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The Impact Of Place-Based Determinants Of Health On Utilization Of Emergency Department Services

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The Impact of Place-Based Determinants of Health on Utilization of Emergency Department Services

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by

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Abstract

The purpose of the study is to investigate whether higher prevalence of place-based structural determinants of health inequity is directly associated with frequent utilization of services in the emergency department. Chi-square and t-test analyses found that compared to non-frequent ED users, frequent ED users were older (mean age 43.18 vs. 35.23, $p<0.001$), more commonly Black or African American (65.13% vs. 52.36%, $p<0.001$), more commonly covered by public insurance [Medicaid (50.62% vs. 36.66%, $p<0.001$) or Medicare (15.45% vs. 11.41%, $p<0.001$)] and more commonly unemployed (41.04% vs. 33.09%, $p<0.001$). Multivariate logistic regression analysis demonstrated that several person-level factors, age of sixty years and older (OR: 3.57; CI [3.38-3.77]), female gender (OR: 1.40; CI [1.32-1.48]), and history of chronic pain (OR: 1.30; CI [1.13-1.50]) significantly increased the likelihood of being diagnosed in the ED with an ACSC (Table 9). Finally, multivariate logistic regression analysis also demonstrated that both person-level factors—homelessness (OR: 3.74; CI [2.35-5.95]), history of abuse (OR: 1.79; CI [1.54-2.09]), and history of substance use disorder (OR: 1.53; CI [1.37-1.69])—and place-level factors with housing instability (1.36; CI [1.33-1.39]) were associated with frequent ED utilization. Using multilevel analysis, compared to within census tracts, the variance between census tracts was found to be greater (3.29 vs. 0.046). In conclusion, there is some evidence that residing in an area with greater prevalence of a social need domain, specifically housing instability, is associated with increased utilization of ED services.

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Table of Contents

Introduction

As safety nets for medical care, emergency departments (ED) encounter patients with complex health care needs that are largely influenced by socioeconomic factors. (1) Social needs, such as food insecurity and unemployment, increase utilization of ED services and adversely impact the health of patients. (2) (3) (4) (5) There is no standard definition for frequent ED users. However, frequent ED users are most commonly defined as having four or more ED visits per year, account for 4.5 to 8 percent of all patients seen in the ED, yet contribute to 21 to 28 percent of all ED visits. (3)

The disproportionate utilization of emergency medical services is problematic due to increased cost of care in the acute setting in addition to inadequate treatment of patients' conditions that are exacerbated by various structural determinants of health. (6) This increased utilization should be treated as "preventable" in the context of structural determinants of health as opposed to the stigmatizing terms of "unnecessary" or "inappropriate". (5) While the term "social determinants of health" is used to discuss the impact of an individual's identity and circumstances, such as through race or environment, on health, the term "structural determinants of health" also takes "the organization of institutions and policies, as well as of neighborhood and cities" into consideration. (7) Subsequently, ED-based interventions are being designed to address structural determinants of health in order to reduce costs and ED visits as well as to improve health outcomes. (8) (9) (10) (11) (12) Ultimately, in order to design effective interventions, it is important to understand and consider the social, economic, and political conditions that shape

the complex health needs of vulnerable patient populations who may disproportionately rely on the ED for medical care. (13) (14)

Studies indicate that frequent ED users experience greater socioeconomic distress, tend to be sicker, report poorer physical health, and are also more likely to utilize other components of the health care system. (3) (13) Multiple studies have demonstrated that adults who live below the federal poverty level are significantly more likely to be frequent ED users. (15) (16) Additionally, being a single parent, having a single or divorced marital status, and completing only high school education or less, are all associated with frequent ED utilization. (17) One large retrospective cohort study that defined frequent ED users as patients who had three or more visits over twelve consecutive months found that adults in fair or poor health were significantly more likely to be frequent ED users compared to adults in good or excellent health (OR: 3.64; $p<0.001$), publicly insured adults were more than twice as likely to be frequent ED users compared to uninsured adults (OR: 2.08; $p<0.001$), and adults who made three or more visits to a physician in an outpatient setting were over five times more likely to engage in frequent utilization of ED services compared to adults who made two or fewer visits to an outpatient physician (OR: 5.29, $p<0.001$). (18)

Health information exchanges and consolidation of big data have enabled the design of effective interventions for patients with complex social needs through the integration of data from community organizations with electronic health records and expanded capacity for capturing access to health care services beyond a single institution. (19) (20) Using these data, some EDs have established partnerships with

multidisciplinary teams of nurses, physicians, patient navigators, lawyers, and social workers working in and outside of the clinical setting on structural determinants of health to improve health care outcomes, such as by improving diabetes management and reducing asthma exacerbations. (21) Medical-legal partnerships have been utilized to help low-income patients remedy or relocate from poor housing conditions that were exacerbating asthma, for instance. (22) ED-based social workers have also been shown to successfully address barriers to accessing health care and management of diabetes, such as transportation, financial instability and food insecurity, and housing. (21) Interventions and policies that address structural determinants of health and prioritize investment in social services have overall been shown to have a positive impact on population health. (23) (24)

Income inequality has been consistently demonstrated to operate as a significant structural determinant of health. (15) (17) (16) The greater New Haven area has one of the highest income inequality gradients in the country. According to a recent study by The Brookings Institution, New Haven is a city with the sixth highest level of income inequality in the country, exceeding the income gradients of major cities like New York City and San Francisco. (25) Findings indicate growing income inequality with income gradients greater in most metropolitan areas in 2014 compared to 2007. (25) Income inequality is in turn related to increased housing cost burden, and housing instability is one of the place-based determinants of health this study will focus on. (25)

Additionally, Yale New Haven Hospital was selected by the Center for Medicare and Medicaid's Innovation (CMMI) to serve as one of 32 participants in the

nation to test the new Accountable Health Communities (AHC) Model over a five-year period starting on May 2017. (26) Specifically, YNHH was selected to participate in the Assistance Track of the AHC Model, which entails providing navigation services to assist high-risk beneficiaries with accessing community services that address health-related social needs. (26) The AHC initiative incentivizes addressing social determinants of health within the health care delivery system. (27) Understanding how structural determinants of health in particular are distributed across Greater New Haven, and their impact on care utilization, are thus essential components of effective program design and implementation to improve population health. (28) This study focused on the social needs of food insecurity, housing instability, and transportation need.

Food Insecurity

Food insecurity is highly prevalent in the United States. Recent estimates indicate that one in seven households in the US cannot reliably afford food. (29) This lack of reliable capacity to afford food, also termed food insecurity, has been shown to adversely impact both access to health care and health outcomes. (29) (30) Much of the research on the association of food insecurity with worse health has been conducted on patients with diabetes, for whom a consistent and a well-planned diet is an essential component of their treatment regimen. (31) (32) A 2001 study that analyzed data for over one thousand and five hundred adults with diabetes attained through the third National Health and Nutrition Examination Survey found that food insecurity is fairly prevalent (6%) in adults with diabetes overall and is significantly more prevalent for patients with incomes below the federal poverty level (17% vs.

4%, p<.001). (31) The study also found that diabetic patients who were also food insecure had a significantly greater number of physician encounters (including in non-urgent outpatient settings) compared to diabetic patients who were not food insecure (12 vs. 7, p<.05). (31) However, this increased utilization of health care services should not be assumed to equate to increased access to health care; there is also evidence of food insecurity being associated with self-reported postponing of needed medical care. (33)

Rather, increased utilization of health care services for diabetic patients experiencing food insecurity has been attributed at least partially to food insecure patients prioritizing the purchase of food over medications. A smaller study looking at approximately three hundred non-critically ill patients in an urban-setting ED found that eleven percent of patients were delaying the purchase of medications in order to ensure they had enough money to buy food, with this tradeoff between food and medication taking place monthly for approximately twenty five percent of that subset of patients. (32) Additionally, fourteen percent of patients reported to have fallen ill due to an inability to afford their medicine, with half of that subset of patients reportedly needing an ED visit or hospital admission as a result. (32) Analysis of data on a larger scale supports this association between food insecurity and hospital admissions. (29)

There is already significant evidence demonstrating that food insecure patients are more likely to eat nutritionally unbalanced foods, such as fast foods, that are cheaper and more accessible in low socioeconomic neighborhood but higher in calories and carbohydrates and associated with increased insulin

resistance. (34) (35) (36) A more recent study using state-level administrative data found that hospital admissions for hypoglycemia were more common for low-income patient populations. (29) The risk for a hospital admission for hypoglycemia was greatly increased by twenty-seven percent in the last week of the month compared to the first week in the low-income population, whereas no analogous temporal variation was found in the high-income population. (29) Additionally, the increase in hospital admissions for hypoglycemia was markedly increased near the end of the month when food budgets are also more likely exhausted for low-income populations, reaffirming the adverse impact of food insecurity on health outcomes and increased utilization of health care services. (29)

Housing Instability

Housing instability, similar to frequent ED use, has no standard definition. However, it can be defined as difficulty paying rent, spending more than fifty percent of household income on housing, experiencing frequent moves, living with friends and relatives or otherwise other overcrowded conditions. (33) Although there is limited data on the prevalence of housing instability, it has been widely documented that housing instability is associated with higher rates of morbidity as well as mortality. (37) (38) People who are homeless, in particular, are not only sicker but also experience increased utilization of emergency medicine services, increased rates of inpatient hospitalization, and longer duration of hospital admissions. (39) (40) (41) In addition to increased morbidity, reduced access to primary care and preventative health services also contributes to increased utilization of ED services by people suffering from homelessness. (33)

Analogous to food insecurity, housing instability is associated with not having a consistent source of health care, delaying needed medical care, and postponing the purchase of medications. (33) Furthermore, even those with stable housing but low income may experience adverse health consequences from poor quality of housing. For instance, buildings that are poorly maintained predispose their residents to indoor health hazards, such as pest infestation and mold, which trigger respiratory conditions such as asthma, elevated lead levels, which cause developmental and behavioral pathology, as well as transmission of infectious diseases, and injury. (42)

A number of interventions targeting housing instability or improving quality of housing have been evaluated. One study looked at the impact of a medical-legal partnership on identifying and addressing poor housing conditions through an outpatient pediatric clinic that largely served a low-income population. (22) Researchers found that the medical-legal partnership—through strong collaboration between clinicians, attorneys, communities, and families—was able to identify a large cluster of substandard, poor quality housing. (22) The study found that out of the forty-five children living within the sixteen identified problematic housing units, thirty-six percent of child had asthma, thirty-three percent had a developmental delay or behavioral disorder, and nine percent had elevated lead levels. (22) Subsequently, the medical-legal partnership was able to yield positive outcomes that mitigated the adverse impact of poor housing conditions on patient health by completing necessary repairs at the unit level, relocating of residents to safer

housing environments, and securing permission for air-conditioning without threat of eviction. (22)

Interventions targeting homelessness, in particular, have also been shown to be similarly effective in improving health outcomes. Preliminary findings from a YNHH-based observational study looking at the impact of a medical respite program on hospital readmission rates for homeless patients found that the respite program improved patients' access to primary care and substance use services, reduced utilization of ED services, and reduced the thirty-day inpatient readmission rate from fifty-one percent to approximately twenty-seven percent. (43) Another study assessed the impact of a "Housing First" intervention for chronically homeless patients with alcoholism found that the provision of housing (in which drinking alcohol was not prohibited) for patients yielded a significant reduction in both utilization and cost of services, including emergency medical services and hospital admissions. (44) Housing instability, housing quality, and homelessness are thus pertinent structural determinants of health for ED-based interventions to focus.

Transportation Need

Similar to both food insecurity and housing instability, transportation need has also been shown to have an adverse impact on access to health services and health outcomes. Estimates for patients who encounter transportation as a barrier to access of health care services range from ten to fifty percent, with patients who have greater comorbidities also more likely to experience transportation barriers (45) Nevertheless, transportation is widely accepted as a barrier for accessing outpatient health services, particularly for low-income patients. (46) This barrier to

access of health care services is particularly detrimental for patients with chronic illness, as it results in delays in necessary medical care and acquisition of medications through the pharmacy. (45) These delays in turn impair adherence to treatment regimens and render patients with both chronic illness and transportation barriers more vulnerable to potentially preventable exacerbations of chronic disease. (45)

Transportation need is multidimensional, and is comprised of facets such as distance to a health care facility and access to a vehicle. Distance, for instance, has been associated with mixed evidence with respect to impact on access to health care services. Studies that subjectively measured distance through self-reported information by patients on whether or not distance to a medical provider was a barrier to access of health care services concluded that distance was a barrier. (45) However, other studies that objective measured distance between patients' homes and health care facilities and its subsequent impact on utilization of health care services concluded that distance was not a barrier. (45) Thus, while perceived distance may operate as a barrier to receiving health care, there is more limited evidence supporting objective distance operating as a barrier to accessing health care services.

Additionally, the capacity to surmount a certain distance to a health care facility is likely dependent on a multitude of other factors such as access to vehicles, ability to ambulate, and ability to afford public transportation. Not surprisingly, several studies have consistently shown that access to a vehicle yielded increased access to health care services, even after adjusting for patient's socioeconomic

status. (45) Additionally, there is some evidence supporting the adverse impact of restrictions on reimbursement for travel for publicly insured patients on access to health care services. One retrospective cohort study that looked at over eighty thousand Medicaid patients found that requiring prior approval for transportation was associated with reductions in visits for primary care visits and refilled prescriptions that were partially alleviated by an increase in utilization of neighborhood health center services. (47) Specifically, the number of visits to hospital-based primary care clinics decreased by sixteen percent while the number of visits to neighborhood health centers increased by seven percent. (47) There was also a decline of visits to emergency departments and urgent care centers by eight percent, raising the concern of transportation barriers also potentially yielding delays in necessary acute medical care. (47)

Statement of Purpose

The hypothesis this study sought to investigate is whether higher prevalence of place-based structural determinants of health inequity are directly associated with increased utilization of services in the emergency department. Specific aims include:

1. Identify geographical variation in ED encounter frequencies and recurrence within the towns of Greater New Haven.
2. Identify most frequent reasons for ED visits among patients deemed as frequent ED users who are defined in this study as having four or more ED visits in one year.

3. Assess the relationship between geographical variation in variation in ED encounter frequencies and geographical variation in the structural determinants of health inequity, particularly food insecurity, limited access to transportation, and housing conditions and cost burden.
4. Evaluate the impact of both person-level factors (homelessness, history of abuse, history of substance use disorder, and history of chronic pain) and place-level factors (food insecurity, housing instability, and transportation need) on being diagnose in the ED with an ambulatory care sensitive condition, specifically angina without procedure, congestive heart failure, hypertension, asthma, chronic obstructive pulmonary disease, diabetes short-term complication, diabetes long-term complication, uncontrolled diabetes, and lower-extremity amputation among patients with diabetes.
5. Evaluate the impact of both person-level factors (homelessness, history of abuse, history of substance use disorder, and history of chronic pain) and place-level factors (food insecurity, housing instability, and transportation need) on engaging in frequent utilization of ED services and how that relationship is influenced by a patient's geographical location defined as patient's census tract.

Methods

Study design

This is a cross-sectional study of an Emergency Department database combined with data from a community-based survey to assess frequent utilization of the ED in relation to place-based determinants of health. The institutional review

board at Yale University approved this protocol and use of both datasets for this study.

Definitions

CMMI has identified five core social needs domains that must be integrated in screening and interventions; these include housing instability, food security, transportation needs, utility needs, and interpersonal safety. (48) As a participant in the AHC Model, YNHH will screen patients for needs within these five social domains. (48) In order to inform the local AHC Model, this study focuses on three of those five domains: housing instability, food insecurity, and transportation needs. These three domains were selected due to limitations in population level data availability for the Greater New Haven population through the DataHaven Community Wellbeing Survey. However, based on a recent national study of Accountable Care Organizations, these were the top three non-medical patient needs. (49)

The place-based determinants of health analyzed in this study include housing instability, food security, and transportation needs. Housing instability will be defined to include housing cost burden and housing insecurity. Housing cost burden is defined as spending more than the federally recommended 30 percent of total income on housing costs. (50) Housing insecurity was defined as a positive response to the 2015 DataHaven Community Wellbeing Survey question, "In the last 12 months, have you not had enough money to provide adequate shelter or housing for you or your family?" (51) Food insecurity was defined as a positive response to the 2015 DataHaven Community Wellbeing Survey question, "Have there been times

in the past 12 months when you did not have enough money to buy food that you or your family needed?" (51) Transportation needs was defined as a positive response to the 2015 DataHaven Community Wellbeing Survey question, "In the past 12 months, did you stay home when you needed or wanted to go someplace because you had no access to reliable transportation?" (51)

Secondary predictor variables included additional factors that entail social disadvantage: history of abuse, history of chronic pain, history of substance use disorder, and homelessness. These social disadvantage factors were identified using past medical history listed for patients in the YNHH Adult ED dataset. History of abuse was defined to include neglect, physical abuse, and sexual abuse. History of chronic pain was defined to include fibromyalgia and other generalized chronic pain. History of substance use disorder was defined to include abuse of alcohol, tobacco, and other illicit substances such as cocaine and heroin. Homelessness was defined to include self-reported homelessness or lack of shelter as discerned from past medical history provided in the YNHH ED dataset. Patients for whom an address was not provided were not assumed to be homeless and were excluded from the multilevel level analysis that took census tracts into consideration.

In this study, frequent ED utilizers are defined as patients who initiate four or more visits in the ED in a period of twelve consecutive months. Health outcomes are measured through prevention quality indicators previously established by the Agency for Healthcare Research and Quality (AHRQ). (52) The prevention quality indicators (PQIs) were developed to identify ambulatory care sensitive conditions (ACSC) which are defined by AHRQ as "conditions for which good outpatient care

can potentially prevent the need for hospitalization, or for which early intervention can prevent complications or more severe disease". (52) Specifically, the ACSCs that pertained to illness in adult patient populations were selected. These included bacterial pneumonia admission rate, dehydration admission rate, urinary tract infection admission rate, perforated appendix admission rate, angina admission without procedure, congestive heart failure admission rate, hypertension admission rate, adult asthma admission rate, chronic obstructive pulmonary disease admission rate, uncontrolled diabetes admission rate, diabetes short-term complication admission rate, diabetes long-term complication admission rate, rate of lower-extremity amputation among patients with diabetes. The ACSCs as defined by AHRQ focus on diagnoses pertain to hospital admissions for chronic illness and a more detailed categorization is provided in Table 1.

Study Setting and Patient Population

The patient population includes adults over age 18 residing in neighborhoods included in the Greater New Haven Community Index 2016. (53) Patients that had a home address within New Haven county in the East Haven, New Haven, and West Haven towns and visited the Yale-New Haven Hospital's (YNHH) Adult Emergency Department (ED) between January 1, 2014 and December 31, 2015 were included. Patients were excluded if they had no ED visits during the study period, resided outside of the Greater New Haven area throughout the entire study period, were younger than 18 years of age or presented to the Pediatric ED. This exclusion criteria was justified as the geographical scope of the study is the

greater New Haven area and the focus is on the impact of place-based determinants of health on ED utilization among adult patients.

Data Sources

Two distinct data sources were utilized for this study, one derived from Yale New Haven Hospital (YNHH) electronic health records and another derived from pre-existing DataHaven community-based survey data. The study uses data from all visits initiated in a YNHH Adult ED over a two-year period, from January 1, 2014 through December 31, 2015. Yale New Haven Hospital is located in New Haven, Connecticut. It is a 944-bed tertiary medical center, including 201 beds at the Children's Hospital and 76 beds at the Psychiatric Hospital. It is the only Level 1 Trauma Center in Southern Connecticut with an estimated 70,000 visits to the ED by adult patients each year. ED visits for ambulatory care sensitive conditions were drawn from a search of the YNHH electronic medical record from 2014 to 2015 and were identified using ICD-9 codes listed in Table 1.

Neighborhood level sociodemographics were drawn from DataHaven's Greater New Haven Community Index 2016. The Community Index combines information from U.S. Census Data, Hospital Reports, and the 2015 DataHaven Community Wellbeing Survey, which is drawn from interviews with 16,219 randomly selected adults in Connecticut. (50)

DataHaven is a non-profit organization based in New Haven, CT that was established in 1992 and operates as a partner in the National Neighborhood Indicators Partnership. (54) The National Neighborhood Indicators Partnership is a national collaborative effort by the Urban Institute that aims to foster the

development and use of neighborhood information systems in local policymaking and community building. (54)

Variables

The primary predictor variables include social need domains of food insecurity, housing, and transportation as defined by percent prevalence of the determinants of health as defined above by zip code utilizing aggregate data available through the DataHaven dataset. These variables were selected to correspond with the core social need domains identified by CMMI. Census tract served as the predictor variable to assess for regional variation in frequent ED utilization in the multilevel analysis and was constructed using individual data available through the YNHH ED dataset. The census tract was geocoded through the U.S. Census Bureau using patient address data listed in the electronic health record at time of ED visit. Secondary predictor variables that were derived from individual data in the YNHH ED dataset include demographic variables of age and gender in addition to social disadvantage factors of history of abuse, history of chronic pain, history of substance use disorder, and homelessness. Other covariates utilized from the ED dataset include disposition status (including admission, discharged, eloped, left before triage or against medical advice, transferred, and expired), employment status, encounter reason, ethnicity, site of ED visit (YNHH York Street, Shoreline, or St. Raphael's Campus), insurance, language, past medical history, race, and religion.

Outcomes

The primary outcome is frequent ED utilization and will be treated as a binary variable. Secondary outcomes include being diagnosed in the ED with an

ACSC. Specifically, these health outcomes will be measured using ICD-9 codes in the EHR database as the study period takes place before complete transition from ICD-9 to ICD-10 at YNHH took place. The ICD-9 codes were selected directly from the AHRQ's Guide to Prevention Quality Indicators. (52) The ICD-9 codes for discharge diagnoses entailing the selected ACSCs are listed in Table 1.

Data Analysis

Descriptive analyses assessing disposition status, most frequent encounter reason, patient language, and religion, and site of ED visit based on individual patient encounter were performed. Additionally, distribution of frequent ED utilization based on demographic variables and patient zip code was assessed. Exploratory data analysis utilizing chi-square contingency table analysis of categorical variables in addition to simple logistic regressions for each predictor variable and primary and secondary outcomes was performed.

Predictive analysis assessing the relationships between predictor and outcome variables was investigated using univariate logistic regression models and colinearity of predictor variables using approximated values of variance inflation factors. Likelihood ratio testing, stepwise forward and backward selection of predictors, regression diagnostics (Pearson's residuals, leverage, and influence measures), goodness-of-fit tests (Pearson's and Hosmer-Lemeshow), and sensitivity analyses were performed to assess model fit. The multivariate logistic regression model for secondary outcome of ACSC was further fit with robust variance and clustered for medical record number to account for multiple ED encounters by an individual patient by allowing for differences in the standard errors due to intra-

group correlation. Multilevel analysis was conducted for the final multivariate logistic regression model of the primary outcome of frequent ED utilization to account for variation in frequent ED utilization between census tracts in the Greater New Haven area. Ultimately, the final multivariate logistic regression model adjusted for age and gender when assessing for associations between person-level and place-level factors on the primary and secondary outcomes.

Data were analyzed using Stata 14.0. Alpha was two-tailed and was set to 0.05. The Yale University Institutional Review Board approved this study.

Student Role

Data collection and generation of the dataset containing information about the social need domains of food insecurity, housing, and transportation was conducted under the leadership of Mark Abraham, Executive Director of DataHaven. Data collection and generation of the YNHH ED dataset was conduced by Dr. Richard Andrew Taylor, Assistant Professor of Emergency Medicine and Director of ED Clinical Informatics and Analytics. Data management and all data analysis was completed by student submitting this thesis. Study design was completed with the guidance of Elizabeth Samuels, MD MPH and Tina Law, Sociology MA.

Results

A total of 139,383 patient encounters in the YNHH ED were included between January 2014 and December 2015. The vast majority of these patient encounters (99.33%) took place in the York Street Campus (Table 2). Most patients spoke English (83.67%) or Spanish (13.81%). Additionally, after Christianity, Islam

was reported as the second most frequent patient religion for 1.98 percent of patients.

For patient ED encounters belonging to the group of frequent ED users, the most frequent encounter reasons included abdominal pain (8.80%), alcohol intoxication (7.76%), chest pain (5.35%), shortness of breath (3.50%), and back pain (2.94%) (Table 3). In comparison, for patient encounters identified to belong to the group of non-frequent ED users, the most frequent encounter reasons included abdominal pain (9.35%), chest pain (5.96%), back pain (4.82%), motor vehicle crash (3.30%), and shortness of breath (3.11%) (Table 4).

There were significant differences in patient characteristics between frequent and non-frequent ED users (Table 5). Frequent ED users were older with a mean age of 43.18 compared to the mean age of 35.23 for non-frequent ED users ($p<0.001$). A significantly higher percentage of frequent ED users were Black or African American (65.13% vs. 52.36%, $p<0.001$) and American Indian or Alaska Native (5.97% vs. 0.25%). Additionally, a significantly higher percentage of frequent ED users had Medicaid (50.62% vs. 36.66%, $p<0.001$) or Medicare (15.45% vs. 11.41%, $p<0.001$) health insurance. A significantly higher percentage of frequent ED users were also unemployed (41.04% vs. 33.09%, $p<0.001$).

Chi-square analysis showed significant difference in the disposition statuses for frequent and non-frequent ED users ($\chi=1200$, $p<.001$) and are further described in Table 6. There were no appreciable differences in percentage of discharges and admissions between frequent and non-frequent ED users. However, frequent ED users had a significantly higher percentage of transfer to another facility (2.77% vs.

1.74%). Frequent ED users also had a significantly higher percentage of eloping (0.73% vs. 0.40%), leaving against medical advice (0.61% vs. 0.50%), and leaving without being seen (1.84% vs. 1.45%). Non-frequent ED users had a significantly higher percentage of patients who expired compared to frequent ED users (0.12% vs. 0.02%).

There were differences between frequent and non-frequent ED use based on zip code (Table 7). The greatest concentration of frequent ED utilization (54.20%) was located in the zip code of 06511, with the second greatest concentration of frequent ED utilization (14.48%) located in the zip code of 06513. ED utilization was similarly concentrated in the zip codes of 06511 and 06513 in descending order for non-frequent ED users but with a lower degree of clustering (31.93% and 26.16%, respectively). Clustering of the social need domains had different patterns based on zip code. The highest prevalence for food insecurity, housing instability, and transportation need was in 06519, 06511, and 06513, respectively (Table 8).

Presentation to the ED for an ACSC differed by patient demographic characteristics, person-level social disadvantage factors, and zip code level social needs indicators (Table 9). Patients who were sixty years and older had 3.57 greater odds of presenting to the ED with an ACSC compared to patients younger than sixty years of age. Female patients had 1.40 greater odds of presenting to the ED with an ACSC compared to male patients. History of chronic pain was associated with a 1.30 greater odds of presenting to the ED with an ACSC. None of the zip code level social need domains (food insecurity, housing instability, and transportation need) led to greater odds of presenting to the ED with a ACSC.

Finally, the multilevel analysis indicated significant variation in distribution of frequent ED utilization between census tracts in the Greater New Haven area (Table 10). The likelihood ratio for the multilevel model compared to the single-level multivariate logistic regression model was 128.68 (p-value <0.001), suggesting that the relationship between social need/social disadvantage factors and frequent utilization of ED services varies significantly with the patient's census tract. The variance within census tracts was noted to be 0.046 while the variance between census tracts was noted to be 3.29, reaffirming that frequent ED utilization is informed to a certain degree by geographic location (Table 10).

In the multilevel analysis, patients who were sixty years and older of age had 0.52 lower odds of being frequent ED users while gender did not significantly change the odds for frequent ED utilization (Table 10). With respect to the remaining person-level predictors, homelessness had the highest odds ratio for frequent ED utilization (3.74; CI [2.35-5.95]) followed by history of abuse (1.79; CI [1.54-2.09]) and history of substance use disorder (1.53; CI [1.37-1.69]) (Table 10). History of chronic pain was the only person-level predictor not associated with greater odds for frequent ED utilization (0.97; CI [0.80-1.17]) (Table 10).

With respect to place-level predictors, housing instability was associated with greater odds of being a frequent ED user (1.36; CI [1.33-1.39]) (Table 10). However, neither food insecurity (0.87; CI [0.86-0.88]) nor transportation need (0.952; CI [0.94-0.96]) were associated with greater odds for frequent ED utilization (Table 10).

Discussion

In this cross-sectional study of 43,537 patients who visited the Yale New Haven Health Emergency Department, compared to non-frequent ED users, frequent ED users were older and more commonly Black or African American, covered by public insurance and unemployed (Table 5). Multivariate logistic regression analysis demonstrated that both person-level factors—homelessness, history of abuse and history of substance use disorder—and place-level factors with housing instability were associated with increased likelihood for frequent ED utilization (Table 10). Using multilevel analysis, compared to within census tracts, the variance between census tracts was found to be greater, reaffirming the influence of patient's geographical location on odds for engaging in frequent ED utilization. Overall, results demonstrated that both person-level and place-level factors, related to social need and disadvantage, interact to increase one's risk for being a frequent ED user; these findings support the need to view frequent utilization of ED services as "preventable" as opposed to "inappropriate".

Many of this study's findings were congruent with previous research on the characteristics of frequent ED utilization. Frequent ED users were comprised of a significantly greater portion of patients on public insurance, with the percentage of patients on Medicaid exceeding the percentage of patients who were uninsured or on private insurance combined (Table 5). It has been previously demonstrated that patients on Medicaid insurance are not only more likely to visit the ED within a 12-month period compared to patients who were uninsured or on private insurance, but are also more likely to have four or more ED visits within 12 consecutive

months. (55) Subsequently, publicly insured patients are more likely to be frequent ED users compared to both privately insured patients and uninsured patients and this was also observed in this study's findings. Additionally, as noted in previous research, this study also found that frequent ED users are significantly more likely to be unemployed compared to non-frequent ED users, likely due an increased dependence on the "safety net" services provided by the ED (Table 5). (56)

Interestingly, there were no significant differences in the most common encounter reasons for presenting to the ED between frequent and non-frequent ED users. This lack of significant differences supports the need to challenge the treatment of frequent ED utilization as "inappropriate" and the ingrained assumption that frequent ED users are exploiting the health care system by utilizing the ED for "non-urgent" care despite growing research demonstrating frequent ED users as significantly sicker than non-frequent ED users. (5) (3) Additionally, although publicly insured patients are more likely to be frequent ED users, they are not more likely to present to the ED with a concern triaged as "non-urgent" by the ED nurses in the referenced studies. (55) Rather, patients who are uninsured, covered by Medicaid, or privately insured present to the ED with concerns that are triaged as "non-urgent" at a similar rate of approximately ten percent. (55) However, it is also imperative to recognize the structural barriers driving "non-urgent" visits to the ED, including those that are ultimately classified as ACSCs and were treated as secondary outcomes in this study.

It has been previously shown that increased insurance coverage is inversely related to changes in the rate of discharge from the ED with an ACSC. Specifically,

one retrospective cohort study looking at county-level data for the state of California between the years 2005 and 2010 found that as the insurance coverage rate increased from the tenth percentile (73.22%) to the median (78.80%), there were 0.1 fewer ED visits for ACSCs per 1000 residents ($p<0.05$). (57) These results corroborate previous research demonstrating that patients without primary care providers, such as due to lack of insurance coverage, are more likely to utilize ED services. (58) Yet, when researchers stratified ACSC into chronic and acute—with acute ACSCs including PQIs for bacterial pneumonia, dehydration, and urinary tract infection while the remaining PQIs categorized in greater detail in Table 1 were grouped under chronic ACSCs—they found that the same increase in a county's rate of insurance coverage for adults was acute associated with 0.2 fewer ED visits for acute ACSCs ($p<0.01$) but 0.1 greater ED visits for chronic ACSCs ($p<0.05$). (57) Both their and this study's findings reaffirm that insurance coverage alone does not adequately explain the disparities in frequent utilization of ED services, including for ACSCs. (55) Instead, barriers to outpatient medical care for publicly insured patients persist despite having insurance coverage.

Growing research indicates that lack of timely access to timely primary care drives many patients to utilize the ED for care, including for reasons that are deemed to be "non-urgent". (59) One study utilizing data from the National Hospital Ambulatory Medical Care Survey and focusing on chronic ACSCs of asthma, chronic obstructive pulmonary disease, congestive heart failure, diabetes, and hypertension, found that compared to the general population, Medicaid patients were disproportionately discharged from the ED with an ACSC (23% vs. 14%) and

were also less likely to have a scheduled follow-up appointment with the referring outpatient physician after discharge (OR: 0.83; CI [0.75-0.92]). (60) These findings are supported by research conducted in the city this study focuses on, New Haven, which used a "secret shopper" methodology and had people call as new patients recently discharged from the ED. (61)

The New Haven study found that Medicaid calls yielded a decreased rate for attaining an appointment within seven days after discharge and a decreased overall appointment rate (25.5%; CI [16.1–34.9])) (53.5%; CI [42.4–64.5]) compared to both state exchange (30.1%; CI [20.8–41.0]) (73.4%; CI [64.1–82.7]) and commercial insurance calls (35.7%; CI [27.1–44.2]) (77.8%; CI [70.0–85.7]). (61) Furthermore, a YNHH-based qualitative study focusing on publicly insured frequent ED users found that reasons for frequent ED use included barriers to accessing primary care that extended beyond timely access such as limited self-efficacy for navigating multiple outpatient appointments and previous adverse outpatient health care experiences such as those related to feeling concerns were not being seriously addressed by provider and stigma of being a Medicaid patient as felt through overheard comments from clinic staff. (62) These findings reaffirm the need to focus on both individual and place-based structural determinants of health, including primary care systems that were not directly addressed in this study, when examining risk for frequent ED use.

In this study, frequent ED users were also much more likely to present with alcohol intoxication and suicidal ideation compared to non-frequent ED users and psychiatric evaluation was present as one of the ten most frequent encounter

reasons for frequent ED users only (Tables 3 and 4). This is consistent with previous research demonstrating that frequent ED users are much more likely to make visits to the ED for mental health, alcohol, or drug-related concerns compared to non-frequent ED users. (63) Encounter reasons such alcohol intoxication and suicide are examples of potentially preventable causes of death that are particularly prevalent among frequent ED users and, consequently, are especially pertinent targets for ED-based public health screenings and interventions. (64) (65)

A significantly higher percentage of frequent ED users were also Black or African American and American Indian or Alaska Native, consistent with previous research showing higher rates of ED utilization for non-Hispanic Black and Native American patients. (55) (66) Additionally, as discussed earlier, frequent ED users are generally sicker with greater co-morbidities and it has been well-documented that Black and Native American patients disproportionately suffer from chronic diseases such as cardiovascular disease, diabetes, and asthma. (67) However, it is important to recognize that similar to other potential predictive factors for frequent ED utilization, race may only be associated with high levels of emergency use in urban areas. (68) Consequently, public health interventions and policy solutions must consider the "interactive effects of geography and population characteristics". (68)

Geographic clustering of frequent ED utilization and the social need domains was observed in this study, as hypothesized. However, no distinct geospatial correlation between frequent ED utilization and clustering of any of the social need domains could be established. This was largely due to the limitation of having place-

based determinants of health that were derived from zip codes of a relatively small urban region of the Greater New Haven area. Nevertheless, these findings can still support subsequent endeavors of more granular hot spotting that facilitate the implementation of targeted interventions for social determinants of health in New Haven.

Homelessness, history of abuse, history of substance use disorder, and history of chronic pain were person-level social disadvantage predictors for frequent ED utilization. The predictor of homelessness was a natural relocation of the locus for the housing social need domain from a geographic unit of analysis (zip code) to the individual and is a well-established indicator of social disadvantage. (69) Abuse and social disadvantage also have a widely accepted bidirectional relationship that ultimately yields an adverse effect on an individual's health. (70) Abuse can hurt social networks and cohesion in communities, and individuals residing in socioeconomically disadvantaged communities are at greater risk of exposure to abuse. (70) Greater prevalence of substance use disorder was observed among frequent ED users, consistent with prior studies. (71) (72) Chronic pain has also been shown in prior studies to be more prevalent among frequent ED users compared to non-frequent ED users. (73) Proposed mechanisms for the relationship between chronic pain and frequent ED use relate to coping mechanisms, racial bias, and occupations disproportionately accessible by individuals with low socioeconomic backgrounds. (74)

Implementation of effective public health screenings for conditions like intimate partner violence, tobacco addiction, and alcohol abuse have been used to

effectively identify patients in the ED who would benefit from additional services to address these social needs. (75) The impact of ED-based interventions for frequent ED users that targeted these social disadvantage factors were effective in reducing utilization of ED services as well as ameliorating the level of the social disadvantage under consideration such as by helping patients recover from alcohol abuse through facilitating connections with rehabilitation programs. For instance, one study that examined the impact of case management on homelessness and substance use among frequent ED users in a public urban ED was shown to be effective in significantly reducing the prevalence of homelessness, alcohol use, and drug use, in addition to decreasing the number of ED visits and costs while increasing patient linkage with primary care services. (12)

Frequent ED users have a worse health status compared to non-frequent ED users and are significantly more likely to have pulmonary disease, cardiovascular disease, and other chronic diseases. (76) Subsequently, it is particularly relevant to assess for the impact of potential predictors for frequent ED use on presenting to the ED with an ambulatory care sensitive condition previously defined and categorized in greater detail in Table 1. Presentations with an ACSC are also rendered as prevention quality indicators that have been established by the AHRQ. (52)

Not surprisingly, older patients had significantly greater odds of presenting with an ACSC due to their increased likelihood of having multiple chronic conditions, which in turn is associated with worse health with respect to activities of daily living and quality of life. (77) Diminished activities of daily living and quality of

life presumably hinder the patients' ability to engage in preventative measures for exacerbations of chronic illness such as medication adherence. (78) Similarly, patients suffering from chronic pain could have an impaired ability to engage in preventative measures for exacerbations of chronic illnesses, causing them to also be more at risk for presenting to the ED with an ACSC.

The gender disparities in presentation to the ED with an ACSC with female patients being more at risk are likely multifactorial. One recent study on acute exacerbations of chronic obstruction pulmonary disease, for instance, found that women are less likely to initiate at-home therapy with anticholinergic medications despite comparable levels of self-reported severity of symptoms compared to their male counterparts. (79) However, this study also found that women are less likely to seek emergency care within the first twenty-four hours after onset of symptoms. (79) It is also possible that provider gender bias plays a role in prescribing of appropriate medications in patients with chronic disease. For instance, a recent study looking at patients with type 2 diabetes and coronary heart disease found that female patients were significantly less likely to be prescribed ACE inhibitors and calcium channel blockers. (80) Another multicenter study examining patients with asthma or chronic obstructive pulmonary disease found that male patients were significantly more likely to be prescribed the newer dry powder inhalers compared to female patients. (81) These differences in prescribing may contribute to the higher rates of ED utilization among women.

The lack of evidence for any of the social need domains (food insecurity, housing instability, and transportation need) yielding a greater risk for presenting

to the ED with an ACSC was particularly surprising in the setting of well-established evidence showing the adverse impact of structural determinants of health on access to medical services and health outcomes. (82) It is plausible that the ascertainment of these social need domains through aggregate measured data in relatively largely geographic units hindered the capacity to capture the true relationships between the studied place-based determinants of health and presentation to the ED with an ACSC. Nevertheless, these findings merit greater future investigation into the impact of social need domains relevant to the model of Accountable Health Communities on Prevention Quality Indicators established by the Agency for Healthcare Research and Quality.

Some of the multilevel analysis findings were consistent with hypothesized relationships between geographic location and frequent ED utilization. A patient's geographic location was associated with various social need and social disadvantage factors and on a patient's predisposition to becoming a frequent ED user. These findings affirm the need to design and implement ED-based interventions to address various structural determinants of health that appropriately take geographic distribution of social need and disadvantage into consideration.

Additionally, results of the multilevel analysis confirmed findings of previously discussed studies on the impact of social disadvantage factors, specifically homelessness, history of abuse, and history of substance use disorder, on risk for frequent ED utilization. However, the impact of older age in reducing the odds of being a frequent ED user was somewhat inconsistent with previous research demonstrating that frequent ED users are more likely to belong older age groups,

possibly due to the declining health of older adults who are in greater need of more frequent medical attention. (83) (17) Yet, one study that found that frequent ED users are more likely to be older looked at adults between thirty-five and sixty-four years of age and compared them to younger patients of eighteen and thirty-four years of age and both of these age ranges are included in the younger age category for this study. (16)

Although this study was unable to perform geospatial analysis between the selected place-based determinants of health (food insecurity, housing instability, and transportation) and hot spotting of frequent ED utilization due to limitations in available geocoded data for the determinants of health in the community DataHaven dataset specifically, future design and evaluation of ED-based interventions should still strive to utilize as much local data as possible in order to keep the interventions as relevant and targeted as possible. Conversely, the person-level data derived from the YNHH ED dataset did include individual addresses that were successfully geocoded to census tracts. Nonetheless, these aforementioned limitations in the data also likely obscured the discernible association between place-level predictors and frequent ED utilization as, unlike what previous evidence suggests, only housing instability was found to yield greater odds of being a frequent ED user.

Limitations

This study has a number of limitations. The focus on one city, New Haven, CT, limits the generalizability of the study's findings to other geographic locations, particularly with respect to rural settings. However, the study's methods and findings can be applied to similar urban settings, especially in cities with academic

emergency departments that have a comparable resource capacity and include vulnerable populations in patient populations served.

Furthermore, we used patient data from a single ED, which may result in under-reporting the number of frequent ED utilizers, if patients used multiple EDs. As such, our estimates are likely conservative. Previous research has demonstrated that patients often have "crossover" visits that entail visits to more than one ED in a single geographic region. (8) This phenomenon is particularly salient among frequent ED users. (8) Crossover visits were minimal in this study given the expanded catchment area of the Yale New Haven Hospital System, which includes all EDs in the Greater New Haven area including York Street Campus, St. Raphael's Campus and Shoreline Campus.

Additionally, interventions targeting repeat ED utilization for an acute injury would inevitably have distinct differences compared to interventions that would effectively target repeat ED utilization for exacerbation of a chronic illness. (83) This study, like most previous literature on frequent ED utilization, does not distinguish between different patterns of use of emergency health services. (83) Yet, the majority of the prevention quality measures included in this study target chronic diseases as opposed to measures that often entail greater short-term resource intensity, such as motor vehicle accidents or head trauma, rendering differences in temporal trends of frequent ED use less relevant for the purpose of our research aims. (84)

The primary predictor variables of place-based determinants of health relied on data based on zip code rather than individuals. Individual data on food, housing,

and transportation needs were not available. A significant portion of the DataHaven data with the aforementioned variables of interest was also not geocoded to Census Tract and there were no addresses provided for the DataHaven participants that could be utilized to geocode to perform a more granular analysis of the impact of these place-based determinants of health. However, an assessment of the geographic distribution of frequent ED utilization based on zip code adjusted for individual social disadvantage factors and aggregate social need data is still useful to understand the interaction of macro and micro social determinants on health.

Finally, a disproportionate portion of the missing data was for individuals later identified to be frequent ED users, rendering it more difficult to assess for significant relationships between hypothesized predictors of social need or disadvantage and ED utilization. It is certainly counterintuitive that a greater percentage of data would be missing for a subgroup that arguably had greater opportunities to have its data captured. Data was missing for frequent ED users at comparable levels spanning across the categories of race, ethnicity, insurance, and employment. It is possible that the same stigma associated with many of the risk factors for frequent ED utilization, such as housing instability, also influences the patient's capacity or predisposition to comprehensively provide responses to the corresponding questions for those categories (5)

Recommendations for Future Research

There is a significant amount of existing research on the adverse impact of structural determinants of health on access to health care services and a growing amount of research on the adverse impact of place-based determinants on tangible

health outcomes. However, there is still limited research on the impact of ED-based interventions targeting various structural determinants of health on not just utilization of ED services, but also on health outcomes in the acute setting and after discharge. Furthermore, as mentioned earlier, in order to effectively design and implement ED-based interventions, it is imperative to first conduct more granular assessments of place-based determinants of health utilizing geocoding.

Geospatial analysis, in particular, is increasingly being applied to inform tailored interventions that target vulnerable patients by identifying geographic variations in risks for poor health. (85) Place-based data reveals significant information regarding the physical, economic, and psychosocial environments that entail structural determinants of health such as quality of housing, education, and exposure to crime. (86) The integration of place-based data into electronic health data can yield a real-time means of stratifying a patient's risk level, such as for an asthma exacerbation, and subsequently connecting the patient to an appropriate upstream intervention such as access to transportation. (86)

Ultimately, detailed assessments of place-based determinants of health would permit for greater understanding of geographic clusters of frequent ED utilization that could benefit from targeted interventions. Such assessments would also generate more necessary information on the interaction between person-level and place-level determinants of health. In addition to targeting frequent ED users, ED-based screenings and interventions must also be employed for other marginalized patient populations that may actually underutilize ED services due to stigma and other structural barriers.

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Table 1. ICD-9 Codes of Ambulatory Care Sensitive Conditions (ACSC) Defined by the Agency for Healthcare Research and Quality (AHRQ)

Ambulatory Care Sensitive Condition	**ICD-9 Code**
Bacterial Pneumonia Admission	
Pneumococcal pneumonia	481
H. influenzae pneumonia	4822
Bacterial pneumonia, not otherwise specified	4829
Mycoplasma pneumonia	4830
Chlamydia pneumonia	4831
Other specified organic pneumonia	4838
Strep pneumonia unspecified	48230
Group A Strep pneumonia	48231
Group B Strep pneumonia	48232
Other Strep pneumonia	48239
Broncopneumonia organic, not otherwise specified	485
Pneumonia, organism, not otherwise specified	486
Dehydration Admission	
Hypovolemia	2765
Urinary Tract Infection Admission	
Chronic pyelonephritis, not otherwise specified	59000
Chronic pyelonephritis with medullary necrosis	59001
Acute pyelonephritis, not otherwise specified	59010
Acute pyelonephritis with medullary necrosis	59011
Renal/perirenal abscess	5902
Pyeloureteritis cystica	5903
Pyenlonephritis, not otherwise specified	59080
Pyelonehritis, in diseases classified elsewhere	59081
Infection of kidney, not otherwise specified	5909
Acute cystitis	5950
Cystitis, not otherwise specified	5959
Urinary tract infection, not otherwise specified	5990
Perforated Appendix Admission	
Acute appendicitis with peritonitis	5400
Abscess of appendix	5401
Angina Admission Without Procedure	
Intermediate Coronary Syndrome	4111
Coronary occlusion without a myocardial infarction	41181
Acute ischemic heart disease, not elsewhere classified	41189
Angina decubitus	4130
Prinzmetal angina	4131
Angina pectoris, not elsewhere classified/not otherwise specified	4139
Congestive Heart Failure (CHF) Admission	
Rheumatic heart failure	39891
Malignant hypertensive heart disease with CHF	40201
Benign hypertensive heart disease with CHF	40211
Hypertensive heart disease with CHF	40291
Malignant hypertensive heart and chronic kidney disease with CHF	40401
Malignant hypertensive heart and chronic kidney disease with CHF and renal failure	40403
Benign hypertensive heart and chronic kidney disease with CHF	40411
Benign hypertensive heart and chronic kidney disease with CHF and renal	40413

failure	
Hypertensive heart and chronic kidney disease, not otherwise specified, with CHF	40491
Hypertensive heart and chronic kidney disease, not otherwise specified, with CHF and renal failure	40493
Congestive heart failure	4280
Left heart failure	4281
Heart failure, not otherwise specified	4289
Hypertension Admission	
Malignant hypertension	4010
Hypertension, not otherwise specified	4019
Malignant hypertensive heart disease without CHF	40200
Benign hypertensive heart disease without CHF	40210
Hypertensive heart disease without CHF	40290
Malignant hypertensive heart disease without renal failure	40300
Benign hypertensive heart disease without renal failure	40310
Hypertensive heart disease without renal failure	40390
Malignant hypertensive heart and chronic kidney disease without CHF or renal failure	40400
Benign hypertensive heart and chronic kidney disease without CHF or renal failure	40410
Hypertensive heart and chronic kidney disease without CHF or renal failure	40490
Adult Asthma Admission	
Extrinsic asthma without status asthmaticus	49300
Extrinsic asthma with status asthmaticus	49301
Extrinsic asthma with acute exacerbation	49302
Intrinsic asthma without status asthmaticus	49310
Intrinsic asthma with status asthmaticus	49311
Intrinsic asthma with acute exacerbation	49312
Chronic obstructive asthma without status asthmaticus	49320
Chronic obstructive asthma with status athmaticus	49321
Chronic obstructive asthma with acute exacerbation	49322
Asthma without status asthmaticus	49390
Asthma with status asthmaticus	49391
Asthma with acute exacerbation	49392
Chronic Obstructive Pulmonary Disease Admission	
Simple chronic bronchitis	4910
Mucopurulent chronic bronchitis	4911
Obstructive chronic bronchitis without acute exacerbation	49120
Obstructive chronic bronchitis with acute exacerbation	49121
Chronic bronchitis, not elsewhere classified	4918
Chronic bronchitis, not otherwise specified	4919
Emphysematous bleb	4920
Emphysema, not elsewhere classified	4928
Bronchiectasis	494
Bronchiectasis without acute exacerbation	4940
Bronchiectasis with acute exacerbation	4941
Chronic airway obstruction, not elsewhere classified	496
Uncontrolled Diabetes Admission	
Diabetes mellitus, type 2, uncontrolled	25002
Diabetes mellitus, type 1, uncontrolled	25003
Diabetes Short-Term Complication Admission	
Diabetes mellitus type 2 with ketoacidosis, controlled	25010

Diabetes mellitus type 1 with ketoacidosis, controlled	25011
Diabetes mellitus type 2 with ketoacidosis, uncontrolled	25012
Diabetes mellitus type 1 with ketoacidosis, uncontrolled	25013
Diabetes mellitus type 2 with hyperosmolarity, controlled	25020
Diabetes mellitus type 1 with hyperosmolarity, controlled	25021
Diabetes mellitus type 2 with hyperosmolarity, uncontrolled	25022
Diabetes mellitus type 1 with hyperosmolarity, uncontrolled	25023
Diabetes mellitus type 2 with coma, controlled	25030
Diabetes mellitus type 1 with coma, controlled	25031
Diabetes mellitus type 2 with coma, uncontrolled	25032
Diabetes mellitus type 1 with coma, uncontrolled	25033
Diabetes Long-Term Complication Admission	
Diabetes mellitus type 2 with renal complications, controlled	25040
Diabetes mellitus type 1 with renal complications, controlled	25041
Diabetes mellitus type 2 with renal complications, uncontrolled	25042
Diabetes mellitus type 1 with renal complications, uncontrolled	25043
Diabetes mellitus type 2 with eye complications, controlled	25050
Diabetes mellitus type 1 with eye complications, controlled	25051
Diabetes mellitus type 2 with eye complications, uncontrolled	25052
Diabetes mellitus type 1 with eye complications, uncontrolled	25053
Diabetes mellitus type 2 with neurological complications, controlled	25060
Diabetes mellitus type 1 with neurological complications, controlled	25061
Diabetes mellitus type 2 with neurological complications, uncontrolled	25062
Diabetes mellitus type 1 with neurological complications, uncontrolled	25063
Diabetes mellitus type 2 with peripheral circulatory disorders, controlled	25070
Diabetes mellitus type 1 with peripheral circulatory disorders, controlled	25071
Diabetes mellitus type 2 with peripheral circulatory disorders, uncontrolled	25072
Diabetes mellitus type 1 with peripheral circulatory disorders, uncontrolled	25073
Diabetes mellitus type 2 with complications, not elsewhere classified, controlled	25080
Diabetes mellitus type 1 with complications, not elsewhere classified, controlled	25081
Diabetes mellitus type 2 with complications, not elsewhere classified, uncontrolled	25082
Diabetes mellitus type 1 with complications, not elsewhere classified, uncontrolled	25083
Diabetes mellitus type 2 with complications, not otherwise specified, controlled	25090
Diabetes mellitus type 1 with complications, not otherwise specified, controlled	25090
Diabetes mellitus type 2 with complications, not otherwise specified, uncontrolled	25092
Diabetes mellitus type 1 with complications, not otherwise specified, uncontrolled	25093

Table 2. Adult Emergency Department Visits by Site

ED Site	Frequency	Percentage
St. Raphael's Campus	442	.32
Shoreline Campus	497	.36
York Street Campus	138,444	99.33
Total	***139,383***	***100***

Table 3. Top 10 Encounter Reasons for Frequent Emergency Department Utilizers (N=56,773)

Encounter Reason	Frequency	Percentage
Abdominal Pain	4,996	8.80
Alcohol Intoxication	4,410	7.76
Chest Pain	3,041	5.35
Shortness of Breath	1,988	3.50
Back Pain	1,670	2.94
Suicidal	1,510	2.66
Cough	1,424	2.51
Fall	1,089	1.92
Psychiatric Evaluation	1,085	1.91
Sore Throat	1,024	1.80

Table 4. Top 10 Encounter Reasons for Non-Frequent Emergency Department Utilizers (N=91,155)

Encounter Reason	Frequency	Percentage
Abdominal Pain	8,523	9.35
Chest Pain	5,437	5.96
Back Pain	3,210	4.82
Motor Vehicle Crash	3,005	3.30
Shortness of Breath	2,840	3.11
Fall	2,506	2.75
Cough	2,105	2.31
Alcohol Intoxication	2,014	2.21
Dizziness	1,846	2.02

Table 5. Demographics for Frequent vs. Non-Frequent Emergency Department Utilizers [A]

		Frequent ED User (N=8,018)	**Non-Frequent ED User** (N=35,519)	***p***	**Test**
Age	Mean(SD)	43.18(.0986)	35.23(.1772)	<.001	T
	Missing (%)	0.00	0.00		
Gender					
Male	Count (%)	4,172 (52.03)	18,751 (52.79)	.219	Chi-Square
Female	Count (%)	3,846 (47.97)	16,768 (47.21)		
	Missing (%)	0.00	0.00		
Race					
American Indian or Alaska Native	Count (%)	11 (5.97)	58 (0.25)	<.001	Chi-Square
Asian	Count (%)	23 (1.25)	741 (3.24)		
Black or African American	Count (%)	1,200 (65.13)	11,959 (52.36)		
Native Hawaiian or Other Pacific Islander	Count (%)	0 (0.00)	63 (0.28)		
Other	Count (%)	5 (0.27)	65 (0.28)		
White or Caucasian	Count (%)	605 (32.81)	9,952 (43.58)		
	Missing (%)	77.00	35.70		
Ethnicity					
Hispanic or Latino	Count (%)	672 (24.50)	10,539 (30.01)	<.001	Chi-Square

Non-Hispanic	Count (%)	2,071 (75.50)	24,585 (69.99)		
	Missing (%)	65.79	1.11		
Insurance					
Private	Count (%)	344 (12.51)	10,321 (29.06)	<.001	Chi-Square
Medicaid	Count (%)	1,392 (50.62)	13,020 (36.66)		
Medicare	Count (%)	425 (15.45)	4,053 (11.41)		
Other	Count (%)	561 (20.4)	7,797 (21.95)		
Self pay	Count (%)	28 (1.02)	328 (0.92)		
	Missing (%)	65.70	0.00		
Employment					
Disabled	Count (%)	528 (19.26)	1,989 (5.66)	<.001	Chi-Square
Full Time	Count (%)	427 (15.58)	10,832 (30.81)		
Not Employed	Count (%)	1,125 (41.04)	11,633 (33.09)		
On Active Military Duty	Count (%)	1 (0.04)	9 (0.03)		
Part Time	Count (%)	182 (6.64)	3,282 (9.34)		
Retired	Count (%)	370 (13.50)	4,707 (13.39)		
Self Employed	Count (%)	34 (1.24)	721 (2.05)		
Student – Full Time	Count (%)	71 (2.59)	1,919 (5.46)		
Student – Part Time	Count (%)	3 (0.11)	66 (0.19)		
	Missing (%)	65.81	1.02		

A- Encounter-level data described in Tables 2-3 was first collapsed to patient-level data before conducting subsequent data analysis

Table 6. Disposition for Frequent vs. Non-Frequent Emergency Department Utilizers (χ=1200, p<.001)

Status	**Frequent ED User** *n(%)*	**Non-Frequent ED User** *n(%)*	**Total** *n(%)*
Discharge	36,323 (70.04)	62,412 (72.30)	98,735 (71.45)
Admit	12,315 (23.75)	20,035 (23.21)	32,350 (23.41)
Transfer to Another Facility	1,436 (2.77)	1,506 (1.74)	2,942 (2.13)
LWBS after Triage	883 (1.70)	1,138 (1.32)	2,021 (1.46)
AMA[A]	316 (0.61)	428 (0.50)	744 (0.54)
Eloped	380 (0.73)	342 (0.40)	722 (0.52)
Send to L&D[B]	48 (0.09)	166 (0.19)	214 (0.15)
LWBS before Triage[C]	73 (0.14)	108 (0.13)	181 (0.13)
Observation	75 (0.14)	89 (0.10)	164 (0.12)
Expired	12 (0.02)	103 (0.12)	115 (0.08)
Total	51,861 (100)	86,327 (100)	138,188 (100)

A - Against Medical Advice
B – Labor and Delivery
C – Left Without Being Seen

Table 7. Frequent ED Utilization Based on Patient Zip Code in Greater New Haven (χ=1900, p<.001)

Zip Code	**Frequent ED User (count,%)** (n=6,939)	**Non-Frequent ED User (count,%)** (n=35,149)
06510	516 (7.44)	954 (2.71)
06511	3,761 (54.20)	11,224 (31.93)
06512	504 (7.26)	5,591 (15.91)
06513	1,005 (14.48)	9,195 (26.16)
06515	463 (6.67)	3,170 (9.02)
06519	690 (9.94)	5,015 (14.27)

Table 8. Geographic Distribution of Food, Housing, and Transportation Social Need Domains[A]

Zip Code	**Food Insecurity (% Prevalence)**	**Housing Instability (% Prevalence)**	**Transportation Need (% Prevalence)**
06510	11.76	5.88	11.76
06511	14.97	8.76	16.95
06512	16.84	5.26	11.58
06513	19.77	8.14	23.84
06515	10.58	4.81	19.23
06519	20.31	8.59	20.31

A- Percent prevalence of social need domains was calculated using DataHaven data by zip code.

Table 9. Association of ED Presentation for an Ambulatory Care Sensitive Condition (ACSC) with Food, Housing, and Transportation Social Need Domains Adjusted for Person-level Predictors

Variable	**Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Percent Positive for ACSC** (n=18,737)	**Percent Negative for ACSC** (n= 131,973)	**P-value**
Person-level Predictors					
Age					
>=60 years	3.76 (3.56-3.98)	3.57 (3.38-3.77)	27.20	72.80	<.001[A]
<60 years	Ref	Ref	9.03	90.97	
Gender					
Female	1.40 (1.33-1.490	1.40 (1.32-1.48)	14.16	85.84	<.001[A]
Male	Ref	Ref	10.51	89.49	

Homelessness (Y)	.46 (.33-.63)	.54 (.38-.76)	6.16	93.84	<.001[A]
(N)	Ref	Ref	12.59	87.41	
History of Abuse (Y)	.62 (.54-.72)	.72 (.63-.83)	8.37	91.63	<.001[A]
(N)	Ref	Ref	12.81	87.19	
History of Substance Use Disorder (Y)	1.05 (.95-1.15)	1.30 (1.19-1.43)	12.87	87.13	.028[A]
(N)	Ref	Ref	12.35	87.65	
History of Chronic Pain (Y)	1.49 (1.31-1.70)	1.30 (1.13-1.50)	17.17	82.83	<.001[A]
(N)	Ref	Ref	12.18	87.82	
Place-level Predictors					
Food Insecurity	1.03 (1.02-1.04)	1.03 (1.02-1.05)	16.96 (mean)	16.65 (mean)	<.001[B]
Housing Instability	.96 (94-.98)	.96 (.94-.98)	7.65 (mean)	7.74 (mean)	<.001[B]
Transportation Need	1.01 (1.00-1.01)	1.00 (.99-1.01)	18.56 (mean)	18.48 (mean)	.009[B]

A - Chi-squared test
B - Two-sample t-test

Table 10. Variation of Impact of Individual- and Place-level Predictors on Frequent ED Utilization by Patient Census Tract

Variable	**Adjusted OR (95% CI)**	**Standard Error**
Intercept	0.46	0.050
Person-level Predictors		
Age [<60 years Ref]	0.52 (0.48-0.57)	0.022
Gender [Male Ref]	0.99 (0.94-1.05)	0.027
Homelessness	3.74 (2.35-5.95)	0.887
History of Abuse	1.79 (1.54-2.09)	0.140
History of Substance Use Disorder	1.53 (1.37-1.69)	0.082
History of Chronic Pain	0.97 (0.80-1.17)	0.092
Place-level Predictors		
Food Insecurity	0.87 (0.86-0.88)	0.005
Housing Instability	1.36 (1.33-1.39)	0.014
Transportation Need	0.95 (0.94-0.96)	0.004
Variance Components	*Variance*	
Within Census Tracts	0.046	0.013
Between Census Tracts	3.286	0.004