Title

A Vision for Equity in Emergency Care: An Examination of the Multi-Level Factors that Impact the Provision of Emergency Medical Services to Hispanic Older Adults

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A Vision for Equity in Emergency Care: An Examination of the Multi-Level Factors that Impact the Provision of Emergency Medical Services to Hispanic Older Adults

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Community Health Sciences

by

Esmeralda Melgoza

2024

ABSTRACT OF THE DISSERTATION

A Vision for Equity in Emergency Care: An Examination of the Multi-Level Factors that Impact the Provision of Emergency Medical Services to Hispanic Older Adults

by

Esmeralda Melgoza

Doctor of Philosophy in Community Health Sciences

University of California, Los Angeles, 2024

Professor Hiram Beltrán-Sánchez, Chair

Emergency medical services (EMS) are an important entry point into the United States (U.S.) healthcare system for Hispanic older adults who often have challenges accessing preventive and diagnostic care (Melgoza et al., 2023). Between 2012 and 2050, the population of Hispanic older adults is projected to quintuple from 3.1 million to 15.4 million, although few studies have assessed the multi-level factors that impact provision of EMS to this population (Hummer & Hayward, 2015; Melgoza et al., 2023). The goal of this dissertation is to investigate the multi-level factors that impact provision of EMS for Hispanic older adults. The first study is a scoping literature review that provides an overview of the current state of the literature in assessing the multi-level factors that impact EMS provision for Hispanic older adults across each link in the out-of-hospital chain of survival. The second and third studies examine the multi-level factors that impact provision of EMS for two different types of emergencies: high acuity cardiac emergencies and low-acuity psychiatric emergencies. McLeroy's (1988) Socio-Ecological Model and Link and Phelan's (1995) Fundamental Cause Theory provide the theoretical foundation for all three studies.

The Chain of Survival Framework also contributes to the theoretical foundation for the first and second studies that focus on EMS provision for cardiac emergencies.

The first study used a scoping literature review methodology to identify studies across multiple databases that meet the inclusion criteria. The second and third studies used cross-sectional data from the San Francisco Department of Emergency Management (SF DEM) and the 2022 5-Year American Community (ACS). In addition to data from SF DEM and ACS, the third study used COVID-19 data from the San Francisco Public Health Department, eviction notices data from the San Francisco Open Data Portal, and homeless count data from the City and County of San Francisco's Public Records Office. Key findings across all three studies suggest the importance of considering factors across multiple levels, and the interplay of these, on provision of EMS for Hispanic older adults.

EMS provision for cardiac emergencies was higher among Hispanics, males, older age groups, and in geographic areas with a higher proportion of Hispanic residents, compared to Whites, females, younger persons, and geographic areas with a lower prorportion of Hispanic residents. On the contrary, EMS provision for psychiatric emergencies was higher among Whites, persons with suspected alcohol or drug use, younger age groups, and in neighborhoods with the highest number of eviction notices, but lower in neighborhoods with the highest concentration of persons who are homeless, compared to Hispanics, persons without suspected alcohol or drug use, older age groups, neighborhoods with fewer numbers of eviction notices, and neighborhoods with fewer persons who are homeless. Overall, this dissertation provides insights into provision of EMS for Hispanic older adults. The findings can inform the development, implementation, and evaluation of interventions and programs, as well as influence policies that address existing health disparities and work to achieve health equity in the prehospital setting.

The dissertation of Esmeralda Melgoza is approved.

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Dedication Page

Para mi papá, quien, aún después de trabajar dos turnos completos, siempre hacía tiempo para leerme, darme consejos y motivarme a estudiar y seguir mis sueños. Gracias por compartir tu pasión por aprender. Mis recuerdos favoritos son tus cuentos de *Mil y una noches* antes de dormir y nuestras conversaciones después de leer *El Padrino* de Mario Puzo y *Kane y Abel* de Jeffrey Archer. Para mi mamá, gracias por tus palabras de aliento, por tu sonrisa, por tus abrazos, y por asegurarte de que mi hermana y yo nunca fuéramos a la escuela con hambre. Gracias por dedicar gran parte de tu vida a nosotras. To my sister, thank you for always ensuring that I can support every thought and opinion with evidence ☺. Your passion for social justice in the education system inspires me every day. I am looking forwarding to having two Dras. Melgoza in the family soon. For my partner, thank you for joining me on thousands of evenings walks to destress after a long day, cooking meals and making coffee for me to ensure I had enough energy to do all my work, and reminding me to get enough sleep. To my aunt, thank you for always providing your unconditional love and support in every check-in call and text message. Para mis abuelitas, abuelitos, tios, tias, primos y primas de las familias Melgoza Mendez y Lopez Arrellano de Ayotlan, Jalisco, Mexico.

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LIST OF ACRONYMS

Acronym	Meaning
ACS	American Community Survey
AED	Automated External Defibrillators
AIAN	American Indian or Alaska Native
AHA	American Heart Association
ALI	Automatic Location Identification
ALS	Advanced Life Support
AMR	American Medical Response (9-1-1 provider agency)
ANI	Automatic Number Identification
AT&T	American Telephone and Telegraph Company
BCPR	Bystander Cardiopulmonary Resuscitation
BLS	Basic Life Support
BVM	Bag-Valve-Mask Ventilation
CA	California
CAPI	Computer-Assisted Personal Interview
CARES	Cardiac Arrest Registry to Enhance Survival
CBO	Community Based Organization
CDC	Centers for Disease Control and Prevention
CEMSIS	California Emergency Medical Services Information System
CEO	Chief Executive Officer
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CMS	Centers of Medicare and Medicaid Services
COBRA	Consolidated Omnibus Reconciliation Act
COVID-19	Coronavirus Disease of 2019
CPMC	California Pacific Medical Center
CPR	Cardiovascular Pulmonary Resuscitation
DHS	Department of Homeland Security
DNR	Do-Not-Resuscitate
DOT	Department of Transportation
ED	Emergency Department
EKG	Electrocardiograms
EMS	Emergency Medical Services
EMSSA	Emergency Medical Services Systems Act
EMT	Emergency Medical Technician
EMTALA	Emergency Medical Treatment and Labor Act
EPCR	Electronic Patient Care Report
ETI	Endotracheal Intubation
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FirstNet	First Responder Network Authority
FPL	Federal Poverty Level
HCT	Head Computed Tomography
HRSA	Health Resources and Services Administration
IHCA	In-Hospital Cardiac Arrests

IOM	Institute of Medicine
IRB	Institutional Review Board
JBI	Journal of Biomedical Informatics
LA	Los Angeles
LEMSA	Local Emergency Medical Service Agency
LEP	Limited English Proficiency
LILACS	Latin American and Caribbean Health Sciences Literature
LT	Laryngeal Tube Insertion
MLE	Maximum Likelihood Estimation
NSDUH	National Survey on Drug Use and Health
NEMSIS	National Emergency Medical Services Information System
NIMS	National Incident Management System
NG9-1-1	Next Generation 9-1-1
NHTSA	National Highway Traffic Safety Administration
NHPI	Native Hawaiian and Other Pacific Islander
NRF	National Response Framework
NRP	National Response Plan
OBRA	Omnibus Budget Reconciliation Act
OHCA	Out-Of-Hospital Cardiac Arrest
OIG	Office of the Inspector General
OMB	Office of Management and Budget
OR	Odds Ratios
OSF	Open Science Framework
QUOROM	Quality of Reporting of Meta-Analyses
PCI	Percutaneous Coronary Intervention
PEA	Pulseless Electrical Activity
PRISMA	Preferred Reporting Items of Systematic Reviews and Meta-Analyses
PRISMA-ScR	Preferred Reporting Items of Systematic Reviews and Meta-Analyses Extension for Scoping Reviews
PRISMA 2009	Preferred Reporting Items of Systematic Reviews and Meta-Analyses (2009)
PRISMA 2020	Preferred Reporting Items of Systematic Reviews and Meta-Analyses (2020)
PSAP	Public Safety Answering Point
PIT	Point-In-Time Count
PUMA	Public Use Microdata Areas
ROSC	Return of Spontaneous Circulation
SCAF	Sudden Cardiac Arrest Foundation
SCERT	Street Crisis Response Team
SES	Socioeconomic Status
SF	San Francisco
SF DEM	San Francisco Department of Emergency Management
SFEMSA	San Francisco Emergency Medical Services Agency
SFFD	San Francisco Fire Department
SORT	Street Overdose Response Team
STEMI	ST-Elevation Myocardial Infarction

TCPR	Telecommunicator Cardiopulmonary Resuscitation
TH	Therapeutic Hypothermia
TTM	Targeted Temperature Management
UCLA	University of California Los Angeles
UCSF	University of California San Francisco
US	United States
USC	University of Southern California
VoIP	Voice over internet protocol
ZIP code	Zone Improvement Plan Code
ZCTAs	ZIP Code Tabulation Areas

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Melgoza, E., Beltrán-Sánchez, H., and Bustamante, A. V. (2021). "Emergency Medical Service Use Among Latinos Aged 50 and Older in California Counties, Except Los Angeles, During the Early COVID-19 Pandemic Period." Frontiers in public health, 9, 660289. https://doi.org/10.3389/fpubh.2021.660289

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Awards

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CHAPTER 1: INTRODUCTION

The Development of the Modern 9-1-1 Emergency System in the United States

The 9-1-1 Emergency System: 1960s to 1990s

In the United States (U.S.), a 9-1-1 call activates the emergency system and initiates a series of events, including contact with a public safety dispatcher, triage of calls to the appropriate department (e.g. emergency medical services (EMS), law enforcement, or fire), dispatch of emergency personnel and resources, on-scene care, ambulance transports to an emergency department (ED) and EMS-ED handoff (Melgoza et al., 2023). While 9-1-1 is currently the universal way to activate emergency services in the U.S., this is a relatively new development (iCERT, 2006). Prior to 1968, there were two main ways to access emergency services. The first way was to dial "0" to reach a telephone operator who would then transfer the call to the appropriate department (Billittier IV et al., 2000). The second way was to memorize and use a seven-digit local telephone number for the nearest police or fire department (Billittier IV et al., 2000). In 1967, the decentralized approach to requesting emergency services changed when President Lyndon B. Johnson's Commission on Law Enforcement and Administration of Justice issued a report recommending the use of a single emergency number in the country (iCERT, 2006). On January 12, 1968, AT&T reserved 9-1-1 as the universal emergency telephone number in the U.S. (Harkins & Strauss, 2008; iCERT, 2006). On February 16, 1969, Alabama Speaker of the House, Rankin Rite made the first 9-1-1 call in Haleyville, Alabama (iCERT, 2006).

The designation of 9-1-1 as the universal emergency number in the U.S. resulted in the development of the Basic 9-1-1 emergency telephone system in the 1960s (iCERT, 2006). The Basic 9-1-1 system routed emergency calls to public safety answering points, or pre-designated public safety call-taking locations (iCERT, 2006). Jurisdictional authority of the Basic 9-1-1

system was given to state and local officials, not the federal government, since communities have more insights on geography, weather, population density, and cultural norms that better inform emergency operations and communications. Oversight of emergency operations and communications at the state and local level also provided a sense of pride and ownership among communities (iCERT, 2006). In the 1970s, the Basic 9-1-1 system was replaced by the Enhanced 9-1-1 system, which provided a faster and more accurate approach to triaging emergency calls (iCERT, 2006). The Enhanced 9-1-1 system used new features that allowed public safety dispatchers to have automatic access to a caller's information, including name, address, and telephone number (iCERT, 2006). Automatic access to a caller's information required the use of new technology, including automatic number identification (ANI) and automatic location identification (ALI) (iCERT, 2006). The Enhanced 9-1-1 system's advanced features allowed public safety dispatchers to direct emergency resources and personnel more accurately to callers who did not know their geographic location, who became disconnected, or who had special needs, including individuals who lacked the ability to speak, hear, or both (Billittier IV et al., 2000).

Another major change in the 9-1-1 emergency system occurred during the early 1990s with the rise in cellular telephones (Geary et al., 1999). Cellular telephones were often not linked to fixed addresses, which made it difficult for 9-1-1 emergency systems to identify a person's location (Geary et al., 1999). In 1996, the Federal Communications Commission (FCC) released a report, which required the provision of wireless Enhanced 9-1-1 services (iCERT, 2006). Cellular phone service providers and vendors of wireless location technologies responded to the report by developing location determination technologies for their users, which made it possible to relay this information to 9-1-1 emergency centers (Geary et al., 1999). In 1999, the Wireless

Communications and Public Safety Act officially designated 9-1-1 as the universal emergency number in the U.S. for both landlines and wireless telephone services (iCERT, 2006).

The 9-1-1 Emergency System: 21st Century

The early 21st century was a time of continued innovations in the U.S. 9-1-1 emergency system. Kari's Law and Section 506 of Ray Baum's Act directly affected the activation of the 9-1-1 emergency system (FCC, 2024). Kari's Law was named after Kari Hunt, a woman who was murdered by her estranged husband in a Texas motel room after her nine-year old daughter failed to connect with a 9-1-1 public safety dispatcher due to the motel's policy that all outbound calls had to use a prefix of "9" prior to dialing a telephone number (FCC, 2024). Kari's Law required multi-line telephone systems, including those found in hotels, motels, and school campuses, to enable callers to dial 9-1-1 directly, without having to dial a prefix or an additional set of numbers (FCC, 2024). Kari's Law also required the multi-line telephone systems to notify a central location, such as a front desk or security office, when a 9-1-1 call was made in the facility (FCC, 2024). Section 506 of Ray Baum's Act, named after Raymond Sims Baum, an American politician, lawyer, and lobbyist, required that multi-line telephone systems and mobile text services share dispatchable location information, including street address, floor level, and suite, apartment or room number to ensure accurate and timely response by emergency services (FCC, 2024).

Two ongoing initiatives including Next Generation 9-1-1 (NG9-1-1) and First Responder Network Authority (FirstNet) are expected to result in additional changes to the U.S. 9-1-1 emergency system (Police Executive Research Forum, 2017). NG9-1-1 is an initiative that makes communication between emergency personnel and community members possible by using a wider range of devices, including landline calls, cellular calls, instant messaging, telematics (i.e. automatic crash notifications) data from vehicles, voice over internet protocol (VoIP) calls, and

live video feeds (Demar et al., 2017). NG9-1-1 also facilitates the transferring of all digital data associated with every emergency call from one public safety answering point to another (Demar et al., 2017). Although NG9-1-1 seeks to provide all digital data associated with an emergency call, there are also concerns about the potential impacts that this initiative may have on the health and well-being of emergency personnel (Demar et al., 2017). For example, there are concerns that the increase in digital data from a wider range of devices may result in greater stress levels, higher levels of vicarious trauma, and more turnover of emergency responders, particularly public safety dispatchers (Demar et al., 2017)FirstNet is the second initiative that is expected to transform the U.S. 9-1-1 emergency system by providing a dedicated, nationwide, high-speed wireless public safety network (Moore, 2016). FirstNet creates an interoperable system for all emergency services, regardless of whether an emergency requires law enforcement, fire, or EMS (Moore, 2016). FirstNet is fully operational across all 50 U.S. states and territories as of 2023, although additional funding from Congress needs to be authorized for the services to be operational after 2027 (Moore, 2016).

The Establishment of the Modern EMS System in the U.S.

The EMS System: 1960s to 1970s

Prior to the 1960s, EMS decision-making was conducted at the local level, with no federal legislation available at the time (Shah, 2006). Local-level decision-making resulted in a decentralized, fragmented, and uncoordinated EMS system (Rockwood et al., 1976; Shah, 2006). EMS was viewed primarily as a transportation service rather than a provider of medical services, which resulted in lower allocation of funds, and contributed to undertrained emergency personnel, ill equipped ambulances, and minimal access to emergency equipment (Shah, 2006). In certain

localities, volunteer rescue squads or local funeral homes provided ambulance transports due to a lack or limited availability of EMS (Atkinson, 2007).

In the 1960s, political, economic, social, and medical innovations resulted in the establishment of the modern EMS system (Harkins & Strauss, 2008; Shah, 2006). The designation of 9-1-1 as the universal emergency number in the U.S. was an important development that established the modern EMS system (iCERT, 2006). In 1965, the establishment of President Lyndon B. Johnson's Commission on Highway Safety also formally recognized the important role of EMS in addressing motor vehicle accidents, an increasingly important public health concern (Shah, 2006). A year later, in 1966, the National Academy of Sciences published a report that presented the shortcomings of the U.S. EMS system, including the limited training of emergency personnel, inefficient transportation, equipment, and communication systems, lack of standardized treatment protocols, and insufficient research (Shah, 2006). The findings from the President's Commission and the report from the National Academy of Sciences were instrumental in the passage of the Highway Safety Act of 1966 and the National Traffic and Motor Vehicles Safety Act (Shah, 2006). Both Acts were critical in the development of the modern EMS system.

The Highway Safety Act of 1966 established the Department of Transportation (DOT), which was responsible for overseeing and improving the EMS system in the U.S. (Shah, 2006). The jurisdictional authority of DOT over EMS reinforced the perspective that prehospital care was mainly a transportation service rather than a provider of medical services (Shah, 2006).The Highway Safety Act of 1966 also resulted in more federal involvement to improve EMS operations, including emergency plans, ambulance specifications, equipment standards, communications, staffing, educational requirements for personnel, and penalties for states who violated EMS provisions (Shah, 2006). In 1970, the National Traffic and Motor Vehicles Safety

Act established the National Highway Traffic Safety Administration (NHTSA), the first federal agency to oversee vehicle safety in the U.S. (Mashaw & Harfst, 1990). NHTSA was also charged with improving EMS by providing funding for the acquisition of ambulances, emergency communication systems, and training for emergency personnel (Mashaw & Harfst, 1990). NHTSA also developed the first national standard curricula for EMS providers in the U.S. (Brooks et al., 2016).

In the 1970s, the perception of the EMS system began to shift from a transportation service to a medical services provider (Shah, 2006). The shift in the perception of EMS was partially explained by innovations in medical technology, adoption of military style prehospital care in the civilian setting from veteran medics returning from the Vietnam War, and the passage of the Emergency Medical Services Systems Act (EMSSA) (Shah, 2006). In 1973, Congress enacted EMSSA, which changed the federal agency responsible for overseeing the EMS system from DOT to the Department of Health, Education, and Welfare (Shah, 2006). The purpose of EMSSA was to create a well-coordinated federal effort to improve EMS nationwide, although the level of success in meeting these standards differed greatly across the country (Pozner et al., 2004).

The EMS System: 1980s and 1990s

Oversight of the EMS system shifted from the federal to the state governments with the passage of the Omnibus Budget Reconciliation Act (OBRA) in 1981 (Institute of Medicine, 2007; National Association of State EMS Officials, 2021). OBRA eliminated categorical grants, which narrowly defined how funds could be spent, in favor of block grants that allowed states to allocate funds wherever they deemed necessary (Institute of Medicine, 2007; National Association of State EMS Officials, 2021). Decision-making power at the state level resulted in more heterogeneity

across EMS systems as the use of funds differed across states (National Association of State EMS Officials, 2021).

The 1986 Emergency Medical Treatment and Labor Act (EMTALA) is another legislation that impacted the EMS system in the U.S. (Zibulewsky, 2001). EMTALA was passed as part of the Consolidated Omnibus Reconcilitation Act (COBRA) (Zibulewsky, 2001). EMTALA was passed to prevent "patient dumping" by mandating that Medicare participating hospitals provide emergency services to individuals experiencing a medical emergency, regardless of the person's socioeconomic or insurance status (Monico, 2010). A medical emergency is defined as the presence of symptoms that are severe enough that the absence of immediate medical attention may jeopardize an individual's health or result in serious impairment of bodily organs or functions (Monico, 2010).

EMTALA impacts the provision of emergency services in the in- and out-of-hospital settings in several ways (Lulla & Svancarek, 2019; Monico, 2010). First, the Office of the Inspector General (OIG) and Centers of Medicare and Medicaid Services (CMS) have the authority to impose penalties on hospital-based EMS systems (i.e. hospital owned or operated ambulances) and hospital systems that fail to comply with EMTALA mandates (Lulla & Svancarek, 2019). The penalties for violating EMTALA include monetary fines, exclusions from Medicare reimbursements and federal prosecution (Lulla & Svancarek, 2019). Second, the EMTALA provisions cover individual who are within 250 yards of a hospital, including parking lots, sidewalks, and adjacent medical buildings, not only within the physical space of an ED (Lulla & Svancarek, 2019). Third, EMTALA requires individuals presenting to a hospital-based EMS system or hospital ED to undergo an appropriate medical screening examination by a qualified healthcare professional to determine whether the person is experiencing a medical emergency, or

not (Lulla & Svancarek, 2019). Fourth, the hospital-based EMS system and hospital ED are required to stabilize individuals experiencing a medical emergency, although appropriate transfers are allowed after stabilization if the healthcare facility cannot provide definitive treatment (Lulla & Svancarek, 2019). Fifth, EMTALA mandates that no transfers be arranged for non-stabilized individuals, unless a qualified healthcare provider deems that the benefits outweigh the risks of transfer (Lulla & Svancarek, 2019).

Although EMTALA was originally created to prevent "patient dumping," the Act had and continues to have critics (Monico, 2010). EMTALA is an unfunded mandate, which some critics argue contributes to an already broken U.S. healthcare system by shifting costs from the government to the hospitals (Monico, 2010). Other critics focus on the ambiguous language included in the Act (Shenoy et al., 2022). EMTALA requires a qualified healthcare provider to determine whether an individual is experiencing a medical emergency by providing an appropriate medical screening (Shenoy et al., 2022). The Act also requires the stabilization of the patient before transferring the individual to another healthcare facility (Shenoy et al., 2022). In practice, however, defining who is a qualified healthcare provider, what constitutes a medical emergency, what is an appropriate medical screening, and when to stabilize a patient prior to transport is subjective and varies across healthcare providers and contexts (Shenoy et al., 2022). Overall, the 1980s was characterized by several important pieces of legislation, which impacted the U.S. EMS system.

On the contrary, the 1990s did not have major piece of legislation that impacted the U.S. EMS system. The NHTSA and HRSA did, however, publish an important report titled, *EMS Agenda for the Future: A Systems Approach* (National Highway Traffic Safety Administration & Health Resources and Services Administration, 1996). The report presented a shared vision for the future of EMS, summarized key lessons from the previous three decades, and provided

recommendations for the better integration of EMS in the U.S. healthcare system. The report identified 14 attributes that required continued development, including more EMS research, integration of health services, legislation and regulation, system finance, human resources, medical direction, education systems, public education, prevention, public access, communication systems, clinical care, information systems, and evaluation (National Highway Traffic Safety Administration & Health Resources and Services Administration, 1996).

The EMS System in the 21st Century

During the early 21st century, the terrorist attacks of September 11, 2001 and the coronavirus (COVID-19) pandemic resulted in EMS being considered one of 16 critical infrastructure sectors in the U.S. (National Coordinator for Critical Infrastructure Security and Resilience, n.d.). A critical infrastructure sector is defined as one "whose assets, systems, and networks, whether physical or virtual, are considered so vital to the U.S. that their incapacitation or destruction would have a debilitating effect on national security, economic security, and/or public health" (National Coordinator for Critical Infrastructure Security and Resilience, n.d. paragraph 1). During the September 11, 2001 terrorist attacks, several logistical and technical challenges were identified in the emergency system including, ineffective communication systems, lack of interoperability across agencies (i.e. fire, police, EMS and emergency management responders) and incompatible equipment (Department of Homeland Security, 2024). As a response to these shortcomings, the U.S. federal government developed the National Response Plan (NRP), which was later replaced with the National Response Framework (NRF) (Federal Emergency Management Agency, n.d.). The NRF provided a framework that is scalable, flexible, and adaptable to facilitate coordination, integration, and response by multiple agencies during emergencies (Federal Emergency Management Agency, n.d.). The National Incident Management

System (NIMS) was also developed at this time to create a shared system, process, and vocabulary that facilitates interagency responses during emergencies (Federal Emergency Management Agency, n.d.).

The COVID-19 pandemic impacted EMS by changing the overall call volume and types of emergency calls received (Handberry et al., 2021; Lerner et al., 2020; Melgoza et al., 2021; Satty et al., 2021). During the first three months of the COVID-19 pandemic, the total number of EMS incidents in the U.S. decreased by 26% compared to the previous three years (Handberry et al., 2021; Lerner et al., 2020; Satty et al., 2021). The precipitous decline in the total number of EMS calls occurred at approximately the same time as the U.S. President's COVID-19 emergency declaration (Handberry et al., 2021; Lerner et al., 2020). The early COVID-19 pandemic period was also characterized by a 46.6% increase in non-transports (i.e. 9-1-1 calls that do not result in an ambulance transport to the ED), compared to the same period during the previous three years (Satty et al., 2021). The increase in non-transports was at least partially explained by fear of COVID-19 infection by individuals accessing EMS, not wanting to overburden the healthcare system, and non-transport policies instituted by EMS agencies to prevent the spread of COVID-19 (Satty et al., 2021). The types of EMS calls before and during the early COVID-19 pandemic also changed (Friedman et al., 2021; Handberry et al., 2021; Melgoza et al., 2021). There was an increase in respiratory distress, cardiac arrest, overdose-related cardiac arrests, and on-scene deaths during the early pandemic period, compared to the same time period in the previous years (Melgoza et al., 2021; Friedman et al., 2020; Goldberg et al., 2021; Lerner et al., 2020).

The COVID-19 pandemic also resulted in changes to EMTALA. As previously discussed, EMTALA was originally developed in the 1980s to prevent "patient dumping" by requiring that hospital-based EMS and Medicare participating hospitals provide a medical examination and

stabilizing treatment to individuals experiencing a medical emergency (Monico, 2010). During the pandemic, the U.S. President's COVID-19 emergency declaration and Section 1135 of the Social Security Act resulted in the development of the 1135 waiver, which provided more flexibility to an already overburdened healthcare system. Three provisions were added to EMTALA during the COVID-19 pandemic, including: 1) the ability to redirect individuals to on- or off-site alternative destinations, including telehealth services, for the mandated medical screening examination; 2) an allowance to transfer non-medically stabilized individuals from one healthcare facility to another and 3) CMS allowed patients on Medicaid and Medicare to be under the direct care of non-physicians (i.e. advanced practice providers, physician assistants and nurse practitioners) (Brown, 2021). Overall, the provisions to EMTALA during the COVID-19 pandemic provided more flexibility to hospital-owned EMS and hospital systems.

EMS Research During the 21st Century

The establishment of a national EMS database was another major advancement during the 21st century (NEMSIS, 2024) The National Emergency Medical Services Information System (NEMSIS) was established as the largest national EMS database that contains prehospital care data from across the U.S. and its territories (NEMSIS, 2024). NEMSIS is the first database to standardize, aggregate, and utilize EMS data from local and state agencies (NEMSIS, 2024). Although NEMSIS is the best EMS database available at the national level, there are two important limitations: 1) the database consists of a convenience sample of EMS activations, not a representative sample and 2) the database includes EMS activations, not individual patients (NEMSIS, 2024). In the U.S., EMS data are also available at the state-level, although the representativeness of the data varies by state. In California, the state-level EMS database is known as the California Emergency Medical Services Information System (CEMSIS) (CEMSIS, 2024).

There are currently ongoing efforts to continue building and linking EMS data with non-prehospital data.

CHAPTER 2: LITERATURE REVIEW

EMS in the U.S. before the COVID-19 pandemic

EMS are an important entry point into the U.S. healthcare system (Farcas et al., 2023; Melgoza, et al., 2023). EMS professionals respond to emergencies that range from non-life-threatening situations to incidents that require critical and time-sensitive care, including cardiac arrests, heart attacks, and stroke (Melgoza et al., 2023). In the U.S., the EMS system is activated with a call to 9-1-1, an action that initiates a series of events, including contact with a public safety dispatcher, triage of calls to the appropriate department (e.g. EMS, law enforcement, or fire), dispatch of emergency personnel and resources, on-scene care, ambulance transports to an ED, and EMS-ED handoff prior to ED admission (Melgoza et al., 2023). The provision of EMS in the prehospital setting impacts patients' trajectories through other sectors of the U.S. healthcare system (Melgoza et al., 2023). For example, ambulance transports are associated with more rapid arrival to the ED, earlier medical assessment, fewer treatment delays in the ED, and higher survival rates for time-sensitive emergencies, including heart attacks, cardiac arrests, and stroke, compared to private vehicle transports (Ekundayo et al., 2013; Loh et al., 2014; Melgoza, et al., 2023).

EMS during the COVID-19 pandemic

After the U.S. President's COVID-19 emergency declaration in March 2020, the overall number of EMS calls in the U.S. decreased by 26% (Handberry et al., 2021; Lerner et al., 2020). Several studies also reported changes in the types of EMS calls received with a doubling of on-scene deaths, a decrease in injury-related emergencies, and an increase in cardiac arrests, drug overdoses and naloxone administrations in the prehospital setting during the pandemic period,

compared to the pre-pandemic period (Handberry et al., 2021; Khoury et al., 2021; Lerner et al., 2020) . The changes in the overall number and types of EMS calls received during the COVID-19 pandemic were attributed to lifestyle changes (e.g. staying at home, participating in less risky recreational activities, and less driving), fear of COVID-19 infection and death, patient-initiated ambulance transport refusals to avoid the overburdening of the healthcare system, and EMS non-transport policies (Lerner et al., 2020).

EMS and Older Adults

The U.S. is experiencing a demographic shift where adults aged 50 years and older currently outnumber children and adolescents (Kaiser Family Foundation, 2023). In 2023, 36.4% of the U.S. population were adults aged 50 years and older, while 24.3% were children and adolescents under the age of 19 years (American Community Survey, 2023)In the U.S. older age is associated with an increased reliance on EMS (Duong et al., 2018; Rucker et al., 1997; Shah et al., 2007). A national study reported that older adults represented 38% of all EMS responses between 1997 and 2000, while another study found that 32.5% of prehospital 9-1-1 calls were attributed to older adults in 2014 (Duong et al., 2018; Shah et al., 2007). One of these studies found that older adults had an EMS utilization rate of 167 per 1,000 population, compared to 39 per 1,000 population for younger people (Shah et al., 2007). Both studies, however, focus on older adults aged 65 years and older, not persons aged 50 years and older. The aging population in the U.S., combined with the high reliance on the EMS system among older adults makes it imperative to conduct research in this area.

A study reported that the top 5 reasons for EMS provision to older adults in the U.S. were cardiovascular emergencies (17.11%), traumatic injuries (10.9%), airway emergencies (9.04%), and neurological and psychiatric disorders (7.4%) (Duong et al., 2018). A study in North Carolina

found that the most common reasons for the repeated provision of EMS among older adults, defined as ambulance transports of the same individual within a 30-day period of the initial transport, were psychiatric disorders, back pain, respiratory conditions, abdominal pain, and diabetes-related complications (Evans et al., 2017). Falls, a type of emergency associated with repeated transports, also accounted for 15.6% of all ambulance transports in this study (Evans et al., 2017).

EMS and Hispanic Older Adults

EMS serves as an entry point into the U.S. healthcare system for underserved populations, including Hispanic older adults who often have challenges accessing preventive and diagnostic care (Melgoza, et al., 2023; Melgoza et al., 2021). While EMS serves as an important entry point for Hispanic older adults, few studies have studied the use and provision of prehospital care for this population (Evans et al., 2017; Joiner et al., 2023; Melgoza et al., 2021). Additional research that expands our understanding of Hispanic older adults' experiences with EMS is important considering that this population is projected to quintuple from 3.1 million to 15.4 million between 2012 and 2050 in the U.S. (Hummer & Hayward, 2015)

Among the studies that have assessed EMS use and provision for Hispanic older adults, health disparities were identified (Melgoza et al., 2021; Seo et al., 2014; Shah et al., 2007). Hispanic older adults who experienced a cardiac emergency were less likely to use EMS, less likely to arrive by ambulance to the ED, more likely to have a non-transport (e.g. EMS contact without an ambulance transport to the ED) after a fall, and less likely to have a repeated EMS transport (e.g. additional EMS transport to the ED within 30 days of the initial transport), compared to non-Hispanic Whites (Evans et al., 2017; Mathews et al., 2011; Shah et al., 2007). During the COVID-19 pandemic, Hispanic older adults were more likely to use EMS for respiratory distress,

compared to the pre-pandemic period, a finding likely associated with the disproportionate impact of the virus on this population (Melgoza et al., 2021).

Why Study Cardiac and Psychiatric-Related Emergencies Among Hispanic Older Adults in the Prehospital Setting?

Cardiac and psychiatric-related emergencies are two of the top five reasons why older adults use EMS in the U.S. (Duong et al., 2018). The current state of the EMS literature, however, is limited in the context of cardiac and psychiatric-related emergencies that occur among Hispanic older adults in the prehospital setting. The three studies in this dissertation address this literature gap and advance our understanding of the multi-level factors that impact provision of prehospital care in the context of cardiac and psychiatric emergencies, with a focus on Hispanic older adults. Insights on the multi-level factors that impact provision of EMS to Hispanic older adults provide evidence for future interventions, programs and policies aimed at achieving a more equitable prehospital system.

Individual-Level Factors That Impact the Provision of EMS for Hispanic Older Adults Who Experience Cardiac Emergencies

Cardiac emergencies, including cardiac arrests and heart attacks, are the most common types of prehospital emergencies among older adults in the U.S. (Duong et al., 2018). Cardiac arrests are emergencies characterized by the severe malfunction, cessation, or absence of electrical activity in the heart muscle (Institute of Medicine, 2015). Heart attacks are a result of a circulatory issue attributed to a partially blocked or completely obstructed artery (Institute of Medicine, 2015). Together, cardiac arrests and heart attacks contribute to heart disease in the U.S. (Institute of Medicine, 2015).

Heart disease is among the top two causes of death among Hispanic older adults in the U.S. (CDC, 2024). While heart disease is one of the leading causes of death among Hispanic older adults, overall cardiac mortality in this population is lower compared to non-Hispanic White older adults, a finding known as the Hispanic paradox (Balfour et al., 2016). The Hispanic paradox posits that Hispanics have a worse health profile relative to non-Hispanic Whites but experience lower rates of overall cardiac mortality (Balfour et al., 2016). The Hispanic paradox, however, should not negate the importance of studying heart disease among Hispanics since this type of health emergency is one of the leading causes of death in this population.

Since cardiac emergencies are common in the prehospital setting, emergency personnel, including EMTs and paramedics, are often the first point of contact that individuals have with the U.S. healthcare system (Melgoza et al., 2023). Few studies, however, have assessed provision of EMS to Hispanic older adults who experience an out-of-hospital cardiac emergency. The current studies report that Hispanics are less likely to receive bystander CPR at home, less likely to have a witnessed cardiac arrest, less likely to receive bystander CPR in public locations, less likely to call 9-1-1, less likely to have a shockable rhythm upon EMS arrival, less likely to receive some on-scene interventions, including electrocardiograms (EKG), more likely to receive mechanical CPR, less likely to use an ambulance as the mode of transport to the ED, more likely to have poor neurological outcomes, and less likely to survive a cardiac emergency, compared to non-Hispanic Whites (Bosson et al., 2019; Canto et al., 2002; Kahn et al., 2019; Mathews et al., 2011; Vadeboncoeur et al., 2008; Zègre-Hemsey et al., 2019). Most of the studies on Hispanics' experiences with EMS, however, do not focus exclusively on provision of EMS for Hispanic older adults.

Neighborhood and Policy-Level Factors That Impact Provision of EMS for Hispanic Older Adults Who Experience Cardiac Emergencies

Neighborhoods with a higher percentage of underserved residents are more likely to experience health disparities in cardiac-related emergency care in the prehospital setting (Hanchate et al., 2019; Hsia et al., 2018; Uzendu et al., 2023). Neighborhoods with a higher percentage of Hispanic residents are less likely to receive BCPR, compared to neighborhoods with a lower percentage of Hispanic residents (Blewer et al., 2020). In this study, BCPR was administered in 39% of cardiac emergencies in neighborhoods with less than 25% Hispanic residents, compared to 27% in neighborhoods with more than 75% Hispanic residents, which suggests between neighborhood differences in BCPR administration (Blewer et al., 2020). Several studies reported that Hispanics are less likely compared to non-Hispanic Whites to receive CPR at home and in public locations regardless of the racial, ethnic, and socioeconomic status (SES) composition of the neighborhoods (Garcia et al., 2022; Moon et al., 2014).

Several studies also report that EMS disparities disproportionately impact low SES, compared to high SES neighborhoods (Hsia et al., 2018). Residents in low SES neighborhoods are less likely to receive BCPR with and without 9-1-1 dispatcher instructions, experience more delays in the return of spontaneous circulation (ROSC), have longer EMS time intervals or delays across all phases of the emergency care continuum, and have lower survival rates after cardiac emergencies, compared to high SES neighborhoods (Gaddam & Singh, 2020; Hsia et al., 2018; Wells et al., 2016). Residents of low SES neighborhoods are less likely to receive EMS care within the national benchmarks of 4, 8, and 15 minutes for emergency care (Hsia et al., 2018).

Multiple studies also suggest that there are disparities in ambulance transport destinations after considering neighborhood-level sociodemographic composition (Hanchate et al., 2019,

2022). Hispanic and Black persons are more likely to be transported to a safety-net hospital ED (e.g., an ED that is legally obligated to provide health care regardless of a patient's insurance status), and less likely to be transported to a reference ED (e.g., most frequent ED destination) compared to non-Hispanic Whites living in the same ZIP code (Hanchate et al., 2019). Hispanic and Black persons are also more likely to experience ED bypassing (e.g., ambulance transport to an ED other than the most proximate) compared to non-Hispanic Whites (Hanchate et al., 2022). Disparities in EMS transport practices and policies result in greater delays in the receipt of treatment, a worse prognosis, and a higher risk of death, especially for time-sensitive health conditions like cardiac emergencies.

Individual-Level Factors That Impact Provision of EMS for Hispanic Older Adults Who Experience Psychiatric Emergencies

In the U.S., psychiatric emergencies are one of the top five reasons why older adults use EMS (Duong et al., 2018). Substance use and homelessness are associated with increased risk of psychiatric emergencies in the prehospital setting (Abramson et al., 2021; Mackelprang et al., 2014). Homeless or unhoused older adults were eight times more likely than housed older adults to use EMS in San Francisco (SF) County (Tangherlini et al., 2016). Male gender, Black race, increased deficiency in activities of daily living, worse physical functioning, and worse social functioning were associated with increased use of EMS among older adults (Shah et al., 2003; Tangherlini et al., 2010). Persons who experience psychiatric emergencies were also more likely to use EMS often and revisit the ED within a 72-hour period after initial discharge, an occurrence known as a bounceback (Supples et al., 2023). Among persons who experience psychiatric emergencies, Hispanics were less likely to have bouncebacks compared to non-Hispanic Whites (Supples et al., 2023). No study to our knowledge has examined psychiatric emergencies in the

prehospital setting, with a focus on Hispanic older adults before or during the COVID-19 pandemic.

During the COVID-19 pandemic, the direct exposure to the virus led to an excessive number of severe infections, hospitalizations and deaths among Hispanic older adults (Garcia et al., 2021). The COVID-19 pandemic also had indirect effects on Hispanic older adults due to disruptions in daily routines, less physical activity, and social isolation, which resulted in fewer interactions with family and friends (Garcia et al., 2021). The heightened susceptibility of severe infection, hospitalization, and death due to COVID-19, combined with the loss of socio-emotional resources increase the risk of psychiatric emergencies among Hispanic older adults (Armitage & Nellums, 2020; Bui et al., 2021). Little is known, however, on the impacts of the COVID-19 pandemic on the provision of EMS to Hispanic older adults, especially with a focus on psychiatric emergencies.

Neighborhood and Policy-Level Factors That Impact Provision of EMS for Hispanic Older Adults Who Experience Psychiatric Emergencies

Literature on the associations between neighborhood-level composition and prehospital emergency care is limited. A study found that higher neighborhood poverty was associated with more ambulance transports for psychiatric emergencies in one county in California, compared to neighborhoods with lower neighborhood poverty (Seim et al., 2017). Neighborhoods with higher poverty were associated with more low, medium, and high acuity emergency calls, compared to neighborhoods with lower poverty (Seim et al., 2017). Another study reported that Hispanics in high-poverty neighborhoods, or low SES areas, were less likely to use inpatient mental health services, compared to Whites (Chow et al., 2011). This study also found that Hispanics in low-poverty neighborhoods were more likely to use emergency services for mental health concerns and

more likely to be referred to mental health services by the criminal justice system compared to Whites (Chow et al., 2011). The studies in this dissertation aim to address the existing research gap and advance our understanding of neighborhood-level composition and provision of EMS to older adults, with a focus on Hispanics.

Overview of San Francisco County, California and its EMS System

Sociodemographic Characteristics in San Francisco County

San Francisco (SF) County is one of fifty-eight counties in California (CA), with a population of approximately 808,988 people (U.S. Census Bureau, 2023). SF County is located in the northwest part of CA, and it is considered a commercial, financial, and cultural center (U.S. Census Bureau, 2024). SF County is comprised of 46.9 miles of land, making it the smallest county in terms of square mileage, but the most densely populated county with 3,575 people per square mile (U.S. Census Bureau, 2024). SF County is organized into 11 supervisorial districts, which are further subdivided into smaller geographic areas, including ZIP codes and ZIP code tabulation areas (ZCTAs) (City and County of San Francisco, 2024).

SF County's population is more diverse in terms of race and place of birth, less ethnically diverse, and has a higher proportion of older adults and persons with more years of formal education compared to CA's population (U.S. Census Bureau, 2023). Specifically, the population of White persons is 51% in SF County and 71% in CA (U.S. Census Bureau, 2023). SF County has a larger percentage of Asian residents (37.2%), compared to CA (15.9%), while the population of Black or African American, American Indian Alaska Native (AIAN), Native Hawaiian or Pacific Islander (NHPI), and people who have two or more races is comparable at the county and state levels (U.S. Census Bureau, 2023). Hispanic ethnic diversity is lower in SF County (15.2%),

compared to CA (39.1%), while the percentage of foreign-born people is higher in SF County (34.2%), relative to CA (26.6%) (U.S. Census Bureau, 2023).

Overview of the San Francisco County's Emergency Medical Services System

The San Francisco Emergency Medical Services Agency (SFEMSA) provides oversight of EMS provided in the City and County of SF (SFEMSA, 2022). The City and County of SF has six authorized ambulance providers who provide 9-1-1 Basic Life Support (BLS), Advanced Life Support (ALS), interfacility transports, or a combination of these services (SFEMSA, 2023). The three authorized ambulance providers who provide 9-1-1 BLS, ALS, or both in the community include SF Fire Department, King-American and American Medical Response (SFEMSA, 2023). NorCal, ProTransport-1, and Royal are authorized ambulance providers that focus on interfacility transports, not emergencies in the prehospital setting (SFEMSA, 2023). Since this dissertation focuses on provision of EMS in the prehospital setting, the data comes from the three authorized ambulance providers who provide emergency services in the prehospital or community setting.

CHAPTER 3: THEORETICAL FRAMEWORK

McLeroy's Socio-Ecological Model

The Main Principles in McLeroy's Socio-Ecological Model

McLeroy's Socio-Ecological Model, hereinafter referred to as socio-ecological model, provides the theoretical grounding for this research. The socio-ecological model is informed by several key principles, including multiple levels of influence on health behaviors, reciprocal causation, and the interdependence or interaction of factors within and across levels (Mcleroy et al., 1988). The first principle posits that there are multiple levels of influence that affect health behaviors (Mcleroy et al., 1988). These multiple levels of influence include factors at the intrapersonal, interpersonal, institutional, community, and public policy levels (Mcleroy et al.,

1988). Each level of influence will be further discussed in the subsequent section (See Chapter 3: Section I.II.). The second principle is reciprocal causation, which is a bidirectional process where individuals shape, and are shaped by their environment (Mcleroy et al., 1988). The third principle posits that the factors across the multiple levels of influence are interdependent, but also interact with one another (Mcleroy et al., 1988). The third principle may be conceptualized as an extension of reciprocal causation, but instead of describing a bidirectional process, it describes multidirectional processes that occur within and across the multiple levels of influence (Mcleroy et al., 1988).

The Five Levels of Influence in McLeroy's Socio-Ecological Model

The socio-ecological model includes the intrapersonal, interpersonal, institutional, community, and public policy levels of influence (see Figure 1) (Mcleroy et al., 1988). The first level of influence includes intrapersonal level factors, such as knowledge, skills, attitudes, and behaviors (Mcleroy et al., 1988). In the context of EMS provision, intrapersonal-level factors that may impact the delivery of care by EMTs, paramedics, and other emergency providers include having the knowledge to accurately assess prehospital emergencies based on patients' signs and symptoms, skills to communicate in the patient's preferred language, knowledge of patient's cultural and intersectional backgrounds to deliver culturally competent care, and providers' awareness of personal biases (Stadeli et al., 2023). During the COVID-19 pandemic, fear of infection and death among EMTs and paramedics may have also impacted the provision of EMS (McAlearney et al., 2022). On their own, intrapersonal-level factors may result in improvements to the provision of EMS, although changes across multiple levels of influence tend to have larger and more sustainable impacts (Mcleroy et al., 1988). Although important, intrapersonal-level changes are necessary, but not sufficient to eliminate health disparities and achieve equity in the

prehospital system. Focusing only on intrapersonal-level factors shifts the responsibility of health disparities on EMS providers, without considering the impacts of the other multi-level factors. Shifting the responsibility on individual EMTs and paramedics may sound like: "Why was the provider not able to communicate in the patient's preferred language?" This type of question ignores interpersonal, institutional, community, and public policy level factors.

The second level of influence in the socio-ecological model includes interpersonal factors, defined as formal or informal systems of support (Mcleroy et al., 1988). In the context of EMS provision, interpersonal factors that may impact patient-provider interactions, include the sociodemographic concordance or discordance of both parties. Patient-provider racial concordance is linked to improved patient involvement in care, greater satisfaction, and better health-related outcomes, while patient-provider gender concordance is associated with increased trust by the patient (Crowe et al., 2020). Patient-provider language discordance is associated with more errors in providing medical directions to 9-1-1 callers and delayed dispatch of emergency personnel and resources (Tate, 2015). Formal and informal systems of support, including having emergency responder colleagues who speak the patient's language or having access to a translator improves provision of EMS when patient-provider discordance is recorded (Stadeli et al., 2023).

The third level of influence in the socio-ecological model consists of institutional or organizational factors (Mcleroy et al., 1988). Institutional or organizational-level factors include rules and regulations that guide these establishments (Mcleroy et al., 1988). In recent years, several EMS agencies have piloted institution-wide changes that impact the delivery of EMS care. For example, the City of Los Angeles Fire Department piloted an Advanced Practitioner Nurse Response unit, which partnered a paramedic with a nurse practitioner to provide low-acuity 9-1-1 callers with out-of-hospital care, release on scene, alternative destination transports, and linkages

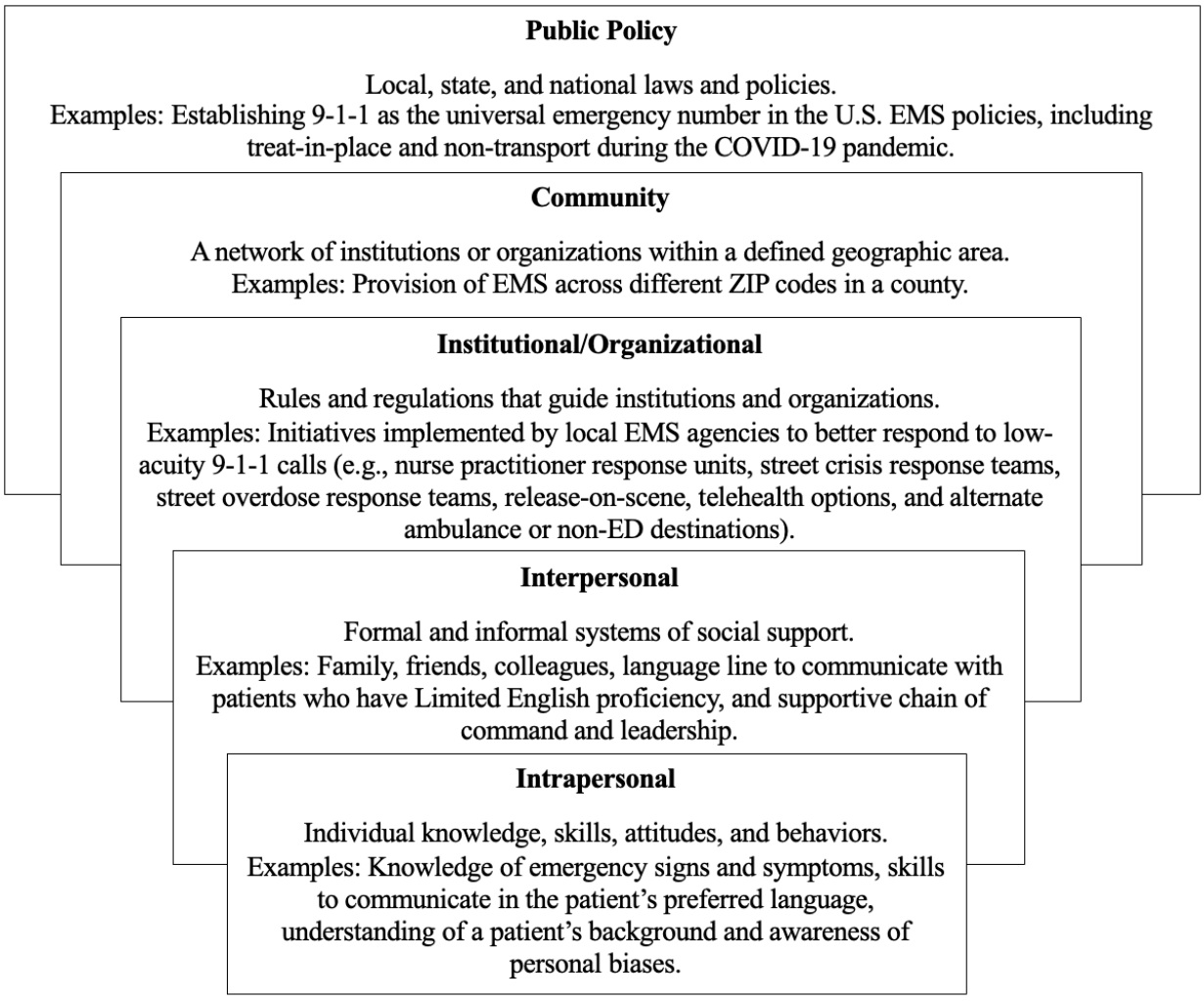
to social services (Sanko et al., 2020). San Francisco (SF) County piloted a Street Crisis Response Team (SCRT) and a Street Overdose Response Team (SORT) for patients experiencing psychiatric and substance use-related emergencies in the community (Goldman et al., 2023). During the COVID-19 pandemic, some EMS agencies also implemented institutional-level changes, such as expanding telehealth options and using alternate destinations when EDs were at capacity (Sanko & Eckstein, 2021). Although changes at the institutional level are crucial to improve provision of EMS, securing funding is also important to sustain these changes long term.

The fourth level of influence in the socio-ecological model is the community level (Mcleroy et al., 1988). The first definition of community posits that individuals are connected to the larger environment via mediating structures, such as family, friends, and community-based organizations (CBOs) (Mcleroy et al., 1988). Consideration of these mediating structures is important because they often exert a strong influence on individual behavior (Mcleroy et al., 1988). For example, EMS provision may improve if EMTs and paramedics build trust and rapport with community members. CBOs can mediate the establishment of trust and rapport between providers and patients by hosting classes and workshops. For example, EMTs and paramedics can lead classes in the community related to fire prevention and safety, cardiopulmonary resuscitation (CPR), and injury prevention. The second definition of community includes a network of institutions or organizations within a defined geographic or political area (Mcleroy et al., 1988). This definition of community allows for the subjective interpretation of the geographic or political boundaries. Using this definition of community, a researcher may compare provision of EMS using prehospital metrics across different geographies, including ZIP codes or census tracts. The third definition of community is a network built around power structures (Mcleroy et al., 1988). Power structures influence the issues that reach the public agenda, determine action items, and allocate

funding and resources (Mcleroy et al., 1988). Some examples of power structures include a network of political, social, or religious institutions (Mcleroy et al., 1988). For example, political institutions often fund local emergency response systems, including police, fire, and EMS. The priorities of these political institutions are often reflected in how the funds are used.

The fifth level of influence in the socio-ecological model is the public policy level (Mcleroy et al., 1988). The public policy level of the socio-ecological model includes macro-level factors that influence health behaviors, including federal, state, and local laws and policies (Mcleroy et al., 1988). An example of a public policy level change that revolutionized the U.S. emergency system is the designation of 9-1-1 as the universal emergency number. This change resulted in the establishment of the modern emergency system in the country. During the COVID-19 pandemic, public policies such as treat-in-place and non-transports were adopted to address issues of ED overcrowding, allocate limited resources based on 9-1-1 call acuity levels, and minimize infections and deaths experienced by patients, EMS personnel, and other healthcare providers (N. Glober et al., 2023).

Figure 1: Adaptation of McLeroy's Socio-Ecological Model in the context of emergency medical services (EMS) provision



Fundamental Cause Theory

The theoretical foundation of this dissertation is also informed by fundamental cause theory (Phelan & Link, 2013). Fundamental cause theory was originally developed to explain the emergency and persistence of health inequities based on socioeconomic status (SES) over time (Clouston & Link, 2021; Phelan & Link, 2013). Over the past thirty years, researchers have identified additional constructs as fundamental causes for health inequities, including stigma, racism, residential segregation, and social conditions (Hatzenbuehler et al., 2013; Link & Phelan, 1995; Phelan & Link, 2015; Williams & Collins, 2001).

The Main Principles in Fundamental Cause Theory

Fundamental cause theory consists of four main tenets. The first tenet posits that the fundamental cause must influence multiple disease outcomes (Phelan & Link, 2013). The second tenet posits that the fundamental cause is associated with multiple risk factors that contribute to several disease outcomes (Phelan & Link, 2013). The coexistence of multiple risk factors is a concept known as the multiplicity of mechanisms (Lutfey & Freese, 2005). The third tenet posits that access to flexible resources, including money, knowledge, power, prestige, and beneficial social connections are deployed to prevent or avoid risks and treat diseases (Phelan & Link, 2013). The fourth tenet posits that the associations between the fundamental cause and health outcomes is reproduced over time with the replacement of intervening mechanisms (Phelan & Link, 2013). The replacement of mechanisms concept requires that the importance of old mechanisms decrease over time (Phelan & Link, 2013).

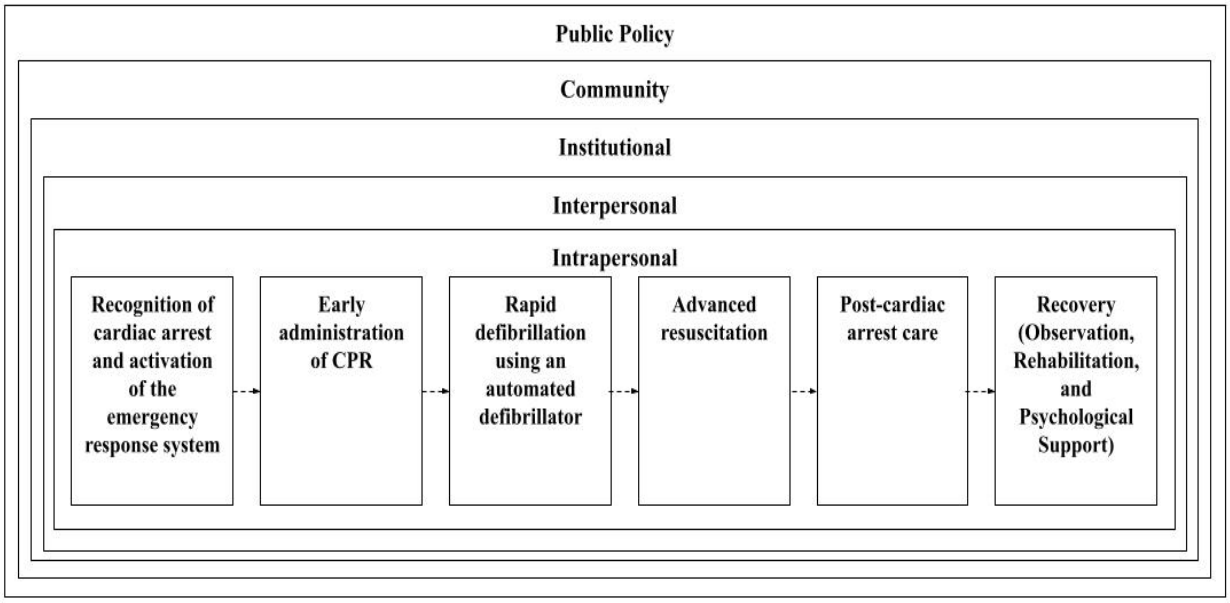
Chain of Survival Framework

Chain of Survival Framework for Out-of-Hospital Cardiac Emergencies

The Chain of Survival Framework, hereinafter referred to as the chain of survival, contributes to the theoretical foundation of this dissertation, with a focus on the first two studies that assess cardiac emergencies. Mary M. Newman, CEO of the Sudden Cardiac Arrest Foundation, first described the chain of survival in 1989 (Newman, 1989). In 1991, the American Heart Association (AHA) adopted and modified the chain of survival (Cummins et al., 1991). The chain of survival was created to emphasize the importance of each individual link and the interrelationships across links in decreasing morbidity and increasing survival after a cardiac emergency in the out-of-hospital setting (Deakin, 2018). The chain of survival includes six links: 1) recognition of cardiac arrest and activation of the emergency response system; 2) early administration of cardiopulmonary resuscitation (CPR); 3) rapid defibrillation using an automated

defibrillator to reestablish a normal heart rhythm; 4) advanced resuscitation by EMS and other healthcare providers; 5) post-cardiac arrest care; 6) and recovery, including observation, rehabilitation, and psychological support (AHA, 2024). In summary, the theoretical framework acknowledges the importance of the multiple levels of influence from the socio-ecological model across each of the links in the chain of survival. Specifically, provision of EMS care across the six links are impacted by factors at the intrapersonal, interpersonal, institutional, community and public policy-level. The theoretical framework created by the socio-ecological model and the chain of survival examine factors both within and across links in the context of providing EMS to older adults who experience an out-of-hospital cardiac emergency.

Figure 2: Adaptation of the Out-of-Hospital Chain of Survival and Socio-Ecological Model in the context of EMS provision

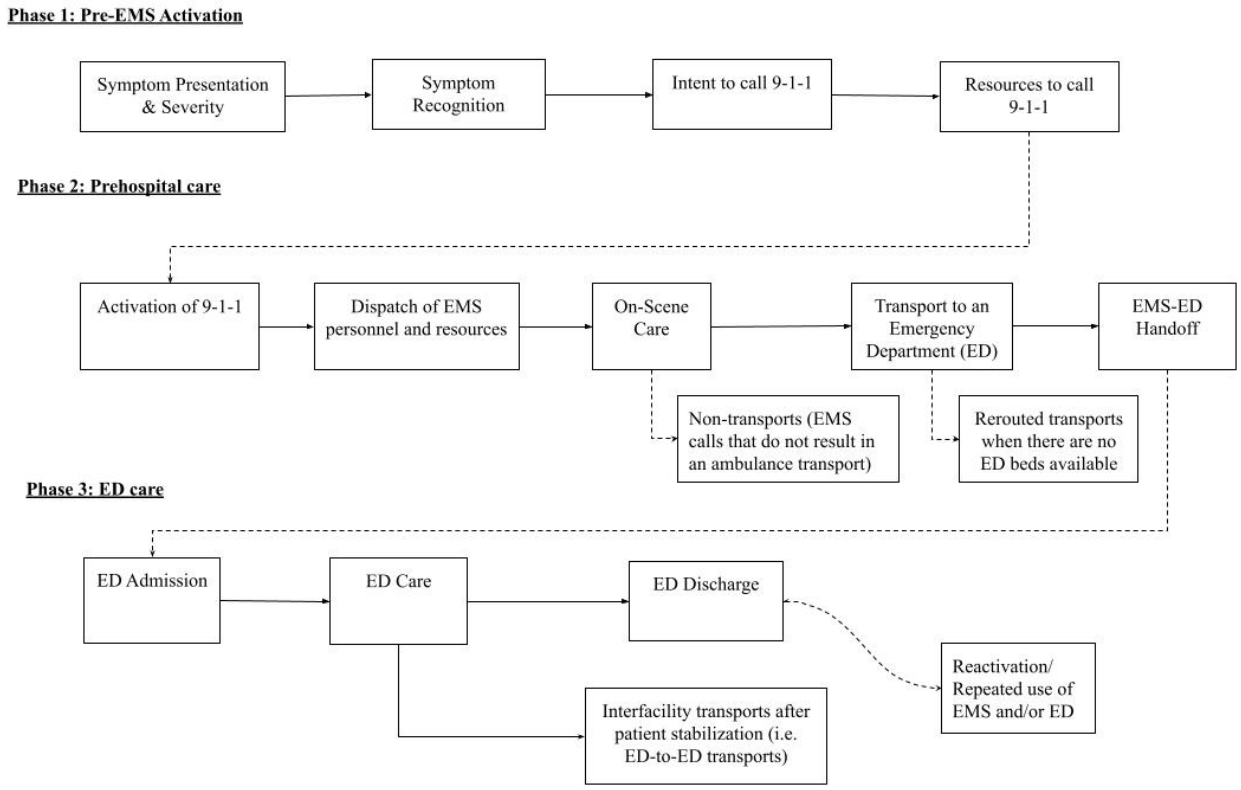


Emergency Care Framework

In this paper, I present the Emergency Care Framework, which describes the major phases and subphases with the in and out-of-hospital emergency care continuum (see Figure 3). The Emergency Care Framework is divided into three phases, including pre-EMS activation, prehospital care, and ED care (see Figure 3). Each phase is divided into several sub-phases (see

Chapter 3: Sections I. Pre-EMS Activation, Section II. Prehospital Care, and Section III. ED Care for more information on the specific subphases within each phase). Multi-level factors at the intrapersonal, interpersonal, institutional, community, and policy level are considered within and across phases and subphases (see Figure 3).

Figure 3: Emergency Care Framework



Pre-EMS Activation

Pre-EMS activation is the first phase in the Emergency Care Framework. The pre-EMS activation phase includes four subphases: symptom presentation and severity, symptom recognition, intention to call emergency services and resources to call 9-1-1 (See Figure 3). The first subphase acknowledges that there are differences in the presentation and severity of symptoms. Presentation of symptoms refers to whether a person is symptomatic or asymptomatic. The second subphase is symptom recognition. If the individual has mild symptoms or is

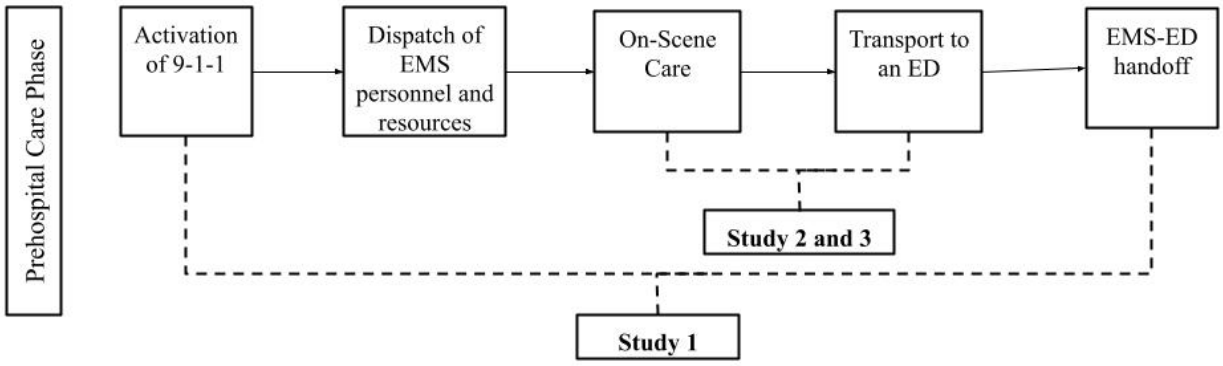
asymptomatic, the person may confuse the symptoms with common diseases, such as allergies, cold, or flu, and may not recognize the need for emergency care. Symptom recognition is particularly important for time-sensitive health conditions, such as heart attacks, cardiac arrests, and stroke, which require prompt and accurate medical attention. Symptom recognition may also be more difficult among persons experiencing psychiatric, behavioral or substance use-related emergencies. Symptom recognition is necessary, although not sufficient, to activate the emergency system. The third subphase is the intention to call 9-1-1. A person may be hesitant to call 9-1-1 due to financial concerns related to lack of insurance, underinsurance, fear of high costs even when insured, immigration concerns, or negative past experiences with the emergency sector. The fourth subphase refers to having the necessary resources to contact 9-1-1. In addition to having an intention to call 9-1-1, the person must also have the resources necessary to activate the emergency system. These resources may include access to a telephone landline or a cellphone. All of the subphases within the pre-EMS activation phase may be applied to the person experiencing the emergency, family members, friends, and bystanders.

Prehospital Care

Prehospital care is the second phase in the Emergency Care Framework. The prehospital care phase includes five subphases: activation of the EMS system, dispatch of emergency personnel and resources, on-scene care, transport to an ED and EMS-ED handoff (See Figure 3). Activation of the EMS system is the first subphase of the Emergency Care Framework. During this subphase, the person calling 9-1-1 communicates with a telecommunicator or emergency dispatcher to assess the need for dispatch. The second subphase is dispatch of emergency personnel and services to the scene, while the third subphase is to provide on-scene prehospital care. The purpose of the second and third subphases is to assess and, if needed, treat the patient on-scene.

The fourth subphase is to transport the patient to a healthcare facility. Some individuals are not transported by EMS due to multiple reasons, including transport refusals, death upon EMS arrival, and EMS non-transport policies. EMS transports may also be rerouted if the initial ED does not have enough beds or if the patient requires specialized care, a common occurrence during the COVID-19 pandemic. The final subphase is EMS-ED handoff, which refers to the act of transferring a patient from EMS to ED care. Patient handoffs are an important subphase to study since they are documented as high-risk events for medical errors (Meisel et al., 2015). Although the Emergency Care Framework is presented in this dissertation, the three studies focus exclusively on the prehospital phase (See Figure 4).

Figure 4: Application of the Emergency Care Framework across the three dissertation studies



ED Hospital Care

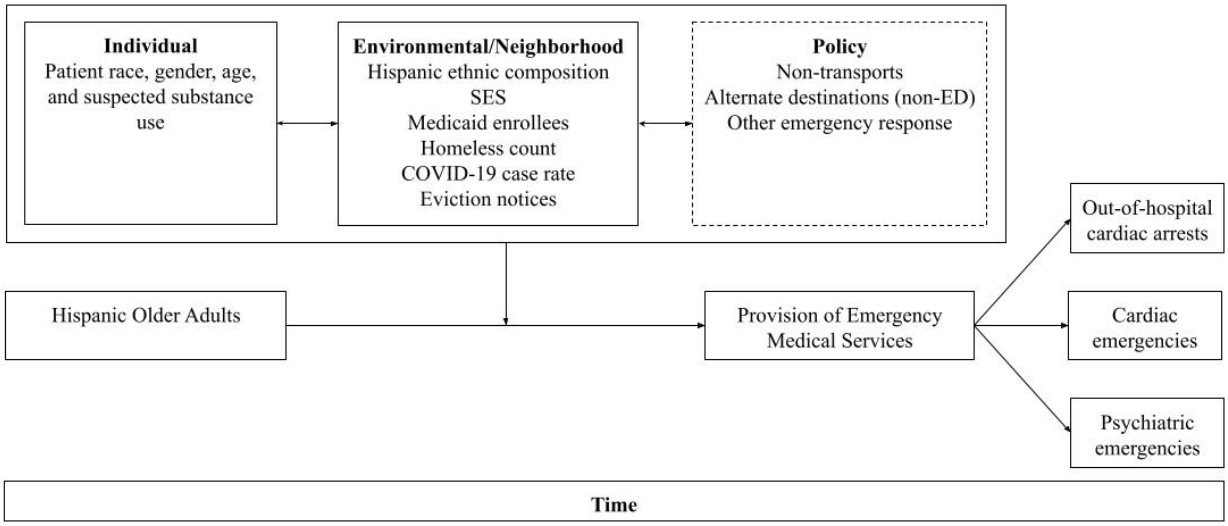
ED care is the third phase in the Emergency Care Framework (See Figure 3). The ED care phase includes three subphases: admissions, provision of care, and discharge from the ED (See Figure 3). The first subphase occurs when EMS hands off the patient to the ED team. In some instances, EMS will provide interfacility transports when patients need to be transported from one health facility to another. The second subphase is the provision of care in the ED, while the third phase is discharge from the ED. After discharge some patients will return to the ED, which

activates a feedback loop. ED care is the most studied phase in the emergency sector, so this is not the focus of this dissertation.

Conceptual Model

The conceptual model shown in Figure 5 guides the three dissertation studies. The main question these studies seek to answer is to what extent EMS provision to older adults differs among Hispanics, compared to other racial groups, after considering factors at the individual, neighborhood, and policy level. The main independent variable of interest is patient race and ethnicity, while the main dependent variable is provision of EMS. Each of the dissertation studies assesses the delivery of care for specific types of prehospital emergencies, including out-of-hospital cardiac arrests, cardiac emergencies, and psychiatric emergencies. Time is also considered across all three of the dissertation studies. The idea of time is especially important in the context of the second and third studies, which use data during the first two years of the COVID-19 pandemic. Specifically, the two studies use data between February 1, 2020, and December 31, 2021, which corresponds to the first two years of the pandemic, where individual, neighborhood and policy level factors may have changed in importance. For example, during the pandemic there was time-sensitive developments, including the declaration of COVID-19 as a public health emergency, an issuance of stay-at-home orders, periods of vaccine unavailability and availability, ambulance non-transport policies and eviction notice moratoriums.

Figure 5: Conceptual model of the multi-level factors that impact provision of EMS to Hispanic older adults



CHAPTER 4:

STUDY #1: A SCOPING LITERATURE REVIEW ON THE PROVISION OF EMERGENCY MEDICAL SERVICES FOR HISPANIC OLDER ADULTS WHO EXPERIENCE AN OUT-OF-HOSPITAL CARDIAC ARREST

INTRODUCTION:

In the United States (U.S.), cardiac arrests are a significant public health concern and a leading cause of death (Institute of Medicine, 2015; SCAF, 2024). Cardiac arrests are characterized by a severe malfunction, cessation, or absence of electrical activity in the heart muscle (Institute of Medicine, 2015). The dysregulation or cessation of electrical activity causes the heart muscle to suddenly stop beating, which results in a sudden loss of consciousness (Institute of Medicine, 2015). Cardiac arrests are classified into two main categories: out-of-hospital cardiac arrests (OHCAs) and in-hospital cardiac arrests (IHCAs) (Institute of Medicine, 2015). It is estimated that there are 356,461 OHCAs and 307,200 IHCAs in the U.S. per year (Andersen et al., 2019; Holmberg et al., 2019; SCAF, 2024; Tsao et al., 2022). Of these, adults comprise 347,322 or 97% of the OHCAs and 292,000 or 95% of the IHCAs (Andersen et al., 2019; Benjamin et al., 2018; Garcia et al., 2022). Of the OHCAs in the U.S., nearly all are assessed by emergency medical service (EMS) providers (Garcia et al., 2022). The classification of cardiac arrests based on the

location of the emergency exemplifies the traditionally separate roles delegated to EMS and in-hospital emergency providers (Institute of Medicine, 2015).

The term cardiac arrest refers to a specific type of cardiac emergency, although it is often used interchangeably and erroneously to describe other health conditions, including heart attacks (Institute of Medicine, 2015). Cardiac arrests and heart attacks are different in terms of underlying causes, symptoms, and recommended course of treatment (Institute of Medicine, 2015). Cardiac arrests result from an electrical problem in the heart muscle, while heart attacks are the result of a circulation issue due to a partially blocked or completely obstructed artery (Institute of Medicine, 2015). The most common symptoms of cardiac arrests are an instantaneous loss of consciousness and collapse (Institute of Medicine, 2015). Heart attack symptomology includes chest pain, shortness of breath, sweatiness, and dizziness (Institute of Medicine, 2015). The main goal for cardiac arrest treatment is the return of spontaneous circulation (ROSC) (Institute of Medicine, 2015). ROSC is a clinical assessment to determine the quality of cardiopulmonary resuscitation (CPR) during a cardiac event and assess signs of life, including a palpable pulse, measurable blood pressure, and breathing, coughing, and moving (Chan & Tang, 2020; Lian et al., 2022). For every minute that passes after a cardiac arrest, there is a 7% to 10% decrease in survival (Institute of Medicine, 2015). Achieving a prompt ROSC, therefore, minimizes the risk of physical and neurological damage and increases the chances of survival (Institute of Medicine, 2015). In contrast, the main goal of treatment for heart attacks is reopening blocked arteries and restoring blood flow to avoid irreversible death of the heart muscle (Institute of Medicine, 2015). Treatments for heart attacks include the administration of medication to dissolve blood clots, dilation of coronary blood vessels, provision of chest pain relief, coronary angioplasty (e.g., a procedure to open clogged blood vessels of the heart), insertion of a stent to open blocked arteries, and delivery

of post-infarct care (Institute of Medicine, 2015). The irreversible death of the heart muscle during a heart attack is estimated to take 20 to 40 minutes after onset of inadequate oxygenation (Institute of Medicine, 2015). Heart attacks may affect the electrical activity of the heart, which can eventually result in a cardiac arrest (Institute of Medicine, 2015). A cardiac arrest, however, cannot cause a heart attack (Institute of Medicine, 2015).

This scoping literature review focuses on cardiac arrests, particularly those that occur in the out-of-hospital setting. The OHCA chain of survival operational framework guides the response to cardiac arrests that occur in the out-of-hospital setting (AHA, 2024). The chain of survival describes the recommended steps, hereinafter referred to as links, that are recommended to decrease the risk of physical and neurological damage and increase the chances of survival after an OHCA (AHA, 2024). The chain of survival concept was first introduced by Mary M. Newman in 1989 as a way to improve cardiac arrest-related outcomes (Newman, 1989). By 1991, the AHA, SCAF and other health organizations adopted, elaborated, and transformed the chain of survival concept into an operational framework that continues to guide the emergency response to OHCAs (Cummins et al., 1991). The most recent version of the chain of survival framework includes six links: early activation of the emergency response system, high-quality cardiopulmonary resuscitation (CPR), defibrillation, advanced resuscitation, post-cardiac arrest care, and recovery (AHA, 2024; SCAF, 2024). The first link is the early activation of the emergency response system, which refers to the prompt identification of a cardiac arrest, early activation of the emergency system with a 9-1-1 call, recognition of an OHCA by a telecommunicator, and timely provision of telecommunicator cardiopulmonary resuscitation (T-CPR) (AHA, 2024; SCAF, 2024). Telecommunicators act as EMS providers by delivering T-CPR during OHCAs. The second link is the provision of CPR, with an emphasis on chest compressions (AHA, 2024; SCAF, 2024). The

third link is defibrillation, which is the early use of an automated external defibrillator (AED) to restart the heart (AHA, 2024; SCAF, 2024). In this study, bystander is a term used to refer to any person (e.g., EMS provider, family, friend, or member of the public) who witnessed an OHCA. Lay bystander is a term used to refer to a subgroup of bystanders who do not have known medical training. EMS providers are bystanders in some cases, although they are not lay bystanders because they have known medical training. The fourth link is advanced resuscitation by EMS providers and ambulance transports to an emergency department (ED) (AHA, 2024; SCAF, 2024). The fifth and sixth links, post-cardiac arrest care and recovery, do not typically take place in the prehospital setting, although they are included in this study if emergency care provided in the prehospital setting is also discussed (AHA, 2024; SCAF, 2024). Post-cardiac arrest care is usually administered in a hospital and includes targeted temperature management (TTM), while recovery may include additional observation and monitoring, rehabilitation, and psychological support (AHA, 2024; SCAF, 2024).

Figure 6: Chain of survival for out-of-hospital cardiac arrests (OHCAs)

Source: AHA. (2024). *Out of Hospital Chain of Survival*. https://cpr.heart.org/en/resources/cpr-facts-and-stats/out-of-hospital-chain-of-survival.

Studies suggest that there are health disparities in the use of EMS by Hispanics in the U.S. (Blewer et al., 2020; Garcia, et al., 2022; Kahn et al., 2019; Melgoza et al., 2023). Few studies, however, have examined the barriers and facilitators to the provision of EMS care for the

increasing population of Hispanic older adults who experience OHCAs. The focus of this scoping literature review is to assess the provision of emergency care for Hispanic older adults who experience an OHCA across the six links in the chain of survival. Within each link, factors are considered at the individual, environmental, neighborhood, and policy-levels. This study is guided by the following aims:

AIMS:

Aim #1: Examine the individual-level facilitators and barriers across the six links (e.g., early activation of the emergency response system, CPR, defibrillation, advanced resuscitation, post-cardiac arrest care, and recovery) in the chain of survival that impact the provision of EMS for Hispanic older adults who experience an OHCA.

Hypothesis #1: Emergency telecommunicators will report more language barriers when OHCAs occur among Hispanic older adults, compared to non-Hispanic Whites, which results in more delays in the recognition of cardiac arrests by telecommunicators and the provision of T-CPR instructions.

Hypothesis #2: Hispanic older adults who experience an OHCA are more likely to have a non-shockable rhythm (e.g., asystole or pulseless electrical activity (PEA)), less likely to receive defibrillation, less likely to achieve ROSC, less likely to receive advanced resuscitation from an EMS provider, less likely to receive post-cardiac arrest emergency care, more likely to have neurological damage, and less likely to survive an OHCA, compared to non-Hispanic White older adults.

Hypothesis #3: Among Hispanic older adults who experience an OHCA, individual-level factors, including female sex, Spanish language, and older age are associated with more delays in the provision of emergency care across the six links in the chain of survival.

Aim #2: Assess the environmental and neighborhood-level facilitators and barriers across the six links in the chain of survival that impact the provision of EMS for Hispanic older adults who experience an OHCA.

Hypothesis #1: Environmental-level factors, such as having an OHCA in a public location, compared to a private residence, are associated with more timely provision of T-CPR, CPR, defibrillation, advanced resuscitation, post-cardiac arrest care, and recovery among Hispanic older adults.

Hypothesis #2: Neighborhood-level factors, including a higher proportion of Hispanic residents and lower socioeconomic status are associated with a lower provision of emergency care across the six links in the OHCA chain of survival, including T-CPR, B-CPR, defibrillation, advanced resuscitation, post-cardiac arrest care, and recovery.

Aim #3: Determine the policy-level facilitators and barriers across the six links in the chain of survival that impact the provision of EMS for Hispanic older adults who experience an OHCA.

Hypothesis #1: Hispanic older adults who are privately insured will have fewer delays in the provision of EMS, compared to persons with government insurance (e.g., Medicaid and Medicare), and uninsured individuals.

Hypothesis #2: EMS policies that inform practices to forego initiation of resuscitative practices for OHCAs in the prehospital setting will disproportionately impact Hispanic older adults since this population is more likely to have delays in T-CPR, less likely to receive B-CPR, more likely to have non-shockable initial rhythms and more likely to have unwitnessed cardiac arrests. A higher proportion of Hispanic older adults who experienced an OHCA will not receive resuscitative efforts from EMS providers in prehospital systems that use these types of policies, compared to non-Hispanic Whites.

METHODS:

What is a scoping literature review?

Scoping literature reviews are an increasingly important approach to synthesize literature and provide justification for future research on a specific topic (Levac et al., 2010; Tricco et al., 2018). Scoping literature reviews provide a comprehensive overview of the existing literature to address broad research questions (Peters et al., 2021). This approach is different from systematic literature reviews, which are used to answer more specific research questions (Peters et al., 2021). The number of reviewers who examine the existing literature also differs for scoping literature reviews and systematic literature reviews (Peters et al., 2021; Stoll et al., 2019). Scoping literature reviews includes one or more reviewers, while systematic literature reviews require at least two reviewers (Peters et al., 2021; Stoll et al., 2019). Scoping literature reviews do not require the critical appraisal of included studies, while this step is a requirement for systematic literature reviews (Levac et al., 2010). The Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews (PRISMA-ScR) guidelines inform the process of conducting a scoping literature review (Tricco et al., 2018). These guidelines are discussed more in depth in the next section.

PRISMA extension for scoping reviews (PRISMA-ScR)

Over the past 25 years, several groups have developed guidelines to conduct meta-analyses, systematic literature reviews, and scoping literature reviews (Tricco et al., 2018). In 1999, the Quality of Reporting of Meta-Analyses (QUOROM) group developed the first guidelines to assess the quality of meta-analyses that focused on randomized controlled trials (Moher et al., 1999). Systematic and scoping literature reviews, however, were not discussed in these guidelines (Moher et al., 1999). In 2009, the Preferred Reporting Items of Systematic Reviews and Meta-Analyses

2009 (PRISMA 2009) guidelines were published to inform and assess the quality of both systematic literature reviews and meta-analyses (Moher et al., 2009). The PRISMA 2009 guidelines were later updated, which resulted in the publication of PRISMA 2020 a few years later (Page et al., 2021). PRISMA 2009 and 2020 provided authors with the criteria to rigorously conduct meta-analyses and systematic literature reviews (Moher et al., 2009; Page et al., 2021).

The development of guidelines for scoping literature reviews occurred almost simultaneously with the publication of PRISMA 2009 and 2020. In 2005, the first methodological guide for scoping literature reviews was published (Arksey & O'Malley, 2005). In 2014, updated guidelines were created for scoping literature reviews by the Journal of Biomedical Informatics (JBI) Scoping Review Methodology Group, and later updated in 2017 (Peters et al., 2021). In 2018, the PRISMA extension for scoping reviews (PRISMA-ScR) was developed by an international team of experts, including members of the JBI working group (Peters et al., 2021; Tricco et al., 2018). The purpose of the PRISMA-ScR guidelines was to provide a better understanding of the relevant concepts and key items to consider when conducting and assessing the quality of research included in scoping literature reviews (Peters et al., 2021; Tricco et al., 2018). Overall, the guidelines for scoping literature reviews, systematic literature reviews, and meta-analyses have revolutionized the way these types of studies are conducted and reviewed.

The current study is informed and guided by the PRISMA-ScR guidelines (Tricco et al., 2018). The PRISMA-ScR guidelines are a revised version of the PRISMA criteria for systematic literature reviews and meta-analyses, referred to hereinafter as "original PRISMA criteria" (Tricco et al., 2018). The PRISMA-ScR guidelines differ from the original PRISMA criteria in three major ways (Tricco et al., 2018). First, the PRISMA-ScR guidelines include revised wording for all items compared to the original PRISMA criteria (Tricco et al., 2018). Second, the PRISMA-ScR

excludes five items that are part of the original PRISMA criteria because they are not relevant to scoping literature reviews (Tricco et al., 2018). Third, PRISMA-ScR includes two optional items related to assessing and recording the quality of included research studies (Tricco et al., 2018). The two optional items in the PRISMA-ScR are required in the original PRISMA criteria (Tricco et al., 2018). The final PRISMA-ScR guidelines include a 22-item checklist with 20 required and 2 optional items (Items 12 and 16) (see Table 1) (Tricco et al., 2018). Although a flow diagram is not required for scoping literature reviews, the current study uses an adaptation of the PRISMA 2020 flow diagram for systematic literature reviews (see Figure 2) to ensure replicability and transparency in the review process (Page et al., 2021).

Table 1: PRISMA-ScR checklist from Tricco et al. 2018

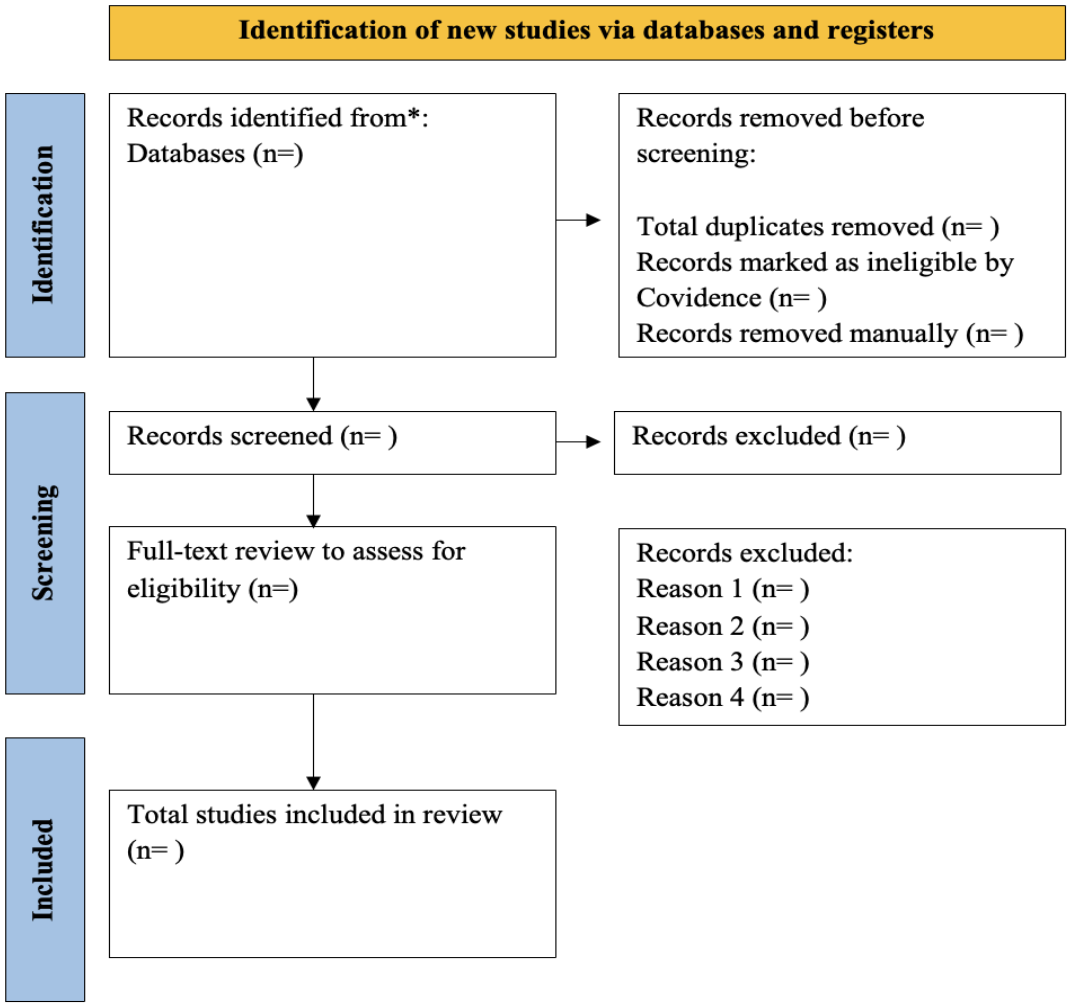
Section	Item Number	Checklist Item	Included (Yes/No)
Title			
Title of study	1	Identify the report as a scoping review.	Yes
Abstract			
Structured summary	2	Provide a structured summary that includes (as applicable) background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Yes
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/ objectives lend themselves to a scoping review approach.	Yes
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g.,	Yes

		population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	
Methods			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Yes
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Yes
Information sources	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Yes
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Yes
Selection of sources of evidence	9	State the process of selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Yes
Data charting process	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Yes
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Yes

Critical appraisal of individual sources of evidence	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Yes
Results			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Yes
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Yes
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Yes
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Yes
Discussion			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Yes
Limitations	20	Discuss the limitations of the scoping review process.	Yes
Conclusions	21	Provide a general interpretation of the results with respect to the review	Yes

		questions and objectives, as well as potential implications and/or next steps.	
Funding			
Funding	22	Describe sources of fundings for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	Yes

Figure 7: Adaptation of the PRISMA 2020 flow diagram from Page et al. 2021



Protocol Registration

A registered research protocol is not a requirement for scoping literature reviews, although it is recommended per the PRISMA-ScR guidelines (Tricco et al., 2018). A research protocol was

submitted for this scoping literature review to increase the rigor of the study, create transparency in the research process, and to avoid duplication by the research community. The research protocol for this study was registered with the Open Science Framework (OSF), a tool that promotes transparency in research (Foster & Deardorff, 2017). OSF provides a time-stamped version of the submitted research protocol, which cannot be modified or deleted, even if the user decides to withdraw the project later (Foster & Deardorff, 2017). OSF provides an option to make the content publicly available or establish an embargo for up to four years (Foster & Deardorff, 2017). For this study, the research protocol was embargoed for four years.

Information Sources

The selection of the databases for this scoping literature review was informed by the Gusenbauer and Haddaway approach (Gusenbauer & Haddaway, 2020). Gusenbauer and Haddaway evaluated the suitability of 28 academic databases for the purposes of evidence synthesis (Gusenbauer & Haddaway, 2020). Databases were rated as either principal or supplementary resources (Gusenbauer & Haddaway, 2020). Principal resources were defined as databases that met all the quality requirements (Gusenbauer & Haddaway, 2020). Supplementary resources were databases that did not meet all the quality requirements and, thus, were only recommended as additional, not principal databases (Gusenbauer & Haddaway, 2020). The databases included in this scoping literature review were rated as principal resources and met all the quality requirements (Gusenbauer & Haddaway, 2020). The databases used for this scoping literature review include PubMed, CINAHL, Web of Science, OVID Embase, and the Latin American and Caribbean Health Sciences Literature (LILACS) in the Virtual Health Library. After meeting with several librarians at UCLA and USC, the Sistema de Información Científica Redalyc

database was included to broaden the search for research articles published in Spanish. A manual citation search was also conducted by the principal investigator.

Search Strategy for Scoping Literature Review

The search strategy for this scoping literature review was finalized on August 16, 2023, after several independent preliminary searches and meetings with librarians from UCLA and USC. A search strategy was developed in both English and Spanish to ensure that the most comprehensive and inclusive scoping literature review was conducted to synthesize the literature on provision of EMS for Hispanic older adults.

Search Strategy for Scoping Literature Review in English and Spanish

The databases included in this scoping literature review are PubMed, CINAHL Complete, Web of Science, EMBASE, Latin American and Caribbean Health Sciences Literature (LILACS), and Redalyc. The searches were conducted in both English and Spanish. The search strategy per database is described below. A manual search of the citations was also conducted by the principal investigator. The search strategies were modified accordingly to account for different available built-in features and filters across each database. Several search strategies were pilot tested by the principal investigator to ensure a more comprehensive search.

PubMed: The PubMed search strategy in English is included below. Two filters were used in this search. The first filter narrowed studies with a publication date between January 1, 2000, and July 31, 2023. The second filter refined the search to include only studies published in English or Spanish.

("Hispanic or Latino"[Mesh] OR "Latino" OR "Latinx" OR "Hispanic OR Latina*" OR "Hispanic/Latino" OR "Mexican American*" OR "Chicana*" OR "Chicano*" OR "Chicanx") AND ("Aged"[Mesh] OR "Elderly" OR "senior citizen" OR "Senior" OR*

"Older Adult") AND ("Emergency Medical Services"[Mesh] OR "Emergency Medical Services" OR "Medical Emergency Service" OR "Prehospital Emergency Care" OR "Prehospital Emergency Service*" OR "Emergicenter*" OR "Emergency Care" OR "Emergency Health Service" OR "Emergency Medical Dispatch" OR "9-1-1" OR "911" OR "Ambulance*" OR "Emergency Mobile Unit*" OR "Paramedics"[Mesh] OR "EMT-Paramedic*" OR "Emergency Medical Technicians"[Mesh] OR "EMT" OR "Emergency Medical Service Personnel" OR "Emergency Medical Service Responder*" OR "Emergency Medical Dispatcher"[Mesh]) AND ("Cardiac Emergency" OR "Out-of-Hospital Cardiac Arrest"[Mesh] OR "Cardiac Arrest*" OR "Sudden Cardiac Arrest" OR "Out of Hospital Heart Arrest*" OR "OHCA" OR "Cardiopulmonary Resuscitation"[Mesh] OR "CPR" OR "Cardio-Pulmonary Resuscitation" OR "Cardio Pulmonary Resuscitation" OR "Mouth-to-Mouth Resuscitation" OR "Mouth to Mouth Resuscitation" OR "Basic Cardiac Life Support" OR "Advanced Cardiac Life Support").*

A second search strategy was created for PubMed using only terms in Spanish. The purpose of the search strategy in Spanish was to conduct a more comprehensive and inclusive search of the published literature in PubMed. After testing preliminary search strategies and per the librarian's suggestions, the search strategy in Spanish was broader, compared to the search strategy in English because few peer-reviewed articles in PubMed are only published in Spanish. The purpose of the search strategy in Spanish was also to find additional relevant publications that were missed with the English and Spanish publication filter. This search also utilized the publication date filter to ensure identified studies were published between January 1, 2000, and July 31, 2023.

"Servicios Médicos de Emergencia" OR "Servicios de Emergencia Médica" OR "Atención Prehospitalaria de Emergencia" OR "Servicio Prehospitalario de Emergencia" OR

"Centro de Emergencia" OR "Atención de Emergencia" OR "Servicios de Salud de Emergencia" OR "9-1-1" O "911" OR "Ambulancia*" OR "Unidad móvil de emergencia*" OR "Paramédicos" OR "Técnicos Médicos de Emergencia" OR "Personal de Servicio Médico de Emergencia"*

CINAHL Complete and Embase: The search strategy used for the CINAHL Complete and Embase databases is included below. This search strategy considered the built-in-features and filters available in the databases. The search in CINAHL Complete used a geography filter to limit the search to U.S. studies with a publication date between January 1, 2000, and July 31, 2023. The Embase search did not use filters.

"Hispanic or Latino" AND "Emergency Medical Services" AND "Cardiac Emergency" OR "Out-of-Hospital Cardiac Arrest" OR "Cardiac Arrest" OR "Sudden Cardiac Arrest" OR "Out of Hospital Heart Arrest*" OR "OHCA"*

Web of Science: The search strategy for Web of Science is included below. The following filters were used: publication dates between January 1, 2000, and July 31, 2023; U.S. as the country of publication; studies in emergency medicine, health care sciences services, and health policy services; and studies published in English or Spanish.

"Emergency Medical Services"[Mesh] OR "Emergency Medical Services" OR "Medical Emergency Service" OR "Prehospital Emergency Care" OR "Prehospital Emergency Service*" OR "Emergicenter*" OR "Emergency Care" OR "Emergency Health Service" OR "Emergency Medical Dispatch" OR "9-1-1" OR "911" OR "Ambulance*" OR "Emergency Mobile Unit*" OR "Paramedics"[Mesh] OR "EMT-Paramedic*" OR "Emergency Medical Technicians"[Mesh] OR "EMT" OR "Emergency Medical Service Personnel" OR "Emergency Medical Service Responder*" OR "Emergency Medical*

Dispatcher"[Mesh] AND "Hispanic or Latino" AND "Older adults" AND "Cardiac Emergency" OR "Out-of-Hospital Cardiac Arrest"[Mesh] OR "Cardiac Arrest" OR "Sudden Cardiac Arrest" OR "Out of Hospital Heart Arrest*" OR "OHCA" OR "Cardiopulmonary Resuscitation"[Mesh] OR "CPR" OR "Cardio-Pulmonary Resuscitation" OR "Cardio Pulmonary Resuscitation" OR "Mouth-to-Mouth Resuscitation" OR "Mouth to Mouth Resuscitation" OR "Basic Cardiac Life Support" OR "Advanced Cardiac Life Support"*

LILACS and REDALYC: The search strategy in Spanish listed below was used to find relevant publications in LILACS and Redalyc. The search strategy was broad to ensure that relevant studies were found during the search.

"Servicio de Emergencia Médica" OR "Atención Prehospitalaria de Emergencia"

Article Inclusion Criteria

The inclusion criteria for this scoping literature review were initially presented at the dissertation proposal defense on April 25, 2023. After the proposal defense, the inclusion criteria were adjusted and finalized to reflect the modified study aims. Studies are included in this scoping literature review if they examine the provision of EMS to Hispanic adults aged 50 years and older who experience an out-of-hospital cardiac arrest (OHCA) in the prehospital setting. EMS is defined as emergency services provided in the prehospital setting by emergency personnel, including 9-1-1 telecommunicators, emergency medical technicians (EMTs) and/or paramedics. Included studies focus on the provision of emergency care by 9-1-1 telecommunicators, EMTs and paramedics, although mention of emergency care provided by civilian or lay bystanders and emergency physicians is acceptable when the delivery of prehospital care is also discussed. Prehospital setting is defined as emergency services provided prior to arrival in an emergency

department (ED). Studies that include emergency care in the in-hospital setting are included only if they also discuss EMS provided in the prehospital setting. Quantitative, mixed methods and qualitative studies are included if they were published in English or Spanish between January 1, 2000, and July 31, 2023. Only studies that examine the EMS system in the U.S. are included.

Article Exclusion Criteria

Studies are excluded from this scoping literature review if they do not include Hispanics aged 50 years and older, do not discuss provision of emergency care for OHCAs with a focus on the prehospital setting, do not focus on the U.S. EMS system, and when research studies are not published between January 1, 2000, and July 31, 2023. Studies are excluded if they focus on use of EMS from the patient perspective because the emphasis of this scoping literature review is on the provision or delivery of emergency care. Insights on the factors that impact use of EMS by Hispanic adults is available in a previously published systematic literature review (Melgoza et al., 2023). Clinical trials, literature reviews, letters to the editor, editorials, and study protocols are excluded from this scoping literature review.

Data Items & Data Charting Process

A Google spreadsheet alphabetically listed the identified and included studies. Relevant data were extracted from each of the included studies, including the following: full citation, title of the study, author(s) names, publication year, objectives, dataset, data collection years, geographic location, study population characteristics, IRB approval confirmation, type of study/study design, total sample size, sample size of Hispanics, sampling method, data analysis method, key findings, strengths of the study, and study limitations.

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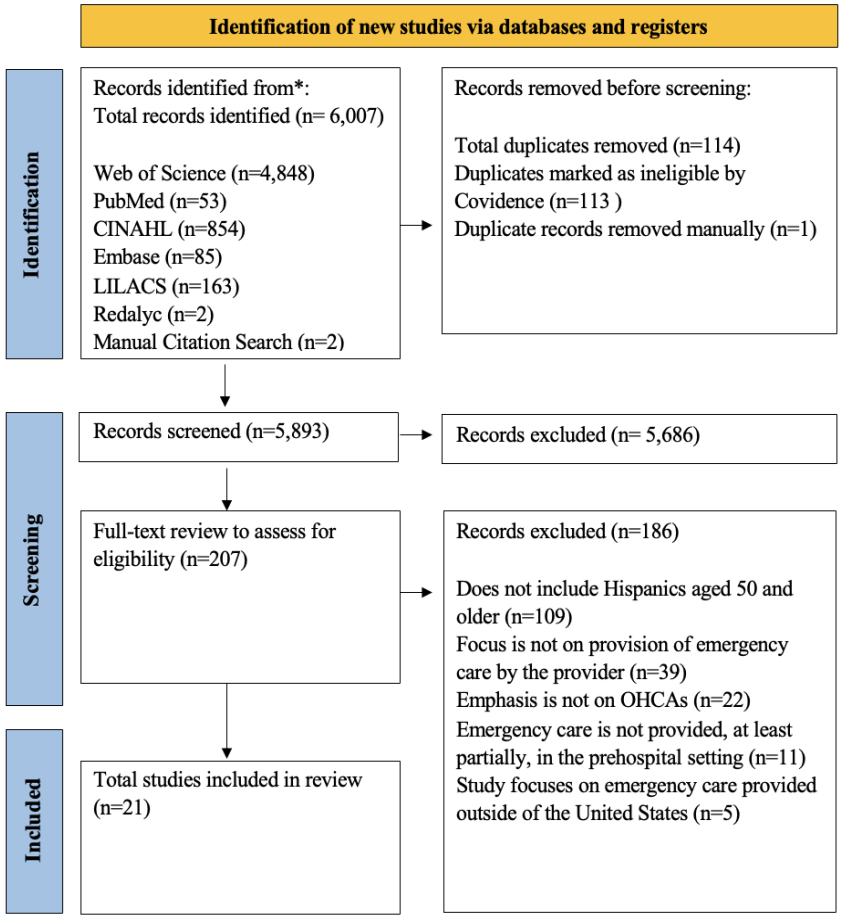
RESULTS:

Adapted Flow Diagram for the Scoping Literature Review

A total of 6,007 studies were identified during the literature search. Of the 6,007 studies, 4,848 were identified in Web of Science, 53 in PubMed, 854 in CINAHL, 85 in Embase, 163 in the Latin American and Caribbean Health Sciences Literature (LILACS), 2 in Redalyc, and 2 via a manual citation search (see Figure 8). The identified studies were imported into Covidence systematic review software, hereinafter referred to as Covidence, which systematically documents every step of the scoping literature review process. The principal investigator reviewed the studies across every step of the research process. Of the 6,007 imported studies, 114 duplicates were identified and removed. The principal investigator screened the titles and abstracts of the remaining 5,893 studies. From these, 5,686 studies were excluded and 207 underwent a full-text review. After the full-text review, 186 studies were excluded because they did not meet at least one of the inclusion criteria. A total of 21 studies met all the inclusion criteria and are included in this scoping literature review (see Figure 8).

Figure 8: Adapted PRISMA flow diagram for scoping literature reviews in the context of EMS provision



Results of Individual Sources of Evidence

This scoping literature review includes 21 studies that met all the inclusion criteria. Of the 21 studies that focused on the provision of emergency care for Hispanic older adults, 3 examined early activation of the emergency response system and telecommunicator provided CPR or T-CPR, 7 assessed early B-CPR, 7 examined early defibrillation, 6 assessed advanced resuscitation, 5 examined post-cardiac arrest care, and 5 focused on recovery after an OHCA (see Tables 2 and 3). Several studies discussed multiple links across the OHCA chain of survival, which explains why the sum of the studies is not 21.

Table 2 shows the 21 studies organized by link and level of influence. All the studies that assessed early activation of the emergency response system and T-CPR focused on individual-

level factors that impact the provision of EMS care to Hispanic older adults (Amen et al., 2020; Mapp et al., 2020; Nuño et al., 2017). Of these three studies, only one assessed neighborhood-level factors, and none of the studies examined policy-level factors (Amen et al., 2020). Among the 7 studies that examined the early administration of CPR, individual-level factors were discussed in all 7 of the studies, environmental and neighborhood-level factors were mentioned in 4 studies, and policy-level factors were not the focus of any study (Bosson et al., 2019; Chugh et al., 2023; Hill et al., 2021; Huebinger et al., 2021; Moon et al., 2014; Sutton et al., 2023; Vadeboncoeur et al., 2008). Of the 7 studies that assessed early defibrillation, 5 focused on individual-level factors, and 2 discussed environmental, neighborhood, and policy-level factors (Bosson et al., 2019; Chugh et al., 2023; Hill et al., 2021; Huebinger et al., 2021; Moon et al., 2014; Sutton et al., 2023; Vadeboncoeur et al., 2008). Of the 6 studies that examined advanced resuscitation after an OHCA, individual-level factors were the focus of 5 studies, environmental and neighborhood-level factors were not the focus of any study, and policy-level factors were central in 1 study (Vadeboncoeur et al., 2008; Weiss et al., 2018; Stoecklein et al., 2022; Kaji et al., 2011; Lupton et al., 2020; Glober et al., 2019). Of the 5 studies that examined post-cardiac arrest emergency care, 5 studies examined individual-level factors, 1 study assessed environmental and neighborhood-level factors, and none of the studies discussed policy-level factors (Bosson et al., 2019; Casey & Mumma, 2018; Morris et al., 2021; Mumma et al., 2015; Reynolds et al., 2017). Of the six studies that assessed recovery, all of the studies focused on individual-level factors, and none discussed environmental, neighborhood, or policy-level factors (Bosson et al., 2019; Casey & Mumma, 2018; DeLia et al., 2015; Eid et al., 2017; Mumma et al., 2015; Reynolds et al., 2017).

Table 2: Studies by level of influence and link in the out-of-hospital chain of survival

	Link #1: Activation of the Emergency Response System and Provision of T-CPR (N=3)	Link #2: B-CPR (N=7)	Link #3: Defibrillation (N=7)	Link #4: Advanced Resuscitation (N=6)	Link #5: Post-Cardiac Arrest (N=5)	Link #6: Recovery (N=6)
Individual-Level Factors	Amen et al., 2019; Mapp et al., 2020; Nuño et al., 2017	Bosson et al., 2019; Chugh et al., 2023; Vadeboncoeur et al., 2008; Sutton et al., 2023; Hill et al., 2021; Huebinger et al., 2021; Moon et al., 2014	Bosson et al., 2019; Chugh et al., 2023; Hill et al., 2021; Sutton et al., 2023; Vadeboncoeur et al., 2008	Kaji et al., 2011; Lupton et al., 2020; Stoecklein et al., 2022; Vadeboncoeur et al., 2008; Weiss et al., 2018	Bosson et al., 2019; Morris et al., 2021; Reynolds et al., 2017; Casey & Mumma, 2018; Mumma et al., 2015	Bosson et al., 2019; DeLia et al., 2015; Eid et al., 2017; Reynolds et al., 2017; Casey & Mumma, 2018; Mumma et al., 2015
Neighborhood-Level Factors	Amen et al., 2019	Chugh et al., 2023; Sutton et al., 2023; Huebinger et al., 2021; Moon et al., 2014	Moon et al., 2014; Huebinger et al., 2021		Morris et al., 2021	
Policy-Level Factors	N/A	N/A	N/A	Glober et al., 2019		

Of the included studies, 1 study was published between 2000 and 2009, 11 studies were published between 2010 and 2019, and 9 studies were published between 2020 and 2023. Most of the studies used local (n=9) and state-level (n=7) data, and only a few studies used multi-state (n=3) and national-level (n=2) data. Hispanic sample size in the included studies ranged from 1 to 99 (n=3), 100 to 999 (n=10), 1,000 to 9,999 (n=5), 10,000+ (n=1), and 2 studies did not provide a sample size. All the studies used quantitative methods, and none used mixed or qualitative methods.

Table 3: Overview of studies that assess provision of emergency care for Hispanic older adults who experienced an out-of-hospital cardiac arrest (OHCA)

Authors	Title	Sample Characteristics and Size	Geographic Location
Amen et al., 2020	Disparity in Receipt and Utilization of Telecommunicator CPR Instruction	Retrospective review and convenience sample of EMS agencies that utilized the Cardiac Arrest Registry to Enhance Survival (CARES). N=170 Hispanics	30 states in the U.S. and the District of Columbia
Bosson et al., 2019	Racial and ethnic differences in outcomes after out-of-hospital cardiac arrest: Hispanics and Blacks may fare worse than non-Hispanic Whites	Retrospective review of registry data N=1,112 Hispanics.	Los Angeles County, California
Casey at el., 2018	Sex, race, and insurance status differences in	Retrospective cohort of patients in the California Office of	California

	hospital treatment and outcomes following out-of-hospital cardiac arrest.	Statewide Health Planning and Development (OSHPD) Patient Discharge Database. N=8,471 Hispanics	
Chugh et al., 2023	Sudden cardiac arrest during the COVID-19 pandemic: A two-year prospective evaluation in a North American community.	Prospective study that uses out-of-hospital cardiac arrests from the ongoing population-based PREdiction of Sudden Death in MulTi-Ethnic COmmunities (PRESTO) study. N=607 Hispanics	Ventura County, California
DeLia et al., 2015	Prehospital transportation to therapeutic hypothermia centers and survival from out-of-hospital cardiac arrest.	Retrospective study using linked statewide prehospital, hospital, and mortality data from the New Jersey (NJ) EMS Data Warehouse, NJ Discharge Data Collection System, and the NJ DOH. N=151 Hispanic patients were treated at TH centers and N=193 Hispanics were treated at other hospitals	New Jersey
Eid et al., 2017	Survival, expenditure and disposition in patients following out-of-hospital cardiac arrest: 1995–2013.	Nationwide serial cross-sectional study that uses data from the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project-Nationwide Inpatient Sample files. N=15,608 Hispanics	United States
Glober et al., 2019	A simple decision rule predicts futile resuscitation of out-of-hospital cardiac arrest	Retrospective cohort analysis using the Cardiac Arrest Registry to Enhance Survival (CARES). N=157 Hispanics	San Mateo County, California
Hill et al., 2021	Retrospective cross sectional analysis of demographic disparities in outcomes of CPR performed by EMS providers in the United States.	Retrospective cross-sectional analysis using the National Emergency Medical Service Information Systems (NEMSIS). N= 442 Hispanics in the whole cohort N= 248 Hispanics for the subsample of people who received bystander CPR or AED	37 states in the United States.
Huebinger et al., 2021	Community disparities in out of hospital cardiac	Study uses the Texas Cardiac Arrest Registry to Enhance	Part of Texas

	arrest care and outcomes in Texas.	Survival, the 2018 American Community Survey 5-year estimates and the 2010 U.S. Census. N=4,236 Hispanics and 35% of census tracts were majority Hispanic/Latino	(13 EMS agencies providing care in 15 counties)
Kaji et al., 2011	Advanced Rescuer-versus Citizen-Witnessed Cardiac Arrest: Is There a Difference in Outcome?	Observational study of a retrospective cohort using data from a single municipal teaching hospital in southwestern Los Angeles, CA N= 24 Hispanics had paramedic-witnessed events and N=99 had citizen-witnessed events.	Los Angeles County
Lupton et al., 2020	Racial disparities in out-of-hospital cardiac arrest interventions and survival in the Pragmatic Airway Resuscitation Trial.	Secondary analysis using data from the Pragmatic Airway Resuscitation Trial (PART). N=163 Hispanics	Birmingham, Alabama; Dallas-Fort Worth, Texas; Milwaukee, Wisconsin; Pittsburgh, Pennsylvania; and Portland, Oregon
Mapp et al., 2020	Dispatcher identification of out-of-hospital cardiac arrest and neurologically intact survival: a retrospective cohort study.	Retrospective cohort study using data from the Quality Assurance/Quality Improvement (QA/QI) for the San Antonio Fire Department. N= 1015.39 PSAP recognized cardiac arrests; N= 320.04 unrecognized cardiac arrests among Hispanics	San Antonio, Texas
Moon et al., 2014	Disparities in bystander CPR provision and survival from out-of-hospital cardiac arrest according to neighborhood ethnicity.	An observational cohort study using the Save Hearts in Arizona Registry and Education (SHARE). Sample size is not provided.	Arizona
Morris et al., 2021	Hispanic/Latino-Serving Hospitals Provide Less Targeted Temperature Management Following Out-of-Hospital Cardiac Arrest.	Retrospective analysis using the Cardiac Arrest Registry to Enhance Survival (CARES). N=7.748	United States
Mumma et al., 2015	Association between treatment at an ST-segment elevation myocardial	Study uses data from the 2011 California Office of Statewide	California

	infarction center and neurologic recovery after out-of-hospital cardiac arrest.	Health Planning and Development. N= 102 Hispanic patients treated at STEMI centers; N= 510 Hispanic patients treated at non-STEMI centers	
Nuño et al., 2017	Disparities in telephone CPR access and timing during out-of-hospital cardiac arrest.	Observational cohort study that uses the Saving Hearts in Arizona Registry and Education (SHARE) Program. N= 39 9-1-1 calls with a Spanish language barrier	Phoenix, Arizona
Reynolds et al., 2017	Use of early head CT following out-of-hospital cardiopulmonary arrest.	Patients who presented to the New York- Presbyterian Hospital - Columbia University Emergency Room N=42 Hispanics who received a head CT; N= 40 for Hispanics who did not receive a head CT	New York
Stoecklein et al., 2022	Paramedic rhythm interpretation misclassification is associated with poor survival from out-of-hospital cardiac arrest.	Retrospective cohort analysis using data from the Salt Lake City Fire Department. N= 94 Hispanics	Salt Lake City, Utah
Sutton et al., 2023	Racial and ethnic disparities in the treatment and outcomes for witnessed out-of-hospital cardiac arrest in Connecticut.	Retrospective study using data from Connecticut in the Cardiac Arrest Registry to Enhance Survival (CARES). N= 580 Hispanics	Connecticut
Vadeboncoeur et al., 2008	Bystander cardiopulmonary resuscitation for out-of-hospital cardiac arrest in the Hispanic vs the non-Hispanic populations.	Secondary analysis using data from the Save Hearts in Arizona Registry and Education (SHARE) Program. N= 273 Hispanics	Arizona
Weiss et al., 2018	Does experience matter? Paramedic cardiac resuscitation experience effect on out-of-hospital cardiac arrest outcomes.	Retrospective analysis using data from the San Antonio Fire Department OHCA Quality Assurance/Quality Improvement database. N= 54.20% of patients were Hispanic in the more experienced paramedic group and N= 51.30% of patients were	San Antonio, Texas

		Hispanic in the less experienced paramedic group	

Link #1 of the OHCA Chain of Survival: Individual, Environmental, Neighborhood, and Policy-Level Factors That Impact Provision of 9-1-1 Telecommunicator Provided Cardiopulmonary Resuscitation (T-CPR) After Activation of the Emergency System

The first link in the out-of-hospital cardiac arrest (OHCA) chain of survival is the early activation of the emergency response system and provision of emergency instructions by telecommunicators (Amen et al., 2020; Mapp et al., 2020; Nuño et al., 2017). Three studies examined the multi-level factors that impact the provision of T-CPR for Hispanic older adults who experienced an OHCA (Amen et al., 2020; Mapp et al., 2020; Nuño et al., 2017). Of the three studies, two assessed individual-level factors and one examined both individual and neighborhood-level factors (Amen et al., 2020; Mapp et al., 2020; Nuño et al., 2017). Two of the three studies reported statistically significant results suggesting that Hispanic older adults are more likely to have an unrecognized cardiac arrest and receive delayed T-CPR (Mapp et al., 2020; Nuño et al., 2017).

The first study found that the average time until telecommunicators recognized cardiopulmonary resuscitation (CPR) need was 87.4 seconds for English-speaking callers, 131 seconds for calls in other languages, and 161 seconds for Spanish-speaking callers (Nuño et al., 2017). This finding suggests that Spanish-speaking calls had the largest delay in telecommunicator recognized CPR compared to 9-1-1 callers who spoke English and other languages (Nuño et al., 2017). The mean time until telecommunicators began CPR instruction was 144 seconds for English-speaking 9-1-1 callers, 170 seconds when other languages were reported, and 231 seconds for Spanish-speaking 9-1-1 callers (Nuño et al., 2017). These results indicate that Spanish-speaking 9-1-1 callers had the largest delay in receiving CPR instruction from emergency telecommunicators, compared to 9-1-1 callers who spoke English and other languages (Nuño et

al., 2017). Spanish-speaking 9-1-1 callers also had the greatest delay from start of call to initiation of first compression with a mean of 291 seconds, compared to 174 seconds for callers in all other languages and 174.4 seconds for English-speaking callers (Nuño et al., 2017). Patients in the Spanish-speaking group were younger compared to the English-speaking group and other language group (Nuño et al., 2017).The findings from this study suggest the need for improvements in the provision of T-CPR, which is an important first step in the OHCA chain of survival.

The second study found that Hispanics had a slightly higher percentage of having an unrecognized cardiac arrest (52.9%), compared to a recognized cardiac arrest (51.7%), when the 9-1-1 call was answered in a public-safety answering point (PSAP) dispatch center, a type of call center that triages emergency calls to police, fire, or EMS (Mapp et al., 2020). The third study found that the provision of T-CPR (aOR: 0.86; 95% CI: [0.55, 1.33], p=0.4950) and use of T-CPR (aOR: 1.05; 95% CI: [0.65, 1.68], p = 0.8533) was lower when OHCAs occurred in Hispanic patients, compared to Whites, although these findings were non-statistically significant (Amen et al., 2020). The presence of any barrier, as indicated by telecommunicators, was associated with decreased odds of receiving T-CPR by 77% (aOR = 0.23, 95% CI: [0.19, 0.29], p<0.001) (Amen et al., 2020). Although there was insufficient evidence in this study to conclude that race and ethnicity was significantly associated with T-CPR instructions, the results did suggest differences by socioeconomic status (Amen et al., 2020). On average, the odds of T-CPR instruction use by bystanders increased by 3% for every $5,000 increase in census tract income (aOR =1.03, p=0.0047) and 5% for every $10,000 increase in census tract income (aOR=1.05, p=0.0047) (Amen et al., 2020). None of the studies that assessed the first link discussed policy-level factors.

Link #2 of the OHCA Chain of Survival: Individual-Level Factors That Impact The Early Administration of Cardiopulmonary Resuscitation (CPR)

The second link in the OHCA chain of survival is the early administration of cardiopulmonary resuscitation (AHA, 2024; SCAF, 2024). Seven studies assessed the provision of CPR to Hispanic older adults who experienced an OHCA (Bosson et al., 2019; Chugh et al., 2023; Hill et al., 2021; Huebinger et al., 2021; Moon et al., 2014; Sutton et al., 2023; Vadeboncoeur et al., 2008). Of the seven studies, all assessed individual-level factors (Bosson et al., 2019; Chugh et al., 2023; Hill et al., 2021; Huebinger et al., 2021; Moon et al., 2014; Sutton et al., 2023; Vadeboncoeur et al., 2008).

Hispanics were less likely to receive B-CPR (32.2% vs. 41.5%; $p<0.0001$) and more likely to be younger (53.2 vs. 64.5 years; $p = .001$), compared to non-Hispanic Whites (Vadeboncoeur et al., 2008). B-CPR in this study was defined as CPR provided by both lay bystanders (e.g., individuals with no known medical training) and trained bystanders (e.g., medically trained individuals, such as emergency responders, off-duty medical personnel, and medically trained caretakers) (Vadeboncoeur et al., 2008). The provision of CPR by lay bystanders was 16.1% for Hispanics compared to 25.8% for non-Hispanic Whites ($p=0.001$) (Vadeboncoeur et al., 2008). Hispanics were also less likely to have witnessed OHCAs, compared to non-Hispanics (82% versus 86%, $p = 0.001$) (Bosson et al., 2019).

A national study reported that there were differences in the provision of CPR by EMS providers based on patients' sociodemographic characteristics, including race, ethnicity, gender, and age (Hill et al., 2021). In the full sample, 75.5% of Hispanic females and 71.9% of Hispanic males (95% CI: [-4.9, 12.2]) received CPR from an EMS provider, a finding that was non-statistically significant (Hill et al., 2021). Among the subsample of patients who received B-CPR, 91.6% of Hispanic males and 87.7% of Hispanic females received CPR from an EMS provider, a finding that was also non-statistically significant [95% CI: -12.2, 4.4]) (Hill et al., 2021). Similarly,

75.4% of Hispanic adults and 71.2% of Hispanic seniors in the full sample received CPR from an EMS provider, although the findings were non-statistically significant (95% CI: [-4.2, 12.4]) (Hill et al., 2021). In the subsample, EMS provided CPR for 92.5% of Hispanic adults and 84.3% of Hispanic seniors, a finding that was non-statistically significant (95% CI: [-3.1, 11.5]) (Hill et al., 2021).

Environmental, Neighborhood, and Policy-Level Factors That Impact The Early Administration of Cardiopulmonary Resuscitation (CPR)

Of the seven studies that assessed the provision of CPR to Hispanic older adults, four studies examined environmental and neighborhood-level factors, and none examined policy-level factors (Chugh et al., 2023; Huebinger et al., 2021; Moon et al., 2014; Sutton et al., 2023). Three of the four studies found that B-CPR was lower in Hispanic compared to non-Hispanic White neighborhoods (Huebinger et al., 2021; Moon et al., 2014; Sutton et al., 2023). One of the four studies found that OHCAs in private residences and unwitnessed cardiac arrests were more common in Hispanic compared to non-Hispanic White neighborhoods (Huebinger et al., 2021). During the coronavirus (COVID-19) pandemic, B-CPR was lower for Hispanics compared to non-Hispanics (Chugh et al., 2023).

A study reported that the provision of B-CPR was 42.3%, which suggests that less than half of the OHCA cases in the study population received this potentially life-saving procedure (Moon et al., 2014). Persons who experienced an OHCA were less likely to receive B-CPR if the emergency occurred in Hispanic neighborhoods (e.g., neighborhoods with 80% of more Hispanic residents), compared to non-Hispanic White neighborhoods (e.g., neighborhoods with 80% of more non-Hispanic White residents) (OR, 0.62; 95% CI: [0.44, 0.89]) (Moon et al., 2014). In another study, a pooled sample of Hispanic and Black patients, referred to hereinafter as minority patients per the study, were less likely than White patients with a witnessed OHCA to receive B-

CPR (OR: 0.66. 95% CI: [0.52, 0.83], p = 0.001) (Sutton et al., 2023). Minority patients were also less likely to be administered B-CPR in integrated (e.g., communities >20% but <50% Black/Hispanic residents) and high-income communities (e.g., communities with a median annual household income of >$80,000) (Sutton et al., 2023).

Another study reported that the rate of bystander witnessed arrests (e.g., cardiac arrests that occur in the presence of at least one other person) were more common in majority white neighborhoods (48.5%), compared to majority Hispanic/Latino neighborhoods (41.5%) (Huebinger et al., 2021). Cardiac arrests at home were higher in majority Hispanic/Latino neighborhoods (84.2%), compared to majority white neighborhoods (81.4%) (Huebinger et al., 2021). Rates of B-CPR were lower in Hispanic/Latino neighborhoods compared to white neighborhoods (OR: 0.7, 95% CI: [0.6-0.8]) (Huebinger et al., 2021). Median income was more than twice as high in white neighborhoods, compared to Hispanic/Latino neighborhoods (Huebinger et al., 2021). High school graduation rates were lower in Hispanic/Latino neighborhoods (41%), compared to White neighborhoods (65.5%) (Huebinger et al., 2021). Rates of unemployment were higher in Hispanic/Latino neighborhoods (7.2%), compared to White neighborhoods (4.4%) (Huebinger et al., 2021). Lower median income (OR: 0.8, 95% CI:[0.7-0.8]), lower rates of high school graduation (OR=0.8, 95% CI: [0.7-0.9]), and higher rates of unemployment (OR: 0.9, 95% CI: [0.8-0.94]) were associated with lower rates of B-CPR (Huebinger et al., 2021). Another study that assessed the provision of emergency care during the coronavirus (COVID-19) pandemic found that Hispanics were less likely than non-Hispanics to receive B-CPR (45% vs. 55%, p = .005) (Chugh et al., 2023). None of the studies on the early administration of CPR discussed policy-level factors.

Link #3: Individual-Level Factors That Impact The Provision of Early Defibrillation and Return of Spontaneous Circulation (ROSC)

The third link in the OHCA chain of survival is early defibrillation of the heart muscle (AHA, 2024; SCAF, 2024). The provision of CPR and the application of an automated external defibrillator (AED) increase a person's chances of survival after an OHCA by attempting to restart the heart muscle (Institute of Medicine, 2015). The main goal of CPR and defibrillation is ROSC, a clinical assessment to assess signs of life, including a palpable pulse, a measurable blood pressure, and whether a person is breathing, coughing, or moving (Chan & Tang, 2020; Lian et al., 2022). Prior to defibrillation, it is important to determine a person's type of heart rhythm (Institute of Medicine, 2015). There are four types of heart rhythms, including asystole, pulseless electrical activity (PEA), ventricular fibrillation (V-Fib), and ventricular tachycardia (V-Tach) (Institute of Medicine, 2015). Of these, only two heart rhythms are shockable, including V-Fib and V-Tach (Institute of Medicine, 2015). Asystole and PEA are considered non-shockable heart rhythms (Institute of Medicine, 2015). Prior to defibrillation, an AED fully analyzes the patient's heart rhythm and sends electrical currents only if the machine determines a rhythm to be shockable (e.g., V-Fib or V-Tach) (Avive, 2023). Achieving a timely ROSC, also minimizes the risk of physical and neurological damage and increases the chances of survival after an OHCA (Institute of Medicine, 2015).

Of the 7 studies that assessed early defibrillation and ROSC, 5 examined individual-level factors (Bosson et al., 2019; Chugh et al., 2023; Hill et al., 2021; Sutton et al., 2023; Vadeboncoeur et al., 2008). Four of the five studies found that Hispanics were less likely to have a shockable rhythm, compared to Whites (Bosson et al., 2019; Chugh et al., 2023; Sutton et al., 2023; Vadeboncoeur et al., 2008). These disparities in heart rhythms remained during the COVID-19 pandemic (Chugh et al., 2023). One study found that Hispanics were less likely to receive

attempted defibrillation by a bystander using an AED (Sutton et al., 2023). One study found non-statistically significant differences in ROSC by race and ethnicity (Hill et al., 2021).

Hispanics were less likely to have a shockable rhythm (Bosson et al., 2019). Hispanics were more likely to have an initial non-shockable rhythm of asystole (53.8% vs. 44.5%; p=.005) and less likely to have a shockable rhythm of V-Fib (20.5% vs. 26.7%, p=.036), compared to non-Hispanics (Vadeboncoeur et al., 2008). During the coronavirus pandemic, Hispanics were less likely to present with a shockable rhythm compared to non-Hispanics (15% vs. 24%; p = .003) (Chugh et al., 2023). Another study reported lower bystander AED placement with attempted defibrillation among minority patients defined here as Hispanic, Latino, and African American, compared to Whites (10.5% in minority patients versus 14.4% in White patients, p=0.004) (Sutton et al., 2023). Minority patients had lower rates of AED application with attempted defibrillation, initial shockable rhythm, and ROSC, compared to White patients (Sutton et al., 2023).

Another study reported ROSC in 36.8% of the full sample (e.g., all persons who experienced an OHCA with and without B-CPR) and 43.5% of the subsample (e.g., all persons with an OHCA who received B-CPR) (Hill et al., 2021). ROSC was reported in 37.8% of Hispanics and 38.3% of Whites in the full sample (Hill et al., 2021). In the full sample, Hispanic females had a slightly higher rate of ROSC compared to Hispanic males (Hispanic females 38.8% versus 37.3% for Hispanic males; 95% CI: [-8.1, 11.1]), and White females had a lower ROSC rate compared to White males (White females 36.3% versus White males 39.4%; 95% CI: [-6.1, 0.13]), although these results were non-statistically significant (Hill et al., 2021). The greatest difference in ROSC between adults and seniors by race was in the Hispanic population (Hispanic adults 42.7% and Hispanic seniors 33.7; 95% CI; [-0.03, 18.0]), and the smallest difference was in the White group (White adults 39.9% and White seniors 37.4%; 95% CI: [-0.5, 5.5%]) (Hill et al., 2021). In the

subsample, Hispanic males showed a higher but non-statistically significant rate of ROSC compared to Hispanic females (Hispanic males 47.9% and Hispanic females 42.0%, 95% CI: -18.9, 7.2]) (Hill et al., 2021). ROSC rates were also higher but non-statistically significant for White males compared to White females (White males 46.2% and White females 42.3%, 95% CI: [-7.9, 0.1]) (Hill et al., 2021). ROSC rates by race and age in the subsample were higher but not statistically significant in Hispanic adults compared to Hispanic seniors (51.7% for Hispanic adults and 40.6% for Hispanic seniors; 95% CI: [-1.2, 23.4]) and greater in White adults compared to White seniors (47.4% in White adults and 43.4% in White seniors; 95% CI: [0.1, 8.0]) (Hill et al., 2021).

Environmental, Neighborhood, and Policy-Level Factors That Impact The Provision of Early Defibrillation

Of the seven studies that focused on early defibrillation and ROSC, two discussed environmental and neighborhood-level factors (Huebinger et al., 2021; Moon et al., 2014). None of the studies discussed policy-level factors. One of the two studies found that shockable heart rhythms were less likely in Hispanic neighborhoods, compared to non-Hispanic White neighborhoods (Moon et al., 2014). One of the two studies found lower rates of AED use in majority Hispanic neighborhoods, compared to White neighborhoods (Huebinger et al., 2021).

OHCAs that occur in Hispanic neighborhoods are less likely to have a shockable (e.g., V-Fib or V-Tach) heart rhythm, compared to non-Hispanic White neighborhoods (17.3% vs. 25.7%, p=.006) (Moon et al., 2014). Another study reported that OHCAs in neighborhoods with majority Hispanic or Latino residents had lower rates of AED use, compared to White neighborhoods (OR: 0.4; 95% CI: [0.3-0.6]) (Huebinger et al., 2021). AED use was also lower in neighborhoods with lower income, higher unemployment rates, and lower high school graduation rates, which are

characteristics that are more commonly found in Hispanic or Latino neighborhoods relative to White neighborhoods (AHA, 2024; Huebinger et al., 2021).

Link #4 Individual-Level Factors That Impact Advanced Resuscitation Approaches for OHCA

The fourth link in the OHCA chain of survival is advanced resuscitation practices delivered exclusively by EMS providers (AHA, 2024). In practice, however, it is important to note that EMS providers can, and do, actively participate in the early activation of the 9-1-1 emergency system and provision of T-CPR, and the administration of CPR and AED defibrillation during an OHCA. EMS providers can witness an OHCA as a bystander (Vadeboncoeur et al., 2008). Bystander in this study refers to any person (e.g., EMS provider, family, friend, or member of the public) who witnessed an OHCA. Lay bystander refers to a subgroup of bystanders who do not have known medical training. Of the six studies that examined advanced resuscitation after OHCA, five assessed individual-level factors, zero focused on environmental and neighborhood-level factors, and one study discussed policy-level factors (Glober et al., 2019; Kaji et al., 2011; Lupton et al., 2020; Stoecklein et al., 2022; Vadeboncoeur et al., 2008; Weiss et al., 2018). Of the five studies that assessed individual-level factors, one study found that more paramedic experience was associated with a higher rate of ROSC (Weiss et al., 2018).Another study found non-statistically significant differences in ROSC between paramedic and citizen-witnessed arrests (Kaji et al., 2011). One study found that Hispanics were less likely to have misclassified shockable rhythms (e.g., shockable heart rhythm classified as non-shockable), compared to Whites (Stoecklein et al., 2022). The last study reported that Hispanics had the lowest success rate for initial advanced airway procedures and the highest percentage of 3 or more attempts made by EMS providers to open the airway (Lupton et al., 2020).

A study found that EMS providers' level of experience had an impact on sustained ROSC rates (Weiss et al., 2018). Paramedics with more experience (e.g., paramedics who participated in >=10 OHCAs as a lead medic) had a sustained ROSC rate of 28.9%, compared to 22.2% for less experienced paramedics (e.g., paramedics who participated as the lead medic in <10 OHCAs) (Weiss et al., 2018).This study's findings suggest that paramedic experience with OHCAs is associated with an increased likelihood of achieving sustained ROSC when they are the lead medic (RR: 1.30, 95% CI: [1.001, 1.692], p-value = 0.047) (Kaji et al., 2011; Weiss et al., 2018). Another study reported non-statistically significant differences in ROSC between paramedic and citizen-witnessed arrests (OR: 1.16, 95% CI: [0.79, 1.68]) (Kaji et al., 2011). Differences in classification and misclassification of heart rhythms by paramedics differed between Hispanics and Whites (Stoecklein et al., 2022). Of 94 Hispanic patients, 62 were correctly classified as non-shockable (66%), 14 were correctly classified as shockable (15%), 5 non-shockable rhythms were misclassified as shockable (5%), and 1 shockable rhythm was misclassified as non-shockable (1%) (Stoecklein et al., 2022). Of the 527 White patients, 270 were correctly classified as non-shockable (51.2%), 105 were correctly classified as shockable (20%), 20 non-shockable rhythms were classified as shockable (3.8%), and 18 shockable rhythms were misclassified as non-shockable (3.4%) (Stoecklein et al., 2022). Whites in this study had a slightly higher percentage of shockable rhythms that were misclassified as non-shockable, compared to Hispanics (Stoecklein et al., 2022).

A study that assessed initial airway strategies after OHCA found racial and ethnic disparities (Lupton et al., 2020). Effective airway management and ventilation is associated with an increase in ROSC, neurological recovery, and is an important component of survival after OHCA (Lupton et al., 2020). Common airway strategies in the out-of-hospital setting after OHCAs include bag-valve-mask ventilation only (BVM-only), laryngeal tube insertion (LT), and endotracheal

intubation (ETI) (Lupton et al., 2020). ETI is considered the gold standard for OHCAs because this approach provides airway control and protection against upper airway obstruction, although some drawbacks include incorrect placement and unnecessary interruptions of chest compressions (Lou et al., 2023; Yang et al., 2019). BVM is the quickest strategy to establish ventilation, although there are shortcomings with this approach, including leakage and gas pressure in the gastrointestinal system, which can result in regurgitation and pulmonary aspiration (Yang et al., 2019). LT is a strategy where a single-use or reusable supraglottic airway device is inserted blindly through the mouth to maintain an open airway, although this approach is less successful for patients who have obstructions, or who are obese (Simon & Torp, 2023). One of the included studies in this scoping literature review found that ETI was attempted in 45.4% of Hispanic and 40.3% of White patients (Lupton et al., 2020). BVM-only was attempted in 4.9% of Hispanic and 12.4% of White patients (Lupton et al., 2020). LT was the initial advanced airway attempted in 49.7% of patients who were Hispanic and 47.3% of White patients (Lupton et al., 2020). Time from EMS arrival to LT airway attempt was the same for Hispanic and White patients at 9.9 minutes (Lupton et al., 2020). Time from EMS arrival to ETI airway attempt was 13 minutes for Hispanics and 11.9 minutes for Whites (Lupton et al., 2020). The success rate for initial advanced airway procedure was lowest among Hispanics, compared to Whites for both LTs and ETIs (Lupton et al., 2020). The success rate for LTs in Hispanics was 87.7% and 91.1% in Whites (Lupton et al., 2020). Hispanics also had a lower success rate for ETIs at 41.9% compared to 51.2% in Whites (Lupton et al., 2020). The multivariable regression model showed a lower but non-statistically significant difference in advanced airway success between Hispanics (OR: 0.73, 95% CI: [0.49, 1.08]) and White patients (Lupton et al., 2020). Hispanic patients also had a higher percentage of 3 or more attempts made by EMS providers to open the airway at 14.7% compared to 9.8% for Whites

(Lupton et al., 2020). The percentage of patients with ROSC upon arrival at an ED was lower for Hispanics (37.7%), compared to White patients (44.8%) (Lupton et al., 2020).

Policy-Level Factors That Impact Advanced Resuscitation Approaches for OHCA

There was one study that discussed advanced resuscitation and explicitly discussed a proposed policy referred to as the "simple decision rule" (Glober et al., 2019). The current EMS approach to OHCA resuscitative efforts is grounded on a maximalist perspective, which provides resuscitative efforts as the standard, unless the patient has a do-not-resuscitate order (DNR) (Glober et al., 2019). The "simple decision rule" posits that OHCA resuscitative efforts should not be provided if an OHCA meets the following criteria: patient has a non-shockable rhythm, the arrest is unwitnessed, and the person is 80 years and older (Glober et al., 2019). The argument of the simple decision rule is that these three criteria describe cases, where providing OHCA resuscitative efforts is futile (Glober et al., 2019). The simple decision rule was 100% specific and 18.6% sensitive using the local San Mateo County, California EMS data for the detection of OHCAs (Glober et al., 2019). The authors argue that providing resuscitation in these cases is more medically, ethically, and financially burdensome and unnecessary (Glober et al., 2019). In the study, patients who had the highest survival to hospital discharge after OHCA were younger, more likely to have a witnessed arrest, received bystander CPR, and had a shockable initial rhythm (Glober et al., 2019). Disparities by race and ethnicity were not found in the study when testing the simple decision rule (Glober et al., 2019).

Link #5: Individual, Environmental, Neighborhood, and Policy-Level Factors That Impact Post-Cardiac Arrest Emergency Care

The fifth link in the OHCA chain-of-survival is post-cardiac arrest care (AHA, 2024). The purpose of post-cardiac emergency care is to stabilize a patient after an OHCA, prevent further complications, and optimize long-term outcomes (Graham et al., 2015). Post-cardiac arrest care

includes, but is not limited to, targeted temperature management or therapeutic hypothermia, and coronary reperfusion therapy (Graham et al., 2015). Targeted temperature management or therapeutic hypothermia, and coronary reperfusion therapy (Graham et al., 2015). Targeted temperature management or therapeutic hypothermia is a post-cardiac arrest treatment that involves reducing the body's core temperature for approximately 12 to 24 hours to increase the likelihood of neurologically intact survival (DeLia et al., 2015). Reperfusion therapy refers to different types of medical treatments, including medications, procedures, and surgeries to restore blood flow to the heart muscle (Graham et al., 2015).

Five studies examined provision of post-cardiac arrest care with a focus on Hispanic older adults (Bosson et al., 2019; Casey & Mumma, 2018; Morris et al., 2021; Mumma et al., 2015; Reynolds et al., 2017). Of the five studies that examined post-cardiac arrest care, all the studies assessed individual-level factors, and one study discussed neighborhood-level factors (Bosson et al., 2019; Casey & Mumma, 2018; Morris et al., 2021; Mumma et al., 2015; Reynolds et al., 2017). At the individual-level, provision of post cardiac emergency care varied between Hispanics and Whites based on the type of treatment (Bosson et al., 2019; Casey & Mumma, 2018; Morris et al., 2021; Mumma et al., 2015; Reynolds et al., 2017). Hispanics were more likely to receive targeted temperature management, compared to Whites, perhaps due to worse neurological status at hospital admission (Bosson et al., 2019; Morris et al., 2021). Hispanics were less likely to receive an early head computer tomography (HCT) within 24 hours after an OHCA(Reynolds et al., 2017). Non-statistically significant differences were found in the provision of cardiac catheterization, a medical procedure that diagnoses and treats certain cardiac conditions and involves threading a catheter through a blood vessel in the arm, upper thigh, groin, or neck, until it reaches the heart, between Hispanics and non-Hispanics (Casey & Mumma, 2018). Non-statistically significant

differences were reported between Hispanics and non-Hispanics in do-not-resuscitate (DNR) orders within 24 hours of experiencing an OHCA (Casey & Mumma, 2018). Hispanics were less likely to receive treatment at healthcare facilities with 24/7 percutaneous coronary intervention (PCI) resuscitation centers, but no differences were found for treatment at ST-Elevation Myocardial Infarction (STEMI) centers, compared to non-Hispanics (Casey & Mumma, 2018; Mumma et al., 2015). At the neighborhood-level, post-cardiac arrest care was worse in neighborhoods with high proportions of Hispanics (Morris et al., 2021). Hispanic-serving hospitals (e.g., hospitals in the top decile for the highest proportion of providing care to Hispanic patients) provided less targeted temperature management regardless of patient race and ethnicity, compared to non-Hispanic-serving hospitals (Morris et al., 2021). None of the studies assessed the impact of policy-level factors on provision of EMS to Hispanic older adults after an OHCA.

Link #6: Individual, Environmental, Neighborhood, and Policy-Level Factors That Impact Recovery after OHCA

The sixth link in the OHCA chain-of-survival is recovery, which includes additional observation, monitoring, rehabilitation, and psychological support (Institute of Medicine, 2015). Previous studies suggest OHCA survivors report cognitive difficulties, fatigue, depression, and restricted mobility, which impacts their participation in everyday life and makes recovery an important link (Lilja et al., 2018). In this scoping review, six studies examined recovery in the context of Hispanic older adults who experienced an OHCA (Bosson et al., 2019; Casey & Mumma, 2018; DeLia et al., 2015; Eid et al., 2017; Mumma et al., 2015; Reynolds et al., 2017). All of the studies focused on individual-level factors related to recovery (Bosson et al., 2019; Casey & Mumma, 2018; DeLia et al., 2015; Eid et al., 2017; Mumma et al., 2015; Reynolds et al., 2017). None of the studies assessed neighborhood or policy-level factors.

At the individual-level, three studies reported that Hispanics had worse neurologic outcomes, including lower odds of neurologically intact survival to hospital discharge and 30-day neurologically intact survival, compared to Whites (Bosson et al., 2019; DeLia et al., 2015; Eid et al., 2017). Two studies found that Hispanics had slightly higher odds of neurological recovery, although the results were non-statistically significant, compared to non-Hispanics (Casey & Mumma, 2018; Mumma et al., 2015). None of the studies assessed recovery beyond neurologic outcomes, including additional observation, monitoring, rehabilitation, and psychological support.

DISCUSSION:

This scoping literature review assessed the multi-level factors that impact provision of emergency care across the six links in the OHCA chain of survival, with a focus on Hispanic older adults aged 50 years and older. The definition of older adults is 50 years and older because evidence suggests that Hispanics who experience an OHCA are younger than their White counterparts (Khosla, 2024). This age cutoff is also supported after reviewing the literature for this study (Nuño et al., 2017; Vadeboncoeur et al., 2008). After thoroughly reviewing 6,007 studies, only 21 of these publications met all the inclusion criteria, which suggests the limited literature that exists in this research area, and the importance of publishing more on this topic to ensure the most equitable provision of emergency care for Hispanic older adults who experience an OHCA (see Table 2).

Another important finding from this scoping literature review is that all the identified studies used quantitative methods, although mixed method and qualitative studies were part of the inclusion criteria developed by the principal investigator. Although quantitative studies provide breadth in our understanding of the factors that impact provision of EMS for Hispanic older adults,

studies that use mixed and qualitative methods can enhance researchers' ability to interpret results more in-depth. Researchers should consider incorporating more diverse methodologies in EMS research. Most of the studies also use local or state-level datasets (76%), while the remaining 24% use multi-state or national-level datasets (see Table 2). This finding suggests that most of the ongoing EMS research continues to rely on local and state-level datasets, with less emphasis on multi-state and national datasets. Of the 21 studies, 12 used local or state-level EMS data from California, Texas, or Arizona, which are states with a high percentage of Hispanics (see Table 2). Local and state-level data typically provides researchers with more granularity, which may be better suited for some research questions, although national-level data can produce results that are more generalizable. The findings from this scoping literature review also suggest an increased interest in health disparities research in EMS over the past two decades. This finding is supported by a previous systematic literature review conducted by the principal investigator, which found a similar trend, although the focus of that study was on use of EMS by Hispanic adults for all health emergencies between 2000 and 2021 (Melgoza et al., 2023). Finally, over half of the studies included in the current scoping literature review had a Hispanic sample size below 999. Smaller sample sizes may affect the ability of researchers to find statistically significant differences.

Similarly, after a comprehensive examination of the literature, there is evidence suggesting that some links in the OHCA chain of survival are understudied. The first and fourth links, which include the recognition of OHCA by telecommunicators and dispatchers, the provision of T-CPR, and the delivery of advanced resuscitation are understudied in the context of EMS provision to Hispanic older adults. On the contrary, the second and third links in the OHCA chain of survival, initiation of B-CPR and defibrillation in the prehospital setting, are more well-studied. Post-cardiac arrest treatment and recovery, the fifth and sixth links, warrant future research. All the

links in the OHCA chain of survival can benefit from taking a multi-level approach that considers the individual, environmental, neighborhood, and policy-level factors, and the interplay of these factors across tiers. Specifically, policy-level factors are largely understudied in the context of providing care to Hispanic older adults across the six links in the OHCA chain of survival.

Policy-level factors were rarely discussed in the included studies, except for two cases (Casey & Mumma, 2018; Glober et al., 2019). The first study assessed the association between having Medicare insurance and OHCA-related outcomes (Casey & Mumma, 2018). Patients with Medicare insurance were less likely to have good neurologic recovery, less likely to survive after an OHCA, and more likely to have a DNR within 24 hours, compared to patients with private insurance (Casey & Mumma, 2018). Future research should assess the associations between different types of health insurance, including Medicaid, Medicare, and private insurance, and provision of emergency care in the prehospital setting. Generally, government-funded insurances, such as Medicare and Medicaid, pay for ground ambulance transportation to the nearest appropriate medical facility only when medically necessary, and if traveling in any other vehicle may endanger a person's health (U.S. Center for Medicare and Medicaid Services, n.d.). Most private health insurance companies cover at least a portion of ambulance transports that are medically necessary, although enrollees may have to pay for a portion of the cost through co-insurance, copayments, or deductibles (Adler et al., 2023). Private-sector ambulance transports result in higher allowed amounts, patient cost sharing, and more surprise bills, compared to public-sector ambulance transports (Adler et al., 2023). Pricing and billing of ground ambulances in both the public and private sectors are directed by local and state-level regulations, which often results in billing systems that are decentralized and fragmented (Adler et al., 2023). Recent federal and state-level efforts have emerged to protect individuals from costly ambulance-related bills (Adler

et al., 2023). At the federal level, an advisory committee was established under the No Surprises Act to address the problem of costly ambulance bills (Adler et al., 2023; Pollitz, 2021). In October 2023, California enacted a new law preventing noncontracting ground ambulance providers from charging patients more than the in-network cost-sharing amount (*Bill Text - AB-716 Ground Medical Transportation.*, 2023). This legislation also prohibits ground ambulance providers from billing uninsured or self-pay patients an amount that surpasses the established payment by Medi-Cal or Medicare fee-for-service, whichever is greater (*Bill Text - AB-716 Ground Medical Transportation.*, 2023).

Another policy discussed is the simple decision rule to limit futile advanced resuscitative efforts in patients who experience an OHCA (Glober et al., 2019). The simple decision rule posits that advanced resuscitative efforts provided to patients who have a non-shockable rhythm, an unwitnessed arrest, and who are over the age of 80 years and older will likely be futile (Glober et al., 2019). Although the authors of this study did not find racial and ethnic disparities in implementing this rule after conducting a retrospective cohort analysis of all cardiac arrests in San Mateo County, California, more studies should be conducted to ensure that this policy does not widen existing health disparities. First, the analysis conducted is retrospective in nature (N. K. Glober et al., 2019). Second, the simple decision rule was assessed using local data from San Mateo County, which limits the generalizability to other populations and contexts. Other local EMS agencies have implemented similar criteria to forgo or halt resuscitation in the prehospital setting, including Los Angeles County, although these studies are also limited to local settings and should not be generalized (Grudzen et al., 2010). These types of polices should undergo strict scrutiny to ensure that forgoing or halting resuscitation does not worsen existing health disparities.

LIMITATIONS:

This scoping literature review highlights several important limitations in EMS research, particularly with a focus on the provision of emergency care to Hispanic older adults who experience an OHCA. First, most of the included studies use local or state-level data, which limits the generalizability of the findings. Future studies should consider using data at the multi-state and national levels if appropriate for the research questions. Second, all the included studies use quantitative methods that provide breadth, although future studies should also incorporate mixed and qualitative methods in their study designs to gain more depth in our understanding of the provision of EMS to Hispanic older adults who experienced OHCAs. Third, many of the included studies focus on individual-level factors that impact the provision of T-CPR, B-CPR, defibrillation, advanced resuscitation, post-cardiac arrest care, and recovery for Hispanic older adults who experienced an OHCA. Future research, however, should assess factors across multiple levels of influence to better understand the mechanisms that result in these health disparities across the links in the OHCA chain of survival. Fourth, policy recommendations to implement new or modify existing EMS policies, including OHCA resuscitative practices, should be based on data analysis at the appropriate level. Local policy recommendations may benefit from using local data that provided more granularity and details for the population in question. Piloting an EMS policy at a local level and recommending it for national level implementation, however, is not recommended.

CONCLUSION:

This scoping literature review assesses the multi-level factors that impact provision of EMS to Hispanic older adults across each link in the OHCA chain of survival. The six links in the OHCA chain of survival include early activation of the emergency response system, high-quality cardiopulmonary resuscitation (CPR), defibrillation, advanced resuscitation, post-cardiac arrest

care, and recovery. Within each of these links, individual, environmental, neighborhood, and policy-level factors were examined. This study advances our understanding in three ways. It is the first scoping literature review to assess provision of EMS to Hispanic older adults, within the context of the OHCA chain of survival and using a multi-level approach. Overall, the findings from this study suggest that recognition of OHCA by telecommunicators and dispatchers, the provision of T-CPR, the delivery of advanced resuscitation, post-cardiac arrest treatment and recovery as it relates to EMS are the least studied links in the OHCA chain of survival. B-CPR and defibrillation are the most commonly studied links in the OHCA chain of survival. All the links in the OHCA chain of survival would benefit from additional research that takes a multi-level approach. In particular, the study of policy-level factors that impact provision of EMS to Hispanic older adults remain a substantial gap in the existing literature.

CHAPTER 5:

STUDY #2: AN ANALYSIS OF 9-1-1 CARDIAC-RELATED EMERGENCY MEDICAL SERVICE CALLS AMONG ADULTS AGED 50 YEARS AND OLDER IN SAN FRANCISCO COUNTY, CALIFORNIA BY NEIGHBORHOOD HISPANIC ETHNIC AND SOCIOECONOMIC COMPOSITION

INTRODUCTION:

Emergency medical services (EMS) are an important link in the chain of survival for out-of-hospital cardiac emergencies, including cardiac arrests and heart attacks (AHA, 2024). Cardiac emergencies require a rapid and accurate response to decrease the risks of adverse neurological outcomes and increase the chances of survival (AHA, 2024; Institute of Medicine, 2015). For every minute that passes after an out-of-hospital cardiac arrest, survival rates decrease by 7% to 10%, with overall survival rates estimated at 23% to hospital admission and 10% to hospital discharge (Garcia et al., 2022; Institute of Medicine, 2015). For heart attacks, survival rates decrease from 90% to 66% when the emergency occurs in the prehospital setting (Institute of Medicine, 2015).

Among people who survive a cardiac emergency, post-cardiac morbidity, including brain injury due to lack of oxygen, weakness, fatigue, and paralysis can also result in short and long-term impacts on quality of life (Amacher et al., 2022). Although overall survival is low and post-cardiac morbidity is high among people who experience a cardiac emergency in the prehospital setting, racial and ethnic disparities persist and result in worse outcomes for these populations (Pu et al., 2024; Toy et al., 2023).

Hispanic patient ethnicity, compared to non-Hispanic Whites, is linked to worse health outcomes along the chain of survival after a cardiac emergency, including lower administration of life-saving interventions, such as bystander cardiopulmonary resuscitation (B-CPR) and use of automatic external defibrillators (AED), lower survival rates and worse neurological outcomes, (Bosson et al., 2019; Pu et al., 2024; Toy et al., 2023). Findings from several studies also suggest that higher Hispanic neighborhood-level ethnic composition is linked to lower administration of B-CPR, use of AEDs, provision of post resuscitation therapies, survival rates, and worse neurological outcomes, compared to patients who experience a cardiac emergency in neighborhoods with a lower Hispanic ethnic composition (Blewer et al., 2020; Huebinger et al., 2021; Uzendu et al., 2023). These studies suggest the importance of considering the interplay of both Hispanic patient ethnicity and neighborhood-level ethnic composition when assessing disparities in the provision of EMS for cardiac emergencies.

Lower socioeconomic status (SES) is another factor that is linked to worse health outcomes along the chain of survival after an out-of-hospital cardiac emergency (Mitchell et al., 2009; Wells et al., 2016; Hsia et al., 2018; Lee et al., 2021). Cardiac-related emergencies that occur in locations with higher tax-assessed property values, which is indicative of higher SES, are more likely to receive B-CPR with and without 9-1-1 dispatcher instructions and have higher survival rates,

compared to locations with lower tax-assessed property values (Mitchell et al., 2009). Persons who experience a cardiac emergency in low-income, high-poverty neighborhoods are less likely to meet national EMS benchmarks, have more delays in the return of spontaneous circulation (ROSC) rates, have longer ambulance response times, have worse neurological function, and have lower overall survival rates, compared to their counterparts in high income, low-poverty neighborhoods (Chan & Tang, 2020; Gaddam & Singh, 2020; Hsia et al., 2018; Wells et al., 2016).

Although findings from the existing literature provide evidence that there are disparities in the provision of EMS for cardiac emergencies by patient and neighborhood-level factors, including race, ethnicity and SES, less is known about the delivery of prehospital care for older adults from underserved populations. The current study focuses on adults aged 50 years and older who were provided EMS for cardiac emergencies during the coronavirus (COVID-19) pandemic. The heightened risk of COVID-19 morbidity and mortality among adults aged 50 years and older, combined with the fear of infection, delays in seeking medical care, and increased barriers to access the U.S. healthcare system, may have contributed to an increased reliance on EMS for cardiac-related emergencies (Garcia et al., 2021; Melgoza et al., 2021).

In this study, I investigate the patient and neighborhood-level factors associated with provision of EMS for cardiac emergencies among adults aged 50 years and older in San Francisco County, California during the COVID-19 pandemic. This study contributes to the existing literature in several ways. First, this study considers the impacts of patients' Hispanic ethnicity, and neighborhood-level characteristics, including Hispanic ethnic composition and SES on the provision of EMS for cardiac emergencies, with a focus on adults aged 50 years and older. Second, this study examines the provision of EMS for cardiac emergencies at the aggregated ZIP code tabulation area (ZCTA) level, which are larger geographic units, compared to census tracts. Most

of the existing EMS literature uses census tracts as the geographic unit of analysis. Third, operationalizing age as persons aged 50 years and older deviates from the traditional cutoff point of 65 years and older used in EMS research. Operationalizing age as 50 years and older accounts for premature health deterioration or weathering among minoritized persons, which heightened the risk of morbidity and mortality in these populations during the COVID-19 pandemic (Geronimus et al., 2006; Walubita et al., 2021). Fourth, this study contributes to the EMS literature by applying rare events logistic regression, a statistical approach commonly used when there are few cases that have an event of interest (King & Zeng, 2001; Tomz et al., 2021). This study is guided by the following four aims:

AIMS:

Aim #1: Assess to what extent provision of EMS for cardiac-related emergencies varies by patient sociodemographic characteristics, including race, ethnicity, gender, age, and suspected drug use among adults aged 50 years and older in SF County during the COVID-19 pandemic (February 1, 2020, to January 31, 2022).

Hypothesis #1: Hispanic ethnicity is associated with a higher provision of EMS for cardiac-related emergencies, compared to White older adults aged 50 years and older.

Hypothesis #2: Female gender is associated with a lower provision of EMS for cardiac-related emergencies, compared to males.

Hypothesis #3: Increasing age and suspected drug use are associated with a greater provision of EMS for cardiac-related emergencies.

Aim #2: Determine to what extent provision of EMS for cardiac-related emergencies varies by aggregated ZCTA-level SES characteristics including, the percentage of people living below the federal poverty level (FPL), Hispanic ethnic composition, and percentage of people enrolled in

Medicaid among older adults aged 50 years and older in SF County during the COVID-19 pandemic (February 1, 2020, and January 31, 2022).

Hypothesis #1: Aggregated ZCTAs with a higher percentage of Hispanic residents will have a greater likelihood of receiving EMS care for cardiac-related emergencies, compared to aggregated ZCTAs with lower percentages of Hispanic residents.

Hypothesis #2: Aggregated ZCTAs with higher percentages of people living below the FPL will have a greater likelihood of receiving EMS for cardiac-related emergencies, compared to aggregated ZCTAs with lower percentages of people living below the FPL.

Hypothesis #3: Aggregated ZCTAs with higher percentages of people enrolled in Medicaid will have a greater likelihood of receiving EMS for cardiac-related emergencies, compared to aggregated ZCTAs with lower percentages of people enrolled in Medi-Cal.

Aim #3: Assess whether provision of EMS for cardiac-related emergencies among adults aged 50 years and older in SF County varies by patient sociodemographic characteristics, including Hispanic ethnicity, and neighborhood-level characteristics, such as Hispanic ethnic composition and SES across two time periods (February 1, 2020, to January 31, 2021, and February 1, 2021, to January 31, 2022).

Hypothesis #1: Provision of EMS for cardiac emergencies is greater for Hispanic older adults, compared to Whites, although this disparity is greater during the first time period (February 1, 2020, to January 31, 2021), relative to the second time period (February 1, 2021, to January 31, 2022).

Hypothesis #2: Neighborhoods with a higher percentage of Hispanic residents have a greater likelihood of EMS provision for cardiac emergencies, compared to neighborhoods with a lower percentage of Hispanic residents, although this disparity is greater during the first time period

(February 1, 2020, to January 31, 2021), relative to the second time period (February 1, 2021, to January 31, 2022).

Hypothesis #3: Provision of EMS for cardiac emergencies is higher in neighborhoods with a greater percentage of people living below the FPL, compared to neighborhoods with a lower percentage of people living below the FPL, although this disparity is higher during the first time period (February 1, 2020, to January 31, 2021), relative to the second time period (February 1, 2021, to January 31, 2022).

METHODS:

San Francisco Emergency Medical Services Dataset

The first dataset used in this study is from the San Francisco Department of Emergency Management (SF DEM). The SF DEM dataset includes electronic patient care reports (ePCRs) submitted by EMS providers between January 1, 2020, and January 31, 2022. The timeframe for this study, however, begins on February 1, 2020, because this is the month when data began to reliably populate in the SF EMS database after the county transitioned to a different analytic service at the end of 2019. The SF DEM dataset includes all 9-1-1 calls where there was an encounter between an EMS provider and a patient. EMS patient encounters differ from EMS responses, where an interaction with a patient may or may not have occurred. EMS responses include dispositions, including no patient found at the scene, cancelled calls, and interfacility transports. The distinction between an EMS patient encounter and an EMS response is important since the latter is an operational event rather than a clinical one. EMS calls without patient contact and cancelled calls do not typically provide data on patient sociodemographic characteristics because there was no contact between the EMS provider and the patient. Interfacility transports where a patient is transported from one healthcare facility to another are excluded from the SF

EMS dataset since these types of responses are initiated by healthcare providers, not patients. Interfacility transports are not relevant for the proposed study, which focuses on the provision of emergency care for cardiac emergencies in the prehospital or community setting. The SF DEM dataset includes ePCRs submitted by three approved 9-1-1 provider agencies that serve SF County, including the SF Fire Department (SFFD), King American Ambulance Company, and American Medical Response (AMR) (SF DEM, 2024). The three other ambulance provider agencies in SF include NORCAL Ambulance, ProTransport-1, and Royal Ambulance, although these agencies focus on interfacility transports, which are not relevant for this study (SF DEM, 2024).

2022 American Community Survey 5-Year Estimates

Since 1790, the U.S. has administered a decennial national census for the purpose of providing a population count that informs congressional representation (U.S. Census Bureau, 2017). The national census also collects additional data that informs public measures to better address the needs of specific communities (U.S. Census Bureau, 2017). Since the 20th century, the questions in the national census are divided into short and long form questions (U.S. Census Bureau, 2017). The short form collects data on sociodemographic characteristics, while the long form contains questions from the short form, plus additional questions about demographic, social, economic, and housing characteristics (U.S. Census Bureau, 2017). Starting in 2000, the long form questions in the national census became the American Community Survey (ACS) (U.S. Census Bureau, 2017). The full administration of the ACS began in 2005 (U.S. Census Bureau, 2017).

The ACS is a nationwide survey that collects annual demographic, social, economic, and housing data on a sample of 3.5 million households in the U.S. (U.S. Census Bureau, 2017, 2022). The ACS is completed via mail, online, telephone, or during an in-person visit interview using a three-phase sequential approach (U.S. Census Bureau, 2022). The first phase gives respondents

the option of completing the ACS via mail or online (U.S. Census Bureau, 2022). The second phase uses telephone calls with a computer-assisted telephone interview (CATI) system, to reach nonrespondents of the first phase who have both a telephone number and a mailable address (U.S. Census Bureau, 2022). The third phase uses field representatives from the U.S. Census Bureau to conduct in-person interviews using a computer-assisted personal interview (CAPI) software (U.S. Census Bureau, 2022). The third phase is used for selected households where there are undeliverable addresses and nonresponses to the two previous phases (U.S. Census Bureau, 2022).

The ACS provides 1-year and 5-year level estimates compared to the 10-year estimates from the national census (U.S. Census Bureau, 2022). The ACS data is available across multiple levels of geography, including but not limited to, block groups, ZIP code tabulation areas (ZCTAs), census tracts, public use microdata areas (PUMAs), counties, states, and the country (U.S. Census Bureau, 2022). The ACS 1-year level estimates are available for geographic areas with a population greater than or equal to 65,000 people (U.S. Census Bureau, 2022). The ACS 5-year level estimates are available for smaller geographies with a population of at least 20,000 people (U.S. Census Bureau, 2022). The ACS 5-year level estimates include data collected over a period of multiple years (U.S. Census Bureau, 2022). The multi-year data collection increases statistical reliability for data obtained from smaller geographies, including ZCTAs (U.S. Census Bureau, 2022). ACS estimates are based on data pooled over the 1-year or 5-year reference period, not a fixed date (Raglin, 2022). For example, the 2022 ACS 5-year estimates are based on data collected from January 1, 2018, through December 31, 2022 (Raglin, 2022). The second dataset used in this study is the 2022 ACS 5-year level estimates for ZCTAs in SF County, California.

Selection and Operationalization of Variables

The variables included in this study are derived from the SF Department of Emergency Management dataset and the 2022 ACS 5-year estimates. Patient race and ethnicity, gender, age, and suspected drug use were extracted from the SF Department of Emergency Management dataset. The aggregated ZCTA variable used the incident ZCTA variable in the SF Department of Emergency Management dataset, plus the percentage of people living below the federal poverty level by ZCTA in the 2022 ACS 5-year estimates. The percentage of Hispanics per ZCTA and percentage of Medicaid enrollment per ZCTA were extracted from the 2022 ACS 5-year estimates. Table 4 includes all the variables and the operationalized definition of each.

Table 4: Operationalization of Variables in Cardiac Study

Cardiac-related 9-1-1 calls	A cardiac-related 9-1-1 call is operationalized as having a primary or secondary provider impression of a cardiac etiology. The primary and secondary provider impressions are composed of International Classification of Diseases-10-Clinical Modification (ICD-10-CM) codes. EMS providers are required to record the primary and secondary provider impressions in an electronic patient care report (ePCR) after responding to a 9-1-1 call.
Patient race ethnicity	Patient race and ethnicity is operationalized as White, Black or African American, Hispanic, Asian, and Other. The Other category includes Native Hawaiian and Pacific Islanders, and American Indian and Alaska Native. The definition of race and ethnicity is based on the U.S. Office of Management and Budget. Aggregation of racial and ethnic categories also accounts for small sample sizes.
Patient gender	Patient gender is operationalized as male or female. These are the only categories available in EMS ePCRs from SF County, CA.
Patient age	Patient age is operationalized as persons aged 50 to 59, 60 to 69, 70 to 79 and 80+ years.
Aggregated incident ZCTAs	SF County is composed of 27 ZCTAs. In this study, incident ZCTAs are aggregated into larger geographic units based on geographic proximity and similar socioeconomic status (SES). SES is operationalized as the percentage of residents living below the federal poverty level. There are 8 larger geographic units composed of multiple ZCTAs, including 1) Treasure Island; 2) Tenderloin, South of Market, Financial District, and Chinatown; 3) Mission District, Bernal Heights, Bayview, Hunters, Ingleside, and Excelsior; 4) Visitacion Valley, Lake Merced, and Lakeside; 5) Polk, Russian Hill, Nob Hill, Western Addition, Japantown, and Embarcadero; 6) Rincon Hill, Potrero Hill, SOMA, and Mission Bay; 7) Sunset, Parkside, Forest Hill, Haight-Ashbury, Inner Richmond, and Outer Richmond; 8) Castro, Noe Valley, St. Francis

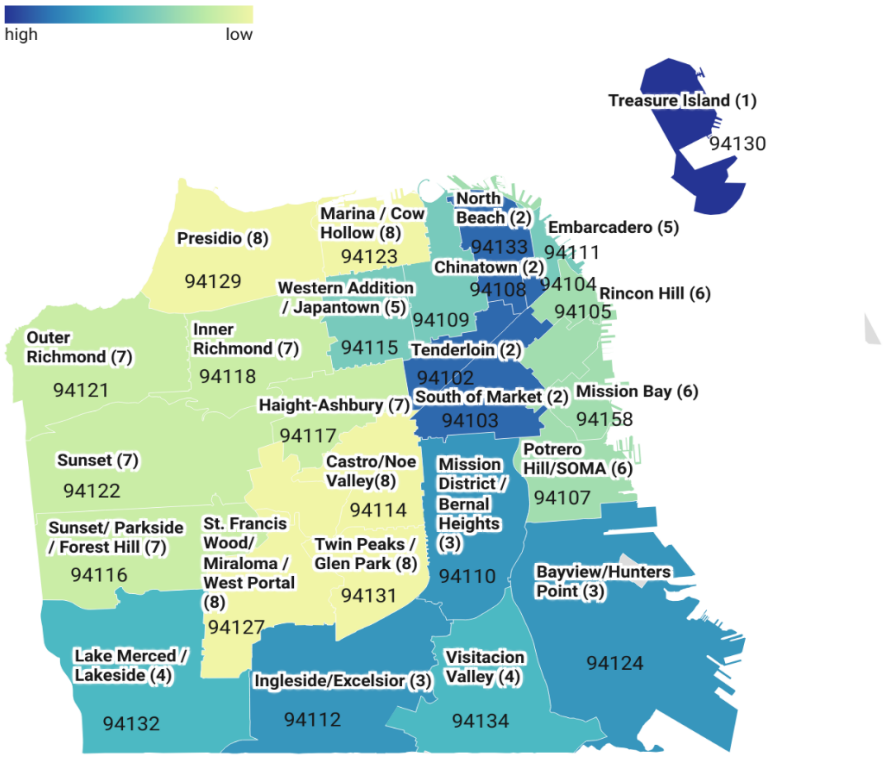
	Wood, Miraloma, West Portal, Twin Peaks, Glen Park, Marina, Cow Hollow and Presidio. Regions 1 (40.10%) and 2 have high percentages of people living below the federal poverty level (16.5% to 20.10%). Regions 3 to 5 have medium percentages of people living below the federal poverty level (10.00% to 16.49%). Regions 6 to 8 have low percentages of people living below the federal poverty level (0.00% to 9.99%).
Hispanic ethnic composition	Hispanic ethnic composition is operationalized as a categorical variable that represents the percentage of residents who identify as Hispanic by ZCTAs. The categories include 0 to 9%, 10% to 19%, 20% to 29% and 30% or more.
Medicaid enrollment	Medicaid enrollment is operationalized as a continuous variable that represents the percentage of residents enrolled in Medicaid by ZCTA.
Suspected Drug Use	Suspected drug use is operationalized as true or false. These are the options available on the EMS ePCRs.

Coding of Variables

The patient race and ethnicity variable is coded using the definition from the U.S. Office of Management and Budget (OMB) (OMB, 2024). The patient race and ethnicity variable is coded as White (1), Black or African American (2), Asian (3), Other (4), and Hispanic (5). Racial and ethnic categories with small sample sizes age aggregated. The Other category is an aggregate of Native Hawaiian and Pacific Islanders (NHOPI) and American Indian and Alaska Native (AIAN) persons, the two groups with small sample sizes. Patient gender is coded as female (0) and male (1). Patient age is a categorical variable coded as 50 to 59 years, 60 to 69 years, 70 to 79 years, and 80 years or older. The aggregated incident ZCTA variable is an aggregate of the 27 ZCTAs in SF County. The 27 ZCTAs were aggregated into 8 larger geographic units based on geographic proximity and similar percentage of people living below the federal poverty level. The aggregated incident ZCTA variable is coded from 1 to 8. Treasure Island was coded 1, Tenderloin, South of Market, Financial District, and Chinatown were coded 2, Mission District, Bernal Heights, Bayview, Hunters, Ingleside, and Excelsior were coded 3, Visitacion Valley, Lake Merced, and Lakeside were coded 4, Polk, Russian Hill, Nob Hill, Western Addition, Japantown, and

Embarcadero were coded 5, Rincon Hill, Potrero Hill, SOMA, and Mission Bay were coded 6, Sunset, Parkside, Forest Hill, Haight-Ashbury, Inner Richmond, and Outer Richmond were coded 7 and Castro, Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, Marina, Cow Hollow and Presidio were coded 8 (See Map 1). The aggregated ZCTAs coded 1 and 2 have high percentages of people living below the federal poverty level and are in the northern part of SF County. High poverty level is defined as having 16.5% to 40.10% of people living below the FPL. Region 1 is Treasure Island which has 40.10% of people living below the FPL, although Region 2 has the largest percentage of people living below the FPL in contiguous SF County with a range of 16.5% to 20.10%. The neighborhoods coded 3, 4, and 5 have medium levels of people living below the federal poverty level and are in the southern and northeastern areas of SF County. Medium poverty level is defined as having 10.00% to 16.49% of people living below the FPL. The neighborhoods coded 6, 7, and 8 have low levels of people living below the federal poverty level and are in the eastern, western, north, and central areas of SF County. Low poverty level is defined as having 0.00 to 9.99% of people living below the FPL. Sensitivity analyses were conducted using different variable specifications to assess for robustness of study results. Hispanic ethnic composition was operationalized as a categorical variable, with four levels, including 0 to 9%, 10% to 19%, 20% to 29% and 30% or more. Robustness checks were coducted using different variable specifications.

Map #1: Aggregated ZCTAs by percentage of residents below the federal poverty level and geographic proximity



Source: 2022 American Community Survey 5-Year Estimates
Note: The number after the neighborhood names corresponds to a larger geographic unit comprised of multiple ZCTAs. For example, all the areas with a (2) correspond to the same aggregated ZCTA.

Data Analyses

Geospatial Visualization

The maps for this study were created using Datawrapper, an interactive software developed by Datawrapper GmbH (Datawrapper GmbH, 2023). The first step in the map creation process was to extract the descriptive statistics from the relevant datasets. For this study, descriptive statistics were extracted from the SF Department of Emergency Management and the 2022 ACS 5-year estimates. The second step was to create a profile on the Datawrapper website. Once the profile was completed, the "Create new map" and "choropleth map" options were selected. The third step was to use the search option to find the correct map for the appropriate geographic unit of interest. For this study, the ZCTA-level map of San Francisco County, California was selected. The fourth step was to upload the extracted data from step one as an Excel worksheet or comma

separated value file. The file contained the ZCTA number and the values with the specific geographic unit of analysis. For example, in this study the geographic unit was the ZCTA, while the values were either exact percentages or numbers denoting aggregate categories. The fifth step was to label and annotate the maps to include the title, legend, key geographic markers, and select the color scheme. The sixth and final step was to publish or save the map to the user profile prior to downloading the image.

Univariate and Bivariate Analyses

Univariate analyses were conducted to assess the distribution of each independent and dependent variable (see Appendix I-II). The patient sociodemographic characteristics include patient race ethnicity, gender, age, and suspected drug use. The neighborhood-level characteristics include aggregated ZCTAs based on geographic proximity and percentage of residents living below the federal poverty level, percentage of Hispanic ethnic composition, and percentage of Medicaid enrollment. The dependent variable is presence or absence of cardiac-related emergencies. Bivariate analyses were used to determine the association between the independent variables and the dependent variable (See Appendix III). Bivariate analyses used chi-squared tests for categorical variables and t-tests for continuous variables. Cross tabulations were also conducted for independent variables. The insights gained from the univariate and bivariate analyses informed the multivariate analysis (Appendix I-IV).

What is Rare Events Logistic Regression?

As shown in the univariate analysis, the fraction of patients reporting the outcome of interest is 7.79%, indicating a rare event (See Appendix III) (King & Zeng, 2001). Rare events logistic regression is an approach that was developed to analyze rare or uncommon events, particularly those that result in a small sample size, when the dependent variable is binary (King

& Zeng, 2001; Tomz et al., 2021). The rare events logistic regression approach was developed to address limitations of "traditional" logistic regression (King & Zeng, 2001; Tomz et al., 2021). Rare events in public health may include, but are not limited to, uncommon or rare diseases or health conditions, epidemics, pandemics, wars, and natural disasters, such as major earthquakes, volcanic eruptions, and tsunamis (King & Zeng, 2001; Tomz et al., 2021). In rare events logistic regression, a penalized likelihood approach is used to find more reliable coefficient estimates that account for rare events and small sample sizes (King & Zeng, 2001; Tomz et al., 2021).

How Does Rare Events Logistic Regression Compare to Logistic Regression and Firth Logistic Regression?

Although this study uses rare events logistic regression as the main multivariate approach, analyses were also conducted using "traditional" logistic regression and Firth's logistic regression to compare results across the three different types of models. In "traditional" logistic regression maximum likelihood estimation (MLE) is used to estimate the coefficients and their standard errors. The use of MLE may result in inaccurate coefficient estimates due to small-sample bias that may arise with rare events (King & Zeng, 2001; Tomz et al., 2021). Firth logistic regression is another type of logistic regression model that reduces bias in estimates when small sample sizes are present (Firth, 1993). Firth logistic regression yields consistent estimates even in cases when separation occurs (Firth, 1993). Separation refers to a scenario when an independent variable or combination of independent variables are perfectly associated with only one type of outcome in a logistic regression (Firth, 1993; Wang, 2014). For example, separation occurs when an independent variable or combination of independent variables are equal to a dependent variable of 1 and none have an outcome of 0 (Wang, 2014). Cardiac emergencies are rare, at 7.79%, relative to non-cardiac emergencies, which comprise 92.2% of all EMS calls (see Table 4). The output

from the logistic regression and Firth logistic regression models are available in Appendix V and VII.

Nested Rare Events Logistic Regression Models

Seven sequential, multivariate rare events logistic regression models were evaluated to examine the association between cardiac-related emergencies, the dependent variable, and the independent variables, patient race and ethnicity, gender, age, aggregated ZIP code, suspected drug use, and ZCTA-level percentage of Hispanic residents and percentage of Medicaid enrollees. Model 1 estimated the relationship between cardiac-related emergencies and patient-level race and ethnicity. Model 2 appended gender to the first model specification. Model 3 added age to the second model specification. Model 4 appended aggregated ZCTAs to the third model specification. Model 5 added ZCTA-level percentage of Hispanic ethnicity to the fourth model specification. Model 6 appended ZCTA-level percentage of Medicaid enrollment to the fifth model specification. The final model appended suspected drug use to the sixth model specification. Statistical significance was determined at a p-value of <.05. This study used STATA 17.0. Sensitivity analyses were conducting using logistic regression, Firth logistic regression and multiple specifications of the independent and dependent variables.

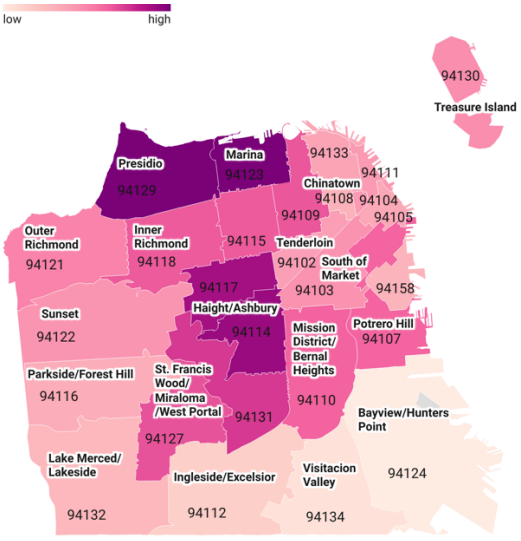
RESULTS:

Geospatial Descriptive Characteristics of San Francisco County, California

Maps 2, 3, 4, and 5 suggest racial and ethnic segregation by place of residence in SF County, California, with the highest proportions of White residents living in the northwest and central neighborhoods, while Hispanics, Black and African American and Asian living along most of the perimeter in SF County, especially in the south, west and northeast areas. The highest percentage of Hispanics live in the Mission District, Bernal Heights, Treasure Island, Presidio

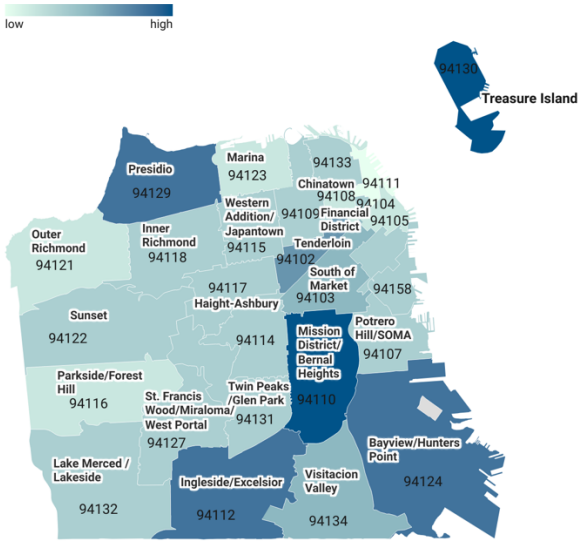
Ingleside, Excelsior Bayview, and Hunters Point (See Map 3). There are a handful of counties with relatively high fractions of two race/ethnicity groups, for example, Presidio with White and Hispanic, and Treasure Island with Hispanics and Blacks (See Map 2, 3, and 4).

<u>Map #2:</u> Percentage of Whites per ZCTA in SF County, CA



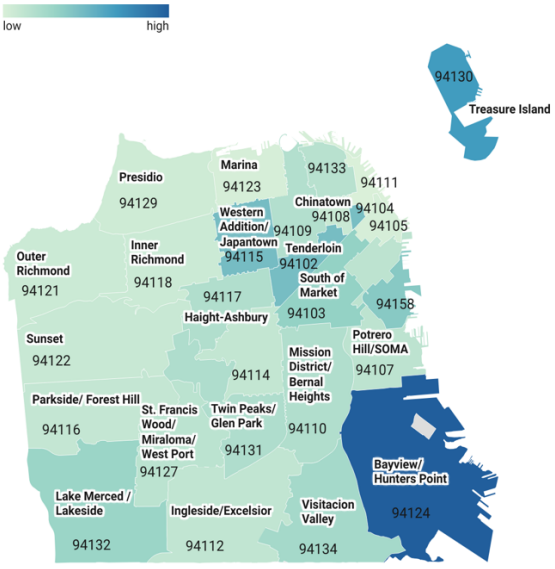
Source: 2022 American Community Survey 5-Year Estimates

<u>Map #3:</u> Percentage of Hispanics per ZCTA in SF County, CA



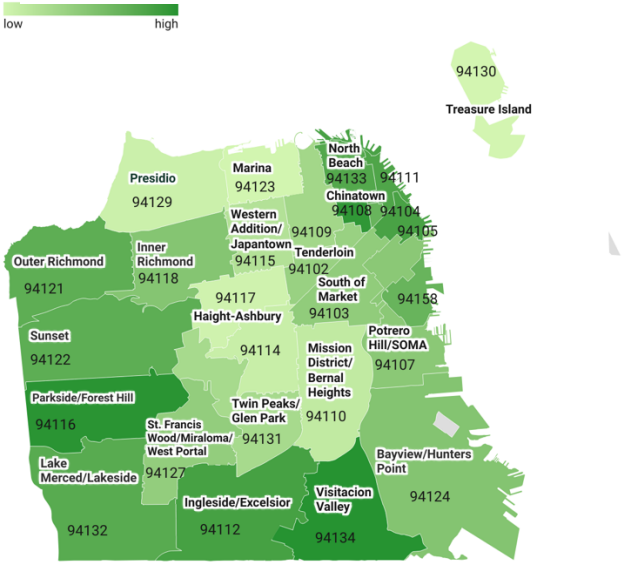
Source: 2022 American Community Survey 5-Year Estimates

<u>Map #4:</u> Percentage of Blacks or African Americans per ZCTA in SF County, CA



Source: 2022 American Community Survey 5-Year Estimates

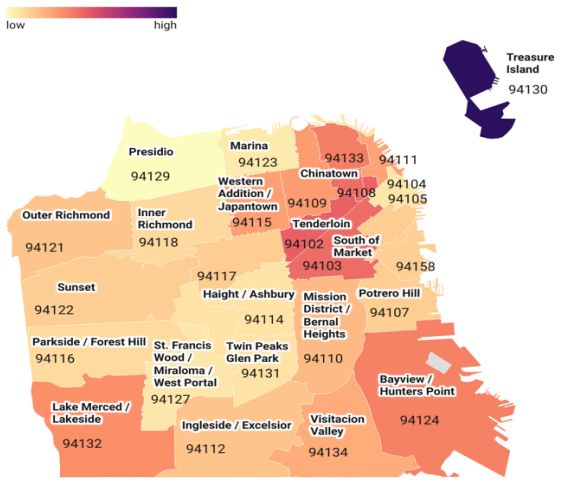
<u>Map #5:</u> Percentage of Asians per ZCTA in SF County, CA



Source: 2022 American Community Survey 5-Year Estimates

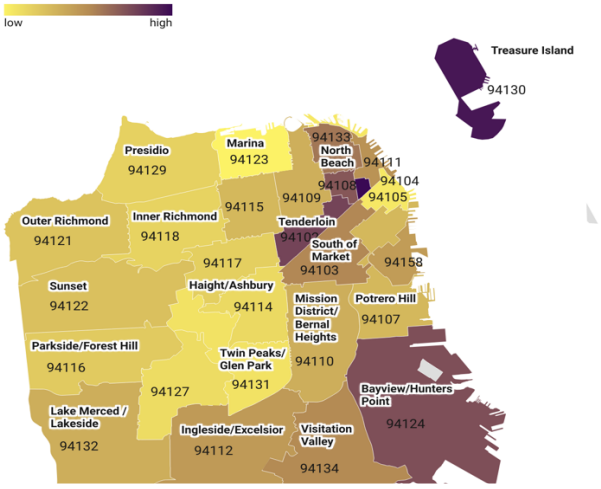
Maps 1 through 8 suggest that the neighborhoods with the highest percentage of people living below the federal poverty level (FPL), or geographic areas with the lowest SES, also have the greatest percentages of Medicaid enrollees, suspected drug use by EMS providers, cardiac emergencies, and residents of racial and ethnic minority backgrounds. Specifically, the highest percentage of people living below the federal poverty level are in Treasure Island (40.1%), Tenderloin (20.1%), Financial District (19.7%), South of Market (18.8%), and Chinatown (18.6%) (See Map 6). The highest percentage of Medicaid enrollees are in the Financial District (48.8%), Treasure Island (46.7%), Tenderloin (38.5%), and Bayview and Hunters Point (36.6%). The high percentages of Medicaid enrollees, or Medi-Cal in California, in low SES areas are consistent with the purpose of the program, which is to provide health insurance to underserved populations, including low-income persons (DHCS, 2024).

<u>Map #6:</u> Percentage of the population below the federal poverty level in SF County, CA



Source: 2022 American Community Survey 5-Year Estimates

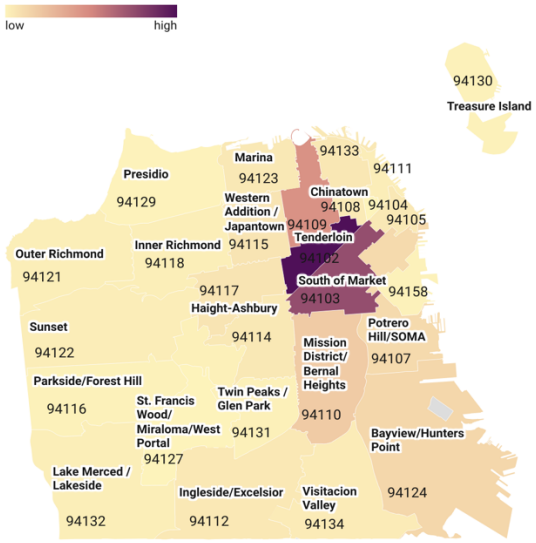
<u>Map #7:</u> Percentage of the population with Medicaid alone or in combination per ZCTA in SF County, CA



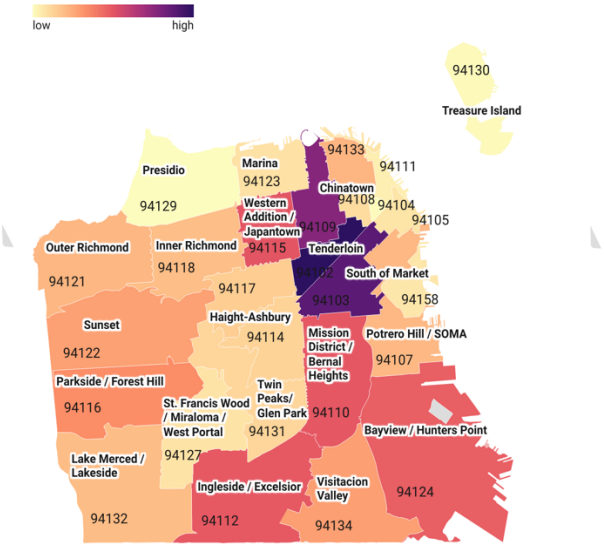
Source: 2022 American Community Survey 5-Year Estimates

<u>Map #8:</u> Percentage of suspected drug use among adults aged 50 years or older per ZCTA in SF County, CA between Feb 2020 and Jan 2022

<u>Map #9:</u> Percentage of 9-1-1 cardiac emergencies among adults 50 years or older in SF County, CA between Feb 2020 and Jan 2022



Source: 2022 San Francisco Department of Emergency Management



Source: 2022 American Community Survey 5-Year Estimates

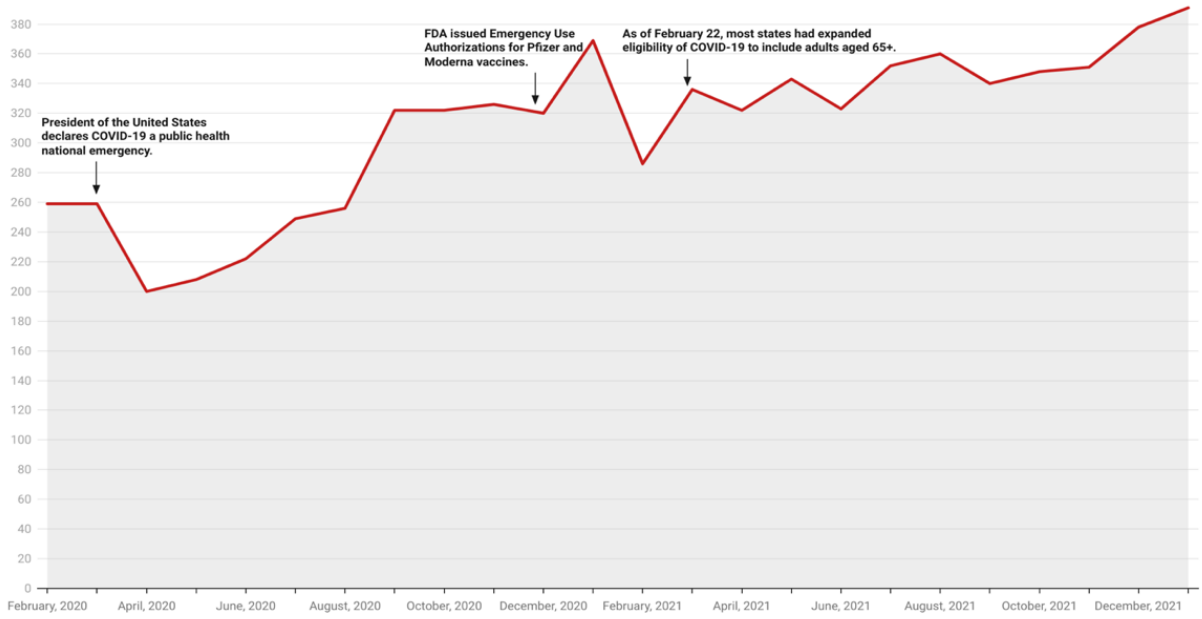
Descriptive Statistics

This study includes all 9-1-1 calls with a patient contact in SF County, California between February 1, 2020, and January 31, 2022. The 9-1-1 calls are restricted to adults aged 50 years and older. The analytic sample is 95,585 9-1-1 emergency calls with a patient contact. Of these, 88,143 or 92% were non-cardiac related and 7,442 or 8% were cardiac-related. Figure 9 shows the total number of cardiac-related 9-1-1 calls by month between February 1, 2020, to January 31, 2022. There was a decline of cardiac-related 9-1-1 calls starting on March 1, 2020, which corresponds to the period when the U.S. President declared COVID-19 a public health emergency. This decline is consistent with previous EMS literature that reported precipitous declines in EMS calls starting in March 2020 (Handberry et al., 2021; Lerner et al., 2020; Melgoza et al., 2021).

The descriptive statistics by cardiac and non-cardiac related EMS calls are available in Table 4. The distribution of patient race, ethnicity, gender, and age are comparable for both cardiac and non-cardiac related EMS calls (see Table 5). Whites comprised 45% of non-cardiac related calls, and 40% of cardiac related calls. Hispanics comprised approximately 10% of both cardiac

and non-cardiac related calls (see Table 5). The gender distribution for both cardiac and non-cardiac related calls was approximately 60% males and 40% females (see Table 5). Approximately 56% of both cardiac and non-cardiac EMS calls occurred among persons between the ages of 50 to 69 years, with lower percentages of calls among persons aged 70 years and older (see Table 5). The highest percentage of cardiac-related EMS calls are recorded in Region 2, which includes neighborhoods with the highest percentage of people living below the FPL in contiguous SF County, including Tenderloin, South of Market, Financial District and Chinatown (see Table 5). Descriptive statistics for cardiac and non-cardiac-related emergencies across the two disaggregated time periods, February 1, 2020, and January 31, 2021 (Time Period 1), and February 1, 2021, and January 31, 2022 (Time Period 2) are available in Appendix I and II.

<u>Figure 9:</u> Number of cardiac 9-1-1 EMS calls with patient contact among adults aged 50 years and older in SF County between February 1, 2020 and January 31, 2022



Source: SF Department of Emergency Management

<u>Table 5:</u> Descriptive statistics of 9-1-1 EMS calls among adults aged 50 years and older in SF County, CA between February 1, 2020 and January 31, 2022 using primary and secondary provider impressions

	No Cardiac-Related 9-1-1 Calls (N=88,143)		Cardiac-Related 9-1-1 Calls (N=7,442)		Cardiac and non-cardiac-related 9-1-1 calls (N=95,585)	
	Number (#)	Percentage (%)	Number (#)	Percentage (%)	Number (#)	Percentage (%)
Race/Ethnicity						
White	39,879	45.24%	3,020	40.58%	42,899	44.88%
Black or African American	21,229	24.08%	1,884	25.32%	23,113	24.18%
Hispanic	8,940	10.14%	789	10.60%	9,729	10.18%
Asian	16,050	18.21%	1,551	20.84%	17,601	18.41%
Other	2,045	2.32%	198	2.66%	2,243	2.35%
Gender						
Female	36,126	40.99%	2,916	39.18%	39,042	40.85%
Male	52,017	59.01%	4,526	60.82%	56,543	59.15%
Age						
50-59	24,901	28.25%	1,989	26.73%	26,890	28.13%
60-69	24,985	28.35%	2,182	29.32%	27,167	28.42%
70-79	17,038	19.33%	1,558	20.94%	18,596	19.45%
80+	21,219	24.07%	1,713	23.02%	22,932	23.99%
Aggregated Incident ZCTA (Aggregated by geographic proximity and percentage of residents below the federal poverty level).[1]						
Treasure Island (High % of poverty)[2]	224	0.25%	21	0.28%	245	0.26%
Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)[3]	27,486	31.18%	2,178	29.27%	29,664	31.03%
Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[4]	16,238	18.42%	1,437	19.31%	17,675	18.49%
Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[5]	5,272	5.98%	487	6.54%	5,759	6.03%
Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[6]	15,071	17.10%	1,301	17.48%	16,372	17.13%
Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[7]	4,095	4.65%	376	5.05%	4,471	4.68%
Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[8]	13,592	15.42%	1,183	15.90%	14,775	15.46%
Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow [9]	6,165	6.99%	459	6.17%	6,624	6.93%
Percentage of Hispanics at the ZCTA level						
0 to 9%	17,705	20.09%	1,406	18.89%	19,111	19.99%
10% to 19%	41,147	46.68%	3,592	48.27%	44,739	46.81%
20 to 29%	22,947	26.03%	1,935	26.00%	24,882	26.03%
30+%	6,344	7.20%	509	6.84%	6,853	7.17%
Percentage of Medicaid enrollees at the ZCTA level	22.46 (Mean) 10.11 (SD)		22.45 (Mean) 9.94 (SD)		22.46 (Mean) 10.10 (SD)	
Suspected Drug Use						
True	4,798	5.44%	336	4.51%	5,134	5.37%
False	83,345	94.56%	7,106	95.49%	90,451	94.63%

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner
[2] High % of people living below FPL off the coast of SF County
[3] High % of people living below FPL in the northeastern corner of SF County
[4] Medium % of people living below FPL and southeastern corner of SF County
[5] Medium % of people living below FPL in the southern corner of SF County
[6] Medium % of people living below FPL in the northeastern corner of SF County
[7] Low % of people living below FPL and in the eastern corner of SF County
[8] Low % of people living below FPL and in the western corner of SF County
[9] Low % of people living below the FPL in north and central SF County

Bivariate Analysis:

Bivariate analysis was conducted using chi-squared tests and tests of proportions. Chi-squares tests determined the association between the binary variable, presence or absence of cardiac emergencies and race and ethnicity, gender, age, aggregated ZCTAs, Hispanic ethnic composition, and suspected drug use (See Appendix III). A t-test was conducted to determine the association between presence or absence of cardiac emergencies and percentage of Medicaid enrollees. Descriptive results suggest that among non-cardiac and cardiac EMS emergencies, there was a higher proportion of males compared to females, Whites compared to other racial and ethnic groups, and persons aged 50 to 69 years compared to 70 years or more. Cardiac and non-cardiac EMS calls were also highest in Region 2, which is the geographic area with the highest percentage of people living below the FPL, or the lowest SES, in contiguous SF County.

Cross tabulations indicate that across all racial and ethnic groups, provision of EMS for cardiac emergencies was higher for males compared to females (See Table 6). Provision of EMS was higher among younger age groups of Hispanics and Black or African American patients, but greater in Asians in older age groups (see Table 6). For example, approximately 73% and 64% of cardiac emergencies among Black or African Americans and Hispanics occurred in persons between the ages of 50 and 69 years but were less common in older age groups for these racial and ethnic groups. In contrast, 65% of cardiac emergencies among Asians occurred in persons aged 70 years and older. The presence of suspected drug use in cardiac emergencies was marked true more often among Black or African American patients, compared to all other racial and ethnic groups (see Table 6).

Table 6: Cross tabulations of patient race and ethnicity with other independent variables for adults aged 50 years and older with a cardiac-related emergency in SF County, CA between February 1, 2020, and January 31, 2022

	White	Black or African American	Asian	Other (NHOPI/AIAN)	Hispanic
Gender					
Female	35.76%	39.86%	46.62%	45.45%	34.47%
Male	64.24%	60.14%	53.38%	54.55%	65.53%
Age					
50-59	25.36%	32.32%	14.38%	42.93%	38.78%
60-69	28.28%	40.87%	20.37%	20.71%	25.48%
70-79	22.42%	18.31%	22.89%	23.74%	16.98%
80+	23.94%	8.49%	42.36%	12.63%	18.76%
Aggegated ZCTA					
(1) Treasure Island	0.17%	0.74%	0.00%	0.00%	0.25%
(2) Tenderloin …	29.74%	35.51%	23.53%	20.71%	25.98%
(3) Mission District …	11.89%	23.20%	18.38%	26.77%	38.40%
(4) Visitacion Valley …	4.34%	8.23%	9.54%	9.60%	4.31%
(5) Polk/Russian Hill…	20.00%	16.19%	15.73%	24.24%	12.67%
(6) Rincon Hill…	4.74%	6.26%	3.68%	5.05%	6.08%
(7) Sunset …	18.91%	7.17%	25.79%	9.09%	7.48%
(8) Castro/Noe Valley	10.23%	2.71%	3.35%	4.55%	4.82%
Suspected Drug Use					
True	3.91%	8.44%	0.32%	5.45%	4.51%
False	96.09%	91.56%	99.68%	94.44%	94.55%

Multivariate Analysis (Full Time Period):

The findings from the seven nested rare events logistic regression models are available in Table 7. The models show the odds ratios of cardiac related emergencies among adults aged 50 years and older in SF County, California between February 1, 2020, and January 31, 2022 by patient and neighborhood-level factors. Provision of EMS for cardiac emergencies was lower for Whites compared to Hispanics (Model 7, OR = 0.85, 95% CI: [0.78, 0.92]), and females compared to males (Model 7, OR = 0.90, 95% CI: [0.86, 0.95]). Increasing age was associated with greater odds of EMS provision for cardiac emergencies, except for the oldest old or persons aged 80 years and older. Specifically, persons aged 60 to 69 years (Model 7, OR = 1.08, 95% CI: [1.01, 1.15]) and 70 to 79 years (Model 7, OR = 1.11, 95% CI: [1.03, 1.19]) were more likely to have a cardiac emergency, compared to persons aged 50 to 59 years old. ZCTAs with higher Hispanic ethnic composition between 10% and 19% had higher provision of EMS (Model 7, OR = 1.11, 95% CI: [1.03, 1.19]), compared to ZCTAs with a lower Hispanic ethnic composition between 0 and 9%

Regions with higher SES, or geographic areas with a lower percentage of people living below the FPL had higher provision of EMS for cardiac emergencies, compared to Region 2, which has the lowest SES in contiguous SF County. Specifically, Regions 3, 4, 5, 6, and 7 had highest provision of EMS for cardiac emergencies, compared to Region 2, which includes the Tenderloin, South of Market, Financial District and Chinatown neighborhoods. Region 3 includes neighborhoods with the highest percentages of Hispanic residents in SF County, including Mission District and Bernal Heights, and also had some of the highest provision of EMS for cardiac emergencies.

Table 7: 9-1-1 cardiac emergencies among adults aged 50 years and older in SF County between February 1, 2020, and January 31, 2022 (Rare Events Logistic Regression Results with provider & secondary provider impressions) (N=95,585)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Race/Ethnicity (Ref = Hispanic)							
White	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***
Black or African American	1.00	1.00	0.99	0.99	0.99	0.97	0.98
Asian	1.09*	1.11*	1.10*	1.10*	1.09	1.09	1.08
Other	1.09	1.10	1.09	1.09	1.09	1.08	1.08
Gender (Ref = Male)							
Female		0.91***	0.91**	0.91***	0.90***	0.90***	0.90***
Age, years (Ref = 50-59)							
60-69			1.09**	1.09**	1.09**	1.09**	1.08*
70-79			1.15***	1.13***	1.13**	1.13**	1.11**
80+			1.00	0.98	0.98	0.98	0.96
Aggregated ZIP codes (Reference = (2) Tenderloin, South of Market, Financial District and Chinatown.)[1]							
(1) Treasure Island (High % of poverty)[2]				1.21	1.42	1.26	1.26
(3) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[3]				1.10**	1.18***	1.25***	1.24***
(4) Visitacion Valley and Lake Merced/Lakeside				1.16**	1.10	1.14*	1.13*
(5) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[5]				1.11**	1.06	1.13*	1.13*
(6) Rincon Hill, Potrero Hill/SOMA, Mission Bay				1.16**	1.14*	1.24**	1.24**
(7) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset				1.11**	1.13**	1.25**	1.24**
(8) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[8]				0.99	1.00	1.14	1.14
Percentage of Hispanics at the neighborhood level (Reference = 0 to 9%)							
10% to 19%					1.10**	1.11**	1.11**
20 to 29%					1.02	0.97	0.97
30+%					0.9	0.90	0.91
Percentage of Medicaid enrollees at the neighborhood level						1.00	1.00
Suspected Drug Use (Ref = True)							1.17
False							0.05**
Constant	0.088***	0.091***	0.086***	0.081***	0.078***	0.065***	0.056***
Observations	95585	95585	95585	95585	95585	95585	95585

Statistical significance: <.05, <.01, and <.001

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner

[2] High % of people living below FPL off the coast of SF County

[3] Medium % of people living below FPL and southeastern corner of SF County

[4] Medium % of people living below FPL in the southern corner of SF County

[5] Medium % of people living below FPL in the northeastern corner of SF County

[6] Low % of people living below FPL and in the eastern corner of SF County

[7] Low % of people living below FPL and in the western corner of SF County

[8] Low % of people living below the FPL in north and central SF County

Multivariate Analysis (By Year):

Appendices VIII and IX show the results of the nested rare events logistic regression models for two time periods, February 1, 2020 to January 31, 2021, and February 1, 2021 to January 31, 2022. The analytic sample is 43,573 and 52,013 in the first and second time periods, respectively. Provision of EMS for cardiac emergencies was lower for Whites, compared to Hispanics, across both time periods, although the disparity was only statistically significant during the second time period [Model 7 for Period 2: OR = 0.80, 95% CI: [0.71 0.89]) (see Appendix VIII and IX). Females had lower odds of cardiac-related emergencies during both time periods, compared to males [Model 7 for Period 1: OR = 0.90, 95% CI: [0.84, 0.97]) [Model 7 for Period 2: OR = 0.91, 95% CI: [0.85, 0.97]) (see Appendix VIII and IX). Provision of EMS for cardiac emergencies was greater with increasing age, except among the oldest old, across both time periods (see Appendix VIII and IX). Neighborhood level factors, including SES, Hispanic ethnic composition, and percentage of Medicaid enrollees were not statistically significant during the first time period, but disparities by neighborhood-level SES were detected during the second time period. The neighborhood-level SES disparities during the second, but not the first time period may be due to leveling that occurred during the first few months of the COVID-19 pandemic when universal policies resulted in lower provision of EMS to all.

Sensitivity Analysis:

The deidentified EMS data shared by SF County only links 9-1-1 calls to specific ZCTAs, not specific addresses, latitude, and longitude, which prevents geolocation of emergency incidents. For these reasons, the current study uses the 5-year level estimates at the ZCTA level from the 2022 ACS. Use of the 5-year level estimates at the ZCTA level maintain respondent confidentiality, produce smaller margins of errors compared to 1-year level estimates, and increase

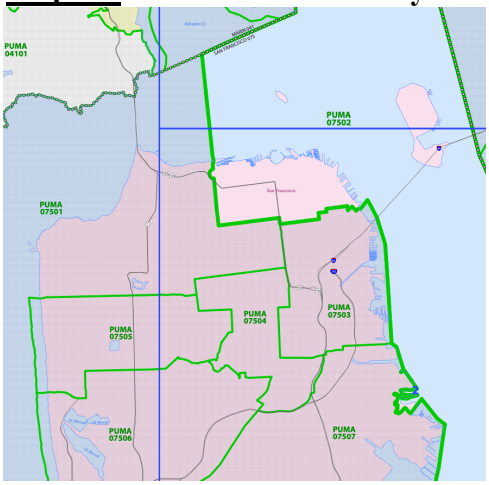
statistical reliability for smaller geographies (U.S. Census Bureau, 2017). The 2022 ACS 5-year estimates at the ZCTA level include pooled data from January 1, 2018, to December 31, 2022. To ensure robustness of results, sensitivity analyses were also conducted using 1-year level estimates at the public use microdata area (PUMA) level. PUMAS are larger geographic units, compared to ZCTAs. Although ZCTAs are not perfectly nested within PUMAS, this sensitivity analysis was used to check whether the results are similar after using 1-year and 5-year level ACS estimates (see Map 10 and 11).

The models that use 1-year level estimates at the PUMA level are consistent with the findings from the 5-year level estimates at the ZCTA level. The ZCTA to PUMA mapping was conducted using data from the Missouri Census Data Center. Appendix X shows that provision of EMS for cardiac emergencies is also lower for Whites, compared to Hispanics and females relative to males. Increasing age is linked to a greater provision of EMS for cardiac emergencies, except for the oldest old. Provision of EMS for cardiac emergencies is also higher in PUMAs with the highest percentage of Hispanics, compared to PUMAS with a lower percentage of Hispanics, and in most of the geographic areas with higher SES, compared to the PUMA with the lowest SES in contiguous SF County.

Map 10: ZCTAs in SF County, CA

Source: (Datawrapper GmbH, 2023b)

Map 11: PUMAs in SF County



Source: (US Census Bureau, 2010)

DISCUSSION:

The prehospital setting often serves as an entry point into the U.S. healthcare system for people who experience an out-of-hospital cardiac emergency, which is a type of incident that requires rapid and accurate treatment to maximize survival and minimize neurological sequalae and death. This study provides important insights on the provision of prehospital care for cardiac emergencies by patient sociodemographic characteristics and neighborhood composition. Provision of EMS for cardiac emergencies during the first two years of the COVID-19 pandemic was higher among Hispanics aged 50 years and older, compared to Whites. This finding aligns with previous studies, which suggest that Hispanic older adults used EMS at higher rates, compared to Whites during the COVID-19 pandemic (Melgoza et al., 2023). Provision of EMS for cardiac emergencies was also higher for ZCTAs with a Hispanic ethnic composition between 10% and 19%, compared to 0 to 9%. Non-statistically significant findings were reported for ZCTAs with a Hispanic ethnic composition between 20 to 29% and 30% or more. The mixed findings for Hispanic ethnic composition may be attributed to the lack of heterogeneity in the percentage of Hispanic residents in SF County's ZCTAs. For example, the percentage of Hispanic residents by ZCTA in SF County ranges between 2.4% to 31.80% (U.S. Census Bureau, 2024). Previous studies that have assessed the association between Hispanic ethnic composition and provision of EMS use cutoff points, including less than 25%, 25% to 49%, 50% to 74%, and greater than 75%, which is not possible in the SF County context (Blewer et al., 2020). The findings from this study also suggest differences in the provision of EMS between Whites and Hispanics between the first and second time periods. I initially hypothesized that the White-Hispanic difference in provision of EMS for cardiac emergencies was larger during the first year of the COVID-19 pandemic since Hispanic older adults were disproportionately impacted by the virus in terms of

cases and deaths. The results from this study, however, suggest that the difference in provision of EMS to Whites and Hispanics was greater during the second year of the COVID-19 pandemic. An explanation for this finding is that access to resources became more important during the second time period since stay-at-home orders and lack of vaccines created a sort of leveling effect across races and ethnicities during the first year of the pandemic.

In this study, provision of EMS for cardiac emergencies was lower among females, compared to males, which is consistent with findings from previously published literature (Jarman et al., 2019). Gender differences in provision of EMS for cardiac emergencies may be attributed to delayed recognition of the emergency signs and symptoms experienced by women, compared to men (Jerath et al., 2011). Women who experience cardiac emergencies often present signs and symptoms, including weakness and fatigue, that may be confused with other non-life-threatening health concerns, and may delay the activation of the EMS system (Jerath et al., 2011). Although the focus of this study is on provision of EMS for cardiac emergencies by emergency medical technicians and paramedics, previous literature also suggests that women are less likely to receive bystander cardiopulmonary resuscitation (B-CPR) in public locations, compared to males (Blewer et al., 2018). According to a national study, women are less likely to receive B-CPR because bystanders are concerned about inappropriate touching that violates modesty or social norms, perception that women are weak, frail, and prone to injury and misperceptions or under recognition about women in acute medical distress (Perman et al., 2019).

This study also found that provision of EMS for cardiac emergencies was greater with increasing age, except among the oldest old or persons aged 80 years and older. Increasing age is a known risk factor for cardiovascular diseases (Rodgers et al., 2019). Using an intersectional approach, this study also suggests that cardiac emergencies occurred more often among younger

Hispanic and Black or African American older adults, compared to Whites and Asians in SF County (see Table 5). For example, the proportion of cardiac emergencies among older adults aged 50 to 69 years was 73.19% for Blacks or African Americans, 64.26% for Hispanics, 53.64% for Whites, and 34.75% for Asians in SF County (see Table 5). The proportion of cardiac emergencies among the oldest old, or adults aged 80 years and older, was 42.36% for Asians, 23.94% for Whites, 18.76% for Hispanics, and 8.49% for Black or African Americans in SF County (see Table 5). These findings align with the current literature that suggests disproportionate rates of cardiovascular disease among younger age groups of Hispanic and African American or Blacks, relative to Whites and Asians (Adam Leigh et al., 2016; Graham, 2015). During the COVID-19 pandemic, chronic conditions, including heart disease increased the risk of complications and death from the virus among Hispanic and African Americans or Blacks (Garcia et al., 2021). A combination of preexisting chronic conditions and the saturation of the U.S. healthcare system, which contributed to delayed access to health care services, resulted in a higher reliance on EMS services for underserved populations, including Hispanics (Garcia et al., 2021; Melgoza et al., 2023).

In this study, suspected drug use was also documented more often among Black or African American adults aged 50 years and older in SF County compared to all the other racial and ethnic groups. These findings align with data released by SF County, which found that overdose-related death rates by race and ethnicity were 387.1 per 100,000 for African American or Black persons, 113.7 per 100,000 for Hispanics, 81.4% per 100,000 for Whites, and 16.9% for Asians and Pacific Islanders (SF County, 2024). In 2021, overdose-related death rates increased substantially for African American or Blacks at 430.4 deaths per 100,000, compared to the previous year (SF County, 2024). Between 2020 and 2021, overdose death rates increased slightly for Whites, but

decreased for Hispanics, Asians, and Pacific Islanders (SF County, 2024). Although the proportions of suspected drug use in the EMS dataset match the trends from overdose-related deaths, future research should also assess how provider bias may impact the overreporting or underreporting of drug use in the prehospital setting. Future studies should continue to consider the impact of drug use on cardiac emergencies, especially considering the ongoing opioid epidemic in this country.

The findings from this study also suggest that provision of EMS was higher in most neighborhoods with higher SES, compared to the geographic area with the lowest SES in contiguous SF County. These findings are consistent with previous pre-pandemic literature that found lower provision of EMS in neighborhoods with lower tax-assessed property values, higher poverty, and lower SES, compared to neighborhoods with higher tax-assessed property values, lower poverty, and higher SES (Mitchell et al., 2009; Wells et al., 2016; Hsia et al., 2018; Lee et al., 2021). Specifically, this study found that Region 2, which consists of the Tenderloin, South of Market, Financial District and Chinatown neighborhoods, and has the lowest SES in contiguous SF County, was much less likely to have EMS provided for cardiac emergencies during the first two years of the COVID-19 pandemic, compared to Regions 3, 4, 5, 6, and 7. Region 3 had one of the highest provisions of EMS for cardiac emergencies, and this geographic area also had the highest percentages of Hispanics in SF County, particularly in the Mission District and Bernal Heights areas.

LIMITATIONS:

This study has several limitations that should be considered. The first limitation is that study findings may not be generalizable to other EMS systems outside of SF County, although the results provide evidence to suggest the importance of studying health disparities in the prehospital

setting. The second limitation is linked to the study time frame, February 1, 2020, to January 22, 2022, which may not be generalizable to the periods before and after the COVID-19 pandemic. The third limitation is that the study timeframe begins on February 1, 2020, not January 1, 2020, because the SF Department of EMS transitioned to a different analytic service in late 2019. The new analytic service did not begin to reliably populate data until February 1, 2020. The fourth limitation is that the deidentified data shared by SF EMS makes it impossible to know if a patient was provided out-of-hospital emergency services more than once during the study period. The fifth limitation is that the EMS datasets have prepopulated data fields, which are not inclusive of certain populations. For example, the only available categories for gender are female and male, while racial and ethnic categories are limited to Hispanic, Black or African American, White, Asian, Native Hawaiian or Pacific Islander, and American Indian or Alaska Native. These categories prevent further disaggregation of the data, which leads to erasure of certain populations from EMS research. The sixth limitation is that although EMS providers complete and submit the ePCRs, the data included in each report is a combination of patient self-report and provider report. Even with these limitations, data from ePCRs is the best source of data currently available in the prehospital setting. The seventh and final limitation is that SF EMS data only contained incident ZCTA as the geographic variable, not addresses, latitude or longitude of the emergency. As a result, the analyses were conducted using ZCTA-level five-year estimates from ACS, although robustness checks were also conducted using PUMA-level one-year ACS estimates.

CONCLUSION:

This study advances our understanding of provision of EMS for cardiac emergencies in the prehospital setting after considering the interplay of both patient and neighborhood level factors. Specifically, the findings from this study suggest that provision of EMS for cardiac emergencies

was higher for Hispanics, compared to Whites aged 50 years and older during the COVID-19 pandemic. Neighborhoods with higher SES were also more likely to receive EMS for cardiac emergencies, compared to neighborhoods with the lowest SES in contiguous SF County. Future studies should assess the impact of Hispanic ethnic composition on provision of EMS in counties with a larger percentage of Hispanics overall.

CHAPTER 6:

STUDY #3: PROVISION OF EMERGENCY MEDICAL SERVICES FOR 9-1-1 PSYCHIATRIC INCIDENTS AMONG ADULTS AGED 50 YEARS AND OLDER BY PATIENT SOCIODEMOGRAPHIC CHARACTERISTICS AND NEIGHBORHOOD-LEVEL HISPANIC ETHNIC COMPOSITION, EVICTION NOTICES, AND HOMELESSNESS

INTRODUCTION: In the United States (U.S.), one in five adults aged 50 years and older had a mental illness in 2021 (SAMHSA, 2023). Of these, only half were provided mental health services, including inpatient or outpatient treatment, counseling, and prescription medication (SAMHSA, 2023). Provision of mental health services was even lower for racial and ethnic minorities (Ndugga et al., 2024). In 2022, only 38% of Black or African Americans, 40% of Hispanics, and 36% of Asians with a mental illness received mental health services, compared to 56% of Whites (Ndugga et al., 2024). These estimates suggest the presence of racial and ethnic disparities in the provision of mental health services among people who have a mental illness in the U.S. (Ndugga et al., 2024). Studies also suggest that the coronavirus (COVID-19) pandemic, and the policies enacted to prevent the spread of the virus contributed to the exacerbation of mental illness by decreasing social interactions, increasing social isolation and loneliness, and creating more barriers to accessing and utilizing mental health services (Koma et al., 2020). Among adults aged 50 years and older who responded to the 2021 National Survey on Drug Use and Health (NSDUH), 32.1% reported delays or cancellations in appointments, 14% reported delays in getting prescriptions, and

7.5% reported inability to access mental health care resulting in moderate to severe impacts on their health (SAMHSA, 2023). The combination of increased mental illness and decrease in access to mental health services may have resulted in an overreliance on the prehospital system by people experiencing a mental or psychiatric emergency (Rivard et al., 2022).

In the U.S., psychiatric emergencies comprised 10% of all EMS 9-1-1 calls between 2012 and 2016, making this type of incident the most common reason why people access the prehospital system (Rivard et al., 2022). In another study, similar findings were reported with psychiatric emergencies comprising 7.4% of all 9-1-1 EMS calls among older adults (Duong et al., 2018). Among people who are provided EMS for psychiatric emergencies, males, people who use substances, and homeless or unhoused residents, are more likely to use the prehospital system, compared to females, people who do not use substances, and housed residents (Abramson et al., 2021; Rivard et al., 2022). A study reported that the rate of EMS provision was 1,155 calls per 1,000 homeless or unhoused residents, compared to 81 calls per 1,000 housed residents, indicating that provision of prehospital care was much higher among homeless, compared to unhoused adults (Abramson et al., 2021). In this study, the most common reason for EMS provision to homeless or unhoused residents was psychiatric emergencies (Abramson et al., 2021). Homeless or unhoused residents were also more likely to have lower acuity EMS calls, compared to housed residents (Abramson et al., 2021). A few studies have also assessed EMS psychiatric emergencies by neighborhood-level racial and ethnic composition, although recent literature on this topic is scarce.

Although there are a few studies that have assessed the links between psychiatric emergencies, and patient and neighborhood-level factors, few studies have assessed the interplay of these factors with a focus specifically on older adults. This study advances our understanding of provision of EMS for psychiatric emergencies in several ways. First, the focus of this study is

on the provision of EMS for psychiatric emergencies among adults aged 50 years and older, which is a largely understudied population, especially in the context of mental health crises that occur in the prehospital setting. Second, this studies also assesses the impacts of Hispanic ethnic composition on psychiatric emergencies in the prehospital setting. Most of the EMS literature that focuses on neighborhood-level Hispanic ethnic composition does so in the context of cardiac emergencies, particularly disparities in the administration of bystander cardiopulmonary resuscitation, not psychiatric emergencies (Blewer et al., 2020; Moon et al., 2014). Third, this study also assesses psychiatric emergencies in the prehospital setting, while accounting for neighborhood-level eviction notices and homelessness. Although several studies have assessed patient-level homelessness, few studies have assessed evictions and homeless at the neighborhood level, especially in the context of EMS provision.

AIMS:

Aim #1: Determine to what extent psychiatric emergencies vary by patient-level factors, including race, ethnicity, gender, age, and suspected alcohol or drug use, among adults aged 50 years and older in San Francisco, California from February 1, 2020, to January 31, 2022.

Hypothesis #1: Psychiatric emergency calls are higher among Hispanics, females, and younger age groups (50 to 59 years), compared to Whites, males, and older age groups (60 to 69 years, 70 to 79 years, and 80+ years).

Hypothesis #2: Psychiatric emergency calls are higher among people with suspected alcohol or drug use, compared to people with no suspected alcohol or drug use.

Aim #2: Determine to what extent provision of EMS for psychiatric emergencies varies by neighborhood-level composition including, Hispanic ethnic composition, percentage of people living below the federal poverty level (FPL), homeless count, number of eviction notices served,

percentage of people enrolled in Medicaid, and COVID-19 case rates, during the time period between February 1, 2020, and January 31, 2022.

Hypothesis #1: Neighborhoods with a higher Hispanic ethnic composition have a higher provision of EMS for psychiatric emergencies, compared to neighborhoods with a lower Hispanic ethnic composition.

Hypothesis #2: Neighborhoods with a higher percentage of people living below the FPL or low SES areas, have higher provision of EMS for psychiatric emergencies, compared to people with a lower percentage of people living below the FPL or high SES areas.

Hypothesis #3: Neighborhoods with a higher homeless count have higher provision of EMS for psychiatric emergencies, compared to neighborhoods with a lower homeless count.

Hypothesis #4: Neighborhoods with a higher number of eviction notices have a higher provision of EMS for psychiatric emergencies, compared to neighborhoods with a lower number of eviction notices.

Aim 3: Determine to what extent time impacts the provision of EMS for psychiatric emergencies during the COVID-19 pandemic.

Hypothesis #1: The provision of psychiatric emergencies declined during the first three months of the COVID-19 pandemic as a result of the public health emergency declaration, quarantine guidelines, fear of infection and death, and lower access and use of health care services.

Hypothesis #2: The provision of psychiatric emergencies is higher during the first year, February 1, 2020 to January 31, 2021, compared to the second year, February 1, 2021 to January 31, 2022, of the COVID-19 pandemic.

METHODS;

San Francisco Emergency Medical Services Dataset

This study uses data from the San Francisco Department of Emergency Management (SF DEM, 2024). The SF DEM dataset consists of electronic patient care reports (ePCRs) that were submitted by EMS providers between January 1, 2020, and January 31, 2022. Although the dataset begins in January 1, 2020, the timeframe for this study begin on February 1, 2020, because this is the month when data began to reliably populate in the SF EMS database after the county transitioned to a different analytic service at the end of 2019. The SF DEM dataset includes all 9-1-1 calls with a patient encounter, which is defined as an emergency response where an EMS provider-patient interaction occurs. A patient encounter is different from an EMS response, which may or may not include an EMS provider-patient interaction. EMS responses include dispositions, such as no patient found at the scene, cancelled calls, and interfacility transports. The distinction between an EMS patient encounter and an EMS response is important since the latter is an operational event rather than a clinical one. Interfacility transports, which are 9-1-1 calls where a patient is transported from one healthcare facility to another are excluded from the SF EMS dataset since these types of responses are typically initiated by healthcare providers, not patients. Interfacility transports are not relevant because the current study focuses on provision of EMS for psychiatric emergencies in the prehospital setting. The SF DEM dataset includes ePCRs submitted by three approved 9-1-1 provider agencies that serve SF County, including the SF Fire Department (SFFD), King American Ambulance Company, and American Medical Response (AMR) (SF DEM, 2024). The three other ambulance provider agencies in SF include NORCAL Ambulance, ProTransport-1, and Royal Ambulance, although these agencies focus on interfacility transports, which are not relevant for this study (SF DEM, 2024).

2022 American Community Survey 5-Year Estimates

Since 1790, the U.S. has administered a decennial national census for the purposes of providing a population count that informs congressional representation and to inform public measures that better address the needs of specific communities (U.S. Census Bureau, 2017). Since the 20th century, the national census divides questions into a short and long form (U.S. Census Bureau, 2017). The short form collects data on socio-demographic characteristics, while the long form contains questions from the short form, plus additional questions about demographic, social, economic, and housing characteristics (U.S. Census Bureau, 2017). Starting in 2000, the long form questions evolved to become the American Community Survey (ACS) (U.S. Census Bureau, 2017). The full administration of the ACS began in 2005 (U.S. Census Bureau, 2017).

The ACS is a nationwide survey that collects annual demographic, social, economic, and housing data on a sample of 3.5 million households in the U.S. (U.S. Census Bureau, 2022). The ACS is completed via mail, online, telephone, or during an in-person visit interview using a three-phase sequential approach (U.S. Census Bureau, 2022). The first phase gives respondents the option of completing the ACS via mail or online (U.S. Census Bureau, 2022). The second phase uses telephone calls with a computer-assisted telephone interview (CATI) system to reach nonrespondents of the first phase who have both a telephone number and a mailable address (U.S. Census Bureau, 2022). The third phase uses field representatives from the U.S. Census Bureau to conduct in-person interviews using a computer-assisted personal interview (CAPI) software (U.S. Census Bureau, 2022). The third phase is used for selected households where there are undeliverable addresses and nonresponses to the two previous phases (U.S. Census Bureau, 2022).

The ACS provides 1-year and 5-year level estimates compared to the 10-year estimates from the national census (U.S. Census Bureau, 2022). The ACS data is available across multiple levels of geography, including but not limited to, block groups, ZIP code tabulation areas

(ZCTAs), census tracts, public use microdata areas (PUMAs), counties, states, and the country (U.S. Census Bureau, 2022). The ACS 1-year level estimates are available for geographic areas with a population greater than or equal to 65,000 people, while the ACS 5-year level estimates are available for smaller geographies with a population of at least 20,000 people (U.S. Census Bureau, 2022). The ACS 5-year level estimates include data collected over a period of multiple years, which provide increased statistical reliability, especially for data collected in smaller geographies, such as ZCTAs (U.S. Census Bureau, 2023). ACS estimates are based on data pooled over the 1-year or 5-year reference period, not a fixed date (Raglin, 2022). For example, the 2022 ACS 5-year estimates are based on data collected from January 1, 2018, to December 31, 2022. This study uses the 2022 ACS 5-year estimates for ZCTAs in SF County, California.

San Francisco Public Health Department COVID-19 Dataset

This study uses COVID-19 data downloaded in February 2023 from the San Francisco Open Data Portal. Data was extracted from the publicly available dataset titled, "Archived: COVID-19 Cases by Geography Over Time," which was uploaded by the Department of Public Health, Population Health Division. This dataset includes COVID-19 cases, including the rate of cumulative cases per 10,000 residents across SF County's ZCTAs during specific time periods.

San Francisco Eviction Notice Data

This study uses eviction notices data that were downloaded in March 2024 from the San Francisco Open Data Portal. Data were extracted from the publicly available dataset titled, "Eviction Notices," which is submitted by the SF Rent Arbitration Board. This dataset provides data on eviction notices filed with the SF Rent Board per San Francisco's Administrative Code 37.9. During the COVID-19 pandemic, there was a moratorium on evictions, which prohibited landlords from removing tenants from their rented properties. Although landlords were prohibited

from removing tenants, evictions notices during the COVID-19 pandemic were still filed and served.

Homeless Count Data from the City and County of San Francisco Public Records

This study uses data on neighborhood-level homelessness from the City and County of San Francisco Public Records Office. The initial data request was submitted on March 7, 2024, and the data was obtained on March 13, 2024. The dataset contains the weighted sum of persons who are unhoused or homeless per ZIP code in SF County during the 2022 Point-in-Time (PIT) Count, which occurred on February 23, 2022. The PIT uses enumerators to count the number of tents and vehicles that are occupied on the given night when the PIT is conducted. There are instances when finding the exact number of people in a tent or vehicle is not possible. To account for this issue, SF County shared the weighted unhoused or homeless count per ZIP code. The weighted homeless count uses supplemental data and additional confirmed sightings on the night of the PIT to provide more accurate estimates. PITs are typically conducted every two years, although a full count was cancelled in 2021 due to the ongoing COVID-19 pandemic. Prior to the 2022 PIT, the most recent count was conducted in 2019, or during the pre-pandemic period.

Selection and Operationalization of Variables

Table 8 provides a detailed description of the operationalized variables across the five datasets. The SF DEM provides data on patient sociodemographic characteristics, including race and ethnicity, gender, age, and health behaviors, such as alcohol or drug use. The ACS 5-year estimates provide data on aggregated incident ZCTAs organized by the percentage of people living below the federal poverty level, Hispanic ethnic composition, and Medicaid enrollment. The SF Public Health Department provides data on COVID-19 case rates, the SF Rent Arbitration Board

shared data on filed eviction notices, and the City and County of San Francisco Public Records provides data on the homeless count per ZIP code.

Table 8: Operationalization of variables

Psychiatric-related 9-1-1 calls	A psychiatric-related 9-1-1 call is a type of emergency where the primary or secondary provider impression indicates a mental health emergency. The primary and secondary provider impressions are based on the International Classification of Diseases-10-Clinical Modification (ICD-10-CM) codes. EMS providers are required to record the primary and secondary provider impressions using specific ICD-10 codes after responding to a 9-1-1 call.
Patient race and ethnicity	Patient race and ethnicity is operationalized as White, Black or African American, Hispanic, Asian, and Other. The Other category is an aggregate of Native Hawaiian and Pacific Islanders (NHOPI), and American Indian and Alaska Natives (AIAN), two populations that have small sample sizes. Race and ethnicity are defined using the 2022 definition released by the U.S. Office of Management and Budget.
Patient gender	Patient gender is operationalized as male or female, which are the only categories available in the EMS ePCRs.
Patient age	Patient age is operationalized as persons aged 50 to 59, 60 to 69, 70 to 79 or 80+ years.
Alcohol or Drug Use	Alcohol or drug use is operationalized as having a primary or secondary provider impression indicative of substance use. The primary and secondary provider impressions are recorded using ICD-10-codes.
Aggregated incident ZCTAs	SF County is composed of 27 ZCTAs. In this study, incident ZCTAs are aggregated into larger geographic units based on geographic proximity and similar socioeconomic status (SES). SES is operationalized as the percentage of residents living below the federal poverty level. There are 7 larger geographic units composed of multiple ZCTAs, including 1) Treasure Island, Tenderloin, South of Market, Financial District, and Chinatown; 2) Mission District, Bernal Heights, Bayview, Hunters, Ingleside, and Excelsior; 3) Visitacion Valley, Lake Merced, and Lakeside; 4) Polk, Russian Hill, Nob Hill, Western Addition, Japantown, and Embarcadero; 5) Rincon Hill, Potrero Hill, SOMA, and Mission Bay; 6) Sunset, Parkside, Forest Hill, Haight-Ashbury, Inner Richmond, and Outer Richmond; 7) Castro, Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, Marina, Cow Hollow and Presidio. Region 1 has high percentages of people living below the federal poverty level (16.5% to 40.10%). Regions 2 to 4 have medium percentages of people living below the federal poverty level (10.00% to 16.49%). Regions 5 to 7 have low percentages of people living below the federal poverty level (0.00% to 9.99%).
Hispanic ethnic composition	Hispanic ethnic composition is operationalized as a categorical variable that represents the percentage of residents who identify as Hispanic by ZCTAs. The categories include 0% to 9%, 10% to 19%, 20% to 29%, and 30% or more.

Medicaid enrollment	Medicaid enrollment is operationalized as a continuous variable that represents the percentage of residents enrolled in Medicaid by ZCTA. Medi-Cal is the state-specific name for Medicaid in the State of California.
Eviction notices	The eviction notice variable consists of all eviction notices filed with the San Francisco Rent Board by ZIP code and is operationalized as a categorical variable. For the full study period, February 1, 2020, and January 31, 2022, the eviction notices variable is operationalized as less than 80, 80 to 160, and 160 to 240.
COVID-19 case rates	The COVID-19 case rate variable is operationalized as a categorical variable. The cumulative COVID-19 case rate variable is reported by the SF Department of Public Health at the ZIP code level. For the full study period, February 1, 2020, and January 31, 2022, the cumulative COVID-19 case rate variable was operationalized as less than 1,000, 1,000 to 1,499, and 1,500 or greater.
Homeless Count	The homeless count variable is operationalized as a categorical variable divided into quintiles. The variable is coded 0 to 4, with 0 indicating lowest homeless count and 4 indicating highest homeless count.

Coding of Variables

A total of 11 variables are included in this study, including 10 independent variables and 1 dependent variable. The dependent variable, psychiatric-related emergencies, was coded as 0 for absence and 1 for presence of this type of incident. The patient race and ethnicity variable was coded using the definition from the U.S. Office of Management and Budget (OMB). Patient race and ethnicity was coded 1 for White, 2 for Black or African American, 3 for Asian, 4 for Other, and 5 for Hispanic. The Other category was an aggregate of NHOPI and AIAN persons, two populations that have small sample sizes Patient gender was coded as 0 for female and 1 for male. Patient age was coded as a categorical variable with the following categories: 50 to 59 years, 60 to 69 years, 70 to 79 years, and 80 years or older. Alcohol or drug use was coded as 0 for false and 1 for true based on the provider primary and secondary impressions. Hispanic ethnic composition was operationalized as a categorical variable and coded in the following way: 1 for 0% to 9%, 2 for 10% to 19%, 3 for 20% to 29%, and 4 for 30% or more. Medicaid enrollment by ZCTA was operationalized as a continuous variable that represents the percentage of residents enrolled in this

program. The eviction notices variable was included as a categorical variable coded from 1 to 3, where 1 represents less than 80 eviction notices, 2 was 80 to 159 eviction notices and 3 was 160 or more eviction notices. The cumulative COVID-19 case rate variable was coded as 1 to 3 in the following order: less than 1000, 1000 to 1499 and 1500 or more. The homeless count variable was operationalized into quartiles, where the first quartile represents ZIP codes with the lowest homeless count and the fourth quartile represents ZIP codes with the highest homeless count.

The 27 ZCTAs in SF County were aggregated using two measures, geographic proximity and percentage of people living below the federal poverty level. The aggregated incident ZCTA variable was coded from 1 to 7. Treasure Island, Tenderloin, South of Market, Financial District, and Chinatown were coded 1, Mission District, Bernal Heights, Bayview, Hunters, Ingleside, and Excelsior were coded 2, Visitacion Valley, Lake Merced, and Lakeside were coded 3, Polk, Russian Hill, Nob Hill, Western Addition, Japantown, and Embarcadero were coded 4, Rincon Hill, Potrero Hill, SOMA, and Mission Bay were coded 5, Sunset, Parkside, Forest Hill, Haight-Ashbury, Inner Richmond, and Outer Richmond were coded 6 and Castro, Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, Marina, Cow Hollow and Presidio were coded 7. The aggregated ZCTAs that were coded 1 have high percentages (16.5% to 40.10%) of people living below the federal poverty level and are in the northern part of SF County. The neighborhoods coded 3, 4, and 5 have medium levels (10.00% to 16.49%) of people living below the federal poverty level and are in the southern and northeastern areas of SF County. The neighborhoods coded 6, 7, and 8 have low levels (0.00% to 9.99%) of people living below the federal poverty level and are in the eastern, western, north, and central areas of SF County.

Data Analyses

Univariate and Bivariate Analysis

This study uses univariate analyses to assess the distribution of the independent and dependent variables. The independent variables include both patient-level sociodemographic characteristics and neighborhood-level composition. The patient sociodemographic characteristics include patient race and ethnicity, gender, age, and alcohol or drug use. The neighborhood-level factors include aggregated incident ZCTAs by geographic proximity and percentage of residents living below the FPL, Hispanic ethnic composition, Medicaid enrollment, eviction notices, COVID-19 case rate, and homeless count. The dependent variable is presence or absence of psychiatric emergencies in EMS provided to adults aged 50 years and older in SF County between February 1, 2020, and January 31, 2022. Bivariate analyses in this study assess the association between the independent variables and the dependent variable. The bivariate analyses used include cross tabulations, chi-squared tests, and t-tests. The results from the univariate and bivariate analyses inform the multivariate analyses.

Logistic Regression Multivariate Analysis

This study uses nested logistic regression models to assess the associations between the independent variables and the dependent variable, presence or absence of psychiatric emergencies. Models 1 to 4 test the association between patient sociodemographic characteristics and the presence or absence of psychiatric-related emergencies. The first model tests the association of patient race and ethnicity with presence or absence of psychiatric-related emergencies. The second model appends patient gender to the first model. The third model adds patient age to the second model. The fourth model appends suspected alcohol or drug use to the third model. Models 5 to 10 include neighborhood-level variables, including Hispanic ethnic composition, Medicaid enrollment, eviction notices, COVID-19 case rates, and homeless count, with one variable

included at a time in this specified order. Model 10 is the full model, which includes all the patient-level sociodemographic and neighborhood-level characteristics described in Table 8.

RESULTS:

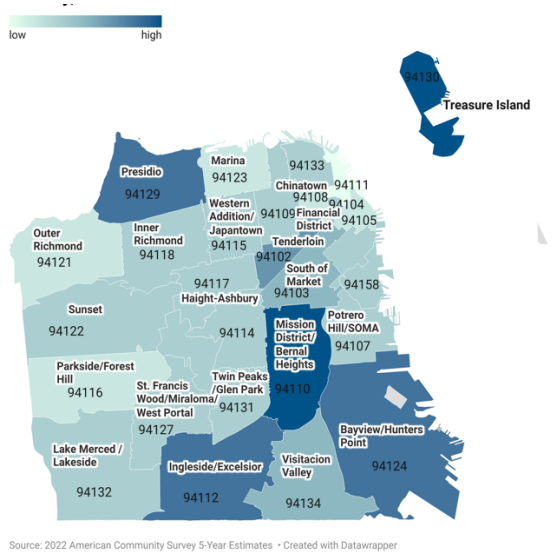
Geospatial Visualization

Maps 12, 13, 14, and 15 suggest racial and ethnic segregation by place of residence in SF County. The highest proportion of White residents reside in the northwest and central neighborhoods of SF County, while Hispanics, Black and African Americans, and Asians live along most of the perimeter, especially in the southern, western, and eastern areas. Specifically, the neighborhoods with the highest percentages of Whites are Presidio, Marina, and Height-Ashbury (see Map 15). The Mission District and Bernal Heights, Treasure Island, Presidio, Ingleside and Excelsior, and Bayview and Hunters Point neighborhoods have the highest percentage of Hispanics (see Map 12). Bayview and Hunters Point, Treasure Island, Tenderloin, and Western Addition and Japantown have the highest percentage of Black or African American residents (see Map 13). Asians constitute at least 45% of the population in 12 of the 27 ZIP codes in SF County, with the highest percentages located in the Visitacion Valley, Chinatown, and Parkside and Forest Hill neighborhoods (see Map 14).

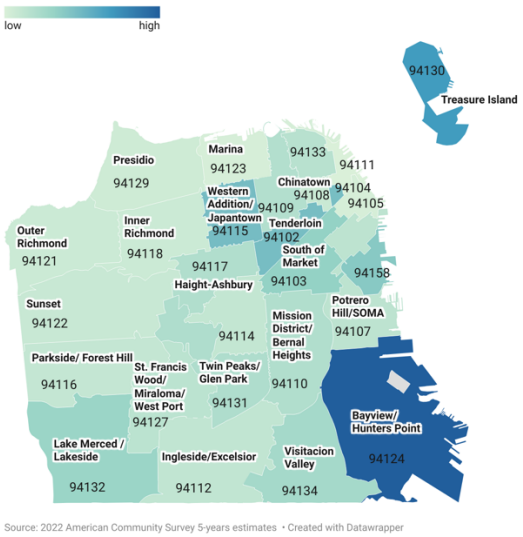
Maps 16, 17, 18, and 19 suggest that the highest number of persons who are homeless, eviction notices, drug or alcohol use, and psychiatric EMS calls are in four neighborhoods on the eastern side of SF County, including Tenderloin, South of Market, Polk and Russian Hill, and Mission District and Bernal Heights, which are also geographic areas with the highest percentage of Hispanic, Black or African American, and Asian residents (See Maps 12, 13, 14, and 15). Specifically, Hispanics, Black or African Americans, and Asian residents comprise more than half of the population in the Bayview and Hunters Point, Tenderloin, and South of Market

neighborhoods. For example, in the Bayview and Hunter Point neighborhood, only 17% of the population identifies as White, and 82% identifies as either Hispanic, Black or African American or Asian.

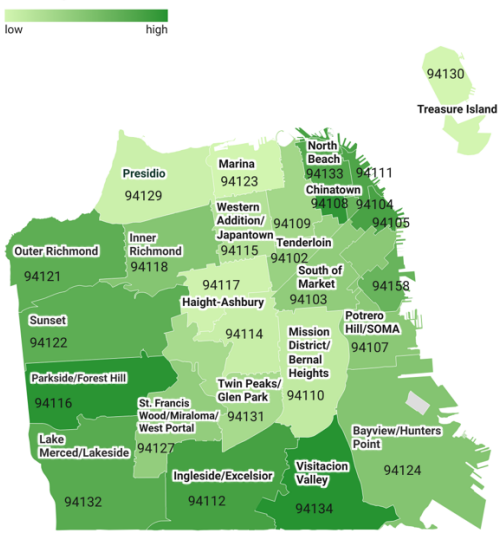
Map #12: Percentage of Hispanics in SF County, CA



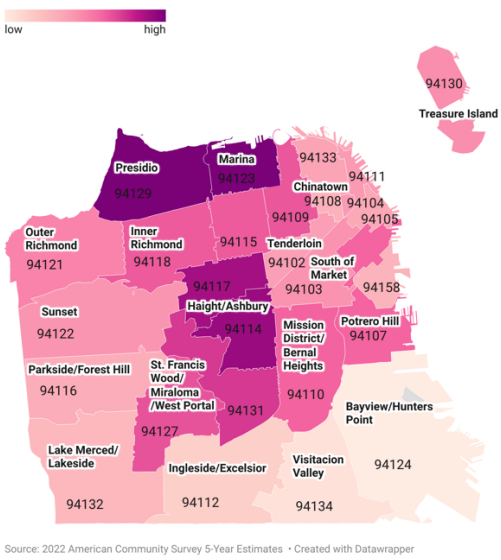
Map #13: Percentage of Black or African Americans in SF County, CA



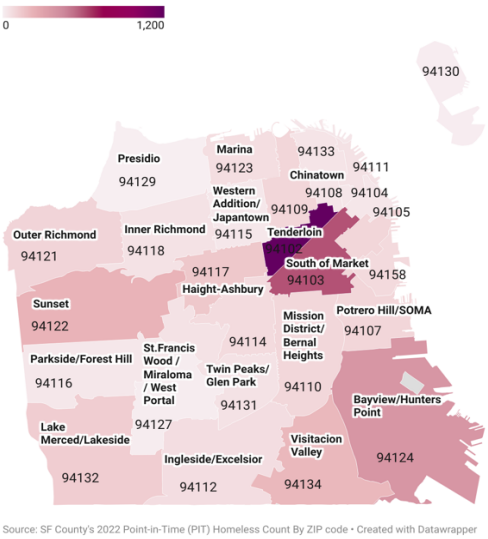
Map #14: Percentage of Asians in SF County, CA



Map #15: Percentage of Whites in SF County, CA

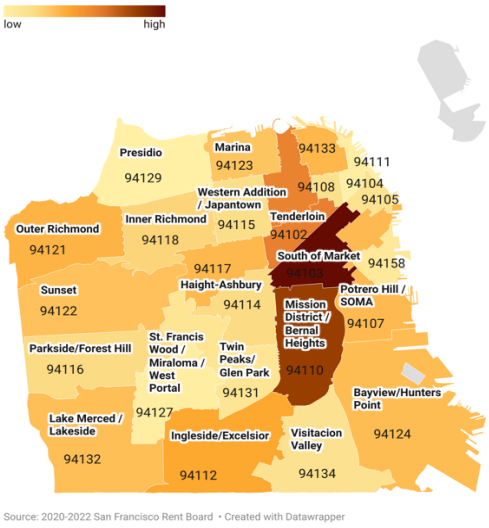


Map #16: Homeless count by ZIP code in SF County, CA



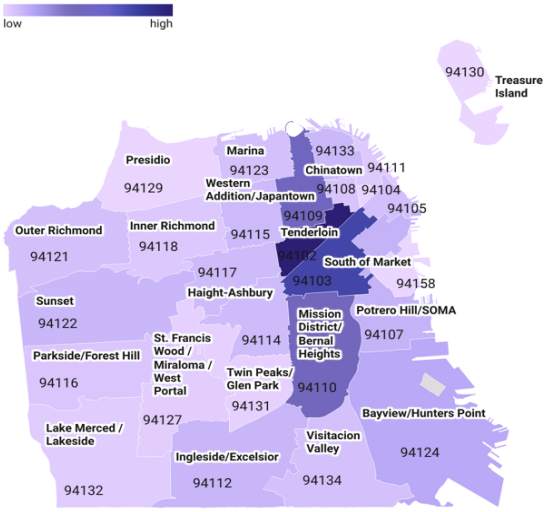
Source: SF County's 2022 Point-in-Time (PIT) Homeless Count By ZIP code • Created with Datawrapper

Map #17: Eviction notices served by ZIP code in SF County, CA



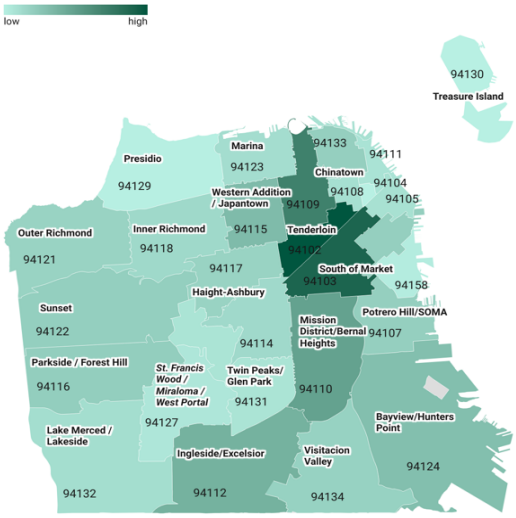
Source: 2020-2022 San Francisco Rent Board • Created with Datawrapper

Map #18: Suspected drug or alcohol by ZIP code in SF County, CA



Source: 2020-2022 San Francisco Department of Emergency Department • Created with Datawrapper

Map #19: Percentage of 9-1-1 psychiatric emergencies among adults



Map: 2020-2022 SF Department of Emergency Management • Created with Datawrapper

Descriptive Statistics

This study includes all 9-1-1 emergency calls with patient contact in SF County between February 1, 2020, and January 31, 2022. The analytic sample includes a total of 95,585 emergency

calls in SF County among adults aged 50 years and older during the two-year study period. Of the 95,585 emergency calls, 81,657 were non-psychiatric and 13,928 were psychiatric-related emergencies. This suggests that 14.57% of all EMS calls among persons aged 50 years and older in SF County were psychiatric- related between February 1, 2020, and January 31, 2022.

Figure 10 shows the total number of psychiatric-related calls by month among adults aged 50 years and older in SF County during the study timeframe. The decline of psychiatric calls is evident starting in March 2020, which corresponds to the timing of the U.S. President's COVID-19 emergency declaration, and the beginning of stay-at-home orders. Another decline in psychiatric-related emergency calls began in late December and early January, which corresponds to the period after the launch of the SF County Street Crises Response Team and the approval of the first COVID-19 vaccine for at-risk populations, including older adults. The SF County Street Crises Response Team is a program that was launched on November 30, 2020, as a collaboration between the San Francisco Department of Public Health, the San Francisco Fire Department, and the Department of Emergency Management to provide on-scene care and provide linkages to care for people experiencing psychiatric emergencies, especially persons who are unhoused or homeless (City & County of SF, 2024).

Figure 10: Number of psychiatric 9-1-1 EMS calls with patient contact among adults 50 years and older in SF County between February 1, 2020, and January 31, 2022

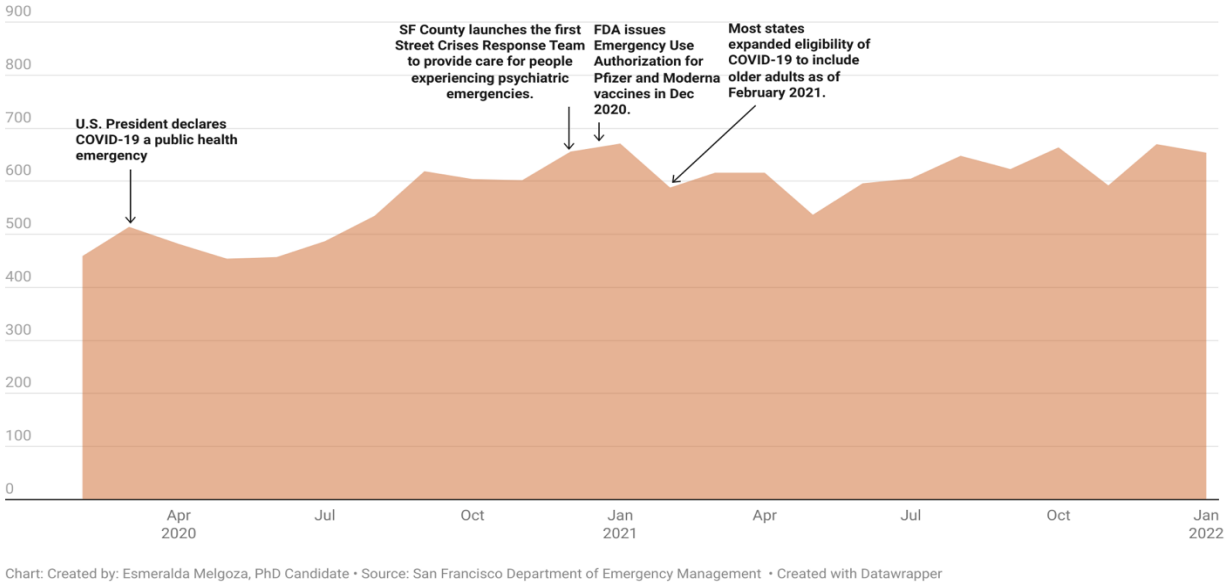


Table 9 shows the descriptive statistics for psychiatric and non-psychiatric EMS calls. The distributions of patient race, ethnicity, and gender are comparable for both psychiatric and non-psychiatric EMS calls. Blacks and Africans Americans are overrepresented in psychiatric EMS calls since they comprise 24.37% of these types of calls, but only 6.6% of the overall population in SF County (U.S. Census Bureau, 2022, 2023, 2024). In contrary, 15.93% of psychiatric EMS calls are reported among Asians, which is an underestimate since this racial group comprises 40.0% of the overall population in SF County (U.S. Census Bureau, 2022, 2023, 2024). Patients with psychiatric EMS calls also tend to be younger and are more likely to have suspected alcohol or drug use, compared to non-psychiatric EMS calls (see Table 9). The highest percentage of psychiatric EMS calls occurred in Region 1, which includes the Treasure Island, Tenderloin, South of Market, Financial District and Chinatown neighborhoods (see Table 9). Psychiatric EMS calls were also higher during the second year of the COVID-19 pandemic, compared to the first year (see Table 9).

Table 9: Descriptive statistics of 9-1-1 psychiatric EMS calls among adults aged 50 years and older in SF County, CA between February 1, 2020, and January 31, 2022 using primary and secondary provider impressions

	No Psychiatric-Related 9-1-1 Calls (N=81,657)		Psychiatric-Related 9-1-1 Calls (N=13,928)		Psychiatric and Non-Psychiatric Related 9-1-1 calls (N=95,585)	
	Number (#)	Percentage (%)	Number (#)	Percentage (%)	Number (#)	Percentage (%)
Race/Ethnicity						
White	36,350	44.52%	6,549	47.02%	42,899	44.88%
Black or African American	19,721	24.15%	3,392	24.35%	23,113	24.18%
Asian	15,380	18.83%	2,221	15.95%	17,601	18.41%
Other	1,912	2.34%	331	2.38%	2,243	2.35%
Hispanic	8,294	10.16%	1,435	10.30%	9,729	10.18%
Gender						
Female	33,675	41.24%	5,367	38.53%	39,042	40.85%
Male	47,982	58.76%	8,561	61.47%	56,543	59.15%
Age						
50-59	21,441	26.26%	5,449	39.12%	26,890	28.13%
60-69	23,231	28.45%	3,936	28.26%	27,167	28.42%
70-79	16,531	20.24%	2,065	14.83%	18,596	19.45%
80+	20,454	25.05%	2,478	17.79%	22,932	23.99%
Alcohol/Drug Use						
True	5,761	7.06%	1,558	11.19%	7,319	7.66%
False	75,896	92.94%	12,370	88.81%	88,266	92.34%
Aggregated ZIP codes						
(1) Treasure Island, Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)	25,242	30.91%	4,667	33.51%	29,909	31.29%
(2) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)	15,179	18.59%	2,496	17.92%	17,675	18.49%
(3) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)	5,086	6.23%	674	4.84	5,759	6.03%
(4) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)	14,014	17.16%	2,358	16.93%	16,372	17.13%
(5) Rincon Hill, Potrero Hill/SOMA, Mission Bay	3,723	4.56%	748	5.37%	4,471	4.68%
(6) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)	12,752	15.62%	2,023	14.52%	14,775	15.46%
(7) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)	5,662	6.93%	962	6.91%	6,624	6.93%
Percentage of Hispanics at the neighborhood level						
0 to 9%	16,185	19.82%	2,926	21.01%	19,117	19.99%
10 to 19%	38,381	47.00%	6,358	45.65%	44,739	46.81%
20 to 29%	21,295	26.08%	3,587	25.75%	24,882	26.03%
30+%	5,796	7.10%	1,057	7.59%	6,853	7.17%
Percentage of Medicaid enrollees at the neighborhood level	22.44 (Mean) 10.09 (SD)		22.60 (Mean) 10.13 (SD)		22.46 (Mean) 10.10 (SD)	
Number of Eviction Notices reported per ZIP code (Between 02/01/20 and 1/31/22)						
Less than 80 eviction notices	36,748	45.00%	5,856	42.04%	42,604	44.57%
80-160 eviction notices	29,830	36.53%	5,201	37.34%	35,031	36.65%
160-240 eviction notices	15,079	18.47%	2,871	20.61%	17,950	18.78%
Cumulative COVID-19 Case Rates						
Case Rate Less than 1000	20,874	25.56%	3,256	23.38%	24,130	25.24%
Case Rate Between 1000 and 1499	27,333	33.47%	4,872	34.98%	32,205	33.69%
Case Rate 1500+	33,450	40.96%	5,800	41.64%	39,250	41.06%
SF Homeless Count per ZIP code						
1st Quintile (Lowest Homeless Count)	15,165	18.57%	2,517	18.07%	17,682	18.50%
2nd Quintile	12,443	15.24%	1,993	14.31%	14,436	15.10%
3rd Quintile	20,688	25.34%	3,595	25.81%	24,283	25.40%
4th Quintile	12,342	15.11%	1,907	13.69%	14,249	14.91%
5th Quintile (Highest Homeless Count)	21,019	25.74%	3,916	28.12%	24,935	26.09%
Years						
Feb 2020 to Jan 2021	37,041	45.36%	6,531	46.89%	43,572	45.58%
Feb 2021 to Jan 2022	44,616	54.64%	7,397	53.11%	52,013	54.42%

Bivariate Analysis

Bivariate analyses were conducted using chi-squared tests and t-tests. Table 10 shows the bivariate association between the patient and neighborhood-level independent variables and the dependent variable. All the bivariate analyses were statistically significant, except for neighborhood-level percentage of Medicaid enrollees.

Table 10: Bivariate associations between patient sociodemographic and neighborhood-level characteristics and provision of psychiatric or non-psychiatric emergency care (N = 95,585)

	Non-psychiatric related		Psychiatric related		Significance
	Number	Percent	Number	Percent	
Overall	81,657	85.43%	13,928	14.57%	
Patient sociodemographic characteristics					
Race Ethnicity					
White	36,350	44.52%	6,549	47.02%	p < .001
Black or African American	19,721	24.15%	3,392	24.35%	
Asian	15,380	18.83%	2,221	15.95%	
Other	1,912	2.34%	331	2.38%	
Hispanic	8,294	10.16%	1,435	10.30%	
Gender					
Female	33,675	41.24%	5,367	38.53%	p < .001
Male	47,982	58.76%	8,561	61.47%	
Age					
50-59	21,441	26.26%	5,449	39.12%	p< .001
60-69	23,231	28.45%	3,936	28.26%	
70-79	16,531	20.24%	2,065	14.83%	
80+	20,454	25.05%	2,478	17.79%	
Suspected Alcohol or Drug Use					
True	5,761	7.06%	1,558	11.19%	p < .001
False	75,896	92.94%	12,370	88.81%	
Neighborhood-level characteristics					
Aggregated ZCTAs					
Treasure Island, Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)	25,242	30.91%	4,667	33.51%	p < .001
Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)	15,179	18.59%	2,496	17.92%	
Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)	5,086	6.23%	674	4.84	
Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)	14,014	17.16%	2,358	16.93%	
Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)	3,723	4.56%	748	5.37%	
Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)	12,752	15.62%	2,023	14.52%	
Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)	5,662	6.93%	962	6.91%	
Percentage of Hispanics at the neighborhood level					
0 to 9%	16,185	19.82%	2,926	21.01%	p = .001
10 to 19%	38,381	47.00%	6,358	45.65%	
20 to 29%	21,295	26.08%	3,587	25.75%	
30%	5,796	7.10%	1,057	7.59%	
Percentage of Medicaid enrollees at the neighborhood level	81,657	Mean: 22.44 SD: 10.09	13,928	Mean: 22.60 SD: 10.13	p = .0818
Number of eviction notices reported by ZIP code (Between 02/01/20 and 01/31/22)					
Less than 80 eviction notices	36,748	45.00%	5,856	42.04%	p < .001
80 to 160 eviction notices	29,830	36.53%	5,201	37.34%	
160 to 240 eviction notices	15,079	18.47%	2,871	20.61%	
Cumulative COVID-19 case rates					
Case rate less than 1000	20,874	25.56%	3,256	23.38%	p < .001
Case rate between 1000 and 1499	27,333	33.47%	4,872	34.98%	
Case rate 1500+	33,450	40.96%	5,800	41.64%	
SF Homeless County per ZIP code					
1st Quintile (Lowest Homeless Count)	15,165	18.57%	2,517	18.07%	p < .001
2nd Quintile	12,443	15.24%	1,993	14.31%	
3rd Quintile	20,688	25.34%	3,595	25.81%	
4th Quintile	12,342	15.11%	1,907	13.69%	
5th Quintile (Highest Homeless Count)	21,019	25.74%	3,916	28.12%	
Years					
Feb 2020 to Jan 2021	37,041	45.36%	6,531	46.89%	p = .001
Feb 2021 to Jan 2022	44,616	54.64%	7,397	53.11%	

Multivariate Analysis

Table 11 suggests that the provision of EMS for psychiatric emergencies during the first two years of the COVID-19 pandemic was higher among adults aged 50 years and older who were White (Model 11, OR = 1.12, 95% CI: [1.05, 1.20] or who had suspected alcohol or drug use (Model 11, OR = 1.34, 95% CI: [1.26, 1.42]), compared to Hispanics or patients with no suspected alcohol or drug use. Increasing patient age was associated with a decrease in the provision of EMS for psychiatric emergencies, although non-statistically significant differences were found by patient gender (see Table 11). Provision of EMS for psychiatric emergencies was also higher in neighborhoods with the highest numbers of eviction notices (Model 11, OR = 1.78, 95% CI: [1.20, 2.64]), but lowest in neighborhoods with the highest number of homeless or unhoused persons (Model 11, OR = 0.56, 95% CI: [0.37, 0.84]), compared to neighborhoods with the lowest number of eviction notices and homeless or unhoused persons. Neighborhoods with a Hispanic ethnic composition between 10 and 19% were less likely to be provided EMS for psychiatric emergencies (Model 11, OR = 0.85, 95% CI: [0.79, 0.91]), compared to neighborhoods with 0 to 9% Hispanic residents, although non-statistically significant differences were found for neighborhoods with 20 to 29% and 30% or more Hispanic residents. Region 2 (Model 11, OR = 0.56, 95% CI: [0.35, 0.90] had the lowest provision of EMS for psychiatric emergencies, compared to Region 1. Region 2 includes neighborhoods with the largest percentages of Hispanic residents within SF County, including Mission District, Bernal Heights, Bayview, Ingleside, and Excelsior, and this region has has higher SES, compared to Region 1. Provision of EMS for psychiatric emergencies was also lower during the second year, compared to the first year of the COVID-19 pandemic (Model 11, OR = 0.95, 95% CI: [0.91, 0.98]).

Sensitivity Analysis

Sensitivity analyses were conducted using different variable specifications and across different levels of geography. The main results of this paper use the 2022 ACS 5-year estimates at the ZCTA level. Appendix XIII shows the results from the logistic regression models using the 2022 ACS 1-year level estimates at the PUMA level, which is a larger geographic unit of analyses that has annual data available. The full model in Appendix XIII shows similar results as the full model in Table 10. Using the 1-year PUMA-level estimates, Whites and persons with suspected alcohol or drug use are provided EMS for psychiatric emergencies more often, compared to Hispanics and persons without suspected alcohol or drug use (See Appendix XIII). Increasing age, and neighborhoods with a higher percentage of Medicaid enrollees, a Hispanic ethnic composition between 10% to 19%, and homeless count in the 5th quintile (highest homeless count) have lower provision of EMS for psychiatric emergencies, compared to younger persons ages 50 to 59 years, and neighborhoods with a lower percentage of Medicaid enrollees, a Hispanic ethnic composition between 0 and 9%, and homeless count in the 1st quintile (lowest homeless count). The logistic regression results at the PUMA level do differ from the ZCTA-level results in several ways. First, ZCTA-level results suggest lower provision of EMS during the second year of the COVID-19 pandemic, compared to the first year, while the PUMA results show the opposite, although the magnitude of the estimates is quite small. Second, more PUMA-level estimates are statistically significant, compared to ZCTA-level estimates, and these findings suggest lower provision of EMS for psychiatric calls in areas with a lower percentage of residents living below the FPL (high SES), compared to the PUMA with the highest percentage of residents living below the FPL (lowest SES).

<u>Table 11:</u> Logistic regression models of 9-1-1 psychiatric EMS calls with patient contact from February 1, 2020, to January 31, 2022, using provider primary and secondary impressions (N = 95,585)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Race/Ethnicity (Ref = Hispanic)											
White	1.04	1.04	1.12***	1.13***	1.12***	1.12***	1.12***	1.12***	1.12***	1.12***	1.12***
Black or African American	0.99	0.99	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99
Asian	0.83***	0.84***	1.03	1.06	1.06	1.05	1.06	1.06	1.06	1.06	1.06
Other	1.00	1.00	1.02	1.05	1.05	1.05	1.06	1.06	1.05	1.06	1.06
Gender (Ref = Male)											
Female		0.90***	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Age, years (Ref = 50-59)											
60-69			0.66***	0.67***	0.67***	0.67***	0.67***	0.67***	0.67***	0.67***	0.67***
70-79			0.48***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***
80+			0.46***	0.48***	0.48***	0.48***	0.48***	0.49***	0.49***	0.49***	0.49***
Alcohol/Drug Use (Ref = Alcohol or Drug Use (FALSE)											
Alcohol or Drug Use (TRUE)				1.35***	1.35***	1.35***	1.35***	1.35***	1.35***	1.34***	1.34***
Aggregated ZIP codes (Reference = (1) Treasure Island, Tenderloin, South of Market, Financial District and Chinatown) (High % of poverty)											
(2) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)					1.00	1.03	0.98	1.06	1.05	1.05	0.56*
(3) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)					0.86**	0.86**	0.84**	0.99	0.97	0.97	0.87
(4) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)					1.02	1.01	0.97	1.11	1.08	1.08	1.05
(5) Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)					1.10*	1.06	1.00	1.21*	1.18	1.18	1.12
(6) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)					1.01	0.94	0.88*	1.05	1.07	1.07	0.98
(7) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)					1.04	0.97	0.88	1.10	1.10	1.10	0.98
Percentage of Hispanics at the neighborhood level (Ref = 0% to 9%)											
10 to 19%						0.88***	0.88***	0.86***	0.86***	0.86***	0.85***
20 to 29%						0.84***	0.88**	0.86**	0.84	0.84	1.34
30+%						0.88*	0.88*	0.82**	0.84	0.84	0.92
Percentage of Medicaid enrollees at the neighborhood level							0.99	1.00	1.00	1.00	0.99
Eviction Notices (Reported by ZIP codes) (Ref = Less than 80 Eviction Notices)											
80-159 Eviction Notices								1.07*	1.06*	1.06*	1.06
160-240 Eviction Notices								1.16*	1.11	1.11	1.78**
Cumulative COVID-19 Case Rates (Reported 01/31/22) (Ref = Case Rate of Less Than 1000 COVID-19 Cases)											
Case Rate Between 1000 and 1499									1.04	1.04	1.02
Case Rate 1500+									1.07	1.07	1.14
Years (Ref = Feb 2020 to Jan 2021)											
Feb 2021 to Jan 2022										0.95**	0.95**
Homeless/Unhoused Persons (Ref = 1st Quartile)											
2nd Quintile											1.05
3rd Quintile											1.02
4th Quintile											1.04
5th Quintile											0.56**
Constant	0.17***	0.17***	0.24***	0.22***	0.22***	0.25***	0.28***	0.22***	0.22***	0.22***	0.24***
Observations	95,585	95,585	95,585	95,585	95,595	95,585	95,585	95,585	95,585	95,585	95,585
Statistical significance: <.05, <.01, and <.001											

DISCUSSION:

This study found that provision of EMS for psychiatric emergencies was higher among Whites, compared to Hispanics aged 50 years and older. The racial and ethnic disparities identified

in this study are consistent with previous EMS literature, which suggest lower provision of EMS for Hispanics, compared to Whites (Melgoza et al., 2023). Most of the existing EMS literature, however, focuses on provision of EMS for non-psychiatric related emergencies, such as cardiac arrests and heart attacks (Kahn et al., 2019; Zègre-Hemsey et al., 2019), strokes (Govindarajan et al., 2015), and pain (Crowe et al., 2023; Kennel et al., 2019). This study adds to the existing EMS literature by suggesting that racial and ethnic disparities in provision of EMS care are also present in the context of psychiatric emergencies, and especially with a focus on adults aged 50 years and older. The lower provision of EMS for psychiatric emergencies among Hispanic older adults in SF County may be attributed to a combination of factors, including a general distrust in emergency services, past negative experiences with EMS, concerns about cost or immigration status, patient-provider language discordance, and fear of COVID-19 infection and death in this population (Melgoza et al., 2021, 2023). Other factors including the launch of SF's Street Crises Response Team (SCRT), a task force created to connect individuals experiencing a mental health emergency with the appropriate services, may have also impacted the provision of EMS for psychiatric emergencies.

The current study also addressing a recurrent research gap, where Hispanic older adults are often excluded in EMS studies. In general, few studies have assessed provision of EMS for psychiatric emergencies among older adults. The few studies that have examined EMS for psychiatric emergencies often lack Hispanic representation (Martínez et al., 2023). For example, a study that assessed provision of EMS to adults aged 50 years and older in Los Angeles, including the delivery of health care for psychiatric emergencies, reported that patients experienced racial bias during their interactions with EMS providers (Martínez et al., 2023). This study, however, did not include Hispanic patients, although 48.1% of the population in Los Angeles is Hispanic

(Martínez et al., 2023). Future EMS research should continue to include the Hispanic population, which is a population that is projected to continue growing in this country.

Provision of EMS for psychiatric emergencies was higher among persons with suspected alcohol or drug use, compared to persons without suspected alcohol or drug use. People who use alcohol or drugs are more likely to have more encounters with EMS, compared to people who do not use alcohol or drugs (Tangherlini et al., 2010, 2016). In a qualitative study of EMS providers, barriers to accessing and utilizing mental health services were identified as important factors that contribute to the high reliance of prehospital care among people who use substances (Blue et al., 2021). During the COVID-19 pandemic, a study reported that between the public health emergency declaration and stay-at-home order, March 10, 2020, to March 22, 2020, there was a precipitous decline in substance use-related 9-1-1 calls (Weiner et al., 2021). Between March 23, 2020, to May 15, 2020, the period after the stay-at-home order, there was an increasing trend of substance use-related calls, which neared pre-COVID-19 levels (Weiner et al., 2021). The increasing trend of substance use-related calls after the stay-at-home order was attributed to increases in social isolation, decreases in social support, an important component for recovery, and increases in fear, anxiety, and financial stressors (Weiner et al., 2021).

This results from this study also suggest that neighborhoods with the highest number of eviction notices (e.g., 160 to 240 evictions) had the highest provision of EMS for psychiatric emergencies, compared to neighborhoods with the lowest number of eviction notices (e.g., less than 80). During the COVID-19 pandemic, eviction moratoriums were passed in several states and cities, which prevented people from getting evicted during the duration of the policy (Leifheit et al., 2021). Nonetheless, people could still be served with eviction notices during the COVID-19 pandemic (Leifheit et al., 2021). Previous studies suggest that there is a link between perceived

risk of eviction and poor mental health (Acharya et al., 2022). A study reported that the odds of depression, anxiety, and prescription medication use for mental health conditions in people who were at-risk of getting evicted were 2.37, 2.65, and 1.17 times higher, compared to the non-risk group (Acharya et al., 2022). The results from the current study align with the previously published literature which suggests that perceived risk of eviction is associated with poor mental health, and higher use of health care services, including EMS for psychiatric emergencies.

In contrast to previously published literature, this study found that neighborhoods with the highest number of homeless or unhoused individuals had the lowest provision of EMS for psychiatric emergencies, compared to neighborhoods with the lowest number of homeless or unhoused individuals. Existing EMS literature suggests that persons who are homeless or unhoused use EMS at disproportionately high rates and for lower acuity conditions, compared to their housed counterparts (Abramson et al., 2021). The findings in the current study may be explained by several factors, including the launch of SF's Street Crises Response Team (SCRT), which is a collaboration between the SF Department of Public Health, SF Fire Department, and SF Department of Emergency Management (Goldman et al., 2023). SCRT is a 9-1-1 dispatched multidisciplinary mobile crisis team that aims to connect people who are homeless or unhoused with the appropriate services, while at the same time decreasing unnecessary use of emergency services in SF County (Goldman et al., 2023). SCRT was launched in November 2019 and continues to provide health care services to people experiencing psychiatric and substance use-related emergencies in SF County (Goldman et al., 2023). SCRT was first piloted in SF's highest demand neighborhoods starting in December 2020, including Tenderloin, South of Market, Mission District, Chinatown, North Beach and Bayview (Goldman et al., 2023). The findings from the current study seem to suggest that the lower provision of EMS for psychiatric emergencies in

the neighborhoods with the highest numbers of homeless or unhoused persons, may be partially explained by the delivery of care by SCRT, which lowers the demand for EMS services in those neighborhoods.

This study also found that neighborhoods with a Hispanic ethnic composition between 10% and 19%, compared to 0 to 9%, had lower provision of EMS for psychiatric emergencies, although non-statistically significant findings were found for neighborhoods with a Hispanic ethnic composition equal to or greater than 20%. Similarly, Region 2, a geographic area with the highest percentage of Hispanics in SF County had lower provision of EMS for psychiatric emergencies, compared to Region 1, a geographic area with a lower percentage of Hispanics. Previous studies suggest that increasing neighborhood-level Hispanic ethnic composition is associated with a lower provision of EMS, although these studies are conducted in contexts with a greater overall percentage of Hispanics, compared to SF County (Blewer et al., 2020; Moon et al., 2014). SF County's overall population of Hispanics is only 16%, which may explain the lack of statistically significance for some of the results related to neighborhood-Hispanic ethnic composition (U.S. Census Bureau, 2023, 2024).

LIMITATIONS:

This study is not without limitations. The first limitation is that the findings from this study may not be generalizable to other EMS agencies and populations outside of SF County. The second limitation is the study period, February 1, 2020, to January 22, 2022, which may not be generalizable to the pre- and post-COVID-19 periods. The third limitation is that the EMS dataset includes deidentified data for all 9-1-1 calls with patient encounters in SF County, which makes it impossible to know whether a patient used the prehospital system more than once during the study period. The same patient may be represented more than once in this EMS dataset, although this

limitation is common in prehospital research that uses deidentified data. The fourth limitation is that the EMS datasets have prepopulated data fields, which do not promote equity and inclusion, but rather exclude certain populations. For example, the only available categories for the race and ethnicity variable are White, Black or African American, Hispanic, Asian, American Indian or Alaska Native, and Native Hawaiian or Pacific Islander. These racial and ethnic categories are not inclusive of persons who identify as multi-racial. The gender variable is also recorded as only female or male. The fifth limitation of this study is that although EMS providers complete and submit the ePCRs, the data included in each report is likely a combination of patient and family self-report and provider report. The sixth limitation is that data at the ZCTA-level are only available as 5-year ACS estimates to protect confidentiality among respondents in smaller geographic areas. To address this limitation, I conducted sensitivity analyses using the 2022 ACS 1-year estimates at the PUMA level, which is a larger geographic unit of analysis, compared to ZCTAs. The final limitation is that homeless count data was obtained from the 2022 Point-in-Count (PIT) dataset. The data from PIT is collected over a period of one night in 2022, which may impact the results, although the count obtained from SF includes the weighted count by ZIP code to increase accuracy. The PIT count is also the best source of data available to obtain a homeless count. Even with these limitations, the datasets selected for this study were meticulously selected to better and more accurately assess the patient and neighborhood-level factors associated with the provision of EMS for psychiatric emergencies.

CONCLUSION:

The findings from this study suggest that provision of EMS for psychiatric emergencies differs across both patient and neighborhood-level factors. As such, patient and neighborhood-level, and the interplay of these, should be considered in future EMS research. The identification

of patient populations and geographic hotspots who are provided EMS for psychiatric emergencies can help inform future policies to better allocate limited prehospital personnel, vehicles, and resources. These EMS hotspots can also inform the development of upstream interventions and programs, such as SF County's SCRT. The current approach to psychiatric crises in the prehospital setting is crises control, but we can change this by focusing more on upstream approaches aimed at prevention, early detection, and management. Upstream interventions and programs can also reduce some of the lower acuity 9-1-1 calls that are currently saturating the EMS system and will increase availability of prehospital personnel and services for high-acuity emergencies.

CHAPTER 7: OVERALL CONCLUSIONS, STRENGTHS, LIMITATIONS, AND FUTURE DIRECTIONS

Using Dissertation Strengths To Inform Practice and Policy

This dissertation advances our understanding of EMS provision to Hispanic older adults aged 50 years and older. The first study is a scoping literature review that examines the state of the literature, with a focus on provision of EMS for cardiac arrests. This scoping literature review considers the individual, environmental, neighborhood, and policy-level factors that impact provision of EMS across each of the links in the OHCA chain of survival. The second study quantitatively assesses the individual and neighborhood level factors that impact provision of EMS to Hispanic older adults who experience a cardiac emergency, a high-acuity 9-1-1 call, in SF County, CA. The third study assesses the individual and neighborhood-level factors that impact EMS provision to Hispanic older adults who experience a psychiatric emergency, a type of 9-1-1 call often considered low-acuity, in SF County, CA. The findings from all three studies can influence policies and practice to address health disparities and achieve health equity in the prehospital setting.

The findings from the three studies can inform upstream approaches to change the focus of our healthcare system from reactive to proactive. It is important for EMS agencies to understand the individual and neighborhood-level characteristics of the areas served to better allocate limited resources. For example, provision of EMS for certain types of emergencies may be more likely for certain population and geographic areas, which can help with decisions regarding the better allocatation of specialized personnel and equipement. The dissertation studies provide insights into which populations and geographic areas were provided more EMS. These findings can inform the development, implementation and evaluation of future interventions and programs. For cardiac emergencies, CPR and AED trainings can be targeted to more specific populations and geographic areas at a higher risk of being provided EMS. The CPR and AED trainings can be offered in multiple languages depending on the sociodemographic characteristics of the populations and hotspots identified. For psychiatric emergencies, upstream services, such as increased access to primary and preventive mental health services are necessary, as well as, EMS-specific efforts. For example, the LA Fire Department piloted an Advanced Practitioner Nurse Response unit before the COVID-19 pandemic, which provided prehospital care and linkages to social services for people with low-acuity 9-1-1 emergencies (Sanko et al., 2020). The LA Fire Department also expanded telehealth options and offered alternate destinations when EDs were at capacity during the COVID-19 pandemic, which were two practices also commonly implemented across multiple agencies during the COVID-19 pandemic (Sanko & Eckstein, 2021).SF County also piloted a Street Crisis Response Team and a Street Overdose Response Team for patients experiencing psychiatric and substance use-related emergencies in the community (Goldman et al., 2023).

Limitations

This dissertation has multiple limitations that should be considered. The first limitation across all three studies is the generalizability of the findings. Most of the studies identified in the first study use local or state-level data, while the second and third studies use SF County EMS data. The second limitation is the lack of qualitative or mixed methods studies in EMS research. This finding was especially evident in the scoping literature review, where most of the identified studies used quantitative methods. The third limitation is that EMS records are often a combination of patient sociodemographic characteristics that result from patient self-report and provider perception, which may result in some inaccurate classifications. A fourth limitation is that the sociodemographic patient sociodemographic characteristics reported in the ePCRs have predetermined categories, which constrains the boundaries of analysis. For example, patient gender is defined as "Male" or "Female," without acknowledging other possible genders. The fifth limitation is that EMS datasets, including the data from SF County, often include all 9-1-1 calls with patient contacts, not unique encounters. This may result in multiple EMS units responding to the same incident, which results in multiple ePCRs submitted for one incident.

Conclusion:

The overall goal of this dissertation is to identify health disparities present in the provision of EMS to older adults, with a focus on Hispanics. The three studies that form this dissertation use a multi-level approach and are innovative in multiple ways. First, the focus of the three studies is on provision of EMS from the provider's perspective. Second, the three studies assess provision of EMS for older adults, with a focus on persons aged 50 years and older, instead of the traditional 65 years and older age cutoff. Using 50 years and older as the age cutoff aligns with the weathering hypothesis, which posits that minoritized persons have a heightened risk of morbidity and mortality, especially during the COVID-19 pandemic (Geronimus et al., 2006; Walubita et al.,

2021). Third, the findings from the three studies support a more equitable allocation of emergency services and personnel to address existing health disparities and work to achieve equity in the prehospital system.

Appendix I: Descriptive statistics of non-cardiac and cardiac- related emergencies among adults aged 50 years and older in San Francisco County, California between February 1, 2020, and January 31, 2021 (Time Period 1: N=43,572)

	No Cardiac-Related 9-1-1 Calls (N=40,260)		Cardiac-Related 9-1-1 Calls (N=3,312)		Cardiac and non-cardiac-related 9-1-1 calls (N=43,572)	
	Number (#)	Percentage (%)	Number (#)	Percentage (%)	Number (#)	Percentage (%)
Race/Ethnicity						
White	18,393	45.69%	1,387	41.88%	19,780	45.40%
Black or African American	9,821	24.39%	825	24.91%	10,646	24.43%
Hispanic	3,939	9.78%	327	9.87%	4,266	18.39%
Asian	7,327	18.20%	688	20.77%	8,015	18.39%
Other	780	1.94%	85.00	2.57%	865	1.99%
Gender						
Female	16,369	40.66%	1,275	38.50%	17,644	40.49%
Male	23,891	59.34%	2,037	61.50%	25,928	59.51%
Age						
50-59	11,576	28.75%	959	28.96%	12,535	28.77%
60-69	11,512	28.59%	970	29.29%	12,482	28.65%
70-79	7,539	18.73%	658	19.87%	8,197	18.81%
80+	9,633	23.93%	725	21.89%	10,358	23.77%
Aggregated Incident ZCTA (Aggregated by geographic proximity and percentage of residents below the federal poverty level).[1]						
Treasure Island (High % of poverty)[2]	105	0.26%	11	0.33%	116	0.27%
Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)[3]	12,625	31.36%	999	30.16%	13,624	31.27%
Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[4]	7,591	18.85%	666	20.11%	8,257	18.95%
Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[5]	2,494	6.19%	213	6.43%	2,707	6.21%
Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[6]	6,683	16.60%	544	16.43%	7,227	16.59%
Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[7]	1,813	4.50%	152	4.59%	1,965	4.51%
Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[8]	6,110	15.18%	543	16.39%	6,653	15.27%
Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[9]	2,839	7.05%	184	5.56%	3,023	6.94%
Percentage of Hispanics at the ZCTA level						
0 to 9%	8,027	19.94%	633	19.11%	8,660	19.88%
10% to 19%	18,617	46.24%	1,559	47.07%	20,176	46.30%
20 to 29%	10,602	26.33	883	26.66%	11,485	26.36%
30+%	3,014	7.49%	237	7.16%	3,251	7.46%
Percentage of Medicaid enrollees at the ZCTA level	22.56 (Mean) 10.14 (SD)		22.59 (Mean) 9.93 (SD)		22.56 (Mean) 10.13 (SD)	
Suspected Drug Use						
True	1,998	4.96%	138	4.17%	2,136	4.90%
False	38,262	95.04%	3,174	95.83%	41,436	95.10%

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner

[2] High % of people living below FPL off the coast of SF County

[3] High % of people living below FPL in the northeastern corner of SF County

[4] Medium % of people living below FPL and southeastern corner of SF County

[5] Medium % of people living below FPL in the southern corner of SF County

[6] Medium % of people living below FPL in the northeastern corner of SF County

[7] Low % of people living below FPL and in the eastern corner of SF County

[8] Low % of people living below FPL and in the western corner of SF County

[9] Low % of people living below the FPL in north and central SF County

Appendix II: Descriptive statistics of non-cardiac and cardiac- related emergencies among adults aged 50 years and older in San Francisco County, California between February 1, 2021, and January 31, 2022 (Time Period 2: N = 52,013)

	No Cardiac-Related 9-1-1 Calls (N=47,883)		Cardiac-Related 9-1-1 Calls (N=4,130)		Cardiac and non-cardiac-related 9-1-1 calls (N=52,013)	
	Number (#)	Percentage (%)	Number (#)	Percentage (%)	Number (#)	Percentage (%)
Race/Ethnicity						
White	21,486	44.87%	1,633	39.54%	23,119	44.45%
Black or African American	11,408	23.82%	1,059	25.64%	12,467	23.97%
Hispanic	5,001	10.44%	462	11.19%	5,463	10.50%
Asian	8,723	18.22%	863	20.90%	9,586	18.43%
Other	1,265	2.64%	113	2.74%	1,378	2.65%
Gender						
Female	19,757	41.26%	1,641	39.73%	21,398	41.14%
Male	28,126	58.74%	2,489	60.27%	30,615	58.86%
Age						
50-59	13,325	27.83%	1,030	24.94%	14,355	27.60%
60-69	13,473	28.14%	1,212	29.35%	14,685	28.23%
70-79	9,499	19.84%	900	21.79%	10,399	19.99%
80+	11,586	24.20%	988	23.92%	12,574	24.17%
Aggregated Incident ZCTA (Aggregated by geographic proximity and percentage of residents below the federal poverty level).[1]						
Treasure Island (High % of poverty)[2]	119	0.25%	10	0.24%	129	0.25%
Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)[3]	14,861	31.04%	1,179	28.55%	16,040	30.84%
Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[4]	8,647	18.06%	771	18.67%	9,418	18.11%
Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[5]	2,778	5.80%	274	6.63%	3,052	5.87%
Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[6]	8,388	17.52%	757	18.33%	9,145	17.58%
Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[7]	2,282	4.77%	224	5.42%	2,506	4.82%
Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[8]	7,482	15.63%	640	15.50%	8,122	15.62%
Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[9]	3,326	6.95%	275	6.66%	3,601	6.92%
Percentage of Hispanics at the ZCTA level						
0 to 9%	9,678	20.21%	773	18.72%	10,451	20.09%
10% to 19%	22,530	47.05%	2,033	49.23%	24,563	47.22%
20 to 29%	12,345	25.78%	1,052	25.47%	13,397	25.76%
30+%	3,330	6.95%	272	6.59%	3,602	6.93%
Percentage of Medicaid enrollees at the ZCTA level	22.38 (Mean) 10.08 (SD)		22.34 (Mean) 9.95 (SD)		22.38 (Mean) 10.07 (SD)	
Suspected Drug Use						
True	2,800	5.85%	198	4.79%	2,998	5.76%
False	45,083	94.15%	3,932	95.21%	49,015	94.24%

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner
[2] High % of people living below FPL off the coast of SF County
[3] High % of people living below FPL in the northeastern corner of SF County
[4] Medium % of people living below FPL and southeastern corner of SF County
[5] Medium % of people living below FPL in the southern corner of SF County
[6] Medium % of people living below FPL in the northeastern corner of SF County
[7] Low % of people living below FPL and in the eastern corner of SF County
[8] Low % of people living below FPL and in the western corner of SF County
[9] Low % of people living below the FPL in north and central SF County

Appendix III: Bivariate associations between patient and neighborhood-level sociodemographic characteristics and provision of emergency care (N = 95, 585)

	Non-cardiac emergency		Cardiac related emergency		Significance
	Number	Percent	Number	Percent	
Overall	88,143	92.21%	7,442	7.79%	
Patient sociodemographic characteristics					
Race Ethnicity					
White	39,879	45.24%	3,020	40.58%	p < .001
Black or African American	21,229	24.08%	1,884	25.32%	
Asian	16,050	18.21%	1,551	20.84%	
Other	2,045	2.32%	198	2.66%	
Hispanic	8,940	10.14%	789	10.60%	
Gender					
Female	36,126	40.99%	2,916	7.47%	p < .01
Male	52,017	59.01%	4,526	8.00%	
Age					
50-59	24,901	28.25%	1,989	7.40%	p< .001
60-69	24,985	28.35%	2,182	8.03%	
70-79	17,038	19.33%	1,558	8.38%	
80+	21,219	24.07%	1,713	7.47%	
Suspected Alcohol or Drug Use					
False	83,345	94.56%	7,106	95.49%	p < .01
True	4,798	5.44%	336	4.51%	
Neighborhood-level characteristics					
Aggregated ZCTAs					p <.01
Treasure Island (High % of poverty)	224	0.25%	21	0.28%	
Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)	27,486	31.18%	2,178	29.27%	
Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)	16,238	18.42%	1,437	19.31%	
Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)	5,272	5.98%	487	6.54%	
Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)	15,071	17.10%	1,301	17.48%	
Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)	4,095	4.65%	376	5.05%	
Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)	13,592	15.42%	1,183	15.90%	
Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)	6,165	6.99%	459	6.17%	
Percentage of Hispanics at the neighborhood level					
0 to 9%	17,705	20.09%	1,406	18.89%	p < .05
10 to 19%	41,147	46.68%	3,592	48.27%	
20 to 29%	22,947	26.03%	1,935	26.00%	
30%	6,344	7.20%	509	6.84%	
Percentage of Medicaid enrollees at the neighborhood level	88,143	Mean: 22.46 SD: 10.11	7,442	Mean: 22.45 SD: 9.94	p = .93

Appendix IV: Descriptive statistics of EMS Calls with Patient Encounters in SF County, California between February 1, 2020, and January 31, 2022

	EMS Calls with Patient Encounters		
Patient Gender	No	Yes	Total
Female	92.53%	7.47%	100%
Male	92.00%	8.00%	100%
Patient Race and Ethnicity			
White	92.96%	7.04%	100%
Black or African Americans	91.85%	8.15%	100%
Hispanic	91.89%	8.11%	100%
Asian	91.19%	8.81%	100%
Other	91.17%	8.83%	100%
Patient Age			
50-59	92.60%	7.40%	100%
60-69	91.97%	8.03%	100%
70-79	91.62%	8.38%	100%
80+	92.53%	7.47%	100%
Aggregated ZCTA by geographic proximity and SES			
(1) Treasure Island	91.43%	8.57%	100%
(2) Tenderloin, South of Market, Financial District, and Chinatown	92.66%	7.34%	100%
(3) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior	91.87%	8.13%	100%
(4) Visitacion Valley and Lake Merced/Lakeside	91.54%	8.46%	100%
(5) Polk/Russian Hill, Nob Hill, Western Addition/Japantown, Embarcadero	92.05%	7.95%	100%
(6) Rincon Hill, Potrero Hill/SOMA, and Mission Bay	91.59%	8.41%	100%
(7) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, and Sunset	91.99%	8.01%	100%
(8) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, Marina/Cow Hollow, and Presidio	93.07%	6.93%	100%
Suspected Drug Use			
False	92.14%	93.46%	100%
True	7.86%	6.54%	100%

Appendix V: Logistic Regression with Provider Primary and Secondary Impressions for Cardiac-Related 9-1-1 Emergencies Among Adults Aged 50 Years and Older in SF County Between February 1, 2020, and January 31, 2022 (Full Time Period)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Race/Ethnicity (Ref = Hispanic)							
White	0.86***	0.86***	0.85***	0.85***	0.85***	0.85***	0.85***
Black or African American	1.00	1.00	0.99	0.99	0.98	0.97	0.98
Asian	1.09*	1.11*	1.10*	1.10*	1.09	1.09	1.08
Other	1.09	1.10	1.09	1.09	1.08	1.08	1.08
Gender (Ref = Male)							
Female		0.91***	0.92***	0.91***	0.90***	0.90***	0.90***
Age, years (Ref = 50-59)							
60-69			1.09**	1.09**	1.09**	1.09**	1.08*
70-79			1.15***	1.13***	1.13**	1.13**	1.11**
80+			1.00	0.98	0.98	0.98	0.96
Aggregated ZIP codes (Reference = Tenderloin, South of Market, Financial District and Chinatown.)[1]							
Treasure Island (High % of poverty)[2]				1.19	1.39	1.24	1.23
Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[3]				1.10**	1.18***	1.25***	1.24***
Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[4]				1.15**	1.10	1.14*	1.13*
Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[5]				1.11**	1.06	1.13*	1.13*
Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[6]				1.16**	1.14*	1.24**	1.24**
Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[7]				1.11**	1.13**	1.25**	1.24**
Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[8]				0.99	1.00	1.14	1.14
Percentage of Hispanics at the neighborhood level (Reference = 0 to 9%)							
10% to 19%						1.11**	1.11**
20 to 29%						0.97	0.97
30+%						0.90	0.91
Percentage of Medicaid enrollees at the neighborhood level						1.00	1.00
Suspected Drug Use (Ref = True)							
False							1.17**
Constant	0.088***	0.091***	0.086***	0.081***	0.077***	0.065***	0.056***
Observations	95585	95585	95585	95585	95585	95585	95585

Statistical significance: <.05, <.01, and <.001

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner

[2] High % of people living below FPL off the coast of SF County

[3] Medium % of people living below FPL and southeastern corner of SF County

[4] Medium % of people living below FPL in the southern corner of SF County

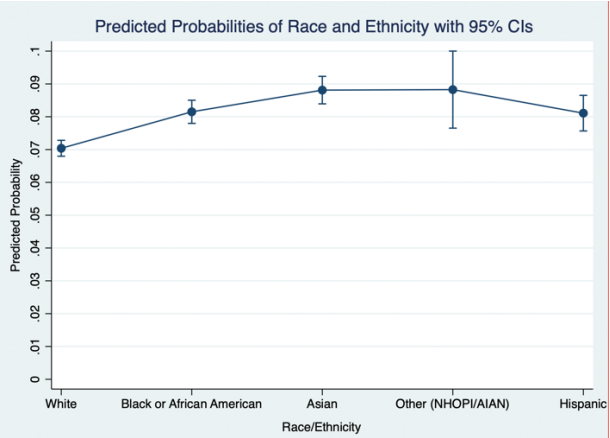
[5] Medium % of people living below FPL in the northeastern corner of SF County

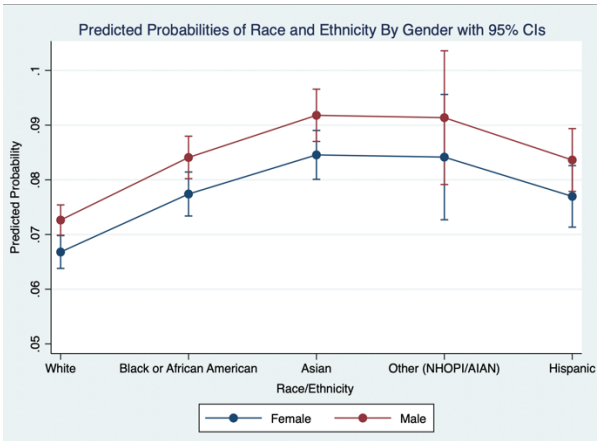
[6] Low % of people living below FPL and in the eastern corner of SF County

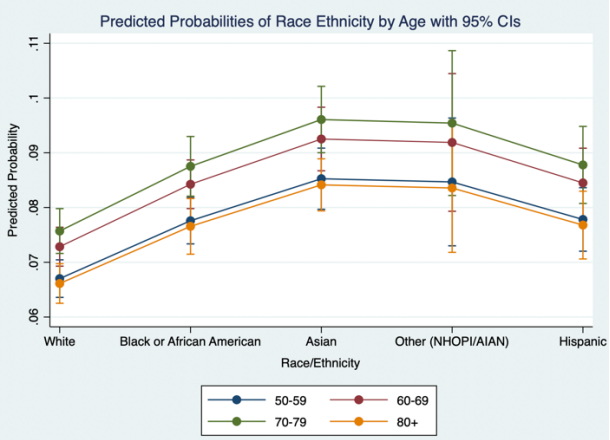
[7] Low % of people living below FPL and in the western corner of SF County

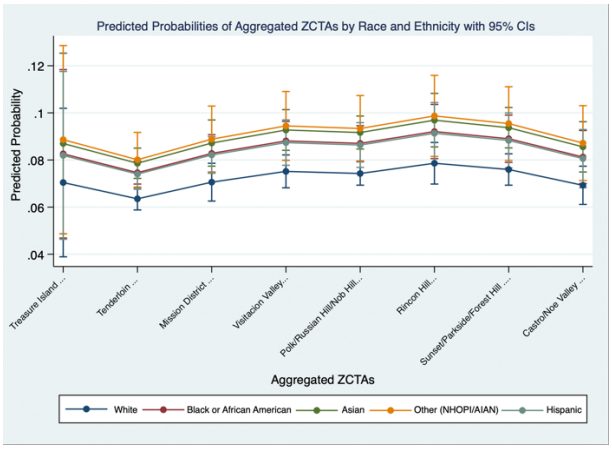
[8] Low % of people living below the FPL in north and central SF County

Appendix VI: Predicted Probabilities of Cardiac Emergencies from the Logistic Regression Models with Provider Primary and Secondary Impressions for Cardiac- Related 9-1-1 Emergencies Among Adults Aged 50 Years and Older in SF County Between February 1, 2020, and January 31, 2022 (Full Time Period)









Appendix VII: Firth Logistic Regression with Provider Primary and Secondary Impressions for Cardiac- Related 9-1-1 Emergencies Among Adults Aged 50 Years and Older in SF County Between February 1, 2020, and January 31, 2022 (Full Time Period)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Race/Ethnicity (Ref = Hispanic)							
White	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***
Black or African American	0.99	1.00	0.99	1.00	0.98	0.97	0.98
Asian	1.09*	1.11*	1.10*	1.10*	1.09	1.09	1.08
Other	1.10	1.10	1.09	1.09	1.08	1.08	1.08
Gender (Ref = Male)							
Female		0.91***	0.91**	0.91***	0.90***	0.90***	0.90***
Age, years (Ref = 50-59)							
60-69			1.09**	1.09**	1.09**	1.09**	1.08*
70-79			1.15***	1.13***	1.13**	1.13**	1.11**
80+			1.00	0.98	0.98	0.98	0.96
Aggregated ZIP codes (Reference = (2) Tenderloin, South of Market, Financial District and Chinatown.)[1]							
(1) Treasure Island (High % of poverty)[2]				1.21	1.42	1.26	1.26
(3) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[3]				1.10**	1.18***	1.25***	1.24***
(4) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[4]				1.16**	1.10	1.14*	1.13*
(5) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[5]				1.11**	1.06	1.13*	1.13*
(6) Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[6]				1.16**	1.14*	1.24**	1.24**
(7) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[7]				1.11**	1.13**	1.25**	1.24**
(8) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[8]				0.99	1.00	1.14	1.14
Percentage of Hispanics at the neighborhood level (Reference = 0 to 9%)							
10% to 19%					1.10**	1.11**	1.11**
20 to 29%					1.02	0.97	0.97
30+%					0.90	0.22	0.91
Percentage of Medicaid enrollees at the neighborhood level						1.00	1.00
Suspected Drug Use (Ref = True)							
False							1.17**
Constant	0.088***	0.091***	0.086***	0.082***	0.077***	0.065***	0.056***
Observations	95585	95585	95585	95585	95585	95585	95585

Statistical significance: <.05, <.01, and <.001

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner

[2] High % of people living below FPL off the coast of SF County

[3] Medium % of people living below FPL and southeastern corner of SF County

[4] Medium % of people living below FPL in the southern corner of SF County

[5] Medium % of people living below FPL in the northeastern corner of SF County

[6] Low % of people living below FPL and in the eastern corner of SF County

[7] Low % of people living below FPL and in the western corner of SF County

[8] Low % of people living below the FPL in north and central SF County

Appendix VIII: Cardiac- Related 9-1-1 Emergencies Among Adults Aged 50 years and Older in SF County Between February 1, 2020, and January 31, 2021 (Rare Events Logistic Regression Results with Provider & Secondary Impressions) (Time Period 1: N=43,572)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Race/Ethnicity (Ref = Hispanic)							
White	0.90	0.90	0.90	0.92	0.91	0.91	0.91
Black or African American	1.01	1.01	0.99	1.00	0.98	0.98	0.99
Asian	1.13	1.14	1.17*	1.16*	1.15	1.15	1.15*
Other	1.31*	1.32*	1.32*	1.33*	1.30*	1.30*	1.30*
Gender (Ref = Male)							
Female		0.89**	0.91*	0.91*	0.90*	0.90*	0.90*
Age, years (Ref = 50-59)							
60-69			1.01	1.01	1.01	1.01	1.00
70-79			1.04	1.03	1.03	1.03	1.01
80+			0.88*	0.87*	0.86*	0.86*	0.85*
Aggregated ZIP codes (Reference = (2) Tenderloin, South of Market, Financial District and Chinatown.)[1]							
(1) Treasure Island (High % of poverty)[2]				1.38	1.72	1.83	1.83
(3) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[3]				1.11*	1.25*	1.21*	1.2
(4) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[4]				1.09	1.03	1.01	1.00
(5) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[5]				1.06	1.00	0.97	0.96
(6) Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[6]				1.07	1.02	0.98	0.97
(7) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[7]				1.15*	1.14*	1.08	1.07
(8) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[8]				0.86	0.85	0.79	0.79
Percentage of Hispanics at the neighborhood level (Reference = 0 to 9%)							
10% to 19%					1.09	1.08	1.09
20 to 29%					0.97	1.00	1.01
30+%					0.81	0.81	0.82
Percentage of Medicaid enrollees at the neighborhood level						0.99	0.99
Suspected Drug Use (Ref = True)							
False							1.19
Constant	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.07***
Observations	43,572	43,572	43,572	43,572	43,572	43,572	43,572

Statistical significance: <.05, <.01, and <.001

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern corner

[2] High % of people living below FPL off the coast of SF County

[3] Medium % of people living below FPL and southeastern corner of SF County

[4] Medium % of people living below FPL in the southern corner of SF County

[5] Medium % of people living below FPL in the northeastern corner of SF County

[6] Low % of people living below FPL and in the eastern corner of SF County

[7] Low % of people living below FPL and in the western corner of SF County

[8] Low % of people living below the FPL in north and central SF County

Appendix IX: Cardiac- Related 9-1-1 Emergencies Among Adults Aged 50 years and Older in SF County Between February 1, 2020, and January 31, 2021 (Rare Events Logistic Regression Results with Provider & Secondary Impressions) (Time Period 2: N=52,013)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Race/Ethnicity (Ref = Hispanic)							
White	0.82***	0.82***	0.80***	0.80***	0.80***	0.80***	0.80***
Black or African American	1.00	1.00	0.99	0.99	0.98	0.97	0.97
Asian	1.07	1.08	1.05	1.04	1.04	1.03	1.03
Other	0.96	0.97	0.96	0.96	0.95	0.95	0.95
Gender (Ref = Male)							
Female		0.92*	0.92*	0.91**	0.91**	0.91**	0.90**
Age, years (Ref = 50-59)							
60-69			1.16**	1.16**	1.16**	1.15**	1.14**
70-79			1.24***	1.22***	1.22***	1.21***	1.20***
80+			1.11*	1.08	1.08	1.08	1.07
Aggregated ZIP codes (Reference = (2) Tenderloin, South of Market, Financial District and Chinatown.)[1]							
(1) Treasure Island (High % of poverty)[2]				1.12	1.24	0.95	0.95
(3) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)[3]				1.09	1.13	1.28**	1.27**
(4) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)[4]				1.21**	1.17*	1.25**	1.25**
(5) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)[5]				1.15**	1.11	1.29**	1.29**
(6) Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)[6]				1.24**	1.23**	1.50***	1.49***
(7) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)[7]				1.09	1.12	1.40***	1.39**
(8) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)[8]				1.10	1.13	1.54**	1.53**
Percentage of Hispanics at the neighborhood level (Reference 0 to 9%)							
10% to 19%					1.12*	1.13*	1.13*
20 to 29%					1.07	0.94	0.94
30+%					0.97	0.99	0.99
Percentage of Medicaid enrollees at the neighborhood level						1.01**	1.01**
Suspected Drug Use (Ref = True)							
False							1.16*
Constant	0.09***	0.09***	0.08***	0.08***	0.07***	0.05***	0.04***
Observations	52,013	52,013	52,013	52,013	52,013	52,013	52,013

Statistical significance: <.05, <.01, and <.001

[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County and located in the northeastern

[2] High % of people living below FPL off the coast of SF County

[3] Medium % of people living below FPL and southeastern corner of SF County

[4] Medium % of people living below FPL in the southern corner of SF County

[5] Medium % of people living below FPL in the northeastern corner of SF County

[6] Low % of people living below FPL and in the eastern corner of SF County

[7] Low % of people living below FPL and in the western corner of SF County

[8] Low % of people living below the FPL in north and central SF County

Appendix X: Logistic Regression with Provider Primary and Secondary Impressions for Cardiac-Related 9-1-1 Emergencies Among Adults Aged 50 Years and Older in SF County Between February 1, 2020, and January 31, 2022 (Full Time Period) by 2021 1-Year ACS Estimates for PUMAS, not Aggregated ZCTAs

Logistic Regression with Primary and Secondary Provider Impressions for Cardiac-Related 9-1-1 Emergencies Among Adults Aged 50 Years and Older in SF County Between February 1, 2020 and January 31, 2022 by PUMAS	
	Full Model
Race/Ethnicity (Ref = Hispanic)	
White	0.84***
Black or African American	0.97
Asian	1.06
Other	1.07
Gender (Ref = Male)	
Female	0.90***
Age, years (Ref = 50-59)	
60-69	1.07*
70-79	1.10**
80+	0.95
PUMAS (Reference = South of Market and Potrero PUMA.)[1]	
Bayview & Hunters Point PUMA (7507) (High % of poverty)	1.18***
Richmond District PUMA (7501) (High % of poverty)	1.15***
North Beach & Chinatown PUMA (7502) (Medium % of poverty)	0.99
Sunset District (South) PUMA (7506) (Medium % of poverty)	1.09*
Sunset District (North) PUMA (7505) (Low % of poverty)	1.18**
Inner Mission & Castro (Low % of poverty)	0.93
Percentage of Medicaid enrollees at the neighborhood	1.00
Suspected Drug Use (Ref = True)	
False	1.17**
Constant	0.074***
Observations	95585
Statistical significance: <.05, <.01, and <.001	
[1] The reference category has the highest percentage of people living below the federal poverty level (FPL) in contiguous SF County.	

Appendix XI: Descriptive statistics of psychiatric EMS calls in San Francisco County, California between February 1, 2020, and January 31, 2021 (Year 1)

	No Psychiatric-Related 9-1-1 Calls (N=37,041)		Psychiatric-Related 9-1-1 Calls (N=6,531)		Psychiatric and Non-Psychiatric Related 9-1-1 calls (N=43,572)	
	Number (#)	Percentage (%)	Number (#)	Percentage (%)	Number (#)	Percentage (%)
Race/Ethnicity						
White	16,699	45.08%	3,081	47.18%	19,780	45.40%
Black or African American	9,050	24.43%	1,596	24.44%	10,646	24.43%
Asian	6,943	18.74%	1,072	16.41%	8,015	18.39%
Other	724	1.95%	141	2.16%	865	1.99%
Hispanic	3,625	9.79%	641	9.81%	4,266	9.79%
Gender						
Female	15,177	40.97%	2,467	37.77%	17,644	40.49%
Male	21,864	59.03%	4,064	62.23%	25,928	59.51%
Age						
50-59	9,909	26.75%	2,626	40.21%	12,535	28.77%
60-69	10,668	28.80%	1,814	27.78%	12,482	28.65%
70-79	7,241	19.55%	956	14.64%	8,197	18.81%
80+	9,223	24.90%	1,135	17.38%	10,358	23.77%
Alcohol/Drug Use						
True	2,829	7.64%	789	12.08%	3,618	8.30%
False	34,212	92.36%	5,742	87.92%	39,954	91.70%
Aggregated ZIP codes						
(1) Treasure Island, Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)	11,541	31.16%	2,199	33.67%	13,740	31.53%
(2) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)	7,094	19.15%	1,163	17.81%	8,257	18.95%
(3) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)	2,377	6.42%	330	5.05%	2,707	6.21%
(4) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)	6,144	16.59%	1,083	16.58%	7,227	16.59%
(5) Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)	1,635	4.41%	330	5.05%	1,965	4.51%
(6) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)	5,705	15.40%	948	14.52%	6,653	15.27%
(7) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)	2,545	6.87%	478	7.32%	3,023	6.94%
Percentage of Hispanics at the neighborhood level						
0 to 9%	7,269	19.62%	1,391	21.30%	8,660	19.88%
10 to 19%	17,245	46.56%	2,931	44.88%	20,176	46.30%
20 to 29%	9,783	26.41%	1,702	26.06%	11,485	26.36%
30+%	2,744	7.41%	507	7.76%	3,251	7.46%
Percentage of Medicaid enrollees at the neighborhood level	22.55 (Mean) 10.11 (SD)		22.59 (Mean) 10.23 (SD)		22.56 (Mean) 10.13 (SD)	
Number of Eviction Notices Per ZIP Code (Between 02/01/20 and						
Less than 50 evictions	19,875	53.66%	3,359	51.43%	23,234	53.32%
50 or more evictions notices	17,166	46.34%	3,172	48.57%	20,338	46.68%
Cumulative COVID-19 Case Rates						
Case Rate Less than 250	10,860	29.32%	1,856	28.42%	12,716	29.18%
Case Rate Between 250 and 499	13,398	36.17%	2,466	37.76%	15,864	36.41%
Case Rate 500+	12,783	34.51%	2,209	33.82%	14,992	34.41%
SF Homeless Count per ZIP code						
1st Quintile	6,762	18.26%	1,179	18.05%	7,941	18.23%
2nd Quintile	5,612	15.15%	949	14.53%	6,561	15.06%
3rd Quintile	9,395	25.36%	1,688	25.85%	11,083	25.44%
4th Quintile	5,643	15.23%	860	13.17%	6,503	14.92%
5th Quintile	9,629	26.00%	1,855	28.40%	11,484	26.36%

Appendix XII: Descriptive statistics of psychiatric EMS calls in San Francisco County, California between February 1, 2021, and January 31, 2022 (Year 2)

	No Psychiatric-Related 9-1-1 Calls (N=44,616)		Psychiatric-Related 9-1-1 Calls (N=7,397)		Psychiatric and Non-Psychiatric Related 9-1-1 calls (N=52,013)	
	Number (#)	Percentage (%)	Number (#)	Percentage (%)	Number (#)	Percentage (%)
Race/Ethnicity						
White	19,651	44.04%	3,468	46.88%	23,119	44.45%
Black or African American	10,671	23.92%	1,796	24.28%	12,467	23.97%
Asian	8,437	18.91%	1,149	15.53%	9,586	18.43%
Other	1,188	2.66%	190	2.57%	1,378	2.65%
Hispanic	4,669	10.46%	794	10.73%	5,468	10.50%
Gender						
Female	18,498	41.46%	2,900	39.21%	21,398	41.14%
Male	26,118	58.54%	4,497	60.79%	30,615	58.86%
Age						
50-59	11,532	25.85%	2,823	38.16%	14,355	27.60%
60-69	12,563	28.16%	2,122	28.69%	14,685	28.23%
70-79	9,290	20.82%	1,109	14.99%	10,399	19.99%
80+	11,231	25.17%	1,343	18.16%	12,574	24.17%
Alcohol/Drug Use						
True	2,932	6.57%	769	10.40%	3,701	7.12%
False	41,684	93.43%	6,628	89.60%	48,312	92.88%
Aggregated ZIP codes						
(1) Treasure Island, Tenderloin, South of Market, Financial District and Chinatown (High % of poverty)	13,701	30.71%	2,468	33.36%	16,169	31.09%
(2) Mission District/Bernal Heights, Bayview/Hunters, and Ingleside/Excelsior (Medium % of poverty)	8,085	18.12%	1,333	18.02%	9,418	18.11%
(3) Visitacion Valley and Lake Merced/Lakeside (Medium % of poverty)	2,708	6.07%	344	4.65%	3,052	5.87%
(4) Polk/Russian Hill/Nob Hill, Western Addition/Japantown, Embarcadero (Medium % of poverty)	7,870	17.64%	1,275	17.24%	9,145	17.58%
(5) Rincon Hill, Potrero Hill/SOMA, Mission Bay (Low % of poverty)	2,088	4.68%	418	5.65%	2,506	4.82%
(6) Sunset/Parkside/Forest Hill, Haight-Ashbury, Inner Richmond, Outer Richmond, Sunset (Low % of poverty)	7,047	15.79%	1,075	14.53%	8,122	15.62%
(7) Castro/Noe Valley, St. Francis Wood, Miraloma, West Portal, Twin Peaks, Glen Park, and Marina/Cow Hollow (Low % of poverty)	3,117	6.99%	484	6.54%	3,601	6.92%
Percentage of Hispanics at the neighborhood level						
0 to 9%	8,916	19.98%	1,535	20.75%	10,451	20.09%
10 to 19%	21,136	47.37%	3,427	46.33%	24,563	47.22%
20 to 29%	11,512	25.80%	1,885	25.48%	13,397	25.76%
30+%	3,052	6.84%	550	7.44%	3,602	6.93%
Percentage of Medicaid enrollees at the neighborhood level	22.34 (Mean) 10.07 (SD)		22.61 (Mean) 10.05 (SD)		22.38 (Mean) 10.07 (SD)	
Eviction Notices (Reported by ZIP codes)						
Less than 80 eviction notices	20,136	45.13%	3,132	42.34%	23,268	44.73%
80-160 eviction notices	16,417	36.80%	2,734	36.96%	19,151	36.82%
160-240 eviction notices	8,063	18.07%	1,531	20.70%	9,594	18.45%
Cumulative COVID-19 Case Rates						
Case Rate Less than 1000	11,426	25.61%	1,710	23.12%	13,136	25.26%
Case Rate Between 1000 and 1499	15,136	33.93%	2,611	35.30%	17,747	34.12%
Case Rate 1500+	18,054	40.47%	3,076	41.58%	21,130	40.62%
SF Homeless Count per ZIP code						
1st Quintile	8,403	18.83%	1,338	18.09%	9,741	18.73%
2nd Quintile	6,831	15.31%	1,044	14.11%	7,875	15.14%
3rd Quintile	11,293	25.31%	1,907	25.78%	13,200	25.38%
4th Quintile	6,699	15.01%	1,047	14.15%	7,746	14.89%
5th Quintile	11,390	25.53%	2,061	27.86%	13,451	25.86%

Appendix XIII: Logistic Regression with Provider Primary and Secondary Impressions for Psychiatric EMS Calls Among Adults Aged 50 Years and Older in SF County at the PUMA level using 1-year estimates from ACS (Full Time Period)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Race/Ethnicity (Ref = Hispanic)											
White	1.04	1.04	1.12***	1.13***	1.12***	1.11***	1.11***	1.11**	1.12***	1.12***	1.12***
Black or African American	0.99	0.99	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.98	0.99
Asian	0.83***	0.84***	1.03	1.06	1.07	1.05	1.05	1.06	1.06	1.06	1.06
Other	1.00	1.00	1.02	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.06
Gender (Ref = Male)											
Female		0.90***	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Age, years (Ref = 50-59)											
60-69			0.66***	0.67***	0.67***	0.67***	0.67***	0.67***	0.67***	0.67***	0.67***
70-79			0.48***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***	0.50***
80+			0.46***	0.48***	0.49***	0.48***	0.48***	0.49***	0.49***	0.49***	0.49***
Alcohol/Drug Use (Ref = Alcohol or Drug Use (FALSE)											
Alcohol or Drug Use (TRUE)				1.35***	1.34***	1.34***	1.34***	1.34***	1.34***	1.34***	1.34***
PUMAS (Reference = South of Market and Potrero PUMA.) (Highest % of poverty)											
Bayview & Hunters Point PUMA (7507) (High % of poverty)					0.90**	0.91*	0.91*	0.94	0.95	0.95	0.64**
Richmond District PUMA (7501) (High % of poverty)					0.99	0.98	0.93	0.96	0.97	0.97	0.9
North Beach & Chinatown PUMA (7502) (Medium % of poverty)					1.06*	1.03*	1.00	1.03	1.00	1.00	1.01
Sunset District (South) PUMA (7506) (Medium % of poverty)					0.95	0.97	0.91*	0.93	0.96	0.96	0.78**
Sunset District (North) PUMA (7505) (Low % of poverty)					0.94	0.90*	0.85**	0.88*	0.92	0.92	0.78**
Inner Mission & Castro (Low % of poverty)					1.04	0.97	0.90	0.92	0.96	0.96	0.85*
Percentage of Hispanics at the neighborhood level (Ref = 0% to 9%)											
10 to 19%						0.89***	0.89***	0.87***	0.86***	0.86***	0.90*
20 to 29%						0.88**	0.93	0.95	0.92	0.92	0.97
30+%						0.93	0.98	0.91	0.85	0.84	0.96
Percentage of Medicaid enrollees at the neighborhood level							0.99*	0.99**	0.99*	0.99*	0.99*
Eviction Notices (Reported by ZIP codes) (Ref = Less than 80 Eviction Notices)											
80-159 Eviction Notices								1.01	1.02	1.02	0.99
160-240 Eviction Notices								1.08*	1.08	1.08	1.08
Cumulative COVID-19 Case Rates (Reported 01/31/22) (Ref = Case Rate of Less Than 1000 COVID-19 Cases)											
Case Rate Between 1000 and 1499									1.07	1.07	0.96
Case Rate 1500+									1.03	1.03	1.26*
Years (Ref = Feb 2020 to Jan 2021)											
Feb 2021 to Jan 2022										1.04**	1.04**
Homeless/Unhoused Persons (Ref = 1st Quartile)											
2nd Quintile											0.92
3rd Quintile											0.98
4th Quintile											1.05
5th Quintile											0.71**
Constant	0.17***	0.17***	0.24***	0.22***	0.22***	0.25***	0.28***	0.27***	0.26***	0.25***	0.29***
Observations	95,585	95,585	95,585	95,585	95,585	95,585	95,585	95,585	95,585	95,585	95,585

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