CB, Kunz M, Larson DM, Garberich RF, Baran K, Henry JT. The impact of regional STEMI systems on protocol use and quality improvement initiatives in community hospitals without cardiac catheterization laboratories. *American Heart Journal Plus: Cardiology Research and Practice*. 2022;13:e100077. doi:https://doi.org/10.1016/j.ahjo.2021.100077
158. Pedigo A, Aldrich T, Odoi A. Neighbourhood disparities in stroke and myocardial infarction mortality: A GIS and spatial scan statistics approach. *BMC Public Health*. 2011;11:644. doi:https://doi.org/10.1186/1471-2458-11-644
159. (HCUP) Healthcare Cost and Utilization Project. HCUP Methods series. Agency for Healthcare Research and Quality. https://hcup-us.ahrq.gov/reports/methods/2014-04.pdf
160. Whitman A, De Lew N, Chappel A, Aysola V, Zuckerman R, Sommers BD. *Addressing Social Determinants of Health:*
Examples of Successful Evidence-Based Strategies

and Current Federal Efforts. 2022. https://aspe.hhs.gov/sites/default/files/documents/e2b650cd64cf84aae8ff0fae7474af82/SDOH-Evidence-Review.pdf
161. Tran R, Forman R, Mossialos E, Nasir K, Kulkarni A. Social Determinants of Disparities in Mortality Outcomes in Congenital Heart Disease: A Systematic Review and Meta-Analysis. *Frontiers in Cardiovascular Medicine*. 2022;9:829902. doi:https://doi.org/10.3389/fcvm.2022.829902
162. Andermann A. Taking action on the social determinants of health in clinical practice: A framework for health professionals. *Canadian Medical Association Journal*. 2016;188:E474-E483. doi:https://doi.org/10.1503%2Fcmaj.160177
163. Dave G, Wolfe MK, Corbie-Smith G. Role of hospitals in addressing social determinants of health: A groundwater approach. *Preventive Medicine Reports*. 2021;21:101315. doi:https://doi.org/10.1016/j.pmedr.2021.101315
164. Oates GR, Jackson BE, Partridge EE, Singh KP, Fouad MN, Bae S. Sociodemographic patterns of chronic disease: How the mid-South region compares to the rest of the country. *American Journal of Preventive Medicine*. 2017;52(1):S31-S39. doi:https://doi.org/10.1016/j.amepre.2016.09.004
165. Martin-Sanchez FJ, Aguiar-Pulido V, Lopez-Campos GH, Peek N, Sacchi L. Secondary use and analysis of big data collected for patient care. *Yearbook of Medical Informatics*. 2017;26(1):28-37. doi:https://doi.org/10.15265%2FIY-2017-008

Appendices

Appendix 1: Checklist for working with the National Inpatient Sample database

	Checklist Item	Description	Checklist Resource
	Obtain and adhere to the HCUP Nationwide Database Data Use Agreement (DUA).[a]	The HCUP DUA governs the disclosure and use of the data, including affirmations to protect individuals, establishments, and the database itself.	For general information, review the *Responsibilities of the Data Purchaser* and the *HCUP Nationwide Database Data Use Agreement (DUA)*. To access the NIS, you must complete the HCUP Data Use Agreement Training.
	Verify privacy protections for individuals and hospitals.	Individuals cannot be identified directly or indirectly. Reporting cell sizes ≤ 10 increases the risk of re-identification and is discouraged, as specified in the Data Use Agreement. At least two hospitals must contribute to each cell.	For general information, review the *Requirements for Publishing with HCUP Data* page on the HCUP User Support (HCUP-US) website.
	Cite HCUP, the NIS, and other HCUP tools.	HCUP, the NIS, and other supporting tools must be correctly cited in the abstract and manuscript.	For more information, review the *Suggested Citations for HCUP Databases and Tools* page on HCUP-US.
	Acknowledge HCUP Partners.	Participating HCUP Partners should be listed in the manuscript by name or acknowledged by a hyperlink to the HCUP-US website.	For more information, review the *List of HCUP Data Partners for Reference in Publications* page on HCUP-US.
Research Design			
	Learn how to account for the NIS sampling design.	The NIS is sampled from the HCUP State Inpatient Databases (SID). Accounting for the sampling design is critical for accurate analyses.	For detailed information, review the *HCUP Methods Report# 2014-04: Nationwide Inpatient Sample (NIS) Redesign Report*. To learn more about the NIS sample design, view the *Sample Design On-line Tutorial* on the *Tutorial Series* page.

	Only inpatient events are captured in the NIS.	The unit of analysis in the NIS is inpatient stays, not individual patients. Only conditions, procedures, and diagnostic tests occurring during a specific inpatient hospital encounter are captured in the NIS. Records of events and diagnoses before or after the stay are not available.	For more information, review the *Contents of the NIS* section of the *Introduction to the NIS* on the *NIS Database Documentation* page. For more information on conducting revisit analyses at the national level, review the *Nationwide Readmissions Database (NRD)*. For State-level information, review the *HCUP Supplemental Variables for Revisit Analyses*.
	Excluded Facilities	The NIS includes community hospitals, but it excludes rehabilitation or long-term acute care (LTAC) hospitals.	Additional information on hospital-level exclusions is included in the *Introduction to the NIS* on the *NIS Database Documentation page*.
	No State-level analyses are performed.	The sampling design of the NIS does not support State-level analyses. The SID must be used for State-level research.	For more information, review *Why the NIS Should Not Be Used to Make State-Level Estimates*. To learn more about the SID, review the *Overview of the State Inpatient Databases (SID)* page on HCUP-US.
	Facility-level analyses are limited.	Starting with 2012, the sampling design of the NIS does not support hospital-level totals because only a sample of discharges from each hospital in the sampling frame are included in the NIS, and hospital sampling rates vary. However, hospital percentages (e.g. percent Medicare patients) can be estimated. Prior to 2012, the NIS was a sample of U.S. community hospitals and could support studies with	For more information, review the "Sampling Design of the NIS" section of the *Introduction to the NIS* on the *NIS Database Documentation* page on HCUP-US.

		hospitals as the unit of analysis because all discharges from each sampled hospital were included in the NIS, although different hospitals were sampled each year. Users should not attempt to identify individual facilities as specified in the Data Use Agreement.	
	No physician-level analyses are performed.	The NIS does not include physician identifiers.	For more information, review the *NIS Description of Data Elements* page on HCUP-US.
	It is not possible to track patients in the NIS.	The NIS does not include patient identifiers.	For more information, review the *Introduction to the NIS* on the *NIS Database Documentation* page on HCUP-US.
	Administrative (ICD) codes are appropriate for the outcomes of interest.	Administrative codes for the conditions or procedures of interest (ICD-9-CM and ICD-10-CM/PCS,) should be selected with care, especially over time, as codes and coding rules change annually.	For more information, review the *Choosing Data Elements for Analysis* section of the *Introduction to the NIS* on the *NIS Database Documentation* page on HCUP-US. Refer to the ICD-10-CM/PCS Resources page on HCUP-US under Data Innovations for a summary of key issues for researchers using HCUP and other administrative databases that include ICD-10-CM/PCS coding. To check for year-to-year variation in administrative codes, consult with a medical coding professional.
	Comorbidities must be distinguished from complications.	Secondary diagnosis codes in the NIS do not differentiate comorbidities from complications, unless	For more information, review the HCUP Methods Series Report # 2004-01, *Comorbidity Software Documentation* and

		they are specific to in-hospital events captured by a specific ICD code that indicates a complication. Select comorbidities are identified by the Elixhauser Comorbidity Software for ICD-9-CM or Elixhauser Comorbidity Software Refined for ICD-10-CM. Data elements derived from these tools are included on the NIS Severity File through quarter 3 of data year 2015 and the NIS Diagnosis and Procedure Groups File beginning data year 2019.	the *Elixhauser Comorbidity Software for ICD-9-CM* or *Elixhauser Comorbidity Software Refined for ICD-10-CM* pages on the HCUP-US website.
	Account for year- based differences in data element availability in the NIS.	The study design should account for differences in data element availability across data years. For example, the number of diagnosis codes present can vary by year.	For more information about data element availability in the NIS, review the *NIS Description of Data Elements* page on HCUP-US.
Data Analysis			
	Use weights for national estimates.	To generate national estimates using the NIS, use the discharge-level weight (DISCWT) to estimate discharges treated at community hospitals (excluding rehabilitation and LTAC facilities) in the United States. To generate national estimates using multiple years of the NIS, you must apply weights using the variable TRENDWT (for data years prior to 2012) and the variable DISCWT	For general information on weights, review *Trend Weights for HCUP NIS Data*. To learn how to apply NIS weights, view the *Producing National HCUP Estimates On-line Tutorial* and review *HCUP Methods Series Report# 2006-05: Using the HCUP National Inpatient Sample to Estimate Trends (Revised 12/15/15).* To learn how to apply the trend weights for multi-year analyses, view the *HCUP Multi-Year Analysis On-line Tutorial* on the *Tutorial Series* page.

		(for data years 2012 and later).	
	Account for the design of the NIS when calculating standard errors.	Standard error calculations should take into account the stratification (data element NIS_STRATUM) and hospitals defining the clusters (data element HOSP_NIS).	For information applicable to data years 2012 and later, review *HCUP Methods Series Report# 2015-09: Calculating National Inpatient Sample (NIS) Variances for Data Years 2012 and Later*. For information applicable to data years 2011 and earlier, review *HCUP Methods Series Report# 2003-02: Calculating National Nationwide Inpatient Sample (NIS) Variances for Data Years 2011 and Earlier*. To learn how to calculate standard errors, view the *HCUP Calculating Standard Errors On-line Tutorial* on the *Tutorial Series* page.
	Account for clustering or nesting of observations.	Discharges in the NIS are clustered, or nested, within hospitals. Hierarchical linear modeling (HLM) is one way to account for this design aspect of the NIS.	For information on using HLM with the NIS, review the *HCUP Methods Series Report# 2007-01: Hierarchical Modeling Using HCUP Data*.
	Account for missing values.	Several techniques are available to assess and reduce the impact of missing data when using the NIS.	For general information, review the *Missing Values* section of the *Introduction to the NIS* on the *NIS Database Documentation* page. For detailed information, review the *HCUP Methods Report# 2015-01: Missing Data Methods for the NIS and SID.*
	Calculate rates of hospital care events per population when you need to control for differences in the underlying populations.	There are several sources of population data that can be used with the HCUP databases to calculate rates of hospital care events per population to improve comparisons between	More information is available under *Population Denominator Data for Use with the HCUP Databases* (multiple documents; updated annually) on the *HCUP Methods Series Reports by Topic* page on HCUP-US.

		subgroups (e.g., region of the country).	
	Estimate incidence or prevalence.	The NIS can be used to estimate incidence or prevalence of both common and rare conditions in some, but not all scenarios.	For information on estimating incidence and prevalence, review the *HCUP Methods Series Report# 2016-06: Using the HCUP Databases to Study Incidence and Prevalence.*
ICD-9-CM to ICD-10-CM/PCS Transition			
	Account for changes in the NIS related to ICD-10-CM/PCS.	The transition to ICD-10-CM/PCS has had a direct impact on the reporting of medical services, and these changes affect research using administrative data. The structure of and data elements included in the NIS are affected by the transition to ICD-10-CM/PCS.	For more information, refer to the *ICD-10-CM/PCS Resources* page on HCUP-US that summarizes key issues for researchers using HCUP and other administrative databases that include ICD-9-CM and ICD-10-CM/PCS coding. For additional information about these changes, review the *2015 NIS Revised File Structure and New Data Elements* and *NIS Changes Beginning Data Year 2016* documents on the *NIS Database Documentation* page on HCUP-US.
	Follow HCUP recommendations for reporting trends with data that include both ICD-9-CM and ICD-10-CM/PCS coding.	Recommendations for reporting trends based on HCUP data that span the October 1, 2015 transition date (before and after the introduction of ICD-10-CM/PCS) have been developed to help researchers design studies.	For more information, review the *Recommendations for Reporting Trends Using ICD-9-CM and ICD-10-CM/PCS Data*.
	Use current versions of HCUP Tools for ICD-10-CM/PCS-coded data.	ICD-10-CM/PCS coding guidance is continuing to evolve. HCUP software tools for ICD-10-CM/PCS will be updated and should be reapplied throughout the research process. For this reason, it is important to always use the most current version of these tools.	Consult the HCUP Tools & Software page on HCUP-US regularly for the most current versions of the HCUP software tools.

[a] HCUP data users acknowledge that violation of the AHRQ confidentiality statute is subject to a civil penalty of up to $14,140 under 42 U.S.C. 299c-3(d), and that deliberately making a false statement about this or any matter within the jurisdiction of any department or agency of the Federal Government violates 18 U.S.C. 1001 and is punishable by a fine, up to five years in prison, or both. Violators of this Agreement may also be subject to penalties under state confidentiality statutes that apply to these data for particular states.

References

1. Khera R, Krumholz HM. With great power comes great responsibility: big data research from the National Inpatient Sample. Circulation: Cardiovascular Quality and Outcomes. 2017 Jul;10:e003846. http://circoutcomes.ahajournals.org/content/10/7/e003846.long
2. Khera R, Angraal S, Couch T, et al. Adherence to methodological standards in research using the National Inpatient Sample. JAMA 2017;318(20):2011-8. https://jamanetwork.com/journals/jama/article-abstract/2664461

Appendix 2: ICD-10-CM codes for condition of interest (AMI)

Condition	ICD-10-CM Codes
Acute Myocardial Infarction	I21x, I22x

Appendix 3: ST-segment elevation myocardial infarction and non-ST-segment elevation myocardial infarction ICD-10-CM codes

Condition	ICD-10-CM Codes
ST-Segment Elevation Myocardial Infarction	I210x, I211x, I213, I219, I21A1, I21A9, I220, I228, I229
Non-ST-Segment Elevation Myocardial Infarction	I214, I222

Appendix 4: Revascularization procedure variable definition (percutaneous coronary intervention and coronary artery bypass graft ICD-10-PCS codes)

Condition	ICD-10-PCS Codes
Percutaneous Coronary Intervention	02703x, 02713x, 02723x, 02733x, 02H03x, 02H23x, 02H33x
Coronary Artery Bypass Graft	02100x, 02104x, 02110x, 02114x, 02120x, 02124x, 02130x, 02134x

Appendix 5: Covariates selected for model building

Model 1: Patient-level characteristics	Age
	Sex
	Race
	Quartile of median household income for ZIP code[a]
Model 2: Model 1 + Lifestyle-related factors	Any smoking history[b]
	Alcohol abuse[c]
	Drug abuse[c]
	Obesity[c]
Model 3: Model 2 + Clinical History/Comorbidities	Acquired Immune Deficiency Syndrome (AIDS)[c]
	Deficiency anemias[c]
	Chronic blood loss anemia[c]
	Arthropathies[c]
	Congestive heart failure[c]
	Chronic pulmonary disease[c]
	Coagulopathies[c]
	Diabetes without chronic complications [c]
	Diabetes with chronic complications[c]
	Hypertension, uncomplicated[c]
	Hypertension, complicated[c]
	Hypothyroidism[c]
	Liver disease, mild to moderate[c]
	Liver disease, severe[c]
	Lymphoma[c]
	Metastatic cancer[c]
	Other neurological disorders[c]
	Paralysis[c]
	Peripheral vascular disease[c]
	Pulmonary circulation disease[c]
	Renal failure, moderate[c]
	Renal failure, severe[c]
	Solid tumor without metastasis, malignant[c]
	Peptic ulcer with bleeding[c]
	Valvular disease[c]
	Weight loss[c]

	AMI type[d]
	Prior myocardial infarction[b]
	Prior coronary artery bypass grafting[b]
	Prior percutaneous coronary intervention[b]
	Prior cerebrovascular disease[b]
Model 4: Model 3 + Hospital-level characteristics	Hospital bed size[e]
	Hospital location/teaching status
	Hospital region[f]

[a] See Appendix 13: Quartile ranges by year for estimated median household income of residents in the patient's ZIP code (USD) based on the National Inpatient Sample database variable definition
[b] See Appendix 12: Other comorbid conditions ICD-10-CM codes
[c] See Appendix 11: Elixhauser Comorbidity Software variables and definitions
[d] See Appendix 3: ST-segment elevation myocardial infarction and non-ST-segment elevation myocardial infarction ICD-10-CM codes
[e] See Appendix 15: Number of patients by year in each hospital bedsize category based on the National Inpatient Sample database variable definition
[f] See Appendix 14: States by year in each hospital region based on the National Inpatient Sample database variable definition

Appendix 6: Covariate definitions for model 1: sociodemographic characteristics

Age	0 – 90 years
Sex	0 = Male
	1 = Female
Race	1 = White
	2 = Black
	3 = Hispanic
	4 = Asian or Pacific Islander
	5 = Native American
	6 = Unspecified
Quartile of median household income for ZIP code[a]	1 = 0 – 25th percentile (lowest)
	2 = 26th – 50th percentile (second lowest)
	3 = 51st – 75th percentile (second highest)
	4 = 76th – 100th percentile (highest)
[a] See Appendix 13: Quartile ranges by year for estimated median household income of residents in the patient's ZIP code (USD) based on the National Inpatient Sample database variable definition	

Appendix 7: Covariate definitions for model 2: model 1 + lifestyle-related factors

Any smoking history[a]	0 = Absent
	1 = Present
Alcohol abuse[b]	0 = Absent
	1 = Present
Drug abuse[b]	0 = Absent
	1 = Present
Obesity[b]	0 = Absent
	1 = Present
[a] See Appendix 12: Other comorbid conditions ICD-10-CM codes [b] See Appendix 11: Elixhauser Comorbidity Software variables and definitions	

Appendix 8: Covariate definitions for model 3: model 2 + clinical history and comorbidities

Acquired Immune Deficiency Syndrome (AIDS)[a]	0 = Absent
	1 = Present
Deficiency anemias[a]	0 = Absent
	1 = Present
Chronic blood loss anemia[a]	0 = Absent
	1 = Present
Arthropathies[a]	0 = Absent
	1 = Present
Congestive heart failure[a]	0 = Absent
	1 = Present
Chronic pulmonary disease[a]	0 = Absent
	1 = Present
Coagulopathies[a]	0 = Absent
	1 = Present
Diabetes without chronic complications[a]	0 = Absent
	1 = Present
Diabetes with chronic complications[a]	0 = Absent
	1 = Present
Hypertension, complicated[a]	0 = Absent
	1 = Present
Hypertension, uncomplicated[a]	0 = Absent
	1 = Present
Hypothyroidism[a]	0 = Absent
	1 = Present
Liver disease, mild to moderate[a]	0 = Absent
	1 = Present
Liver disease, severe[a]	0 = Absent
	1 = Present
Lymphoma[a]	0 = Absent
	1 = Present
Metastatic cancer[a]	0 = Absent
	1 = Present
Other neurological disorders[a]	0 = Absent
	1 = Present
Paralysis[a]	0 = Absent
	1 = Present
Peripheral vascular disease[a]	0 = Absent
	1 = Present
Pulmonary circulation disease[a]	0 = Absent
	1 = Present
Renal failure, moderate[a]	0 = Absent
	1 = Present

Renal failure, severe[a]	0 = Absent
	1 = Present
Solid tumour without metastasis, malignant[a]	0 = Absent
	1 = Present
Peptic ulcer with bleeding[a]	0 = Absent
	1 = Present
Valvular disease[a]	0 = Absent
	1 = Present
Weight loss[a]	0 = Absent
	1 = Present
Acute myocardial infarction type[b]	0 = ST-segment elevation myocardial infarction
	1 = non- ST-segment elevation myocardial infarction
Prior myocardial infarction[c]	0 = Absent
	1 = Present
Prior coronary artery bypass graft[c]	0 = Absent
	1 = Present
Prior percutaneous coronary intervention[c]	0 = Absent
	1 = Present
Prior cerebrovascular disease[c]	0 = Absent
	1 = Present

[a] See Appendix 11: Elixhauser Comorbidity Software variables and definitions
[b] See Appendix 12: Other comorbid conditions ICD-10-CM codes
[c] See Appendix 3: ST-segment elevation myocardial infarction and non-ST-segment elevation myocardial infarction ICD-10-CM codes

Appendix 9: Covariate definitions for model 4: model 3 + hospital-level characteristics

Hospital bedsize[a]	1 = Small
	2 = Medium
	3 = Large
Hospital location/teaching status	1 = Rural
	2 = Urban nonteaching
	3 = Urban teaching
Hospital census region[b]	1 = Northeast
	2 = Midwest
	3 = South
	4 = West

[a] See Appendix 15: Number of patients by year in each hospital bedsize category based on the National Inpatient Sample database variable definition

[b] See Appendix 14: States by year in each hospital region based on the National Inpatient Sample database variable definition

Appendix 10: Covariates selected based on Andersen's Model of Health Services Use

Predisposing factors	Age
	Sex
	Race
Enabling Resources	Quartile of median household income for ZIP code[a]
Need-for-care factors	Acquired Immune Deficiency Syndrome (AIDS)[b]
	Deficiency anemias[b]
	Chronic blood loss anemia[b]
	Arthropathies[b]
	Congestive heart failure[b]
	Chronic pulmonary disease[b]
	Coagulopathies[b]
	Diabetes without chronic complications[b]
	Diabetes with chronic complications[b]
	Hypertension, complicated[b]
	Hypertension, uncomplicated[b]
	Hypothyroidism[b]
	Liver disease, mild to moderate[b]
	Liver disease, severe[b]
	Lymphoma[b]
	Metastatic cancer[b]
	Other neurological disorders[b]
	Paralysis[b]
	Peripheral vascular disease[b]
	Pulmonary circulation disease[b]
	Renal failure, moderate[b]
	Renal failure, severe[b]
	Solid tumor without metastasis, malignant[b]
	Peptic ulcer with bleeding[b]
	Valvular disease[b]
	Weight loss[b]
	Prior myocardial infarction[c]
	Prior coronary artery bypass grafting[c]
	Prior percutaneous coronary intervention[c]
	Prior cerebrovascular disease[c]

[a] See Appendix 12: Other comorbid conditions ICD-10-CM code
[b] See Appendix 11: Elixhauser Comorbidity Software variables and definitions
[c] See Appendix 13: Quartile Ranges by Year for Estimated Median Household Income of Residents in the Patient's ZIP Code (USD) based on the National Inpatient Sample database variable definition

Appendix 11: Elixhauser Comorbidity Software variables and ICD-10-CM codes

Condition	ICD-10-CM Codes
Acquired Immune Deficiency Syndrome (AIDS)	B20, O9871x, O9872, O9873, Z21
Alcohol Abuse	F101x0, F102x, F1094, F1095x, F1096, F1097, F10980, G621, I426, K2920, K2921, K7010, K7011, O9931x
Arthropathies	A1801, A1802, A3984, A5441, A5442, L4050, L4051, L4054, L4059, L900, L940, L941, L943, M01Xx, M02x, M05x, M06x, M076x, M08x, M120x, M30x, M310, M311, M312, M3130, M3131, M314, M315, M316, M317, M318, M319, M32x, M33x, M34x, M3500, M3501, M3502, M3503, M3504, M3509, M351, M352, M353, M355, M356, M358, M359, M360, M361, M368, M450, M451, M452, M453, M454, M455, M456, M457, M458, M459, M460x, M461, M465x, M468x, M469x, M498x
Chronic Blood Loss Anemia	D500, O9081, O9902, O9903
Chronic Pulmonary Disease	J41x, J42, J43x, J44x, J452x, J47x, J60, J61, J62x, J63x, J65, J66x, J67x, J684, J701, J703
Coagulopathy	D6109, D611, D612, D613, D6181x, D619, D65, D66, D67, D680, D681, D682, D6831x, D684, D688, D689, D691, D693, D694x, D695x, D696, D698, D699, D7582, O9911x, O9912, O9913
Congestive Heart Failure	I0981, I110, I130, I132, I50x, I97130, I97131, O29121, O29122, O29123, R570, Z95811, Z95812
Deficiency Anemias	D501, D508, D509, D51x, D52x, D53x, D63x, D649, O9901x
Diabetes With Chronic Complications	E082x, E083x, E0832x, E0833x, E0834x, E0835x, E0836, E0837x, E0839, E084x, E085x, E086x, E088, E092x, E093x, E094x, E095x, E096x, E098, E102x, E103x, E104x, E105x, E106x, E108, E112x, E113x, E114x, E115x, E116x, E118, E132x, E133x, E134x, E135x, E136x, E138
Diabetes Without Chronic Complications	E0800, E0801, E0810, D0811, E089, E0900, E0901, E0910, E0911, E099, E1010, E1011, E109, E1100, E1101, E1110, E1111, E119, E1300, E1301, E1310, E1311, E139, O24x
Drug Abuse	F111x, F112x, F122x, F131x, F132x, F133x, F142x, F152x, F161x, F162x, F181x, F182x, F191x, F192x, O9932x
Hypertension, Complicated	H3503x, I11x, I12x, I13x, I15x, I161, I674, O101x, O102x, O103x, O104x, O109x, O11x, O16x
Hypertension, Uncomplicated	I10, I160, I169, O1001x, O1002, O1003
Hypothyroidism	E00x, E01x, E02, E03x, E890
Liver Disease, Mild	A5145, E5274, B18x, B1910, B1920, B199, B251, B581, K700, K7010, K7011, K702, K7030, K7031, K709, K713, K714, K7150, K7151, K716, K717, K718, K73x, K74x, K751,

	K752, K753, K754, K7581, K7589, K759, K760, K761, K762, K763, K764, K7681, K7689, K769, K77
Liver Disease, Moderate to Severe	B190, B1911, B1921, I8500, I8501, I8511, I864, K7040, K7041, K7210, K7211, K7290, K7291, K765, K766, K767, K9182, Z944
Lymphoma	C81x, C82x, C83x, C84x, C85x, C86x, C88x, C900x, C902x, C903x, C960, C962x, C964, C969, C96A, C96Z, D47Z9
Metastatic Cancer	C77x, C78x, C79x, C7Bx, C800
Obesity	E6601, E6609, E661, E662, E668, E669, O9921x, R939, Z683x, Z684x, Z6854
Other Neurological Disorders	E750x, E751x, E7523, E7525, E7526, E7529, E754, F05, F842, G35, G360, G368, G369, G37x, G47411, G47419, G47421, G47429, G890, G91x, G930, G934x, G935, G936, G937, G938x, G939, G94, O9935x, P916x
Paralysis	G041, G800, G801, G802, G808, G809, G81x, G82x, G83x, I6903x, I6904x, I6905x, I6906x, I6913x, I6914x, I6915x, I6916x, I6923x, I6924x, I6925x, I6933x, I6934x, I6935x, I6936xx, I6983x, I6984x, I6985x, I6986x, I6993x, I6994x, I6995x, I6996x, R532
Peptic Ulcer With Bleeding	K25x, K26x, K27x, K28x
Peripheral Vascular Disease	A5200, A5201, A5202, A5209, I70x, I7100, I7101, I7102, I7103, I711, I712, I713, I714, I715, I716, I718, I719, I72x, I7301, I731, I7381, I7389, I739, I74x, I75x, I77x, I78x, I79x, I99x, K3181x, K551, K558, K559, Z9582x
Pulmonary Circulation Disease	I27x, I28x
Renal Failure, Moderate	N183x, N189, N19
Renal Failure, Severe	I120, I1311, I132, N184, N185, N186, Z49x, Z9115, Z940, Z992
Solid Tumor Without Metastasis, Malignant	C0x, C1x, C2x, C3x, C40x, C41x, C43x, C440x, C441x, C4420x, C4429x, C4430x, C4439x, C4440, C4449, C4450x, C4459x, C4460x, C4469x, C4470x, C4479x, C4480, C4489, C4490, C4499, C45x, C46x, C47x, C48x, C49x, C4Ax, C50x, C51x, C52, C53x, C54x, C55, C561, C562, C569, C57x, C58, C6x, C70x, C71x, C72x, C73, C74x, C75x, C76x, C7Ax, D469, E3121, E3122, E3123
Valvular Disease	A1884, A2382, A3951, A5203, B3321, B376, I011, I018, I019, I020, I05x, I06x, I07x, I08x, I091, I0989, I330, I339, I34x, I35x, I36x, I37x, I38, I39, M3211, Q22x, Q23x, T8201Xx, T8202Xx, T8203Xx, T82221x, T82222x, T82223x,, T82228x, T826XXx, Z952, Z953, Z954
Weight Loss	E40, E41, E42, E43, E440, E441, E45, E46, O251x, R634, R64

Appendix 12: Other comorbid conditions ICD-10-CM codes

Condition	**ICD-10-CM Codes**
Any Smoking History	F172, F1720, F17200, F17201, F17203, F17208, F17209, F1721, F17210, F17211, F17213, F17218, F17219, Z716, Z720, O9933, O99330, O99331, O99332, O99333, O99334, O99335, Z87891
Prior Myocardial Infarction	I252
Prior Coronary Artery Bypass Graft	Z951
Prior Percutaneous Coronary Intervention	Z9861, Z955
Prior Cerebrovascular Disease	I60x, I61x, I63x, H34x

Appendix 13: Quartile ranges by year for estimated median household income of residents in the patient's ZIP code (USD) based on the National Inpatient Sample database variable definition from 2015 to 2019

Year	Quartile 1	Quartile 2	Quartile 3	Quartile 4
2015	1 – 41,999	42,000 – 51,999	52,000 – 67,999	68.000+
2016	1 – 42,999	43,000 – 53,999	54,000 – 70,999	71,000+
2017	1 – 43,999	44,000 – 55,999	56,000 – 73,999	74,000+
2018	1 – 45,999	46,000 – 58,999	59,000 – 78,999	79,000+
2019	1 – 47,999	48,000 – 60,999	61,000 – 81,999	82.000+

Appendix 14: States by year in each hospital region based on the National Inpatient Sample database variable definition from 2015 to 2019

NORTHEAST REGION	
2015	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey
2016	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey
2017	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey
2018	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey
2019	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey
MIDWEST REGION	
2015	Wisconsin, Michigan, Illinois, Indiana, Ohio, Missouri, North Dakota, South Dakota, Nebraska, Kansa, Minnesota, Iowa
2016	Wisconsin, Michigan, Illinois, Indiana, Ohio, Missouri, North Dakota, South Dakota, Nebraska, Kansa, Minnesota, Iowa
2017	Wisconsin, Michigan, Illinois, Indiana, Ohio, Missouri, North Dakota, South Dakota, Nebraska, Kansa, Minnesota, Iowa
2018	Wisconsin, Michigan, Illinois, Indiana, Ohio, Missouri, North Dakota, South Dakota, Nebraska, Kansa, Minnesota, Iowa
2019	Wisconsin, Michigan, Illinois, Indiana, Ohio, Missouri, North Dakota, South Dakota, Nebraska, Kansa, Minnesota, Iowa
SOUTHERN REGION	
2015	Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Mississippi, Oklahoma, Texas, Arkansas, Louisiana
2016	Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Mississippi, Oklahoma, Texas, Arkansas, Louisiana
2017	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Mississippi, Oklahoma, Texas, Arkansas, Louisiana
2018	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Mississippi, Oklahoma, Texas, Arkansas, Louisiana
2019	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Mississippi, Oklahoma, Texas, Arkansas, Louisiana
WEST REGION	
2015	Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico, Alaska, Washington, Oregon, California, Hawaii
2016	Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico, Alaska, Washington, Oregon, California, Hawaii

2017	Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico, Alaska, Washington, Oregon, California, Hawaii
2018	Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico, Alaska, Washington, Oregon, California, Hawaii
2019	Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico, Alaska, Washington, Oregon, California, Hawaii

Appendix 15: Number of patients by year in each hospital bedsize category based on the National Inpatient Sample database variable definition from 2015 to 2019

Location and Teaching Status	Hospital Bedsize		
	Small	Medium	Large
NORTHEAST REGION			
Rural	1 – 49	50 – 99	100+
Urban, nonteaching	1 – 124	125 – 199	200+
Urban, teaching	1 – 249	250 – 424	425+
MIDWEST REGION			
Rural	1 – 29	30 – 49	50+
Urban, nonteaching	1 – 74	75 – 174	175+
Urban, teaching	1 – 249	250 – 374	375+
SOUTHERN REGION			
Rural	1 – 39	40 – 74	75+
Urban, nonteaching	1 – 99	100 – 199	200+
Urban, teaching	1 – 249	250 – 449	450+
WESTERN REGION			
Rural	1 – 24	25 – 44	45+
Urban, nonteaching	1 – 99	100 – 174	175+
Urban, teaching	1 – 199	200 – 324	325+

Appendix 16: Baseline characteristics by race for acute myocardial infarction patients ≥ 18 years from 2015-2019

	Overall (Weighted N = 2 798 225)	White Race (Weighted n = 1 984 150)	Black Race (Weighted n = 307 775)	Hispanic Race (Weighted n = 235 305)	Asian or Pacific Islander Race (Weighted n = 75 370)	Native American Race (Weighted n = 15 850)	Unspecified Race (Weighted n = 80 690)
Patient-level characteristics, No. (%)							
Age, mean ± SD (years)	70 ± 13.5	68.1 ± 13.2	62.7 ± 13.8	64.5 ± 13.7	66.4 ± 13.7	63.7 ± 12.9	64.9 ± 13.4
Sex							
Male	1 741 090 (62.2%)	1 248 435 (62.9%)	166 090 (54.0%)	147 715 (62.8%)	49 845 (66.1%)	9 670 (61.0%)	54 155 (67.1%)
Female	1 056 650 (37.8%)	735 380 (37.1%)	141 635 (46.0%)	87 545 (37.2%)	25 525 (33.9%)	6 180 (39.0%)	26 520 (32.9%)
Quartiles of median household income for patient zip code							
0-25th percentile (Lowest)	843 600 (30.7%)	526 775 (27.0%)	163 420 (54.0%)	90 170 (39.2%)	9 720 (13.1%)	7 285 (49.2%)	21 715 (27.6%)
26th-50th percentile (Second Lowest)	752 535 (27.4%)	563 325 (28.9%)	64 985 (21.5%)	59 330 (25.8%)	13 460 (18.1%)	3 730 (25.2%)	17 510 (22.3%)
51st-75th percentile (Second Highest)	649 210 (23.6%)	486 695 (25.0%)	45 965 (15.2%)	49 645 (21.6%)	20 355 (27.4%)	2 375 (16.0%)	19 310 (24.6%)
76th-100th percentile (Highest)	501 920 (18.3%)	373 540 (19.2%)	28 210 (9.3%)	30 935 (13.5%)	30 870 (41.5%)	1 415 (9.6%)	20 015 (25.5%)
Expected primary payer							
Medicare	1 602 050 (57.3%)	1 197 445 (77.3%)	156 820 (10.1%)	113 610 (48.3%)	36 110 (2.3%)	8 360 (0.5%)	36 665 (45.5%)
Medicaid	262 985 (9.4%)	135 345 (6.8%)	51 015 (16.6%)	40 160 (17.1%)	12 030 (16.0%)	2 500 (15.9%)	13 355 (16.6%)
Private insurance	709 275 (25.4%)	511 795 (25.8%)	66 350 (21.6%)	54 705 (23.3%)	22 180 (29.5%)	3 060 (19.4%)	22 230 (3.3%)
Self-pay	129 635 (4.6%)	75 515 (60.2%)	20 940 (16.7%)	19 515 (15.6%)	3 170 (2.5%)	695 (0.6%)	5 620 (4.5%)
No charge	11 330 (0.4%)	5 965 (54.0%)	2 390 (21.6%)	1 770 (16.0%)	280 (2.5%)	25 (0.2%)	620 (5.6%)
Other	78 870 (2.8%)	55 385 (73.6%)	9 720 (12.9%)	5 345 (7.1%)	1 545 (2.1%)	1 110 (1.5%)	2 105 (2.8%)
In-hospital mortality							
Yes	129 755 (4.6%)	94 810 (73.2%)	8 105 (6.3%)	17 975 (13.9%)	4 855 (3.8%0	320 (0.3%)	3 505 (2.7%)
No	2 666 615 (95.4%)	1 506 290 (56.6%)	254 665 (9.6%)	690 855 (26.0%)	124 670 (4.7%0	11 010 (0.4%)	75 235 (2.8%)
Comorbidities, No. (%)							
AIDS	12 370 (0.4%)	5 840 (0.3%)	4 235 (1.4%)	1 260 (0.5%)	175 (0.2%)	45 (0.3%)	525 (0.7%)
Alcohol abuse	101 325 (3.6%)	69 575 (3.5%)	13 910 (4.5%)	9 075 (3.9%)	1 675 (2.2%)	870 (5.5%)	2 665 (3.3%)
AMI type							
NSTEMI	1 976 555 (70.6%)	1 394 955 (70.3%)	232 345 (75.5%)	167 545 (71.2%)	52 540 (69.7%)	11 405 72.0%)	53 455 (66.3%)
STEMI	821 670 (29.4%)	589 195 (29.7%)	75 430 (24.5%)	67 760 (28.8%)	22 830 (30.3%)	4 445 (28.0%)	27 235 (33.8%)
Arthropathies	81 740 (2.9%)	60 490 (3.1%)	9 185 (3.0%)	5 650 (2.4%)	1 465 (1.9%)	460 (2.9%)	1 810 (2.2%)
Chronic blood loss anemias	18 225 (0.7%)	12 600 (0.6%)	2 260 (0.7%)	1 490 (0.6%)	630 (0.8%)	165 (1.0%)	515 (0.6%)
Chronic pulmonary disease	585 050 (20.9%)	439 630 (22.2%)	63 275 (20.6%)	36 435 (15.5%)	10 855 (14.4%)	3 195 (20.2%)	13 555 (16.8%)
Coagulopathies	180 675 (6.5%)	125 525 (6.3%)	19 010 (6.2%)	15 895 (6.8%)	6 950 (9.2%)	1 055 (6.7%)	5 270 (6.5%)

Congestive heart failure	1 074 355 (38.4%)	743 160 (37.5%)	134 090 (43.6%)	93 570 (39.8%)	31 005 (41.1%)	6 445 (40.7%)	31 185 (38.7%)
Deficiency anemias	461 630 (16.5%)	289 750 (14.6%)	73 990 (24.0%)	49 765 (21.2%)	17 340 (23.0%)	3 330 (21.0%)	13 650 (16.9%)
Diabetes with chronic complications	586 760 (21.0%)	384 300 (19.4%)	76 625 (24.9%)	65 495 (27.8%)	20 630 (27.4%)	4 530 (28.6%)	17 850 (22.1%)
Diabetes without chronic complications	417 745 (14.9%)	282 970 (14.3%)	48 255 (15.7%)	42 225 (17.9%)	12 800 (17.0%)	2 660 (16.8%)	13 960 (17.3%)
Drug abuse	90 375 (3.2%)	54 900 (2.8%)	19 605 (6.4%)	8 470 (3.6%)	1 670 (2.2%)	600 (3.8%)	2 355 (2.9%)
Hypertension, complicated	909 475 (32.5%)	615 545 (31.0%)	127 345 (41.4%)	82 585 (35.1%)	27 465 (36.4%)	5 595 (35.3%)	24 965 (30.9%)
Hypertension, uncomplicated	1 105 845 (39.5%)	798 980 (40.3%)	112 630 (36.6%)	88 985 (37.8%)	27 210 (36.1%)	6 070 (38.3%)	32 130 (39.8%)
Hypothyroidism	341 160 (12.2%)	266 285 (13.4%)	22 310 (7.3%)	24 285 (10.3%)	7 030 (9.3%)	1 640 (10.4%)	7 890 (9.8%)
Liver disease, mild to moderate	85 260 (3.1%)	54 505 (2.8%)	12 715 (4.1%)	9 235 (3.9%)	2 980 (4.0%)	695 (4.4%)	2 785 (3.5%)
Liver disease, severe	12 485 (0.5%)	8 685 (0.4%)	1 030 (0.3%)	1 570 (0.7%)	310 (0.4%)	125 (0.8%)	395 (0.5%)
Lymphoma	16 180 (0.6%)	11 935 (0.6%)	1 805 (0.6%)	1 085 (0.5%)	415 (0.6%)	35 (0.2%)	365 (0.5%)
Metastatic cancer	37 910 (1.4%)	27 760 (1.4%)	4 145 (1.4%)	2 630 (1.1%)	1 005 (1.3%)	170 (1.1%)	925 (1.2%)
Obesity	515 880 (18.4%)	367 335 (18.5%)	62 975 (20.5%)	43 550 (18.5%)	8 570 (11.4%)	3 305 (20.9%)	12 945 (16.0%)
Other neurological disorders	124 180 (4.4%)	88 365 (4.5%)	14 420 (4.7%)	9 450 (4.0%)	3 470 (4.6%)	515 (3.3%)	3 740 (4.6%)
Paralysis	68 625 (2.5%)	41 055 (2.1%)	13 275 (4.3%)	6 860 (2.9%)	2 710 (3.6%)	455 (2.9%)	2 315 (2.9%)
Peptic ulcer with bleeding	22 425 (0.8%)	15 475 (0.8%)	2 465 (0.8%)	1 955 (0.8%)	960 (1.3%)	125 (0.8%)	675 (0.8%)
Peripheral vascular disease	272 050 (9.7%)	201 405 (10.2%)	27 775 (9.0%)	19 270 (8.2%)	7 415 (9.8%)	1 255 (7.9%)	6 060 (7.5%)
Previous cerebrovascular accident	35 015 (1.3%)	23 165 (1.2%)	4 745 (1.5%)	3 230 (1.4%)	3 230 (1.7%)	150 (1.0%)	1 155 (1.4%)
Previous coronary artery bypass graft	284 545 (10.2%)	214 790 (10.8%)	23 085 (7.5%)	22 110 (9.4%)	6 825 (9.1%)	1 575 (9.9%)	7 255 (9.0%)
Previous myocardial infarction	444 830 (15.9%)	323 655 (16.3%)	49 605 (16.1%)	33 870 (14.4%)	10 670 (14.2%)	2 805 (17.7%)	10 665 (13.2%)
Previous percutaneous coronary intervention	486 405 (17.4%)	355 135 (17.9%)	50 680 (16.5%)	37 98- (16.1%)	11 055 (14.7%)	2 805 (17.7%)	12 725 (15.8%)
Pulmonary circulation disease	152 735 (5.5%)	105 255 (5.3%)	21705 (7.1%)	11 850 (5.0%)	4 040 (5.4%)	980 (6.2%)	3 975 (4.9%)
Renal failure, moderate	432 010 (15.4%)	305 825 (15.4%)	54 880 (17.8%)	32 815 (14.0%)	12 030 (16.0%)	2 105 (13.3%)	10 575 (13.1%)
Renal failure, severe	214 790 (7.7%)	117 740 (5.9%)	43 670 (14.2%)	28 015 (11.9%)	11 105 (14.7%)	1 985 (12.5%)	6 515 (8.1%)
Any smoking history	1 347 790 (48.2%)	989 375 (49.9%)	152 190 (49.5%)	91 210 (38.8%)	26 100 (34.6%)	7 700 (48.6%)	33 925 (42.0%)
Solid tumor without metastasis, malignant	53 890 (1.9%)	39 965 (2.0%)	5 770 (1.9%)	3 685 (1.6%)	1 425 (1.9%)	230 (1.5%)	1 220 (1.5%)
Valvular disease	411 475(14.7%)	305 505 (15.4%)	39 715 (12.9%)	29 425 (12.5%)	10 855 (14.4%)	2 200 (13.9%)	9 705 (12.0%)
Weight loss	94 355 (3.4%)	63 985 (3.2%)	12 975 (4.2%)	7 845 (3.3%)	3 310 (4.4%)	575 (3.6%)	2 700 (3.4%)
Procedures, No. (%)							
Coronary artery bypass graft (CABG)	245 385 (8.8%)	176 765 (8.9%)	19 180 (6.2%)	21 875 (9.3%)	8 155 (10.8%)	1 560 (9.8%)	7 515 (9.3%)

Percutaneous coronary intervention (PCI)	1 339 155 (47.9%)	974 895 (49.1%)	121 550 (39.5%)	105 815 (45.0%)	33 925 (45.0%)	7 645 (48.2%)	41 690 (51.7%)
Revascularization procedures	1 567 575 (56.0%)	1 139 280 (57.4%)	139 575 (45.4%)	126 230 (53.7%)	41 545 (55.1%)	9 120 (57.5%)	48 620 (60.3%)
Hospital-level characteristics, No. (%)							
Hospital bed size							
Small	494 820 (17.7%)	353 735 (17.8%)	53 870 (17.5%)	40 115 (17.1%)	12 745 (16.9%)	2 845 (18.0%)	13 420 (16.6%)
Medium	853 335 (30.5%)	597 935 (30.1%)	95 830 (31.1%)	81 570 (34.7%)	22 645 (30.1%)	3 900 (24.6%)	25 885 (32.1%)
Large	1 450 070 (51.8%)	1 032 480 (52.0%)	158 075 (51.4%)	113 620 (48.3%)	39 980 (53.0%)	9 105 (57.4%)	41 385 (51.3%)
Hospital region							
Northeast	489 745 (17.5%)	367 485 (18.5%)	44 395 (14.4%)	32 140 (13.7%)	11 720 (15.6%)	985 (6.2%)	24 355 (30.2%)
Midwest	629 455 (22.5%)	495 235 (25.0%)	59 325 (19.3%)	14 365 (6.1%)	6 880 (9.1%)	3 055 (19.3%)	8 470 (10.5%)
South	1 145 370 (40.9%)	792 850 (40.0%)	174 390 (56.7%)	103 425 (44.0%)	12 220 (16.2%)	5 760 (36.3%)	30 600 (37.9%)
West	533 655 (19.1%)	328 580 (16.6%)	29 665 (9.6%)	85 375 (36.3%)	44 550 (59.1%)	6 050 (38.2%)	17 265 (21.4%)
Hospital location/teaching status							
Rural	214 265 (7.7%)	178 570 (9.0%)	15 160 (4.9%)	4 360 (1.9%)	1 240 (1.7%)	2 720 (17.2%)	1 590 (2.0%)
Urban non-teaching	648 755 (23.2%)	475 305 (24.0%)	55 815 (18.1%)	58 270 (24.8%)	18 465 (24.5%)	2 880 (18.2%)	18 140 (22.5%)
Urban teaching	1 935 205 (69.2%)	1 330 275 (67.1%)	236 800 (76.9%)	172 675 (73.4%)	55 665 (73.9%)	10 250 (64.7%)	60 960 (75.6%)

Appendix 17: All logistic regression analyses results for in-hospital mortality as the outcome

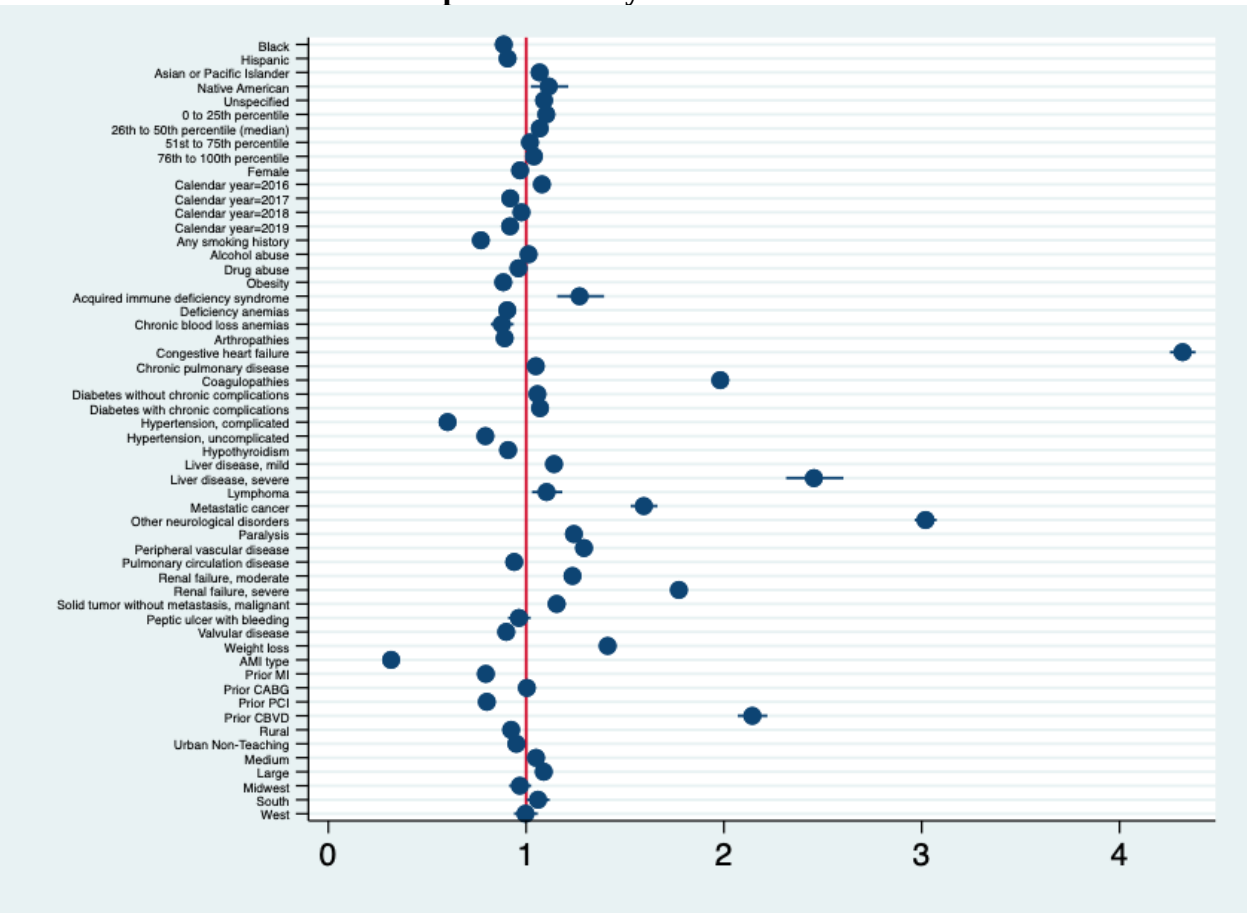
	Model 1	Model 2	Model 3	Model 4
	Sociodemographic Characteristics[a]	Model 1 + Lifestyle Factors[b]	Model 2 + Clinical History[c]	Model 3 + Hospital Characteristics[d]
Quartiles of median household income for patient's ZIP code				
Highest	*Reference Level*			
Second highest	1.01 [0.99-1.03] *P*<0.001	1.02 [1.00-1.04] *P*<0.05	1.18 [1.00-1.04] *P*=0.080	1.02 [1.00-1.04] *P*=0.057
Second lowest	1.06 [1.04-1.08] *P*<0.001	1.07 [1.05-1.09] *P*<0.001	1.07 [1.04-1.09] *P*<0.001	1.07 [1.05-1.09] *P*<0.001
Lowest	1.11 [1.09-1.13] *P*=0.219	1.13 [1.10-1.15] *P*<0.001	1.10 [1.08-1.12] *P*<0.001	1.10 [1.08-1.13] *P*<0.001
Race				
White	*Reference Level*			
Black	0.99 [0.97-1.01] *P*=0.431	0.98 [0.96-1.00] *P*=0.084	0.89 [0.87-0.91] *P*<0.001	0.89 [0.87-0.91] *P*<0.001
Hispanic	1.01 [0.98-1.03] *P*=0.508	0.97 [0.95-0.99] *P*<0.05	0.91 [0.89-0.93] *P*<0.001	0.91 [0.88-0.93] *P*<0.001
Asian or Pacific Islander	1.28 [1.24-1.32] *P*<0.001	1.22 [1.17-1.26] *P*<0.001	1.07 [1.03-1.11] *P*<0.001	1.07 [1.03-1.11] *P*<0.001
Native American	1.15 [1.06-1.25] *P*<0.05	1.13 [1.05-1.23] *P*<0.05	1.11 [1.02-1.21] *P*<0.05	1.11 [1.02-1.11] *P*<0.05
Unspecified	1.27 [1.23-1.31] *P*<0.001	1.23 [1.19-1.27] *P*<0.001	1.10 [1.06-1.14] *P*<0.001	1.09 [1.05-1.13] *P*<0.001
Age	1.05 [1.05-1.05] *P*<0.001	1.04 [1.04-1.04] *P*<0.001	1.04 [1.04-1.04] *P*<0.001	1.04 [1.04-1.04] *P*<0.001
Indicator of sex				
Male	*Reference Level*			
Female	0.96 [0.95-.97] *P*<0.001	0.93 [0.92-0.94] *P*<0.001	0.97 [0.96-0.98] *P*<0.001	0.97 [0.96-0.98] *P*<0.001
Year				
2015	*Reference Level*			
2016	0.96 [0.93-0.99] *P*<0.05	0.96 [0.93-0.99] *P*<0.05	1.08 [1.04-1.11] *P*<0.001	1.08 [1.05-1.12] *P*<0.001
2017	0.96 [0.93-0.99] *P*<0.05	0.96 [0.94-0.99] *P*<0.05	0.92 [0.89-0.95] *P*<0.001	0.92 [0.89-0.95] *P*<0.001
2018	0.93 [0.91-0.96] *P*<0.001	0.95 [0.92-0.97] *P*<0.001	0.97 [0.94-1.01] *P*=0.103	0.98 [0.94-1.01] *P*=0.153
2019	0.90 [0.88-0.93] *P*<0.001	0.91 [0.89-0.94] *P*<0.001	0.92 [0.89-0.95] *P*<0.001	0.92 [0.89-0.95] *P*<0.001
Any smoking history		0.70 [0.69-0.71] *P*<0.001	0.77 [0.76-0.78] *P*<0.001	0.77 [0.76-0.78] *P*<0.001
Alcohol abuse		1.18 [1.15-1.22] *P*<0.001	1.01 [0.98-1.05] *P*=0.524	1.01 [0.98-1.05] *P*=0.489
Drug abuse		1.04 [1.00-1.08] *P*<0.05	0.96 [0.92-1.00] *P*=0.052	0.96 [0.92-1.00] *P*=0.052
Obesity		0.86 [0.85-0.88] *P*<0.001	0.88 [0.87-0.91] *P*<0.001	0.88 [0.87-0.90] *P*<0.001
AIDS			1.28 [1.16-1.40] *P*<0.001	1.27 [1.16-1.39] *P*<0.001

Deficiency anemias		0.90 [0.89=0.92] *P*<0.001	0.90 [0.89-0.92] *P*<0.001
Chronic blood loss anemias		0.88 [0.82-0.94] *P*<0.001	0.88 [0.82-0.94] *P*<0.001
Arthropathies		0.89 [0.86-0.93] *P*<0.001	0.89 [0.86-0.93] *P*<0.001
Congestive heart failure		4.32 [4.26-4.39] *P*<0.001	4.32 [4.25-4.38] *P*<0.001
Chronic pulmonary disease		1.05 [1.03-1.06] *P*<0.001	1.05 [1.03-1.07] *P*<0.001
Coagulopathies		1.99 [1.95-2.03] *P*<0.001	1.98 [1.95-2.02] *P*<0.001
Diabetes without chronic complications		1.06 [1.04-1.08] *P*<0.001	1.06 [1.04-1.08] *P*<0.001
Diabetes with chronic complications		1.07 [1.05-1.09] *P*<0.001	1.07 [1.05-1.09] *P*<0.001
Hypertension, complicated		0.60 [0.59-0.61] *P*<0.001	0.60 [0.59-0.61] *P*<0.001
Hypertension, uncomplicated		0.79 [0.78=0.81] *P*<0.001	0.79 [0.78-0.81] *P*<0.001
Hypothyroidism		0.91 [0.89-0.93] *P*<0.001	0.91 [0.89-0.93] *P*<0.001
Liver disease, mild to moderate		1.14 [1.10-1.18] *P*<0.001	1.14 [1.10-1.18] *P*<0.001
Liver disease, severe		2.45 [2.31-2.60] *P*<0.001	2.46 [2.31-2.60] *P*<0.001
Lymphoma		1.10 [1.03-1.18] *P*<0.05	1.10 [1.03-1.18] *P*<0.05
Metastatic cancer		1.60 p1.53-1.67] *P*<0.001	1.59 [1.52-1.66] *P*<0.001
Other neurological disorders		3.03 [2.97-3.08] *P*<0.001	3.02 [2.96-3.08] *P*<0.001
Paralysis		1.24 [1.20-1.28] *P*<0.001	1.24 [1.20-1.28] *P*<0.001
Peripheral vascular disease		1.29 [1.27-1.32] *P*<0.001	1.29 [1.27-1.32] *P*<0.001
Pulmonary circulation disease		0.94 [0.92-0.96] *P*<0.001	0.94 [0.92-0.96] *P*<0.001
Renal failure, moderate		1.23 [1.21-1.25] *P*<0.001	1.23 [1.21-1.26] *P*<0.001
Renal failure, severe		1.77 [1.74-1.81] *P*<0.001	1.77 [1.74-1.81] *P*<0.001

Solid tumor without metastasis, malignant		1.15 [1.11-1.20] *P*<0.001	1.15 [1.11-1.20] *P*<0.001
Peptic ulcer with bleeding		0.97 [0.91-1.03] *P*=0.255	0.96 [0.91-1.02] *P*=0.222
Valvular disease		0.90 [0.89-0.92] *P*<0.001	0.90 [0.88-0.91] *P*<0.001
Weight loss		1.41 [1.38-1.45] *P*<0.001	1.41 [1.38-1.45] *P*<0.001
AMI type			
STEMI	*Reference Level*		
NSTEMI		0.32 [0.31-0.32] *P*<0.001	0.32 [0.31-0.32] *P*<0.001
Prior MI		0.80 [0.78-0.81] *P*<0.001	0.80 [0.78-0.81] *P*<0.001
Prior CABG		1.00 [0.98-1.02] *P*=0.747	1.00 [0.98-1.02] *P*=0.702
Prior PCI		0.80 [0.79-0.82] *P*<0.001	0.80 [0.79-0.82] *P*<0.001
Prior CBVD		2.15 [2.08-2.23] *P*<0.001	2.14 [2.07-2.22] *P*<0.001
Hospital location/teaching status			
Urban teaching	*Reference Level*		
Rural			0.92 [0.90-0.95] *P*<0.001
Urban non-teaching			0.95 [0.93-0.97] *P*<0.001
Hospital bed size			
Small	*Reference Level*		
Medium			1.05 [1.03-1.08] *P*<0.001
Large			1.09 [1.06-1.11] *P*<0.001
Hospital region			
Northeast	*Reference Level*		
Midwest			0.97 [0.91-1.03] *P*=0.276
South			1.06 [1.00-1.12] *P*<0.05
West			1.00 [0.94-1.06] *P*=0.919

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Appendix 18: Coefficient plot for adjusted logistic regression analysis results for in-hospital mortality as the outcome



Appendix 19: Baseline characteristics by socioeconomic status among patients with a primary or secondary acute myocardial infarction diagnosis

Patient-level characteristics, No. (%)	**Overall (Weighted N = 2 798 225)**	**0-25th percentile (Lowest) (Weighted n = 1 455 010)**	**26th-50th percentile (Weighted n = 1 267 875)**	**51st-75th percentile (Weighted n = 1 086 680)**	**76th-100th percentile (Highest) (Weighted n = 835 590)**
Age, mean ± SD (years)	68.7 ± 13.8	67.2 ± 13.8	68.8 ± 13.7	69.3 ± 13.7	70.5 ± 13.7
Sex					
Male	2 783 370 (58.9%)	826 215 (56.8%)	739 925 (58.4%)	649 315 (59.8%)	512 450 (61.3%)
Female	1 945 805 (41.1%)	628 525 (43.2%)	527 785 (41.6%)	437 215 (40.2%)	323 040 (38.7%)
Race					
White	3 333 730 (72.9%)	894 220 (63.2%)	944 295 (77.5%)	813 370 (77.7%)	625 740 (77.3%)
Black	568 850 (12.4%)	303 815 (21.5%)	119 660 (9.82%)	84 585 (8.08%)	51 070 (6.3%)
Hispanic	383 655 (8.4%)	151 170 (10.7%)	96 395 (7.91%)	79 395 (7.58%)	48 470 (6.00%)
Asian or Pacific Islander	128 190 (2.8%)	17 435 (1.23%)	23 050 (1.89%)	34 975 (3.34%)	50 995 (6.30%)
Native American	27 715 (0.6%)	12 625 (0.90%)	6 755 (0.55%)	4 215 (0.40%)	2 305 (0.28%)
Unspecified	129 280 (2.8%)	35 545 (2.51%)	28 340 (2.33%)	30 875 (2.95%)	31 310 (3.87%)
Comorbidities, No. (%)					
AIDS	22 300 (0.5%)	9 250 (0.64%)	5 120 (0.40%)	4 135 (0.38%)	2 935 (0.35%)
Alcohol abuse	1 020 475 (21.6%)	64 715 (4.45%)	50 795 (4.01%)	41 430 (3.81%)	28 570 (3.42%)
AMI type					
NSTEMI	1 522 630 (43.5%)	468 045 (43.7%)	413 765 (43.7%)	347 700 (43.5%)	266 160 (43.0%)
STEMI	1 977 700 (56.5%)	602 985 (56.3%)	533 770 (56.3%)	452 220 (56.5%)	353 020 (57.0%)
Arthropathies	152 265 (3.2%)	43 940 (3.00%)	41 235 (3.25%)	35 600 (3.28%)	29 030 (3.47%)
Chronic blood loss anemias	45 725 (1.00%)	14 150 (1.00%)	12 385 (1.00%)	10 220 (0.94%)	8 170 (1.00%)
Chronic pulmonary disease	1 117 320 (23.6%)	384 525 (26.4%)	312 560 (24.7%)	238 820 (22.0%)	161 230 (19.3%)
Coagulopathies	456 035 (9.6%)	136 385 (9.37%)	118 680 (9.36%)	106 465 (9.80%)	86 180 (10.3%)
Congestive heart failure	2 115 550 (44.7%)	676 270 (46.5%)	566 765 (44.7%)	476 885 (43.9%)	358 305 (42.9%)
Deficiency anemias	1 020 475 (21.6%)	334 340 (23.0%)	266 535 (21.0%)	227 265 (20.9%)	175 175 (21.0%)
Diabetes with chronic complications	1 082 820 (22.9%)	355 900 (24.5%)	291 175 (23.0%)	244 255 (22.5%)	173 665 (20.8%)
Diabetes without chronic complications	643 900 (13.6%)	211 880 (14.6%)	175 980 (13.9%)	141 940 (13.1%)	102 395 (12.3%)
Drug abuse	175 460 (3.7%)	69 195 (4.76%)	44 815 (3.53%)	34 605 (3.18%)	21 430 (2.56%)
Hypertension, complicated	1 647 690 (34.8%)	529 905 (36.4%)	440 270 (34.7%)	372 055 (34.2%)	277 390 (33.2%)
Hypertension, uncomplicated	1 630 355 (34.5%)	498 685 (34.3%)	438 615 (34.6%)	375 960 (34.6%)	287 745 (34.4%)
Hypothyroidism	614 715 (13.0%)	176 535 (12.1%)	169 545 (13.4%)	143 820 (13.2%)	114 790 (13.7%)
Liver disease, mild to moderate	203 845 (4.3%)	72 630 (5.00%)	52 175 (4.12%)	43 315 (3.99%)	30 895 (3.70%)
Liver disease, severe	47 765 (1.00%)	15 735 (1.08%)	12 855 (1.01%)	10 435 (0.96%)	7 635 (0.91%)
Lymphoma	36 805 (0.8%)	9 730 (0.67%)	9 110 (0.72%)	9 325 (0.86%)	8 055 (0.96%)
Metastatic cancer	95 890 (2.00%)	27 080 (1.86%)	24 920 (1.97%)	22 625 (2.08%)	19 685 (2.36%)
Obesity	831 870 (17.6%)	265 200 (18.2%)	231 200 (18.2%)	192 335 (17.7%)	129 475 (15.5%)
Other neurological disorders	465 870 (9.9%)	147 360 (10.1%)	123 195 (9.72%)	105 785 (9.73%)	81 600 (9.77%)
Paralysis	209 145 (4.4%)	71 340 (4.90%)	53 685 (4.23%)	45 160 (4.16%)	35 370 (4.23%)
Peptic ulcer with bleeding	58 130 (1.2%)	18 310 (1.26%)	15 665 (1.24%)	12 900 (1.19%)	10 195 (1.22%)
Peripheral vascular disease	485 255 (10.3%)	146 485 (10.1%)	129 504 (10.2%)	114 500 (10.5%)	86 655 (10.4%)
Previous cerebrovascular accident	100 370 (2.1%)	32 240 (2.22%)	25 955 (2.05%)	22 610 (2.08%)	17 610 (2.11%)
Previous coronary artery bypass graft	495 790 (10.5%)	151 665 (10.4%)	138 595 (10.9%)	113 340 (10.4%)	84 130 (10.1%)

Previous myocardial infarction	689 515 (14.6%)	211 450 (14.5%)	186 785 (14.7%)	159 880 (14.7%)	119 660 (14.3%)
Previous percutaneous coronary intervention	758 895 (16.0%)	232 580 (16.0%)	208 125 (16.4%)	173 780 (16.0%)	131 755 (15.8%)
Pulmonary circulation disease	354 550 (7.50%)	109 885 (7.55%)	94 810 (7.48%)	82 170 (7.56%)	61 865 (7.40%)
Renal failure, moderate	868 860 (18.4%)	266 470 (18.3%)	235 450 (18.6%)	199 965 (18.4%)	152 785 (18.3%)
Renal failure, severe	491 010 (10.4%)	169 875 (11.7%)	126 915 (10.0%)	107 815 (9.92%)	78 510 (9.40%)
Any smoking history	2 089 660 (44.2%)	678 385 (46.6%)	576 540 (45.5%)	469 900 (43.2%)	326 840 (39.1%)
Solid tumor without metastasis, malignant	117 440 (2.50%)	33 820 (2.33%)	31 085 (2.45%)	27 505 (2.53%)	23 110 (2.77%)
Valvular disease	769 800 (16.3%)	216 375 (14.9%)	208 045 (16.4%)	183 155 (16.9%)	149 415 (17.9%)
Weight loss	336 140 (7.11%)	109 415 (7.52%)	87 780 (6.92%)	74 350 (6.84%)	58 725 (7.03%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	873 765 (18.5%)	219 685 (15.1%)	238 935 (18.9%)	224 125 (20.6%)	176 375 (21.1%)
Medium	1 407 175 (29.8%)	419 915 (28.9%)	369 180 (29.1%)	320 855 (29.5%)	272 515 (32.6%)
Large	2 448 970 (51.8%)	815 410 (56.0%)	659 760 (52.0%)	541 700 (49.9%)	386 700 (46.3%)
Hospital region					
Northeast	885 665 (18.7%)	165 940 (11.4%)	203 925 (16.1%)	234 455 (21.6%)	269 095 (32.2%)
Midwest	1 080 470 (22.8%)	306 675 (21.1%)	346 215 (27.3%)	272 770 (25.1%)	146 015 (17.5%)
South	1 870 805 (39.6%)	794 795 (54.6%)	502 400 (39.6%)	337 245 (31.0%)	199 160 (23.8%)
West	892 970 (18.9%)	187 600 (12.9%)	215 335 (17.0%)	242 210 (22.3%)	221 320 (26.5%)
Hospital location/teaching status					
Rural	394 865 (8.4%)	212 170 (15.6%)	130 260 (10.3%)	37 680 (3.47%)	5 415 (0.65%)
Urban non-teaching	1 046 370 (22.1%)	273 615 (18.8%)	299 070 (23.6%)	256 770 (23.6%)	198 275 (23.7%)
Urban teaching	3 288 675 (69.5%)	969 225 (66.6%)	838 545 (66.1%)	792 230 (72.9%)	631 900 (75.6%)

Appendix 20: Logistic regression analyses results for primary exposures among patients with a primary or secondary acute myocardial infarction diagnosis with in-hospital mortality as the outcome

VARIABLES	Model 1 Sociodemographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]
Quartiles for median household income for patient ZIP code				
Highest	*Reference Level*			
Second highest	1.12 [1.11-1.13] *P*<0.001	1.05 [1.03-1.06] *P*<0.001	1.05 [1.03-1.06] *P*<0.001	1.05 [1.04-1.07] *P*<0.001
Second lowest	1.06 [1.05-1.07] *P*<0.001	1.08 [1.07-1.09] *P*<0.001	1.08 [1.07-1.10] *P*<0.001	1.09 [1.07-1.11] *P*<0.001
Lowest	1.12 [1.02-1.05] *P*<0.001	1.14 [1.13-1.16] *P*<0.001	1.12 [1.10-1.13] *P*<0.001	1.13 [1.11-1.14] *P*<0.001
Race				
White	*Reference Level*			
Black	1.05 [1.04-1.06] *P*<0.001	1.03 [1.02-1.04] *P*<0.001	0.91 [0.90-0.93] *P*<0.001	0.91 [0.89-0.92] *P*<0.001
Hispanic	1.01 [1.00-1.03] *P*<0.05	0.96 [0.95-0.98] *P*<0.001	0.95 [0.94-0.97] *P*<0.001	0.95 [0.93-0.96] *P*<0.001
Asian or Pacific Islander	1.21 [1.19-1.24] *P*<0.001	1.14 [1.11-1.16] *P*<0.001	1.06 [1.04-1.09] *P*<0.001	1.06 [1.03-1.08] *P*<0.001
Native American	1.17 [1.12-1.23] *P*<0.001	1.14 [1.09-1.20] *P*<0.001	1.08 [1.02-1.15] *P*<0.05	1.08 [1.02-1.15] *P*<0.05
Unspecified	1.17 [1.14-1.19] *P*<0.001	1.12 [1.10-1.14] *P*<0.001	1.10 [1.07-1.13] *P*<0.001	1.09 [1.06-1.12] *P*<0.001
Hospital region				
Northeast	*Reference Level*			
Midwest				0.90 [0.86-0.94] *P*<0.001
South				1.01 [0.97-1.05] *P*=0.667
West				0.98 [0.93-1.03] *P*=0.408

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Appendix 21: Baseline characteristics by socioeconomic status for hospital region with in-hospital mortality as the outcome

Patient-level characteristics, No. (%)	Overall (Weighted N = 2 798 225)	Northeast (Weighted n = 473 785)	Midwest (Weighted n = 582 340)	South (Weighted n = 1 096 190)	West (Weighted n = 496 275)
Age, mean ± SD (years)	70 ± 13.5	68.3 ± 13.5	67.2 ± 13.6	66.1 ± 13.4	67.4 ± 13.3
Sex					
Male	1 741 090 (62.2%)	301 755 (61.6%)	387 125 (61.5%)	708 230 (61.9%)	343 980 (64.5%)
Female	1 056 650 (37.8%)	187 935 (38.4%)	242 275 (38.5%)	436 890 (38.2%)	189 550 (35.5%)
Race					
White	1 984 150 (73.5%)	367 485 (76.4%)	495 235 (84.3%)	792 850 (70.8%)	328 580 (64.2%)
Black	307 775 (11.4%)	44 395 (9.2%)	59 325 (10.1%)	174 390 (15.6%)	29 665 (5.8%)
Hispanic	235 305 (8.7%)	32 140 (6.7%)	14 365 (2.5%)	103 425 (9.2%)	85 375 (16.7%)
Asian or Pacific Islander	75 370 (2.8%)	11 720 (2.4%)	6 880 (1.2%)	12 220 (1.1%)	44 550 (8.7%)
Native American	15 850 (0.6%)	985 (0.2%)	3 055 (0.5%)	5 760 (0.5%)	6 050 (1.2%)
Unspecified	80 690 (3.0%)	24 355 (5.1%)	8 470 (1.4%)	30 600 (2.7%)	17 265 (3.4%)
Quartiles of median household income by patient's ZIP code					
Highest	501 920 (18.3%)	151 365 (31.4%)	87 080 (14.0%)	128 915 (11.5%)	134 560 (26.0%)
Second highest	649 210 (23.6%)	130 845 (27.1%)	161 600 (25.9%)	209 950 (18.7%)	146 815 (28.4%)
Second lowest	752 535 (27.4%)	113 155 (23.5%)	203 910 (32.7%)	308 190 (27.5%)	127 280 (24.6%)
Lowest	843 600 (30.7%)	87 255 (18.1%)	171 590 (27.5%)	475 550 (42.4%)	109 205 (21.1%)
Died					
Yes	129 755 (4.6%)	23 175 (4.7%)	27 740 (4.4%)	52 190 (4.6%)	26 650 (5.0%)
No	2 666 615 (95.4%)	466 140 (95.3%)	601 535 (95.6%)	1 092 160 (95.4%)	506 780 (95.0%)
Comorbidities, No. (%)					
AIDS	12 370 (0.4%)	2 960 (0.6%)	1 690 (0.3%)	6 295 (0.6%)	1 425 (0.3%)
Alcohol abuse	101 325 (3.6%)	16 720 (3.4%)	23 550 (3.7%)	40 785 (3.6%)	20 270 (3.8%)
AMI type					
NSTEMI	1 976 555 (70.6%)	349 735 (71.4%)	441 295 (70.1%)	816 595 (71.3%)	368 930 (69.1%)
STEMI	821 670 (29.4%)	140 010 (28.6%)	188 160 (29.9%)	328 775 (28.7%)	164 725 (30.9%)
Arthropathies	81 740 (2.9%)	14 870 (3.0%)	19 940 (3.2%)	31 720 (2.8%)	15 210 (2.9%)
Chronic blood loss anemias	18 225 (0.7%)	2 970 (0.6%)	4 585 (0.7%)	7 315 (0.6%)	3 355 (0.6%)
Chronic pulmonary disease	585 050 (20.9%)	100 840 (20.6%)	146 235 (23.2%)	239 670 (20.9%)	98 305 (18.4%)
Coagulopathies	180 675 (6.5%)	28 380 (5.8%)	42 550 (6.8%)	71 995 (6.3%)	37 750 (7.1%)
Congestive heart failure	1 074 355 (38.4%)	186 210 (38.0%)	242 030 (38.5%)	436 910 (38.2%)	209 205 (39.2%)
Deficiency anemias	461 630 (16.5%)	73 090 (14.9%)	103 935 (16.5%)	191 655 (16.7%)	92 950 (17.4%)
Diabetes with chronic complications	586 760 (21.0%)	92 380 (18.9%)	135 300 (21.5%)	243 025 (21.2%)	116 055 (21.8%)
Diabetes without chronic complications	417 745 (14.9%)	77 795 (15.9%)	88 820 (14.1%)	179 600 (15.7%)	71 530 (13.4%)
Drug abuse	90 375 (3.2%)	13 685 (2.8%)	17 685 (2.8%)	36 465 (3.2%)	22 540 (4.2%)
Hypertension, complicated	909 475 (32.5%)	151 010 (30.8%)	209 400 (33.3%)	376 430 (32.9%)	172 635 (32.4%)
Hypertension, uncomplicated	1 105 845 (39.5%)	196 670 (40.2%)	245 965 (39.1%)	465 695 (40.7%)	197 515 (37.0%)
Hypothyroidism	341 160 (12.2%)	59 765 (12.2%)	83 250 (13.2%)	134 160 (11.7%)	63 985 (12.0%)
Liver disease, mild to moderate	85 260 (3.1%)	13 585 (2.8%)	17 880 (2.8%)	34 070 (3.0%)	19 725 (3.7%)
Liver disease, severe	12 485 (0.5%)	2 115 (0.4%)	2 645 (0.4%)	5 075 (0.4%)	2 650 (0.5%)
Lymphoma	16 180 (0.6%)	3 240 (0.7%)	3 815 (0.6%)	5 945 (0.5%)	3 180 (0.6%)
Metastatic cancer	37 910 (1.4%)	7 495 (1.5%)	8 815 (1.4%)	13 990 (1.2%)	7 610 (1.4%)
Obesity	515 880 (18.4%)	81 425 (16.6%)	132 795 (21.1%)	208 910 (18.2%)	92 750 (17.4%)
Other neurological disorders	124 180 (4.4%)	19 640 (4.0%)	29 140 (4.6%)	49 375 (4.3%)	26 025 (4.9%)
Paralysis	68 625 (2.5%)	11 525 (2.4%)	14 340 (2.3%)	28 560 (2.5%)	14 200 (2.7%)
Peptic ulcer with bleeding	22 425 (0.8%)	3 825 (0.8%)	5 070 (0.8%)	9 240 (0.8%)	4 290 (0.8%)
Peripheral vascular disease	272 050 (9.7%)	44 500 (9.1%)	64 790 (10.3%)	106 990 (9.3%)	55 770 (10.5%)
Previous cerebrovascular accident	35 015 (1.3%)	5 800 (1.2%)	7 670 (1.2%)	14 310 (1.3%)	7 235 (1.4%)
Previous coronary artery bypass graft	284 545 (10.2%)	46 640 (9.5%)	68 145 (10.8%)	120 910 (10.6%)	48 850 (9.2%)
Previous myocardial infarction	444 830 (15.9%)	71 610 (14.6%)	109 650 (17.4%)	171 430 (15.0%)	92 140 (17.3%)
Previous percutaneous coronary intervention	486 405 (17.4%)	82 185 (16.8%)	122 585 (19.5%)	193 070 (16.9%)	88 565 (16.6%)
Pulmonary circulation disease	152 735 (5.5%)	29 155 (6.0%)	36 695 (5.8%)	56 280 (4.9%)	30 605 (5.7%)
Renal failure, moderate	432 010 (15.4%)	72 210 (14.7%)	107 925 (17.2%)	168 690 (14.7%)	83 185 (15.6%)

Renal failure, severe	214 790 (7.7%)	37 210 (7.6%)	44 335 (7.0%)	87 300 (7.6%)	45 945 (8.6%)
Any smoking history	1 347 790 (48.2%)	226 365 (46.2%)	337 055 (53.6%)	548 940 (47.9%)	235 430 (44.1%)
Solid tumor without metastasis, malignant	53 890 (1.9%)	10 670 (2.2%)	12 315 (2.0%)	20 810 (1.8%)	10 095 (1.9%)
Valvular disease	411 475(14.7%)	82 080 (16.8%)	97 850 (15.6%)	155 325 (13.6%)	76 220 (14.3%)
Weight loss	94 355 (3.4%)	15 900 (3.3%)	22 940 (3.6%)	34 745 (3.0%)	20 770 (3.9%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	494 820 (17.7%)	92 690 (18.9%)	127 985 (20.3%)	198 080 (17.3%)	76 065 (14.3%)
Medium	853 335 (30.5%)	170 175 (34.8%)	143 875 (22.9%)	380 795 (33.3%)	158 490 (29.7%)
Large	1 450 070 (51.8%)	226 880 (46.3%)	357 595 (56.8%)	566 495 (49.5%)	299 100 (56.1%)
Hospital location/teaching status					
Rural	214 265 (7.7%)	26 740 (5.5%)	68 715 (10.9%)	101 120 (8.8%)	17 690 (3.3%)
Urban non-teaching	648 755 (23.2%)	64 175 (13.1%)	127 530 (20.3%)	301 235 (26.3%)	155 815 (29.2%)
Urban teaching	1 935 205 (69.2%)	398 830 (1.4%)	433 210 (68.8%)	743 015 (64.9%)	360 150 (67.5%)

Appendix 22: Unadjusted bivariate analyses for primary exposures of interest with in-hospital mortality as the outcome

	Model 0 Unadjusted Bivariate Analyses
Race	
White	*Reference Level*
Black	0.81 [0.80-0.83] *P*<0.001
Hispanic	0.87 [0.85-0.89] *P*<0.001
Asian or Pacific Islander	1.16 [1.13-1.20] *P*<0.001
Native American	0.93 [0.86-1.00] *P*=0.060
Unspecified	1.10 [1.06-1.13] *P*<0.001
Quartiles for median household income for patient ZIP code	
Highest	*Reference Level*
Second highest	0.97 [0.95-0.98] *P*<0.001
Second lowest	1.00 [0.98-1.02] *P*=0.934
Lowest	1.00 [0.98-1.02] *P=0.966*
Hospital region	
Northeast	*Reference Level*
Midwest	0.97 [0.92-1.02] *P*=0.229
South	0.97 [0.92-1.02] *P*=0.192
West	1.06 [1.00-1.12] *P*<0.05

Appendix 23: Logistic regression analyses results for primary exposures for hospital regions with in-hospital mortality as the outcome

VARIABLES	Northeast		Midwest		South		West	
	Model 3 Model 2 + Clinical History[a]	Model 4 Model 3 + Hospital Characteristics[b]	Model 3 Model 2 + Clinical History[a]	Model 4 Model 3 + Hospital Characteristics[b]	Model 3 Model 2 + Clinical History[a]	Model 4 Model 3 + Hospital Characteristics[b]	Model 3 Model 2 + Clinical History[a]	Model 4 Model 3 + Hospital Characteristics[b]
Quartiles for median household income for patient ZIP code								
Highest	*Reference Level*		*Reference Level*		*Reference Level*		*Reference Level*	
Second highest	1.02 [0.98-1.06] P=0.333	1.02 [0.98-1.06] P=0.307	0.95 [0.91-0.99] P<0.05	0.95 [0.91-1.00] P<0.05	1.06 [1.02-1.10] P<0.05	1.06 [1.02-1.10] P<0.05	1.05 [1.01-1.09] P<0.05	1.05 [1.01-1.09] P<0.05
Second lowest	1.00 [0.96-1.04] P=0.947	1.00 [0.96-1.04] P=0.940	1.01 [0.97-1.06] P=0.625	1.02 [0.97--1.06] P=0.507	1.12 [1.08-1.16] P<0.001	1.13 [1.09-1.17] P<0.001	1.10 [1.05-1.15] P<0.001	1.09 [1.05-1.14] P<0.001
Lowest	1.09 [1.04-1.14] P<0.001	1.09 [1.04-1.14] P<0.001	1.07 [1.02-1.12] P<0.05	1.07 [1.02-1.13] P<0.05	1.12 [1.08-1.16] P<0.001	1.13 [1.09-1.17] P<0.001	1.20 [1.14-1.25] P<0.001	1.19 [1.14-1.24] P<0.001
Race								
White	*Reference Level*		*Reference Level*		*Reference Level*		*Reference Level*	
Black	0.87 [0.82-0.93] P<0.001	0.87 [0.82-0.92] P<0.001	0.74 [70-0.78] P<0.001	0.73 [0.69-0.77] P<0.001	0.97 [0.94-1.00] P<0.05	0.96 [0.93-0.99] P<0.05	0.80 [0.75-0.86] P<0.001	0.80 [0.75-0.86] P<0.001
Hispanic	0.94 [0.88-1.00] P=0.059	0.93 [0.87-0.99] P<0.05	0.93 [0.84-1.02] P=0.123	0.92 [0.84-1.02] P=0.104	0.95 [0.91-0.98] P<0.05	0.94 [0.90-0.97] P<0.05	0.85 [0.81-0.89] P<0.001	0.85 [0.81-0.89] P<0.001
Asian or Pacific Islander	0.96 [0.87-1.06] P=0.383	0.95 [0.86-1.04] P=0.269	1.09 [0.97-1.23] P=0.150	1.09 [0.97-1.22] P=0.169	1.10 [1.01-1.20] P<0.05	1.10 [1.01-1.20] P<0.05	1.07 [1.01-1.12] P<0.05	1.07 [1.02-1.12] P<0.05
Native American	2.27 [1.75-2.95] P<0.001	2.26 [1.74-2.93] P<0.001	0.82 [0.65-1.03] P=0.087	0.82 [0.65-1.03] P=0.082	1.04 [0.91-1.20] P=0.570	1.06 [0.92-1.21] P=0.447	1.11 [0.97-1.28] P=0.129	1.12 [0.97-1.28] P=0.121
Unspecified	1.03 [0.96-1.10] P=0.437	1.02 [0.95-1.09] P=0.660	1.07 [0.96-1.20] P=0.236	1.07 [0.96-1.20] P=0.207	1.15 [1.08-1.22] P<0.001	1.14 [1.07-1.21] P<0.001	1.11 [1.03-1.20] P<0.05	1.10 [1.03-1.19] P<0.05

[a] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease

[b] Hospital bed size, hospital location/teaching status, hospital region

Appendix 24: Unadjusted bivariate analyses for primary exposures of interest with revascularization procedure use as the outcome

	Model 0 Unadjusted Bivariate Analyses
Race	
White	*Reference Level*
Black	0.62 [0.61-0.63] *P*<0.001
Hispanic	0.93 [0.92-0.94] *P*<0.001
Asian or Pacific Islander	1.03 [1.02-1.05] *P*<0.001
Native American	0.92 [0.89-0.95] *P*<0.001
Unspecified	1.23 [1.21-1.25] *P*<0.001
Quartiles for median household income for patient ZIP code	
Highest	*Reference Level*
Second highest	0.95 [0.94-0.95] *P<0.001*
Second lowest	0.86 [0.86-0.87] *P*<0.001
Lowest	0.76 [0.76-0.77] *P*<0.001
Hospital region	
Northeast	*Reference Level*
Midwest	1.40 [1.26-1.57] *P*<0.001
South	1.49 [1.34-1.65] *P*<0.001
West	1.58 [1.40-1.77] *P*<0.001

Appendix 25: All logistic regression analyses results for revascularization procedure use as the outcome

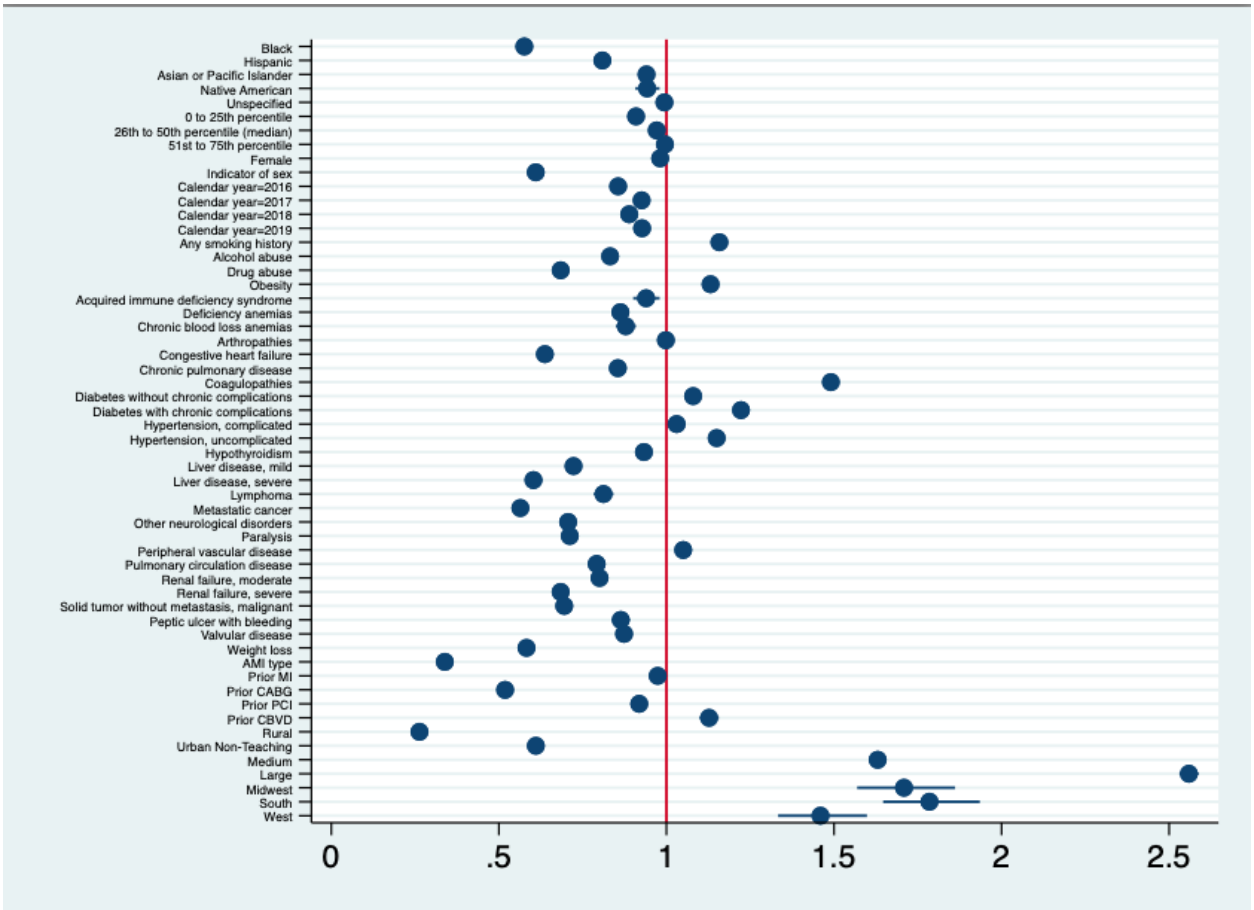
	Model 1	Model 2	Model 3	Model 4
	Sociodemographic Characteristics[a]	Model 1 + Lifestyle Factors[b]	Model 2 + Clinical History[c]	Model 3 + Hospital Characteristics[d]
Race				
White	*Reference Level*			
Black	0.55 [0.54-0.55] *P*<0.001	0.56 [0.55-0.56] *P*<0.001	0.62 [0.61-0.62] *P*<0.001	0.58 [0.57-0.58] *P*<0.001
Hispanic	0.83 [0.82-0.84] *P*<0.001	0.84 [0.84-0.85] *P*<0.001	0.86 [0.85-0.87] *P*<0.001	0.81 [0.80-0.82] *P*<0.001
Asian or Pacific Islander	0.93 [0.91-0.94] *P*<0.001	0.94 [0.92-0.96] *P*<0.001	0.98 [0.96-1.00] *P*<0.05	0.94 [0.92-0.96] *P*<0.001
Native American	0.83 [0.80-0.86] *P*<0.001	0.83 [0.80-0.86] *P*<0.001	0.91 [0.88-0.95] *P*<0.001	0.94 [0.91-0.98] *P*<0.05
Unspecified	1.07 [1.06-1.09] *P*<0.001	1.08 [1.07-1.10] *P*<0.001	1.07 [1.05-1.09] *P*<0.001	0.99 [0.98-1.01] *P*=0.486
Quartiles for median household income for patient ZIP code				
Highest	*Reference Level*			
Second highest	0.94 [0.94-0.95] *P*<0.001	0.94 [0.93-0.95] *P*<0.001	0.98 [0.97-0.98] *P*<0.001	1.00 [0.99-1.00] *P*=0.337
Second lowest	0.87 [0.86-0.88] *P*<0.001	0.87 [0.86-0.88] *P*<0.001	0.92 [0.91-0.93] *P*<0.001	0.97 [0.96-0.98] *P*<0.001
Lowest	0.80 [0.79-0.81] *P*<0.001	0.80 [0.79-0.80] *P*<0.001	0.86 [0.85-0.87] *P*<0.001	0.91 [0.90-0.92] *P*<0.001
Age	0.97 [0.97-0.97] *P*<0.001	0.97 [0.97-0.97] P<0.001	0.98 [0.98-0.98] P<0.001	0.98 [0.98-0.98] P<0.001
Indicator of sex				
Male	*Reference Level*			
Female	0.61 [0.61-0.62] *P*<0.001	0.61 [0.61-0.62] P<0.001	0.61 [0.61-0.61] P<0.001	0.61 [0.61-0.61] P<0.001
Year				
2015	*Reference Level*			
2016	0.86 [0.85-0.88] *P*<0.001	0.85 [0.84-0.87] P<0.001	0.81 [0.79-0.82] P<0.001	0.86 [0.84-0.87] P<0.001
2017	0.87 [0.85-0.88] *P*<0.001	0.87 [0.86-0.88] P<0.001	0.88 [0.87-0.89] P<0.001	0.93 [0.91-0.94] P<0.001
2018	0.92 [0.91-0.93] *P*<0.001	0.91 [0.89-0.92] P<0.001	0.84 [0.82-0.85] P<0.001	0.89 [0.88-0.90] P<0.001
2019	0.95 [0.94-0.97] *P*<0.001	0.94 [0.93-0.96] P<0.001	0.87 [0.86-0.88] P<0.001	0.93 [0.91-0.94] P<0.001
Any smoking history		1.13 [1.12-1.13] P<0.001	1.16 [1.16-1.17] P<0.001	1.16 [1.15-1.16] P<0.001
Alcohol abuse		0.81 [0.80-0.82] P<0.001	0.83 [0.82-0.84] P<0.001	0.83 [0.82-0.84] P<0.001
Drug abuse		0.66 [0.65-0.67] P<0.001	0.69 [0.68-0.70] P<0.001	0.68 [0.67-0.70] P<0.001
Obesity		1.07 [1.06-1.07] P<0.001	1.14 [1.13-1.14] P<0.001	1.13 [1.12-1.14] P<0.001
AIDS			0.99 [0.95-1.03] P=0.635	0.94 [0.90-0.98] P<0.05

Deficiency anemias		0.87 [0.86-0.87] P<0.001	0.86 [0.86-0.87] P<0.001
Chronic blood loss anemias		0.88 [0.86-0.91] P<0.001	0.88 [0.85-0.91] P<0.001
Arthropathies		1.00 [0.98-1.01] P=0.830	1.00 [0.98-1.01] P=0.843
Congestive heart failure		0.65 [0.65-0.65] P<0.001	0.64 [0.63-0.64] P<0.001
Chronic pulmonary disease		0.84 [0.84-0.85] P<0.001	0.86 [0.85-0.86] P<0.001
Coagulopathies		1.54 [1.53-1.56] P<0.001	1.49 [1.47-1.51] P<0.001
Diabetes without chronic complications		1.07 [1.06-1.08] P<0.001	1.08 [1.07-1.09] P<0.001
Diabetes with chronic complications		1.22 [1.21-1.23] P<0.001	1.22 [1.21-1.23] P<0.001
Hypertension, complicated		1.03 [1.02-1.04] P<0.001	1.03 [1.02-1.04] P<0.001
Hypertension, uncomplicated		1.15 [1.14-1.15] P<0.001	1.15 [1.14-1.16] P<0.001
Hypothyroidism		0.93 [0.92-0.94] P<0.001	0.93 [0.92-0.94] P<0.001
Liver disease, mild to moderate		0.73 [0.72-0.75] P<0.001	0.72 [0.71-0.73] P<0.001
Liver disease, severe		0.61 [0.58-0.64] P<0.001	0.60 [0.58-0.63] P<0.001
Lymphoma		0.84 [0.81-0.87] P<0.001	0.81 [0.78-0.84] P<0.001
Metastatic cancer		0.59 [0.57-0.60] P<0.001	0.56 [0.55-0.58] P<0.001
Other neurological disorders		0.72 [0.71-0.73] P<0.001	0.71 [0.70-0.72] P<0.001
Paralysis		0.72 [0.71-0.73] P<0.001	0.71 [0.70-0.72] P<0.001
Peripheral vascular disease		1.06 [1.05-1.07] P<0.001	1.05 [1.04-1.06] P<0.001
Pulmonary circulation disease		0.79 [0.78-0.80] P<0.001	0.79 [0.78-0.80] P<0.001
Renal failure, moderate		0.80 [0.80-0.81] P<0.001	0.80 [0.79-0.81] P<0.001
Renal failure, severe		0.69 [0.68-0.70] P<0.001	0.68 [0.68-0.69] P<0.001
Solid tumor without metastasis, malignant		0.70 [0.69-0.72] P<0.001	0.70 [0.68-0.71] P<0.001

Peptic ulcer with bleeding		0.88 [0.86-0.91] P<0.001	0.86 [0.84-0.89] P<0.001
Valvular disease		0.89 [0.88-0.89] P<0.001	0.87 [0.87-0.88] P<0.001
Weight loss		0.59 [0.58-0.60] P<0.001	0.58 [0.57-0.59] P<0.001
AMI type			
STEMI	*Reference Level*		
NSTEMI		0.34 [0.33-0.34] P<0.001	0.34 [0.34-34] P<0.001
Prior MI		0.99 [0.98-1.00] P<0.05	0.97 [0.97-0.98] P<0.001
Prior CABG		0.52 [0.52-0.53] P<0.001	0.52 [0.51-0.52] P<0.001
Prior PCI		0.92 [0.92-0.93] P<0.001	0.92 [0.91-0.93] P<0.001
Prior CBVD		1.16 [1.13-1.19] P<0.001	1.13 [1.10-1.16] P<0.001
Hospital location/teaching status			
Urban teaching	*Reference Level*		
Rural			0.26 [0.26-0.27] P<0.001
Urban non-teaching			0.61 [0.60-0.62] P<0.001
Hospital bed size			
Small	*Reference Level*		
Medium			1.63 [1.61-1.65] P<0.001
Large			2.56 [2.53-2.59] P<0.001
Hospital region			
Northeast	*Reference Level*		
Midwest			1.71 [1.57-1.86] *P*<0.001
South			1.78 [1.65-1.94] *P*<0.001
West			1.46 [1.33-1.60] *P*<0.001

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Appendix 26: Coefficient plot for adjusted logistic regression analysis results for revascularization procedure use as the outcome



Appendix 27: Logistic regression interaction analyses results for socioeconomic status and race and socioeconomic status and region with revascularization procedure use as the outcome

VARIABLES	**Median Household Income for Patient ZIP Code**			
	Lowest	Second Lowest	Second Highest	Highest
Hospital Region				
Northeast		*Reference Level*		
Midwest	0.94 [0.91-0.97] *P*<0.001	0.96 [0.93-0.98] *P*<0.05	0.94 [0.91-0.97] *P*<0.001	*Reference Level*
South	0.99 [0.96-1.02] *P*=0.430	0.96 [0.93-0.98] *P*<0.05	0.96 [0.94-0.99] *P*<0.05	
West	0.88 [0.85-0.91] *P*<0.001	0.91 [0.88-0.93] *P*<0.001	0.90 [0.88-0.93] *P*<0.001	
Race				
White		*Reference Level*		
Black	0.98 [0.95-1.01] *P*=0.180	0.96 [0.93-0.99] *P*<0.05	0.99 [0.95-1.02] *P*=0.409	
Hispanic	0.90 [0.88-0.93] *P*<0.001	0.93 [0.90-0.96] *P*<0.001	0.98 [0.94-1.01] *P*=0.151	*Reference Level*
Asian or Pacific Islander	0.97 [0.91-1.02] *P*=0.204	0.95 [0.90-0.99] *P*<0.05	0.90 [0.86-0.94] *P*<0.001	
Native American	1.03 [0.90-1.17] *P*=0.696	1.02 [0.88-1.17] *P*=0.833	1.04 [0.90-1.22] *P*=0.574	
Unspecified	0.79 [0.75-0.83] *P*<0.001	0.89 [0.85-0.94] *P*<0.001	0.89 [0.84-0.93] *P*<0.001	

Appendix 28: Baseline characteristics by socioeconomic status among patients with ST-segment elevation myocardial infarction

	Overall (Weighted N = 821 670)	0-25th percentile (Lowest) (Weighted n = 234 225)	26th-50th percentile (Weighted n = 219 790)	51st-75th percentile (Weighted n = 195 195)	76th-100th percentile (Highest) (Weighted n = 156 670)
Patient-level characteristics, No. (%)					
Age, mean SD (years)	64.2 ± 13.4	63.2 ± 13.4	64.2 ± 13.3	64.5 ± 13.3	65.4 ± 13.4
Sex					
Male	555 540 (67.6%)	152 180 (65.0%)	147 430 (67.1%)	133 905 (68.6%)	110 680 (70.7%)
Female	266 005 (32.4%)	82 020 (35.0%)	72 325 (32.9%)	61 260 (31.4%)	45 975 (29.4%)
Race					
White	589 195 (74.9%)	150 820 (66.8%)	165 390 78.7%)	146 595 (78.7%)	116 025 (77.2%)
Black	75 430 (9.6%)	39 180 (17.3%)	16 315 (7.8%)	11 610 (6.2%)	7 055 (4.7%)
Hispanic	67 760 (8.6%)	24 370 (10.8%)	16 915 (8.1%)	15 165 (8.1%)	9 600 (6.4%)
Asian or Pacific Islander	22 830 (2.9%)	2 760 (1.2%)	4 085 (2.0%)	5 810 (3.1%)	9 860 (6.6%)
Native American	4 445 (0.6%)	1 885 (0.8%)	1 105 (0.5%)	705 (0.4%)	455 (0.3%)
Unspecified	27 235 (3.5%)	6 915 (3.1%)	5 765 (2.8%)	6 480 (3.5%)	7 270 (4.8%)
Comorbidities, No. (%)					
AIDS	3 795 (0.5%)	1 475 (0.6%)	1 020 (0.5%)	710 (0.4%)	475 (0.3%)
Alcohol abuse	31 150 (3.8%)	9 820 (4.2%)	8 405 (3.8%)	7 060 (3.6%)	5 110 (3.3%)
Arthropathies	21 860 (2.7%)	5 910 (2.5%)	5 870 (2.7%)	5 125 (2.6%)	4 480 (2.9%)
Chronic blood loss anemias	4 290 (0.5%)	1 360 (0.6%)	1 030 (0.5%)	970 (0.5%)	820 (0.5%)
Chronic pulmonary disease	143 490 (17.5%)	46 630 (19.9%)	40 800 (18.6%)	31 545 (16.2%)	21 815 (13.9%)
Coagulopathies	46 030 (5.6%)	12 385 (5.3%)	11 890 (5.4%)	11 080 (5.7%)	9 650 (6.2%)
Congestive heart failure	280 285 (34.1%)	83 650 (35.7%)	74 020 (33.7%)	64 855 (33.2%)	52 215 (33.3%)
Deficiency anemias	91 920 (11.2%)	29 015 (12.4%)	23 410 (10.7%)	20 650 (10.6%)	17 085 (10.9%)
Diabetes with chronic complications	135 405 (16.5%)	42 405 (18.1%)	36 885 (16.8%)	30 520 (15.6%)	22 955 (14.7%)
Diabetes without chronic complications	117 565 (14.3%)	36 085 (15.4%)	32 195 (14.7%)	27 385 (14.0%)	19 705 (12.6%)
Drug abuse	27 550 (3.4%)	10 620 (4.5%)	7 070 (3.2%)	5 675 (2.9%)	3 425 (2.2%)
Hypertension, complicated	213 150 (26.0%)	65 040 (27.8%)	56 625 (25.8%)	49 360 (25.3%)	38 165 (24.4%)
Hypertension, uncomplicated	339 460 (41.3%)	98 280 (42.0%)	91 270 (41.5%)	80 675 (41.3%)	62 780 (40.1%)
Hypothyroidism	84 595 (2.7%)	22 430 (9.6%)	23 115 (10.5%)	20 265 (10.4%)	17 125 (10.9%)
Liver disease, mild to moderate	21 980 (2.7%)	7 410 (3.2%)	5 745 (2.6%)	4 685 (2.4%)	3 695 (2.4%)
Liver disease, severe	3 155 (0.4%)	1 010 (0.4%)	915 (0.4%)	605 (0.3%)	560 (0.4%)
Lymphoma	4 135 (0.5%)	975 (0.4%)	965 (0.4%)	1 170 (0.6%)	945 (0.6%)
Metastatic cancer	10 665 (1.3%)	2 910 (1.2%)	2 690 (1.2%)	2 540 (1.3%)	2 350 (1.5%)
Obesity	137 565 (16.7%)	40 015 (17.1%)	37 610 (17.1%)	33 345 (17.1%)	24 155 (15.4%)
Other neurological disorders	38 495 (4.7%)	11 310 (4.8%)	10 095 (4.6%)	9 060 (4.6%)	7 345 (4.7%)
Paralysis	15 565 (1.9%)	5 455 (2.3%)	3 935 (1.8%)	3 350 (1.7%)	2 500 (1.6%)
Peptic ulcer with bleeding	5 605 (0.7%)	1 870 (0.8%)	1 470 (0.7%)	1 170 (0.6%)	980 (0.6%)
Peripheral vascular disease	64 075 (7.8%)	18 385 (7.9%)	17 010 (7.7%)	15 600 (8.0%)	11 865 (7.6%)
Previous cerebrovascular accident	12 140 (1.5%)	3 710 (1.6%)	3 060 (1.4%)	2 905 (1.5%)	2 180 (1.4%)
Previous coronary artery bypass graft	42 135 (5.1%)	12 960 (5.5%)	11 945 (5.4%)	9 375 (4.8%)	7 100 (4.5%)
Previous myocardial infarction	99 515 (12.1%)	29 735 (12.7%)	26 485 (12.1%)	23 815 (12.2%)	17 680 (11.3%)
Previous percutaneous coronary intervention	111 825 (13.6%)	33 235 (14.2%)	30 055 (13.7%)	26 270 (13.5%)	20 395 (13.0%)
Pulmonary circulation disease	27 015 (3.3%)	8 210 (3.5%)	7 010 (3.2%)	6 355 (3.3%)	4 950 (3.2%)

Renal failure, moderate	85 265 (10.4%)	25 180 (10.8%)	22 795 (10.4%)	19 900 (10.2%)	15 955 (10.2%)
Renal failure, severe	33 485 (4.1%)	11 100 (4.7%)	8 840 (4.0%)	7 435 (3.8%)	5 625 (3.6%)
Any smoking history	410 975 (50.0%)	126 910 (54.2%)	114 765 (52.2%)	95 075 (48.7%)	66 485 (42.2%)
Solid tumor without metastasis, malignant	14 450 (1.8%)	4 080 (1.7%)	3 815 (1.7%)	3 455 (1.8%)	2 830 (1.8%)
Valvular disease	83 450 (10.2%)	22 870 (9.8%)	22 215 (10.1%)	20 145 (10.3%)	16 750 (10.7%)
Weight loss	23 220 (2.8%)	7 395 (3.2%)	6 050 (2.8%)	5 180 (2.7%)	4 210 (2.7%)
Procedures, No. (%)					
Coronary artery bypass graft (CABG)	40 850 (5.0%)	11 725 (5.0%)	11 560 (5.3%)	9 390 (4.8%)	7 275 (4.6%)
Percutaneous coronary intervention (PCI)	591 720 (72.0%)	163 540 (69.8%)	157 985 (71.9%)	143 890 (73.7%)	114 930 (73.4%)
Revascularization procedures	621 970 (75.7%)	172 210 (73.5%)	166 550 (75.8%)	150 805 (77.3%)	120 360 (76.8%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	132 450 (16.1%)	30 965 (13.2%)	36 140 (16.4%)	34 360 (17.6%)	28 430 (18.2%)
Medium	246 190 (30.0%)	66 345 (28.3%)	62 695 (28.5%)	59 005 (30.2%)	53 520 (34.2%)
Large	443 030 (53.9%)	136 915 (58.5%)	120 955 (55.0%)	101 830 (52.2%)	74 720 (47.7%)
Hospital region					
Northeast	140 010 (17.0%)	23 895 (10.2%)	31 750 (14.5%)	37 345 (19.1%)	44 775 (28.6%)
Midwest	188 160 (22.9%)	48 970 (20.9%)	60 140 (27.4%)	49 425 (25.3%)	28 010 (17.9%)
South	328 775 (40.0%)	129 665 (55.4%)	89 050 (40.5%)	62 420 (32.0%)	40 860 (26.1%)
West	164 725 (20.1%)	31 695 (13.5%)	38 850 (17.7%)	46 005 (23.6%)	43 025 (27.5%)
Hospital location/teaching status					
Rural	56 075 (6.8%)	30 475 (13.0%)	18 140 (8.3%)	5 160 (2.6%)	1 005 (0.6%)
Urban non-teaching	184 625 (22.5%)	45 115 (29.3%)	53 090 (24.2%)	45 490 (23.3%)	37 440 (23.9%)
Urban teaching	580 970 (70.7%)	158 635 (67.7%)	148 560 (67.6%)	144 545 (74.1%)	118 225 (75.5%)

Appendix 29: Unadjusted bivariate analyses for primary exposures of interest among ST-segment elevation myocardial infarction patients with revascularization procedure use as the outcome

	Model 0 Unadjusted Bivariate Analyses
Race	
White	*Reference Level*
Black	0.56 [0.55-0.57] *P*<0.001
Hispanic	0.93 [0.91-0.95] *P*<0.001
Asian or Pacific Islander	1.05 [1.02-1.09] *P*<0.001
Native American	0.77 [0.72-0.83] *P*<0.001
Unspecified	1.18 [1.15-1.22] *P*<0.001
Quartiles for median household income for patient ZIP code	
Highest	*Reference Level*
Second highest	0.95 [0.93-0.97] *P*<0.001
Second lowest	0.84 [0.83-0.86] *P*<0.001
Lowest	0.74 [0.73-0.75] *P*<0.001
Hospital region	
Northeast	*Reference Level*
Midwest	1.47 [1.32-1.63] *P*<0.001
South	1.48 [1.34-1.63] *P*<0.001
West	1.34 [1.79-2.12] *P*<0.001

Appendix 30: All logistic regression analyses results for ST-elevation myocardial infarction patients with revascularization procedure use as the outcome

	Model 1	Model 2	Model 3	Model 4
	Sociodemographic Characteristics[a]	Model 1 + Lifestyle Factors[b]	Model 2 + Clinical History[c]	Model 3 + Hospital Characteristics[d]
Race				
White	*Reference Level*			
Black	0.50 [0.49-0.51] *P*<0.001	0.51 [0.50-0.52] *P*<0.001	0.57 [0.56-0.58] *P*<0.001	0.54 [0.53-0.55] *P*<0.001
Hispanic	0.83 [0.81-0.85] *P*<0.001	0.85 [0.83-0.87] *P*<0.001	0.87 [0.85-0.89] *P*<0.001	0.83 [0.81-0.85] *P*<0.001
Asian or Pacific Islander	0.93 [0.90-0.97] *P*<0.001	0.95 [0.91-0.98] *P*<0.05	1.00 [0.97-1.04] *P*=0.897	0.98 [0.94-1.01] *P*=0.217
Native American	0.69 [0.64-0.74] *P*<0.001	0.69 [0.64-0.75] *P*<0.001	0.73 [0.67-0.79] *P*<0.001	0.74 [0.69-0.81] *P*<0.001
Unspecified	1.01 [0.98-1.05] *P*=0.396	1.03 [0.99-1.06] *P*=0.111	1.07 [1.03-1.11] *P*<0.001	1.02 [0.98-1.05] *P*=0.352
Quartiles for median household income for patient ZIP code				
Richest	*Reference Level*			
Second richest	0.95 [0.94-0.97] *P*<0.001	0.95 [0.93-0.97] *P*<0.001	0.97 [0.95-0.99] *P*<0.05	0.98 [0.96-1.00] *P*<0.05
Second poorest	0.85 [0.84-0.87] *P*<0.001	0.85 [0.83-0.86] *P*<0.001	0.88 [0.86-0.90] *P*<0.001	0.92 [0.90-0.94] *P*<0.001
Poorest	0.78 [0.77-0.80] *P*<0.001	0.78 [0.76-0.79] *P*<0.001	0.83 [0.82-0.85] *P*<0.001	0.88 [0.86-0.90] *P*<0.001
Age	0.96 [0.96-0.96] P<0.001	0.97 [0.96-0.97] P<0.001	0.98 [0.98-0.98] P<0.001	0.98 [0.98-0.98] P<0.001
Indicator of sex				
Male	*Reference Level*			
Female	0.60 [0.59-0.61] P<0.001	0.60 [0.59-0.61] P<0.001	0.59 [0.58-0.60] P<0.001	0.59 [0.59-0.60] P<0.001
Year				
2015	*Reference Level*			
2016	0.91 [0.88-0.94] P<0.001	0.90 [0.87-0.93] P<0.001	0.85 [0.82-0.88] P<0.001	0.88 [0.85-0.92] P<0.001
2017	0.86 [0.83-0.89] P<0.001	0.87 [0.84-0.90] P<0.001	0.89 [0.86-0.92] P<0.001	0.93 [0.90-0.96] P<0.001
2018	0.51 [0.49-0.52] P<0.001	0.50 [0.48-0.52] P<0.001	0.53 [0.51-0.55] P<0.001	0.57 [0.55-0.59] P<0.001
2019	0.54 [0.52-0.56] P<0.001	0.54 [0.52-0.55] P<0.001	0.57 [0.55-0.59] P<0.001	0.62 [0.60-0.64] P<0.001
Any smoking history		1.25 [1.24-1.27] P<0.001	1.30 [1.28-1.31] P<0.001	1.29 [1.27-1.31] P<0.001
Alcohol abuse		0.73 [0.71-0.75] P<0.001	0.76 [0.74-0.79] P<0.001	0.77 [0.74-0.79] P<0.001
Drug abuse		0.60 [0.59-0.62] P<0.001	0.63 [0.61-0.65] P<0.001	0.63 [0.61-0.65] P<0.001
Obesity		1.00 [0.98-1.02] P=0.977	1.07 [1.05-1.08] P<0.001	1.06 [1.04-1.08] P<0.001
AIDS			1.07 [0.98-1.17] P=0.128	1.03 [0.95-1.12] P=0.502
Deficiency anemias			0.77 [0.75-0.78] P<0.001	0.77 [0.75-0.78] P<0.001

Chronic blood loss anemias		0.72 [0.67-0.77] P<0.001	0.71 [0.66-0.77] P<0.001
Arthropathies		0.95 [0.91-0.98] P<0.05	0.95 [0.92-0.98] P<0.05
Congestive heart failure		0.66 [0.65-0.67] P<0.001	0.65 [0.65-0.66] P<0.001
Chronic pulmonary disease		0.73 [0.72-0.75] P<0.001	0.74 [0.73-0.75] P<0.001
Coagulopathies		1.15 [1.12-1.18] P<0.001	1.11 [1.09-1.14] P<0.001
Diabetes without chronic complications		1.06 [1.04-1.08] P<0.001	1.06 [1.04-1.08] P<0.001
Diabetes with chronic complications		1.06 [1.04-1.08] P<0.001	1.06 [1.04-1.08] P<0.001
Hypertension, complicated		0.92 [0.90-0.94] P<0.001	0.92 [0.90-0.93] P<0.001
Hypertension, uncomplicated		1.17 [1.15-1.19] P<0.001	1.17 [1.15-1.19] P<0.001
Hypothyroidism		0.88 [0.86-0.90] P<0.001	0.88 [0.86-0.90] P<0.001
Liver disease, mild to moderate		0.70 [0.67-0.72] P<0.001	0.69 [0.67-0.71] P<0.001
Liver disease, severe		0.64 [0.58-0.69] P<0.001	0.63 [0.58-0.69] P<0.001
Lymphoma		0.78 [0.72-0.84] P<0.001	0.76 [0.70-0.82] P<0.001
Metastatic cancer		0.52 [0.50-0.55] P<0.001	0.51 [0.49-0.54] P<0.001
Other neurological disorders		0.67 [0.65-0.68] P<0.001	0.65 [0.64-0.67] P<0.001
Paralysis		0.60 [0.57-0.62] P<0.001	0.59 [0.57-0.62] P<0.001
Peripheral vascular disease		0.93 [0.91-0.95] P<0.001	0.93 [0.91-0.94] P<0.001
Pulmonary circulation disease		0.65 [0.63-0.67] P<0.001	0.66 [0.64-0.67] P<0.001
Renal failure, moderate		0.75 [0.73-0.76] P<0.001	0.75 [0.73-0.76] P<0.001
Renal failure, severe		0.51 [0.50-0.52] P<0.001	0.51 [0.49-0.52] P<0.001
Solid tumor without metastasis, malignant		0.64 [0.62-0.67] P<0.001	0.64 [0.61-0.67] P<0.001
Peptic ulcer with bleeding		0.87 [0.82-0.93] P<0.001	0.86 [0.81-0.92] P<0.001
Valvular disease		0.78 [0.77-0.80] P<0.001	0.77 [0.76-0.79] P<0.001
Weight loss		0.52 [0.51-0.54] P<0.001	0.52 [0.50-0.54] P<0.001
Prior MI		0.98 [0.96-1.00] P<0.05	0.97 [0.95-0.99] P<0.05
Prior CABG		0.37 [0.37-0.38] P<0.001	0.38 [0.37-0.39] P<0.001
Prior PCI		0.74 [0.73-0.76] P<0.001	0.74 [0.73-0.76] P<0.001
Prior CBVD		1.23 [1.17-1.28] P<0.001	1.20 [1.14-1.25] P<0.001

Hospital location/teaching status		
Urban teaching	*Reference Level*	
Rural		0.34 [0.32-0.35] P<0.001
Urban non-teaching		0.80 [0.79-0.82] P<0.001
Hospital bed size		
Small	*Reference Level*	
Medium		1.48 [1.44-1.52] P<0.001
Large		1.96 [1.92-2.01] P<0.001
Hospital region		
Northeast	*Reference Level*	
Midwest		1.64 [1.49-1.80] *P*<0.001
South		1.64 [1.50-1.79] *P*<0.001
West		1.26 [1.14-1.39] *P*<0.001

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Appendix 31: Baseline characteristics by socioeconomic status among patients with non-ST-segment elevation myocardial infarction

	Overall (Weighted N = 1 976 555)	0-25th percentile (Lowest) (Weighted n = 609 375)	26th-50th percentile (Weighted n = 532 745)	51st-75th percentile (Weighted n = 454 015)	76th-100th percentile (Highest) (Weighted n = 345 250)
Patient-level characteristics, No. (%)					
Age, mean SD (years)	68.1 ± 13.3	66.9 ± 13.4	68.2 ± 13.3	68.6 ± 13.3	69.6 ± 13.3
Sex					
Male	1 185 550 (60.0%)	350 145 (57.5%)	317 500 (59.6%)	278 165 (61.3%)	216 700 (62.8%)
Female	790 645 (40.0%)	259 090 (42.5%)	215 165 (40.4%)	175 780 (38.7%)	128 505 (37.2%)
Race					
White	1 394 955 (73.0%)	375 955 (63.4%)	397 935 (77.6%)	340 100 (77.7%)	257 515 (76.9%)
Black	232 345 (12.2%)	124 240 (21.0%)	48 670 (9.5%)	34 355 (7.8%)	21 155 (6.3%)
Hispanic	167 545 (8.8%)	65 800 (11.1%)	42 415 (8.3%)	34 480 (7.9%)	21 335 (6.4%)
Asian or Pacific Islander	52 540 (2.8%)	6 960 (1.2%)	9 375 (1.8%)	14 545 (3.3%)	21 010 (6.3%)
Native American	11 405 (0.6%)	5 400 (0.9%)	2 625 (0.5%)	1 670 (0.4%)	960 (0.3%)
Unspecified	53 433 (2.8%)	14 800 (2.5%)	11 745 (2.3%)	12 830 (2.9%)	12 745 (3.8%)
Comorbidities, No. (%)					
AIDS	8 575 (0.4%)	3 375 (0.6%)	2 045 (0.4%)	1 580 (0.4%)	1 230 (0.4%)
Alcohol abuse	70 175 (3.6%)	23 730 (3.9%)	19 010 (3.6%)	15 830 (3.5%)	10 065 (2.9%)
Arthropathies	59 880 (3.0%)	17 565 (2.9%)	16 110 (3.0%)	13 895 (3.1%)	11 415 (3.3%)
Chronic blood loss anemias	13 935 (0.7%)	4 350 (0.7%)	3 815 (0.7%)	3 195 (0.7%)	2 355 (0.7%)
Chronic pulmonary disease	441 560 (22.3%)	153 350 (25.2%)	123 960 (23.3%)	93 960 (20.6%)	62 520 (18.1%)
Coagulopathies	134 645 (6.8%)	40 060 (6.6%)	35 450 (6.7%)	32 105 (7.1%)	24 605 (7.1%)
Congestive heart failure	794 070 (40.2%)	259 785 (42.6%)	214 970 (40.4%)	176 545 (38.9%)	128 655 (37.3%)
Deficiency anemias	369 710 (18.7%)	122 955 (20.2%)	97 230 (18.3%)	81 685 (18.0%)	61 610 (17.9%)
Diabetes with chronic complications	451 355 (22.8%)	149 045 (24.5%)	121 425 (22.8%)	101 920 (22.5%)	71 620 (20.7%)
Diabetes without chronic complications	300 180 (15.2%)	99 560 (16.3%)	82 380 (15.5%)	65 630 (14.5%)	47 185 (13.7%)
Drug abuse	62 825 (3.2%)	24 695 (4.1%)	16 360 (3.1%)	12 460 (2.7%)	7 625 (2.2%)
Hypertension, complicated	696 325 (35.2%)	225 870 (37.1%)	188 190 (35.3%)	155 975 (34.4%)	114 160 (33.1%)
Hypertension, uncomplicated	766 385 (38.8%)	235 050 (38.6^%)	206 615 (38.8%)	176 975 (39.0%)	134 130 (38.9%)
Hypothyroidism	256 656 (13.0%)	74 860 (12.3%)	71 190 (13.4%)	59 805 (13.2%)	46 460 (13.5%)
Liver disease, mild to moderate	63 280 (3.2%)	22 025 (3.6%)	16 310 (3.1%)	13 890 (3.1%)	9 535 (2.8%)
Liver disease, severe	9 330 (0.5%)	3 025 (0.5%)	2 595 (0.5%)	2 030 (0.5%)	1 455 (0.4%)
Lymphoma	12 045 (0.6%)	3 260 (0.5%)	3 040 (0.6%)	3 025 (0.7%)	2 549 (0.7%)
Metastatic cancer	27 245 (1.4%)	7 840 (1.3%)	7 265 (1.4%)	6 215 (1.4%)	5 455 (1.6%)
Obesity	378 315 (19.1%)	119 915 (19.7%)	105 710 (19.8%)	87 430 (19.3%)	58 865 (17.1%)
Other neurological disorders	85 685 (4.3%)	26 560 (4.4%)	23 015 (4.3%)	19 465 (4.3%)	15 195 (4.4%)
Paralysis	53 060 (2.7%)	19 165 (3.2%)	13 665 (2.6%)	11 040 (2.4%)	8 205 (2.4%)
Peptic ulcer with bleeding	16 820 (0.9%)	5 415 (0.9%)	4 490 (0.8%)	3 670 (0.8%)	2 920 (0.9%)
Peripheral vascular disease	207 975 (10.5%)	62 795 (10.3%)	56 570 (10.6%)	48 630 (10.7%)	36 435 (10.6%)
Previous cerebrovascular accident	22 875 (1.2%)	7 395 (1.2%)	5 965 (1.1%)	5 155 (1.1%)	3 930 (1.1%)
Previous coronary artery bypass graft	242 410 (12.3%)	75 455 (12.4%)	68 320 (12.8%)	54 880 (12.1%)	39 820 (11.5%)
Previous myocardial infarction	345 315 (17.5%)	107 120 (17.6%)	93 890 (17.6%)	79 720 (17.6%)	58 685 (17.0%)
Previous percutaneous coronary intervention	374 580 (19.0%)	116 305 (19.1%)	103 960 (19.5%)	85 230 (18.8%)	62 695 (18.2%)

Pulmonary circulation disease	125 720 (6.4%)	39 495 (6.5%)	33 985 (6.4%)	28 830 (6.4%)	21 215 (6.1%)
Renal failure, moderate	346 645 (17.5%)	106 915 (17.6%)	95 155 (17.9%)	79 490 (17.5%)	59 315 (17.2%)
Renal failure, severe	181 305 (9.2%)	62 400 (10.2%)	47 370 (8.9%)	39 645 (8.7%)	28 990 (8.4%)
Any smoking history	936 815 (47.4%)	304 135 (49.9%)	259 675 (48.7%)	210 990 (46.5%)	145 480 (42.1%)
Solid tumor without metastasis, malignant	39 440 (2.0%)	11 455 (1.9%)	10 615 (2.0%)	9 165 (2.0%)	7 6615 (2.2%)
Valvular disease	328 025 (16.6%)	93 505 (15.3%)	90 075 (16.9%)	77 785 (17.1%)	61 125 (17.7%)
Weight loss	71 135 (3.6%)	24 040 (4.0%)	18 815 (3.5%)	15 500 (3.4%)	11 375 (3.3%)
Procedures, No. (%)					
Coronary artery bypass graft (CABG)	204 535 (10.4%)	60 460 (9.9%)	55 805 (10.5%)	48 920 (10.8%)	35 790 (10.4%)
Percutaneous coronary intervention (PCI)	747 510 (37.8%)	220 575 (36.2%)	202 720 (38.1%)	177 715 (39.1%)	133 350 (38.6%)
Revascularization procedures	945 680 (47.8%)	279 195 (45.8%)	256 730 (48.2%)	225 070 (49.6%)	168 070 (48.7%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	362 370 (18.3%)	92 590 (15.2%)	99 695 (18.7%)	93 110 (20.5%)	70 810 (20.5%)
Medium	607 145 (30.7%)	182 380 (29.9%)	160 295 (30.1%)	138 710 (30.6%)	114 865 (33.3%)
Large	1 007 040 (51.0%)	334 405 (54.9%)	272 755 (51.2%)	222 195 (48.9%)	159 575 (46.2%)
Hospital region					
Northeast	349 735 (17.7%)	63 360 (10.4%)	81 405 (15.3%)	93 500 (20.6%)	106 590 (30.9%)
Midwest	441 295 (22.3%)	122 620 (20.1%)	143 770 (27.0%)	112 175 (24.7%)	59 070 (17.1%)
South	816 595 (41.3%)	345 885 (56.8%)	219 140 (41.1%)	147 530 (32.5%)	88 055 (25.5%)
West	368 930 (18.7%)	77 510 (12.7%)	88 430 (16.6%)	100 810 (22.2%)	91 535 (26.5%)
Hospital location/teaching status					
Rural	158 190 (8.0%)	85 950 (14.1%)	51 290 (9.6%)	14 980 (3.3%)	2 035 (0.6%)
Urban non-teaching	464 130 (23.5%)	123 340 (20.2%)	134 735 (25.3%)	112 760 (24.8%)	85 235 (24.7%)
Urban teaching	1 354 235 (68.5%)	400 085 (65.7%)	346 720 (65.1%)	326 275 (71.9%)	257 980 (74.7%)

Appendix 32: Unadjusted bivariate analyses for primary exposures of interest among non-ST-segment elevation myocardial infarction patients with revascularization procedure use as the outcome

	Model 0 Unadjusted Bivariate Analyses
Race	
White	*Reference Level*
Black	0.66 [0.65-0.67] *P*<0.001
Hispanic	0.93 [0.92-0.94] *P*<0.001
Asian or Pacific Islander	1.01 [0.99-1.03] *P*=0.276
Native American	1.01 [0.97-1.05] *P*<0.001
Unspecified	1.18 [1.16-1.20] *P*<0.001
Quartiles for median household income for patient ZIP code	
Highest	*Reference Level*
Second highest	0.97 [0.96-0.98] *P*<0.001
Second lowest	0.90 [0.89-0.91] *P*<0.001
Lowest	0.81 [0.80-0.81] *P*<0.001
Hospital region	
Northeast	*Reference Level*
Midwest	1.59 [1.43-1.77] *P*<0.001
South	1.63 [1.47-1.80] *P*<0.001
West	1.66 [1.48-1.85] *P*<0.001

Appendix 33: All logistic regression analyses results for non-ST-elevation myocardial infarction patients with revascularization procedure use as the outcome

	Model 1	Model 2	Model 3	Model 4
	Sociodemographic Characteristics[a]	Model 1 + Lifestyle Factors[b]	Model 2 + Clinical History[c]	Model 3 + Hospital Characteristics[d]
Race				
White	*Reference Level*			
Black	0.59 [0.59-0.60] *P*<0.001	0.60 [0.60-0.61] *P*<0.001	0.64 [0.63-0.64] *P*<0.001	0.60 [0.58-0.60] *P*<0.001
Hispanic	0.85 [0.84-0.86] *P*<0.001	0.86 [0.85-0.87] *P*<0.001	0.87 [0.86-0.88] *P*<0.001	0.81 [0.80-0.82] *P*<0.001
Asian or Pacific Islander	0.92 [0.91-0.94] *P*<0.001	0.94 [0.92-0.96] *P*<0.001	0.97 [0.95-0.99] *P*<0.05	0.92 [0.90-0.94] *P*<0.001
Native American	0.92 [0.88-0.96] *P*<0.001	0.93 [0.89-0.97] *P*<0.001	0.98 [0.94-1.02] *P*=0.398	1.02 [0.97-1.06] *P*=0.456
Unspecified	1.06 [1.04-1.08] *P*<0.001	1.08 [1.06-1.10] *P*<0.001	1.08 [1.06-1.10] *P*<0.001	1.00 [0.98-1.02] *P*=0.749
Quartiles for median household income for patient ZIP code				
Richest	*Reference Level*			
Second richest	0.96 [0.95-0.97] *P*<0.001	0.96 [0.95-0.97] *P*<0.001	0.98 [0.97-0.99] *P*<0.001	1.00 [0.95-1.01] *P*=0.421
Second poorest	0.91 [0.90-0.92] *P*<0.001	0.90 [0.89-0.91] *P*<0.001	0.94 [0.93-0.95] *P*<0.001	0.99 [0.98-1.00] *P*=0.148
Poorest	0.84 [0.83-0.84] *P*<0.001	0.83 [0.82-0.84] *P*<0.001	0.87 [0.86-0.88] *P*<0.001	0.93 [0.92-0.94] *P*<0.001
Age	0.97 [0.97-0.97] P<0.001	0.97 [0.97-0.97] P<0.001	0.98 [0.98-0.98] P<0.001	0.98 [0.98-0.98] P<0.001
Indicator of sex				
Male	*Reference Level*			
Female	0.63 [0.63-0.63] P<0.001	0.63 [0.63-0.63] P<0.001	0.62 [0.61-0.62] P<0.001	0.62 [0.61-0.62] P<0.001
Year				
2015	*Reference Level*			
2016	0.88 [0.86-0.89] P<0.001	0.86 [0.85-0.88] P<0.001	0.79 [0.78-0.81] P<0.001	0.84 [0.83-0.86] P<0.001
2017	0.89 [0.87-0.90] P<0.001	0.89 [0.87-0.90] P<0.001	0.89 [0.87-0.90] P<0.001	0.93 [0.91-0.95] P<0.001
2018	1.04 [1.03-1.06] P<0.001	1.02 [1.01-1.04] P<0.05	0.96 [0.94-0.98] P<0.001	1.02 [1.00-1.03] P=0.063
2019	1.08 [1.06-1.09] P<0.001	1.06 [1.04-1.07] P<0.001	0.99 [0.97-1.01] P=0.173	1.05 [1.03-1.07] P<0.001
Any smoking history		1.11 [1.11-1.12] P<0.001	1.13 [1.12-1.14] P<0.001	1.13 [1.12-1.13] P<0.001
Alcohol abuse		0.84 [0.83-0.85] P<0.001	0.85 [0.84-0.87] P<0.001	0.85 [0.84-0.87] P<0.001
Drug abuse		0.68 [0.66-0.69] P<0.001	0.71 [0.70-0.72] P<0.001	0.70 [0.69-0.71] P<0.001
Obesity		1.17 [1.16-1.18] P<0.001	1.16 [1.15-1.17] P<0.001	1.15 [1.14-1.16] P<0.001
AIDS			0.99 [0.95-1.04] P=0.664	0.93 [0.89-0.98] P<0.05

Deficiency anemias		0.89 [0.88-0.90] P<0.001	0.89 [0.88-0.90] P<0.001
Chronic blood loss anemias		0.94 [0.91-0.98] P<0.05	0.94 [0.90-0.98] P<0.05
Arthropathies		1.02 [1.00-1.04] P=0.065	1.02 [1.00-1.04] P=0.070
Congestive heart failure		0.65 [0.64-0.65] P<0.001	0.63 [0.63-0.64] P<0.001
Chronic pulmonary disease		0.88 [0.87-0.88] P<0.001	0.89 [0.88-0.89] P<0.001
Coagulopathies		1.68 [1.66-1.70] P<0.001	1.62 [1.60-1.64] P<0.001
Diabetes without chronic complications		1.08 [1.07-1.09] P<0.001	1.09 [1.08-1.10] P<0.001
Diabetes with chronic complications		1.26 [1.25-1.27] P<0.001	1.25 [1.24-1.26] P<0.001
Hypertension, complicated		1.08 [1.06-1.09] P<0.001	1.08 [1.07-1.09] P<0.001
Hypertension, uncomplicated		1.15 [1.14-1.16] P<0.001	1.16 [1.15-1.17] P<0.001
Hypothyroidism		0.94 [0.93-0.95] P<0.001	0.95 [0.94-0.95] P<0.001
Liver disease, mild to moderate		0.75 [0.74-0.77] P<0.001	0.74 [0.73-0.76] P<0.001
Liver disease, severe		0.61 [0.58-0.64] P<0.001	0.60 [0.57-0.63] P<0.001
Lymphoma		0.85 [0.82-0.89] P<0.001	0.82 [0.79-0.86] P<0.001
Metastatic cancer		0.60 [0.59-0.62] P<0.001	0.58 [0.56-0.60] P<0.001
Other neurological disorders		0.76 [0.75-0.78] P<0.001	0.75 [0.73-0.76] P<0.001
Paralysis		0.76 [0.74-0.77] P<0.001	0.75 [0.73-0.76] P<0.001
Peripheral vascular disease		1.10 [1.08-1.11] P<0.001	1.08 [1.07-1.09] P<0.001
Pulmonary circulation disease		0.83 [0.82-0.84] P<0.001	0.83 [0.82-0.84] P<0.001
Renal failure, moderate		0.82 [0.81-0.83] P<0.001	0.81 [0.81-0.82] P<0.001
Renal failure, severe		0.73 [0.72-0.73] P<0.001	0.72 [0.71-0.73] P<0.001
Solid tumor without metastasis, malignant		0.73 [0.71-0.74] P<0.001	0.71 [0.70-0.73] P<0.001

Peptic ulcer with bleeding		0.91 [0.88-0.94] P<0.001	0.88 [0.85-0.92] P<0.001
Valvular disease		0.91 [0.90-0.92] P<0.001	0.90 [0.89-0.91] P<0.001
Weight loss		0.63 [0.62-0.65] P<0.001	0.62 [0.61-0.64] P<0.001
Prior MI		0.99 [0.98-1.00] P<0.05	0.97 [0.96-0.98] P<0.001
Prior CABG		0.55 [0.55-0.56] P<0.001	0.55 [0.54-0.56] P<0.001
Prior PCI		0.98 [0.97-0.99] P<0.001	0.97 [0.97-0.98] P<0.001
Prior CBVD		1.18 [1.14-1.21] P<0.001	1.14 [1.11-1.18] P<0.001
Hospital location/teaching status			
Urban teaching	*Reference Level*		
Rural			0.24 [0.23-0.24] P<0.001
Urban non-teaching			0.56 [0.55-0.56] P<0.001
Hospital bed size			
Small	*Reference Level*		
Medium			1.68 [1.65-1.70] P<0.001
Large			2.80 [2.76-2.83] P<0.001
Hospital region			
Northeast	*Reference Level*		
Midwest			1.90 [1.74-2.07] *P*<0.001
South			1.92 [1.77-2.09] *P*<0.001
West			1.57 [1.43-1.73] *P*<0.001

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Appendix 34: Baseline characteristics by socioeconomic status for percutaneous coronary intervention

	Overall (Weighted N = 1 339 155)	0-25th percentile (Lowest) (Weighted n = 384 095)	26th-50th percentile (Weighted n = 360 695)	51st-75th percentile (Weighted n = 321 575)	76th-100th percentile (Highest) (Weighted n = 248 265)
Patient-level characteristics, No. (%)					
Age, mean SD (years)	64.3 ± 12.6	63.4 ± 12.6	64.4 ± 12.6	64.7 ± 12.6	65.2 ± 12.6
Sex					
Male	911 630 (68.1%)	249 430 (65.0%)	243 060 (67.4%)	222 430 (69.2%)	179 080 (72.1%)
Female	427 260 (31.9%)	134 595 (35.1%)	117 580 (32.6%)	99 080 (30.0%)	69 150 (27.9%)
Race					
White	974 895 (75.8%)	250 430 (67.4%)	275 945 (80.1%)	245 510 (79.8%)	186 380 (78.1%)
Black	121 550 (9.5%)	64 320 (17.3%)	25 555 (7.4%)	18 640 (6.1%)	11 110 (4.7%)
Hispanic	105 815 (8.2%)	38 735 (10.4%)	26 635 (7.7%)	23 450 (7.6%)	14 630 (6.1%)
Asian or Pacific Islander	33 925 (2.6%)	4 250 (1.1%)	5 895 (1.7%)	8 795 (2.9%)	14 500 (6.1%)
Native American	7 645 (0.6%)	3 430 (0.9%)	1 780 (0.5%)	1 155 (0.4%)	735 (0.3%)
Unspecified	41 690 (3.2%)	10 400 (2.8%)	8 880 (2.6%)	10 105 (3.3%)	11 180 (4.7%)
Comorbidities, No. (%)					
AIDS	5 875 (0.4%)	2 245 (0.6%)	1 475 (0.4%)	1 170 (0.4%)	755 (0.3%)
Alcohol abuse	153 145 (11.4%)	14 150 (3.7%)	12 640 (3.5%)	10 770 (3.4%)	7 185 (2.9%)
AMI type					
NSTEMI	747 470 (55.8%)	220 560 (57.4%)	202 720 (56.2%)	177 705 (55.3%)	133 335 (53.7%)
STEMI	591 685 (44.2%)	163 535 (42.6%)	157 975 (43.8%)	143 870 (44.7%)	114 930 (46.3%)
Arthropathies	36 850 (2.8%)	10 020 (2.6%)	10 070 (2.8%)	8 720 (2.7%)	7 325 (3.0%)
Chronic blood loss anemias	5 205 (0.4%)	1 615 (0.4%)	1 355 (0.4%)	1 170 (0.4%)	970 (0.4%)
Chronic pulmonary disease	239 530 (17.9%)	78 715 (20.5%)	67 855 (18.8%)	53 350 (16.6%)	35 175 (14.2%)
Coagulopathies	53 055 (4.0%)	14 595 (3.8%)	13 680 (3.8%)	12 790 (4.0%)	10 945 (4.4%)
Congestive heart failure	386 565 (28.9%)	118 920 (31.0%)	103 745 (28.8%)	89 770 (27.9%)	66 840 (26.9%)
Deficiency anemias	153 145 (11.4%)	49 075 (12.8%)	39 705 (11.0%)	34 720 (10.8%)	26 945 (10.9%)
Diabetes with chronic complications	246 005 (18.4%)	77 610 (20.2%)	66 390 (18.4%)	57 390 (17.9%)	40 330 (16.2%)
Diabetes without chronic complications	206 110 (15.4%)	64 175 (16.7%)	56 370 (15.6%)	47 690 (14.9%)	34 000 (13.7%)
Drug abuse	39 135 (2.9%)	14 510 (3.8%)	10 315 (2.9%)	8 520 (2.7%)	4 930 (2.0%)
Hypertension, complicated	348 235 (26.0%)	106 985 (27.9%)	93 670 (26.0%)	81 990 (25.5%)	59 510 (24.0%)
Hypertension, uncomplicated	589 815 (44.0%)	171 140 (44.6%)	159 880 (44.3%)	140 990 (43.8%)	106 990 (43.1%)
Hypothyroidism	144 265 (10.8%)	38 865 (10.1%)	39 590 (11.0%)	35 505 (11.0%)	27 695 (11.2%)
Liver disease, mild to moderate	33 185 (2.5%)	10 735 (2.8%)	8 670 (2.4%)	7 595 (2.4%)	5 510 (2.2%)
Liver disease, severe	3 915 (0.3%)	1 145 (0.3%)	1 070 (0.3%)	860 (0.3%)	765 (0.3%)
Lymphoma	6 675 (0.5%)	1 600 (0.4%)	1 645 (0.5%)	1 755 (0.6%)	1 540 (0.6%)
Metastatic cancer	14 075 (1.1%)	3 675 (1.0%)	3 715 (1.0%)	3 535 (1.1%)	2 885 (1.2%)
Obesity	250 575 (18.7%)	73 300 (19.1%)	69 470 (19.3%)	61 290 (19.1%)	42 215 (17.0%)
Other neurological disorders	38 270 (2.9%)	11 110 (2.9%)	10 350 (2.9%)	9 395 (2.9%)	6 915 (2.8%)
Paralysis	21 970 (1.6%)	7 570 (2.0%)	5 785 (1.6%)	4 650 (1.5%)	3 545 (1.4%)

Peptic ulcer with bleeding	7 945 (0.6%)	2 520 (0.7%)	2 080 (0.6%)	1 715 (0.5%)	1 455 (0.6%)
Peripheral vascular disease	112 220 (8.4%)	33 140 (8.6%)	30 780 (8.5%)	27 040 (8.4%)	19 325 (7.8%)
Previous cerebrovascular accident	13 515 (1.0%)	4 035 (1.1%)	3 570 (1.0%)	3 195 (1.0%)	2 460 (1.0%)
Previous coronary artery bypass graft	102 365 (7.6%)	31 555 (8.2%)	29 135 (8.1%)	23 605 (7.3%)	16 385 (6.6%)
Previous myocardial infarction	197 920 (14.8%)	59 570 (15.5%)	53 720 (14.9%)	47 345 (14.7%)	33 790 (13.6%)
Previous percutaneous coronary intervention	222 725 (16.6%)	67 180 (17.5%)	61 430 (17.0%)	52 230 (16.2%)	38 015 (15.3%)
Pulmonary circulation disease	44 680 (3.3%)	13 245 (3.5%)	12 260 (3.4%)	10 600 (3.3%)	7 915 (3.2%)
Renal failure, moderate	151 725 (11.3%)	44 605 (11.6%)	40 950 (11.4%)	36 640 (11.4%)	27 055 (10.9%)
Renal failure, severe	66 075 (4.9%)	22 085 (5.8%)	17 010 (4.7%)	15 085 (4.7%)	10 835 (4.4%)
Any smoking history	691 260 (51.6%)	214 340 (55.8%)	193 850 (53.7%)	161 335 (50.2%)	109 550 (44.1%)
Solid tumor without metastasis, malignant	20 730 (1.6%)	5 840 (1.5%)	5 465 (1.5%)	5 165 (1.6%)	3 905 (1.6%)
Valvular disease	138 520 (10.3%)	37 650 (9.8%)	38 070 (10.6%)	33 965 (10.6%)	26 390 (10.6%)
Weight loss	23 085 (1.7%)	7 540 (2.0%)	6 215 (1.7%)	5 035 (1.6%)	3 800 (1.5%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	205 890 (15.4%)	49 010 (12.8%)	55 765 (15.5%)	54 535 (17.0%)	42 715 (17.2%)
Medium	402 845 (30.1%)	110 475 (28.8%)	105 355 (29.2%)	96 970 (30.2%)	82 635 (33.3%)
Large	730 420 (54.5%)	224 610 (58.5%)	199 575 (55.3%)	170 070 (52.9%)	122 915 (49.5)
Hospital region					
Northeast	215 940 (16.1%)	35 890 (9.3%)	48 715 (13.5%)	59 685 (18.6%)	68 230 (27.5%)
Midwest	320 585 (23.9%)	81 925 (21.3%)	103 175 (28.6%)	85 360 (26.5%)	47 325 (19.1%)
South	549 555 (41.0%)	217 930 (56.7%)	149 180 (41.4%)	105 510 (32.8%)	66 160 (26.7%)
West	253 075 (18.9%)	48 350 (12.6%)	59 625 (16.5%)	71 020 (22.1%)	66 550 (26.8%)
Hospital location/teaching status					
Rural	80 995 (6.1%)	44 375 (11.6%)	25 770 (7.1%)	7 635 (2.4%)	1 330 (0.5%)
Urban non-teaching	299 740 (22.4%)	73 940 (19.3%)	87 705 (24.3%)	74 710 (23.2%)	57 840 (23.3%)
Urban teaching	958 420 (71.6%)	265 780 (69.2%)	247 220 (68.5%)	239 230 (74.4%)	189 095 (76.2%)

Appendix 35: Logistic regression analyses results for primary exposures with percutaneous coronary intervention as the outcome

	Model 1 Sociodemographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]
Race				
White	*Reference Level*			
Black	0.62 [0.62-0.63] P<0.001	0.63 [0.63-0.64] P<0.001	0.72 [0.71-0.72] P<0.001	0.68 [0.68-0.69] P<0.001
Hispanic	0.82 [0.82-0.83] P<0.001	0.83 [0.82-0.84] P<0.001	0.86 [0.85-0.87] P<0.001	0.82 [0.81-0.83] P<0.001
Asian or Pacific Islander	0.85 [0.83-0.86] P<0.001	0.85 [0.83-0.86] P<0.001	0.90 [0.88-0.92] P<0.001	0.87 [0.86-0.89] P<0.001
Native American	0.78 [0.76-0.81] P<0.001	0.79 [0.76-0.82] P<0.001	0.87 [0.84-0.91] P<0.001	0.89 [0.86-0.93] P<0.001
Unspecified	1.05 [1.04-1.07] P<0.001	1.06 [1.04-1.07] P<0.001	1.04 [1.03-1.06] P<0.001	0.99 [0.98-1.01] P=0.468
Quartiles for median household income for patient ZIP code				
Highest	*Reference Level*			
Second highest	0.94 [0.93-0.95] P<0.001	0.94 [0.93-0.95] P<0.001	0.97 [0.97-0.98] P<0.001	0.99 [0.98-1.00] P<0.05
Second lowest	0.87 [0.86-0.87] P<0.001	0.87 [0.86-0.87] P<0.001	0.92 [0.91-0.92] P<0.001	0.95 [0.94-0.96] P<0.001
Lowest	0.81 [0.80-0.82] P<0.001	0.81 [0.80-0.82] P<0.001	0.88 [0.87-0.88] P<0.001	0.91 [0.91-0.92] P<0.001
Hospital region				
Northeast	*Reference Level*			
Midwest				1.62 [1.50-1.75] P<0.001
South				1.59 [1.48-1.71] P<0.001
West				1.44 [1.33-1.56] P<0.001

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Appendix 36: Baseline characteristics by socioeconomic status for coronary artery bypass graft

	Overall (Weighted N = 245 385)	0-25th percentile (Lowest) (Weighted n = 72 195)	26th-50th percentile (Weighted n = 67 365)	51st-75th percentile (Weighted n = 58 310)	76th-100th percentile (Highest) (Weighted n = 43 065)
Patient-level characteristics, No. (%)					
Age, mean SD (years)	65.3 ± 10.6	64.4 ± 10.6	65.2 ± 10.7	65.8 ± 10.6	66.4 ± 10.6
Sex					
Male	179 950 (73.3%	50 730 (70.3%)	48 825 (72.5%)	43 850 (75.2%)	33 135 (76.9%)
Female	65 416 (26.7%)	21 460 (29.7%)	18 540 (27.5%)	14 445 (24.8%)	9 930 (23.1%)
Race					
White	176 765 (75.2%)	47 830 (68.7%)	50 645 (78.7%)	43 930 (78.9%)	31 330 (76.1%)
Black	19 180 (8.2%)	9 755 (14.0%)	4 235 (6.6%)	3 065 (5.5%)	1 755 (4.3%)
Hispanic	21 875 (9.3%)	8 335 (12.0%)	5 680 (8.8%)	4 540 (8.2%)	2 915 (7.1%)
Asian or Pacific Islander	8 155 (3.5%)	1 110 (1.6%)	1 550 (2.4%)	2 115 (3.8%)	3 245 (7.9%)
Native American	1 560 (0.7%)	705 (1.0%)	405 (0.6%)	225 (0.4%)	120 (0.3%)
Unspecified	7 515 (3.2%)	1 925 (2.8%)	1 805 (2.8%)	1 780 (3.2%)	1 820 (4.4%)
Comorbidities, No. (%)					
AIDS	1 090 (0.4%)	375 (0.5%)	290 (0.4%)	195 (0.3%)	185 (0.4%)
Alcohol abuse	44 680 (18.2%)	3 440 (4.8%)	2 925 (4.3%)	2 520 (4.3%)	1 520 (3.5%)
AMI type					
NSTEMI	204 545 (83.4%)	60 460 (83.8%)	55 805 (82.8%)	48 920 (83.9%)	35 790 (83.1%)
STEMI	40 850 (16.7%)	11 735 (16.3%)	11 560 (17.2%)	9 390 (16.1%)	7 275 (16.9%)
Arthropathies	10 585 (4.3%)	1 840 (2.6%)	1 720 (2.6%)	1 500 (2.6%)	1 125 (2.6%)
Chronic blood loss anemias	3 160 (1.3%)	935 (1.3%)	865 (1.3%)	770 (1.3%)	535 (1.2%)
Chronic pulmonary disease	53 460 (21.8%)	17 850 (24.7%)	15 525 (23.1%)	11 840 (20.3%)	7 365 (17.1%)
Coagulopathies	57 605 (23.5%)	15 870 (22.0%)	15 645 (23.2%)	14 325 (24.6%)	10 635 (24.7%)
Congestive heart failure	103 520 (42.2%)	31 575 (43.7%)	27 835 (41.3%)	24 300 (41.7%)	17 955 (41.7%)
Deficiency anemias	44 680 (18.2%)	14 045 (19.5%)	12 050 (17.9%)	10 230 (17.5%)	7 580 (17.6%)
Diabetes with chronic complications	69 295 (28.2%)	21 425 (29.7%)	19 095 (28.4%)	16 095 (27.6%)	11 460 (26.6%)
Diabetes without chronic complications	34 275 (14.0%)	10 780 (14.9%)	9 645 (14.3%)	7 795 (13.4%)	5 375 (12.5%)
Drug abuse	7 410 (3.0%)	2 725 (3.8%)	2 030 (3.0%)	1 595 (2.7%)	940 (2.2%)
Hypertension, complicated	84 805 (34.6%)	25 960 (36.0%)	22 975 (34.1%)	20 010 (34.3%)	14 275 (33.2%)
Hypertension, uncomplicated	101 250 (41.3%)	29 665 (41.1%)	28 310 (42.0%)	23 820 (40.9%)	17 615 (40.9%)
Hypothyroidism	26 410 (10.8%)	7 285 (10.1%)	7 510 (11.2%)	6 260 (10.7%)	4 965 (11.5%)
Liver disease, mild to moderate	8 105 (3.3%)	2 570 (3.6%)	2 100 (3.1%)	1 875 (3.2%)	1 440 (3.3%)
Liver disease, severe	1 070 (0.4%)	340 (0.5%)	315 (0.5%)	255 (0.4%)	160 (0.4%)
Lymphoma	1 210 (0.5%)	345 (0.5%)	290 (0.4%)	360 (0.6%)	195 (0.5%)
Metastatic cancer	2 340 (1.0%)	665 (0.9%)	620 (0.9%)	475 (0.8%)	550 (1.3%)
Obesity	61 350 (25.0%)	18 260 (25.3%)	17 705 (26.3%)	14 450 (24.8%)	9 905 (23.0%)
Other neurological disorders	16 690 (6.8%)	5 025 (7.0%)	4 410 (6.6%)	3 880 (6.7%)	3 065 (7.1%)
Paralysis	7 175 (2.9%)	2 520 (3.5%)	1 855 (2.8%)	1 650 (2.8%)	1 010 (2.4%)
Peptic ulcer with bleeding	2 645 (1.1%)	785 (1.1%)	710 (1.1%)	645 (1.1%)	465 (1.1%)
Peripheral vascular disease	29 460 (12.0%)	8 365 (11.6%)	7 980 (11.9%)	7 315 (12.6%)	5 270 (12.2%)
Previous cerebrovascular accident	5 480 (2.2%)	1 820 (2.5%)	1 355 (2.0%)	1 330 (2.3%)	875 (2.0%)
Previous coronary artery bypass graft	4 900 (2.0%)	1 455 (2.0%)	1 325 (2.0%)	1 280 (2.2%)	715 (1.7%)
Previous myocardial infarction	34 325 (14.0%)	10 350 (14.3%)	9 555 (14.2%)	8 145 (14.0%)	5 635 (13.1%)
Previous percutaneous coronary intervention	33 940 (13.8%)	10 080 (14.0%)	9 515 (14.1%)	7 900 (13.6%)	5 800 (13.5%)
Pulmonary circulation disease	13 290 (5.4%)	4 080 (5.7%)	3 635 (5.4%)	3 015 (5.2%)	2 380 (5.5%)
Renal failure, moderate	37 410 (15.3%)	11 005 (15.2%)	10 160 (15.1%)	8 885 (15.2%)	6 625 (15.4%)

Renal failure, severe	15 280 (6.2%)	4 830 (6.7%)	4 005 (6.0%)	3 635 (6.2%)	2 560 (5.9%)
Any smoking history	124 465 (50.7%)	39 055 (54.1%)	35 060 (52.0%)	28 840 (49.5%)	19 315 (44.9%)
Solid tumor without metastasis, malignant	3 680 (1.5%)	945 (1.3%)	1 040 (1.5%)	890 (1.5%)	740 (1.7%)
Valvular disease	46 635 (1.5%)	13 185 (18.3%)	12 670 (18.8%)	11 290 (19.4%)	8 665 (20.1%)
Weight loss	10 840 (4.4%)	3 610 (5.0%)	2 930 (4.4%)	2 385 (4.1%)	1 705 (4.0%)
Hospital-level characteristics, No. (%)					
Hospital bed size					
Small	27 800 (11.3%)	7 710 (10.7%)	8 085 (12.0%)	7 215 (12.4%)	4 300 (10.0%)
Medium	66 990 (27.3%)	19 645 (27.2%)	18 155 (27.0%)	15 755 (27.0%)	12 075 (28.0%)
Large	150 595 (61.4%)	44 840 (62.1%)	41 125 (61.1%)	35 340 (60.6%)	26 690 (62.0%)
Hospital region					
Northeast	39 110 (15.9%)	6 350 (8.8%)	9 030 (13.4%)	10 690 (18.3%)	12 515 (29.1%)
Midwest	53 485 (21.8%)	12 965 (18.0%)	17 560 (26.1%)	14 710 (25.2%)	7 800 (18.1%)
South	107 700 (43.9%)	43 735 (60.6%)	29 520 (43.8%)	20 240 (34.7%)	12 000 (27.9%)
West	45 090 (18.4%)	9 145 (12.7%)	11 255 (16.7%)	12 670 (21.7%)	10 750 (25.0%)
Hospital location/teaching status					
Rural	7 500 (3.1%)	4 430 (6.1%)	2 265 (3.4%)	480 (0.8%)	125 (0.3%)
Urban non-teaching	41 060 (16.7%)	11 565 (16.0%)	12 480 (18.5%)	9 710 (16.7%)	6 590 (15.3%)
Urban teaching	196 825 (80.2%)	56 200 (77.8%)	52 620 (78.1%)	48 120 (82.5%)	36 350 (84.4%)

Appendix 37: Logistic regression analyses results for primary exposures with coronary artery bypass graft as the outcome

	Model 1 Sociodemographic Characteristics[a]	Model 2 Model 1 + Lifestyle Factors[b]	Model 3 Model 2 + Clinical History[c]	Model 4 Model 3 + Hospital Characteristics[d]
Race				
White	*Reference Level*			
Black	0.67 [0.66-0.68] P<0.001	0.67 [0.66-0.69] P<0.001	0.61 [0.60-0.62] P<0.001	0.57 [0.56-0.58] P<0.001
Hispanic	1.05 [1.03-1.06] P<0.001	1.06 [1.04-1.08] P<0.001	1.02 [1.00-1.03] P=0.077	0.97 [0.95-0.98] P<0.001
Asian or Pacific Islander	1.30 [1.26-1.33] P<0.001	1.36 [1.32-1.39] P<0.001	1.27 [1.23-1.30] P<0.001	1.23 [1.20-1.26] P<0.001
Native American	1.19 [1.12-1.26] P<0.001	1.18 [1.11-1.25] P<0.001	1.14 [1.07-1.21] P<0.001	1.19 [1.12-1.27] P<0.001
Unspecified	1.05 [1.03-1.08] P<0.001	1.07 [1.04-1.10] P<0.001	1.07 [1.04-1.10] P<0.001	1.01 [0.98-1.04] P=0.564
Quartiles for median household income for patient ZIP code				
Highest	*Reference Level*			
Second highest	1.03 [1.01-1.04] P<0.05	1.02 [1.00-1.03] P<0.05	1.01 [0.99-1.02] P=0.440	1.03 [1.01-1.04] P<0.05
Second lowest	1.04 [1.03-1.06] P<0.001	1.03 [1.02-1.05] P<0.001	1.02 [1.01-1.04] P<0.05	1.07 [1.05-1.09] P<0.001
Lowest	0.98 [0.97-1.00] P<0.05	0.97 [0.96-0.99] P<0.05	0.95 [0.94-0.97] P<0.001	1.00 [0.99-1.02] P=0.887
Hospital region				
Northeast	*Reference Level*			
Midwest				1.43 [1.24-1.65] P<0.001
South				1.66 [1.45-1.90] P<0.001
West				1.23 [1.06-1.43] P<0.05

[a] Age, sex, race, quartile of median household income for ZIP code
[b] Smoking, alcohol abuse, drug abuse, obesity
[c] AIDS, deficiency anemias, chronic blood loss anemia, arthropathies, congestive heart failure, chronic pulmonary disease, coagulopathies, diabetes without chronic complications, diabetes with chronic complications, hypertension, hypothyroidism, liver disease, lymphoma, metastatic cancer, other neurological disorders, paralysis, peripheral vascular disease, pulmonary circulation disease, renal failure, solid tumour without metastasis, malignant, peptic ulcer with bleeding, valvular disease, weight loss, prior myocardial infarction, prior coronary artery bypass graft, prior percutaneous coronary intervention, prior cerebrovascular disease
[d] Hospital bed size, hospital location/teaching status, hospital region

Curriculum Vitae

Name: Olivia Haldenby

Post-secondary Education and Degrees:

Western University
London, Ontario, Canada
2015-2019 H.B.HSc. (Honours Specialization Health Sciences)

Western University
London, Ontario, Canada
2020-2022 M.Sc. (Epidemiology and Biostatistics)

Honours and Awards:

Western Graduate Research Scholarship
2020-2022

Related Work Experience

Analytical Epidemiologist
Institute for Clinical Evaluative Sciences (ICES) Central
Toronto, Ontario, Canada
2022-Present

Research Assistant
Western University
London, Ontario, Canada
2021-Present

Teaching Assistant
Western University
London, Ontario, Canada
2021

Information Technology / Clinical Informatics Student
St. Thomas Elgin General Hospital
St. Thomas, Ontario, Canada
2019-2020