The Role of Social and Clinical Determinants in the Frequent Utilization of Emergency Departments

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Acknowledgments

This work has been in many ways a culmination of a multitude of experiences in my upstream pursuit of 'the causes of the causes of the causes' of poor health outcomes. This reference to the famed model of public health epidemiology aptly describes the roles of individual physical and mental health outcomes, health care services delivery, health behaviors, public benefits, and social determinants that are captured within this dissertation. In addition, it is analogous to my personal public health journey from physician, to public health practitioner, to proponent for policy change. Significantly, this work unifies the stages of evolution in my understanding of the constructs and consequences of a better performing health system geared towards population health outcomes.

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This dissertation signifies not only an academic milestone, but a testament to a life of service, scientific inquiry and public health leadership. I excitedly look forward to applying the freshly honed skills and perspectives arising from this work in the next lap of my public health journey.

Abstract of Dissertation

The Role of Social and Clinical Determinants in the Frequent Utilization of Emergency Departments

Objective: Patients who utilize Emergency Department (ED) services at least four times per year, also referred to as frequent utilizers of EDs (FUEDs) comprise a high-cost-high-need vulnerable group of patients. Persistent ED users, people who use the ED 4 or more times for two consecutive years are a subset of FUEDs with the greatest needs and poorest health outcomes. FUEDs are less than 10% of all ED patients but account for a quarter of ED visits. Much of the research to date has focused on the clinical conditions and high use of health care services of FUEDs, much less is known about the impact of social determinants of health (SDH) on FUEDs. In this dissertation, I use the WHO CSDH framework to examine the relationship of social and clinical determinants and FUEDs' unmet social and clinical needs, total and preventable ED visits, and persistent ED use.

Study Design: Analysis of claims data merged with interview data from George Washington University Hospital (GWUH) Frequent User Study was used in a retrospective cohort study design. I used multivariate linear, negative binomial and logistic regression respectively to model the three main study outcomes: (1) number of unmet needs; (2) total and preventable ED visits; and (3) persistent ED use, as a function of structural SDH (education, employment, income), intermediary SDH (homelessness, food insecurity, social support) and clinical determinants (access to care, clinical illness severity, care continuity, behavioral health status) of health.

Population Studied: 474 DC Medicaid beneficiaries, 18-64 years, who attended GWUH between October 2015 – 2016 and had 4 or more ED visits in a calendar year.

Principal Findings: In Aim 1, 24 unmet needs grouped into 4 unique domains based on a factor analysis: material resources, health care management and literacy, employment and family-related needs. FUEDs experienced an average of 5.7 unmet needs and had a high burden of

mental illness (60%). 80% reported material resource needs, such as housing, food, and transportation. 56% reported health care management and literacy needs (HCML) including dental (30%), medical care needs (22%) and psychiatric needs (20%). 45% reported employment related needs. When the number of unmet needs was modeled as a function of social (SDH) and clinical determinants of health, SDH contributed to 37% of the variance in the number of unmet needs while clinical determinants contributed less (18%). Poor access to food and shelter (β 3.12, CI 1.78,4.45), and poor behavioral health status (β 1.58, CI 0.49, 2.66) were associated with increased number of unmet needs. Social support (β -0.88, CI -1.24, -0.52) and higher income levels (β -1.92, CI -3.22, -0.63) were associated with decreased number of unmet needs.

Aim 2 revealed that in one year, FUEDs had an average of 16.2 total ED visits and 30% of these ED visits were preventable. 60% of FUEDs had a diagnosed mental illness but there was significant underutilization of psychiatric services (mean 1.2, SD 4.4). Multivariate analyses revealed that increased physical illness severity, poor behavioral health status, inadequate food and shelter were associated with an increased number of total and preventable ED visits. For example, a one unit increase in the level of social support was associated with a 6% decrease in the number of total (IRR 0.94, CI 0.88, 1.01) ED visits and 14% decrease in preventable (IRR 0.86, CI 0.77, 0.96) ED visits. Physical illness severity and care continuity had a significant positive interaction effect upon both total (IRR 0.90, CI 0.85 0.96) and preventable ED utilization (IRR 0.89, CI 0.81, 0.97).

Aim 3 showed that persistent FUEDs are sicker than non-persistent FUEDs. Greater duration of unemployment (OR 1.83) and cumulative homelessness (OR 2.03) were significantly associated with persistent ED use, however adjusting for access to public assistance renders their effects non-significant. Public assistance is strongly and positively associated with increased odds of persistent ED use (OR 2.24), and may buffer the influence of cumulative homelessness and severe behavioral illness on the odds of persistent ED use. Greater physical illness severity is strongly associated with persistent ED use (OR 3.11).

Conclusion: Frequent ED use will not change substantially without addressing SDH such as low social support and lack of adequate food and housing that significantly contribute to the unmet needs, frequent and persistent ED utilization. Behavioral health is a significant clinical determinant of unmet needs and total and preventable ED utilization among FUEDs. Clinical determinants such as increased clinical illness severity are significant drivers of persistent ED use, with social determinants having lesser influence.

Policy Implications: This research is directly applicable to DC Medicaid Care Coordination initiatives whereby patients with multiple chronic illnesses can receive a care coordination benefit. Some of the clinical problems cannot be coordinated effectively in this high need vulnerable population unless social adversities are addressed. Curbing ED use by FUEDs will require a two-pronged approach: adequate and coordinated ambulatory care for those most at risk as well as attention to specific social determinants they experience. Data from this research can inform state based Accountable Health Community and Health Home initiatives. FUEDs will benefit from tailored interventions that address food and housing needs and provide social support, especially in a patient population that has a high burden of mental illness. A data infrastructure to assess a comprehensive array of social needs alongside clinical needs should be incorporated at EDs and primary care sites for such high-need high-cost patients. Information from such a data infrastructure can also be used to increase alignment of Medicaid services with other safety net agencies to enable resource allocation efficiencies. This information can also be used to better prioritize public resources.

Table of Contents

Acknowledgements…… iv
Abstract …….. vi
List of Figures……..... xi
List of Tables……. xii
Chapter One: Background 1
1.2. Public Health Significance 2
1.3. Purpose of the Research 5
1.4. Policy Implications of the Research 6
Chapter Two: Conceptual Framework and Literature Review.....9
2.1. Conceptual Framework 9
2.2. Literature Review 15
2.2.1. Characteristics of FUEDs 15
2.2.2. Health care Utilization and FUED.....19
2.2.3. Persistent FUEDs 26
2.2.4. Unmet Needs of FUEDs 27
2.2.5. Knowledge Gaps 30
Chapter Three: Methods 35
3.1.1. Overview of the Study.....35
3.1.2. Study Setting and Population 35
3.1.3. Data Sources.....36
3.2. Aims and Hypotheses 39
3.2.1. Aim 1 and Hypotheses.....39
3.2.2. Aim 2 and Hypotheses.....39
3.2.3. Aim 3 and Hypotheses.....40
3.3. Variable Construction: Dependent (Outcome) Variables.....41
3.3.1 Aim 1 Outcome Variable: Number of Unmet Needs 41
3.3.2. Aim 2 Outcome Variables: Total and Preventable ED Utilization.....45
3.3.3. Aim 3 Outcome Variable: Persistent ED Use (PED) 48
3.4. Variable Construction: Independent Variables.....49
3.4.1. Social Determinants of Health (SDH). 52
3.4.2. Public Benefits 52

3.4.3. Clinical Conditions 53
3.4.4. Care Continuity (CC) 54
3.4.5. Access to regular care 56
3.5. Correlation and Endogeneity 57
3.6. Data Analysis 59
3.6.1. Aim 1 Data Analysis 59
3.6.2. Aim 2 Data Analysis 61
3.6.3. Aim 3 Data Analysis 62
Chapter Four: Results 64
4.1. Aim 1 Results 64
4.2. Aim 2 Results 79
4.3. Aim 3 Results 90
Chapter Five: Discussion 99
5.1. Interpretation of findings 99
5.2. Contributions 104
5.3. Limitations 109
5.3. Policy Implications and Recommendations 112
5.4. Conclusion 117

List of Figures

Figure 1: WHO Commission on Social Determinants of Health (CSDH) Conceptual Framework. Source: WHO. Commission on Social Determinants of Health. A conceptual framework for action on the social determinants of health. Discussion paper 2007. 9

Figure 2: Analytic Framework 13

Figure 3: Distribution of Variable "Number of Unmet Needs" 43

Figure 4: Distribution of Variable "Number of Unique Unmet Need Domains" 43

Figure 5: Distribution of Variable "Number of ED Visits" 46

Figure 6: Distribution of Variable "Number of Preventable ED visits" 46

Figure 7: Derivation of ED visit definition 47

Figure 8: Minnesota Algorithm Flow Chart 48

Figure 9: Normal Distribution of Residuals (Assumption of Normality) 60

Figure 10: Predicted Number of Total ED Visits By CC and Physical Illness Severity Levels. ... 88

Figure 11: Predicted Number of Preventable ED Visits by CC and Physical Illness Severity. 88

List of Tables

Table 1: Factor Loadings of Different Unmet Needs Among FUEDs 44

Table 2: Reliability Testing of Domains of Unmet Needs 44

Table 3: Description of Independent Variables.....49

Table 4: Description and Prevalence of Unmet Needs of FUEDs (n=474).....70

Table 5: Description of Patient Characteristics, Social and Clinical Determinants of Health Among FUEDs (n=474) 71

Table 6: Bivariate relationship between specific domains of unmet needs and Social and Clinical determinants.....73

Table 7: Influence of Social and Clinical Determinants on Number of Unmet Needs (0-24) 75

Table 8: Sensitivity Analysis – Influence of Social and Clinical Determinants upon Number of Unmet Needs (0-24) using Poisson Regression 77

Table 9: Sensitivity Analyses – Influence of Social and Clinical Determinants on No. of Domains of Unmet Needs (0-4) 78

Table 10: Utilization measures of FUEDs, n=474 83

Table 11:Bivariate Associations between Independent Variables and ED Utilization 84

Table 12: Multivariate Regression Associations of Social and Clinical Determinants with Total and Preventable ED Utilization.....86

Table 13:Marginal Change in Total and Preventable ED Utilization Based on Marginal Changes in each Independent Variable Level from the Base Category (holding all other covariates at their means) 87

Table 14:Predicted Change in Number of ED Visits for Different Scenarios.....89

Table 15: Comparison of Frequency Distribution of Persistent and Non-Persistent FUEDs with respect to social and clinical determinants 94

Table 16:Association of Social and Clinical determinants with Persistent ED Use - Step-wise modelling 96

Table 17: Marginal Probability of Persistent ED Use 98

Chapter One: Background, Significance and Research Purpose

1.1. Background

Frequent use of emergency departments (ED) is of great concern to policymakers and practitioners. Patients who utilize ED services frequently, at least four times per year,[1] also referred to as frequent utilizers of EDs (FUEDs) comprise 4.5% to 8% of all ED patients but account for 21% to 28% of all ED visits.[2] The phenomenon of frequent use of the ED highlights health system inefficiencies that pervade the entire healthcare environment.[3] In its 2006 report on 'The Future of Emergency Care', the Institute of Medicine (IOM) noted that increasing use of the emergency care system represents "failures of the larger health care system"; "the limited alternatives available in many communities, and the inadequate preventive care and chronic care received by many."[4]

Research suggests that frequent ED utilization is driven in part by the lack of appropriate ambulatory care and unmet health and social needs. [5,6] Despite having greater outpatient health care utilization, FUEDs experience fragmented and discontinuous care that is not fully addressing their health needs.[5,7] They typically present to the ED with problems that warrant emergency care,[2,8] however their underlying complex health and social needs are not optimally managed in the ED setting.[2] Moreover, the majority of FUEDs comprise vulnerable patient groups[7] with multiple chronic diseases that require significant resources to manage effectively.[9] One analysis estimated the cost of ED over use at $38 billion each year.[10] Frequent use of the ED is a clear sign that the health care system and the larger socio-economic environment in which people live is not adequately serving the health and social needs of a subgroup of the population. The sections that

follow elaborate on the public health significance of FUEDs, the purpose of this research and its policy implications.

1.2. Public Health Significance

Significance to Medicaid

Medicaid is the largest public health care insurance program covering 70 million low income Americans.[11] It is the only public health insurance program dedicated to socio-economically vulnerable people. In addition to low income children and adults, Medicaid covers the disabled and the elderly poor. Vulnerable patients have a higher prevalence of complex health needs than the general population.[12] For example, 45% of Medicaid enrollees have 3 or more diagnosed chronic conditions and almost half of those qualifying for disability under Medicaid suffer from mental illness. [13,14] By providing a comprehensive range of much needed benefits to address serious health needs, the Medicaid program is indispensable for vulnerable groups who may otherwise not have any health coverage. [15,16]

Between 1997 and 2013, ED visits by the Medicaid population increased 36%.[17] Medicaid beneficiaries have a higher prevalence of frequent ED use compared to the privately insured.[18] Using statewide ED visit claims data, Fuda and colleagues estimated that 2.1% of all Medicaid beneficiaries used the ED five or more times in 2003 compared to 0.4% of people privately insured.[18] Most Medicaid FUEDS have a substantial burden of disease.[19,20] They are at risk for increased hospitalizations,[21] and have a higher mortality rate. [21,22,18]

Increased Health Care Costs and Utilization

FUEDs consume more health care services including outpatient, primary care, psychiatric services and in-patient hospital care.[21] Subsequently, they incur much higher health care costs compared to non FUEDs in part because they are at increased risk of hospitalization per visit.[21] One analysis of the Medical Expenditure Panel Study (MEPS) found that while FUEDs comprised only 1% of the study population they were responsible for 18% of all ED visits and 16% of all ED related expenses.[23]A small proportion of Medicaid beneficiaries are therefore responsible for a disproportionate share of total expenditures.[3,11,24] States are grappling with the increased costs of providing care to FUEDs. For example, in 2007, the California Department of Health Care Services incurred over $400 million in acute care costs from 28,000 FUEDs.[25]

Poor Health Outcomes

Contrary to concerns about non-urgent ED use, research shows that about 90% of all ED visits by Medicaid beneficiaries are for serious or urgent conditions.[2] In addition to having a higher burden of chronic disease, a recent systematic review reported FUEDs to have a median 2.2 fold increased odds of mortality compared to non-FUEDs.[21]

Increased Health Needs

Despite a higher utilization of health care services, FUEDs report greater unmet health needs, are more likely to have no usual source of care and be dissatisfied with their care.[2,22,26,27] Unmet health needs can contribute to higher utilization of emergency care.[28] Often times FUEDs visits are for management of acute exacerbations of chronic illnesses that ideally need coordinated and continuous management in the outpatient setting.[7,29]

Increased Social Needs

Studies show consensus that FUEDs commonly experience socio-economic insecurities that adversely affect their health. [7,26,30,31] Research shows that the majority of FUEDs experience numerous adverse social determinants of health (SDH).[7,26,30,31] They tend to have a lower level of education and income; and face barriers to basic necessities such as food and shelter, mental health and substance abuse treatment, all of which exacerbate frequent ED utilization.[7,23,26,30–33]

Conclusion

The worse health outcomes, increased health care costs and needs of this vulnerable population have motivated greater scrutiny into FUEDs. The resource strain due to FUEDs on the health care system is significant.[10,19] State health officials and policy makers pressed by budgetary constraints have resorted to increasing copays, denying payments and other rationing techniques to limit ED utilization and its associated health care costs.[34,35] However, frequent use of EDs is a distal manifestation that cannot be effectively addressed without identifying the underlying larger systemic problems of social determinants of health in addition to fragmentation of care.[10,36] Understanding how these factors relate to FUEDs is a critical step to recognize those at risk of frequent ED utilization, determine inefficiencies and gaps in their experience of health care and design effective interventions and policies.[7] Inquiry into FUEDs therefore presents a public health opportunity to explore social factors and aspects of health care delivery that can have greater attributable effects on health.[37]

1.3. Purpose of the Research

Despite the evidence on the significant impact of social determinants of health (SDH) on chronic diseases, clinical outcomes and use of ED services,[30,38] the literature is lacking a comprehensive inquiry into the types of SDH specifically experienced by FUEDs that may influence their use of the ED. Few studies have comprehensively measured FUEDs' social and medical unmet needs. FUED studies that have been previously conducted are limited to a few social problems, namely homelessness and substance abuse.[33,39–43] Furthermore, although the importance of care continuity on clinical outcomes and ED use has been discussed by many studies,[44–50] there has been no exploration of the specific influence of SDH factors while accounting for the effect of continuity of health care on preventable ED use. In addition, it is important to identify factors that may cause persistent frequent ED use to predict and prevent future ED use by FUEDs.

This dissertation aims to bridge the aforementioned gaps in knowledge through three research aims by: (1) examining the influence of social (SDH) and clinical determinants of health on unmet needs of FUEDs; (2) evaluating the influence of care continuity (CC), other clinical determinants and SDH on overall and preventable ED utilization; (3) identifying the SDH and clinical determinants of persistent ED use. By doing so, this research aims to better understand the social factors that influence FUEDs' utilization controlling for continuity of care and clinical conditions.

Aim 1

The first aim provides a description of the SDH and unmet needs experienced by FUEDs as well as differentials between participants based on sociodemographic factors and

clinical illness severity. Previous descriptive analyses of SDH of FUEDs have primarily focused on a limited number of SDH. A comprehensive variable of unmet needs was created to capture more than 20 types of social and medical needs that FUEDs describe experiencing. The analysis describes the SDH and unmet social and medical needs that FUEDs experience and examines: a) the relationship between unmet needs and social determinants (SDH); b) the relationship between unmet needs and clinical determinants such as access to regular care and clinical illness.

Aim 2

The second aim characterizes the types of ambulatory health care services utilized (primary, specialist, mental health) as well as enumerate specific aspects of utilization by FUEDs, such as care continuity (CC) and number of total and preventable ED visits. Relatively few studies have characterized the care patterns of frequent utilizers in Medicaid. In addition, this aim also analyses how SDH and clinical determinants (CC and clinical illness) influence total and preventable ED utilization.

Aim 3

The third aim assesses the relationship between specific predictors (SDH and clinical determinants) and persistent ED utilization. It also estimates the marginal probability of being a persistent ED user based on these results.

1.4. Policy Implications of the Research

Expansions of Medicaid coverage under the Patient Protection and Affordable Care Act (PPACA) and numerous other policies and programs under the health reform umbrella have caused greater acknowledgment of the importance of SDH in influencing health

outcomes and health care costs. Acknowledging the role of SDH and the related unmet social needs on health and health care utilization, the IOM and the National Quality Forum recently recommended the routine collection of SDH data on patients.[51,52] Moreover, health care providers are increasingly recognizing the significance of unmet social needs and their influence on the poor health of their patients.[22,53–56]A recent Robert Wood Johnson Foundation survey found that 85% of polled physicians believed that unmet social needs are responsible for worsening of health outcomes and are as important as clinical needs.[57] Despite these observances, the actual documentation of unmet social needs and SDH of patients is rare.[58]

As a result, through numerous demonstrations and initiatives, Accountable Care Organizations (ACO), Patient Centered Medical Homes (PCMH), not-for-profit hospitals and Accountable Health Communities (AHC) are all engaging with patients to understand and address their non-medical and social needs such as transportation, housing and food insecurity.[37,59,60] Amid the uncertainty and threats to the viability of the ACA and Medicaid expansion following proposed legislation to repeal the ACA in 2017, the need for continued momentum of these activities is even greater. This research will buttress the evidence base informing these novel endeavors by examining a comprehensive measure of unmet needs.

The policy implications of this research to Medicaid are significant. The poorer health outcomes, greater health needs and higher costs associated with Medicaid FUEDS make it important to better understand the SDH, the unmet needs and the health care utilization patterns of this vulnerable population. A better understanding of these factors will inform the development and implementation of appropriate interventions suitable for

Medicaid enrollees.[2,7] For state health care agencies, this means guidance in health care budget allocations and caring for a vulnerable population that faces loss of health care coverage in the event of a repeal of the ACA or changes to the Medicaid program eligibility requirements. For health care practitioners, hospitals, policy makers, program funders and community health organizations that are already collaborating to understand and address priority social and medical needs in the community, the information being sought through this research will prove valuable in their decision and policy making.

Finally, poor and vulnerable people have often been reprimanded for excessive, unwarranted and costly use of ED services, with the overarching reaction of policy makers being to restrict access of health services to the very people who need it the most. Reversal of Medicaid expansion that took place under the ACA could result in restrictions to health care access for low income populations again.[59] This research is therefore timely for the current atmosphere of policy changes pertinent to the Medicaid population and other vulnerable groups. Information on specific factors such as unemployment and income that increase ED utilization by FUEDs will provide some granular evidence as well as provide policy makers with insights about gaps in the current health and social welfare system that need to be addressed if Medicaid aims to improve the health of their beneficiaries.

Chapter Two: Conceptual Framework and Literature Review

2.1. Conceptual Framework

This dissertation draws on a socio-ecological perspective of health – that individual behavior and health outcomes are related to the socio-economic and political context in which they occur. This perspective is reflected in the conceptual framework developed by the World Health Organization's Commission on Social Determinants of Health (CSDH) (Figure 1).

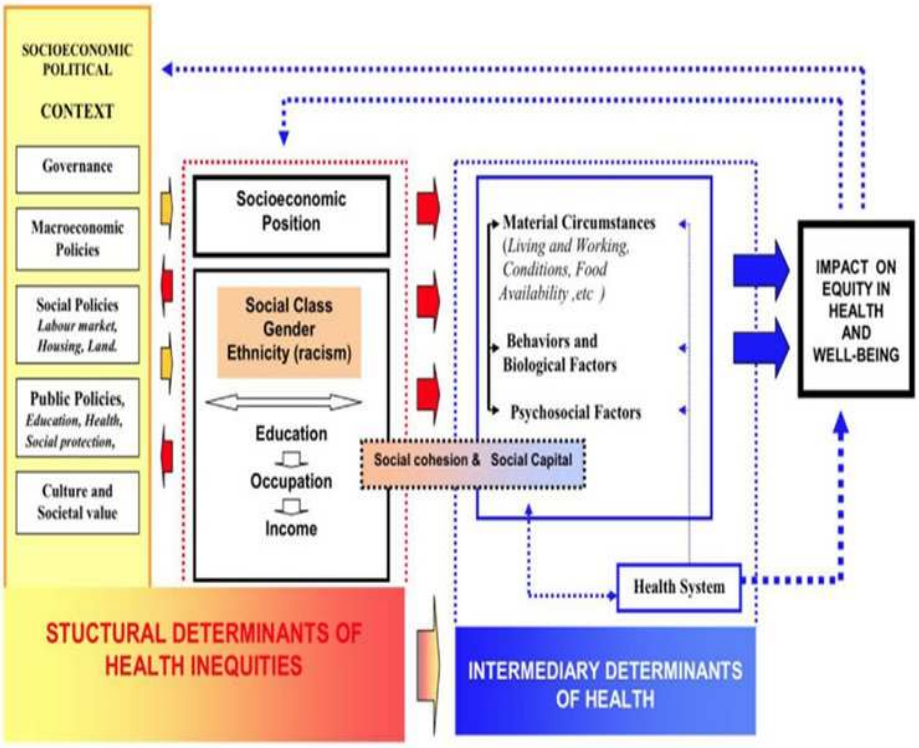

Figure 1: WHO Commission on Social Determinants of Health (CSDH) Conceptual Framework. Source: WHO. Commission on Social Determinants of Health. A conceptual framework for action on the social determinants of health. Discussion paper 2007.

The CSDH framework[60] is both an informative and analytic guide for understanding the greater role of social determinants of health (SDH) on health and well-

being. Driven by theoretical approaches including the psychosocial, 'social production of disease and eco-social' theories,[61] this framework specifically details the proximal relation of SDH to clinical illness. It specifies SDH as being either (i) structural or (ii) intermediary. Moreover, health is framed as a social phenomenon and thereby this framework broaches the social policy significance of health as an issue of social justice. This lends the framework a feature of action-ability and thereby is applicable to health policy research.

Unlike other popular models applied in health services research that anchor social determinants as individual characteristics (eg. Aday-Anderson, Gelberg-Anderson Behavioral Model for Vulnerable Populations), this framework posits that structural social determinants of health influence intermediary social determinants which in turn impact health and well-being. The structural SDH are social class, race, gender, education and income.

The intermediary SDH experienced by individuals include (i) material circumstances (food, housing, neighborhood quality, physical work environment, etc), (ii) psychosocial circumstances (psychosocial stressors, stressful living circumstances and relationships, social support, coping styles), and (iii) behavioral and biological factors (nutrition, physical activity, tobacco consumption, alcohol consumption, genetic factors). Furthermore, the framework conceptualizes the role of the health care system as a mediator as well as an intermediary social determinant. It emphasizes the dynamic interplay of socio-economic conditions, health care system and population level factors on individual health outcomes.

Impact of SDH on health outcomes

The CSDH framework provides an appropriate lens to observe the different types of SDH and their significant influence on health relative to other factors. While healthcare is important for health, a strong body of research demonstrates that it is a weak determinant relative to other predictors of health and wellbeing.[62–64] Health is a function of numerous factors of which healthcare comprises a mere 10% compared to the 20% attributed to SDH factors and 40% attributed to behavioral factors.[64,65] Social, economic and environmental factors play a stronger role than health care services in influencing the behavioral factors that impact health.[60,64,66,67]

The impact of SDH is well established and evident on all measures of health including health status, morbidity, mortality and health related quality of life.[66,68–73] For instance, people with less than a high school education have a life expectancy that is 6 years lesser than those who have a college education.[74] People who have not completed high school are more likely to live in environments that pose health hazards – the neighborhoods are unsafe, exposed to garbage and have poor housing.[75] Low income and low education often co-vary and contribute to a low socio-economic status (SES).[76] Low SES is associated with a greater likelihood of premature death, and higher likelihood of smoking, and early onset of chronic illnesses.[77–80] Lack of resources in a low SES population can be experienced as financial hardship, low literacy, food insecurity, unsafe housing environment and social marginalization all of which incur chronic stress that is detrimental to health and wellbeing.[77] Researchers have concluded that SDH factors (including education, poverty, lack of social support and racism) account for more than a third of annual deaths in the US.[81]

Analytic Framework

With the CSDH framework as my foundation, I developed an analytic framework (Figure 2) to guide my analyses. This dissertation focuses on the following key relationships: (1) SDH, clinical determinants and unmet needs; (2) SDH, clinical determinants and ED visits; and (3) SDH, clinical determinants and persistent ED use. This analytic framework adapted the CSDH framework in the following ways:

(1) 'Health and wellbeing' is represented by 'Medical Conditions'

(2) 'Emergency Department (ED) Utilization' focuses on total number of emergency department visits.

(3) 'Unmet needs' is included as a measurable mediator pathway through which SDH exert their influence on the development and progression of clinical disease. The extent to which society and individuals themselves can positively influence their living and working conditions will affect the influence of intermediary SDH on medical conditions. People who experience unmet and social needs (i.e. poor housing conditions, inadequate food, etc.) will be more likely to develop and suffer from more severe clinical illness compared to others that are able to get their medical and social needs met.

(4) 'Continuity of Ambulatory Care' and 'Hospitalizations' are representative of an aspect of "The health system" and comprise care outside of the ED (non-ED care utilization). Both these aspects of health care utilization can contribute to the fragmentation of care that may exacerbate ED utilization. Fragmentation of the US health care system is a characteristic that has been well criticized and held responsible for adverse consequences on the health and wellbeing of individuals,

the quality of health care delivery and associated costs. This is also a pertinent issue to our sample of FUEDs.

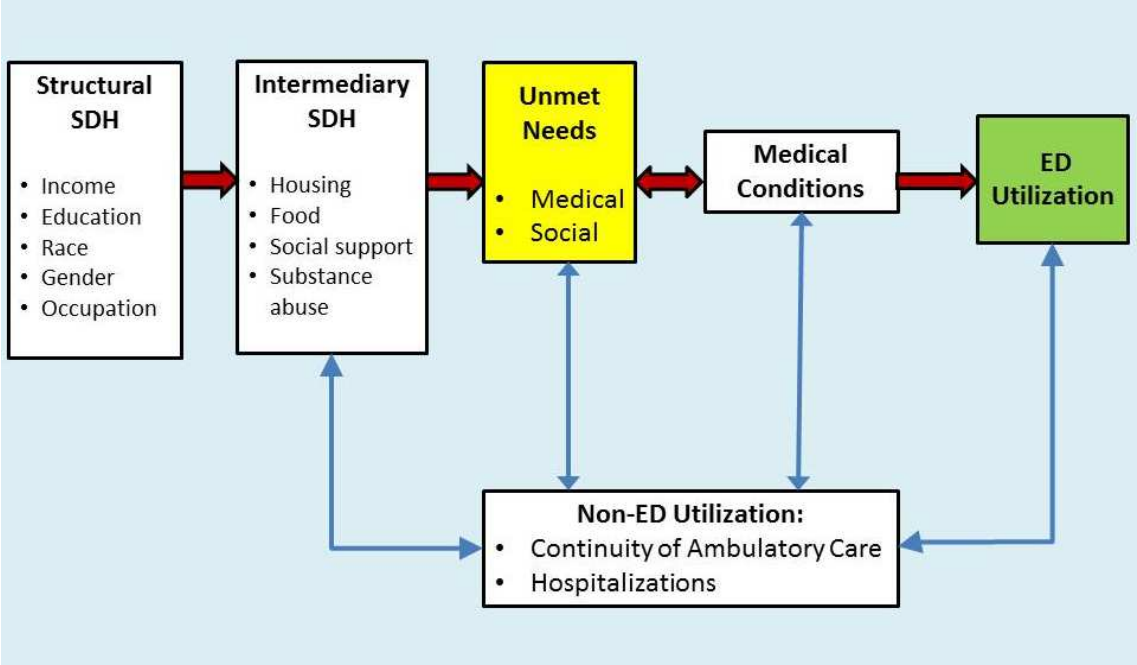

Figure 2: Analytic Framework

Figure 2 illustrates how there are both direct paths from SDH to acute care utilization via the development of medical conditions, as well as an indirect path via a discontinuous health care system that interplays with SDH, unmet needs, and medical conditions, and also contributes to acute care utilization.

This analytic framework guided the testing of several analytic models to estimate the magnitude of influence exerted by SDH and clinical determinants (fragmentation of non-acute health care) upon unmet needs and acute care utilization. It demonstrates the close relationship of non-clinical and clinical factors upon ED utilization that can be tested in the analysis.

The next section provides a review of the literature relating to the constructs in the analytic framework.

2.2. Literature Review

This dissertation examines the role of unmet social and clinical needs, social determinants of health (SDH), and clinical determinants (CC and clinical illness) upon the frequent use of emergency departments (ED) among Medicaid patients. This chapter supports the scientific rationale of this research by summarizing the literature in the following areas: (1) the socio-demographic, SDH and clinical characteristics of FUEDs; (2) FUEDs' utilization of health care services; (3) persistent FUEDs; and (4) FUEDs' unmet medical and social needs. It concludes by highlighting important knowledge gaps that this research attempts to address.

2.2.1. Characteristics of FUEDs

There is no standard definition of a FUED.[2,21,26,82,83] The most common definition used is a person who visits an ED at least four times in a 12 month period.[2,21,30,84–86] The prevalence rate estimates range from 1% to 5% depending on the patient population and the data source.[5,9,18] Estimates of FUEDs are higher among Medicare, Medicaid and Veterans' Health Administration beneficiaries compared to those privately insured.[5,18,87] Despite differences in the prevalence of FUEDs, FUEDs account for approximately one-quarter of all ED visits.[2] Prior research has shown that FUEDs can comprise between 4.5% and 8% of all ED patients but account for 21% to 28% of all ED visits.[2]

The majority of FUED studies are single site cohort studies and they demonstrate the heterogeneity of FUEDs.[2,7,21,86] Given the high costs and poor outcomes associated with FUED, it is surprising that there are few population-based studies. It is evident from the

literature that FUEDs are a heterogeneous population in terms of their sociodemographic characteristics and clinical conditions. Moreover, FUEDs who use the ED 4 times a year, may be quite different from FUEDs who use the ED 50 times or more.[88] Despite this heterogeneity, there is consensus in the literature that FUEDs are a distinct, high risk and vulnerable group of patients[21] who generally have low socio-economic status, report fair or poor health, and have a high burden of chronic diseases.[2,5]

- **Socio-demographic characteristics: gender, age, race, insurance status**

Some studies have found males more likely to be FUEDs,[89,90] while others have found the opposite, with females more likely to use EDs frequently.[18,91–93] A few studies have concluded that gender is not a significant predictor of frequent use of the ED,[21] and it is possible study criteria and study population has contributed to the discrepant findings. FUEDs exhibit a bimodal distribution in age, with increased likelihood of FUEDs in age groups 25-44 years and >65 years.[2,18,94] African Americans and Hispanics have higher FUED rates compared to whites.[29] Compared to individuals with private insurance in the US, patients with Medicaid and Medicare are more likely to frequently use the ED.[26] Analysis of one nationally representative study found that Medicaid enrollees comprised 23% of FUEDs (> = 4 ED visits) compared to just 7% of non-FUEDs (1-3 ED visits).[26] Another statewide study, found no difference in the FUED rate among Medicaid beneficiaries, Medicare beneficiaries and the uninsured but a much higher rate than the privately insured.[18] Moreover, while primary care access seems to be protective of FU for patients in a National Health Insurance System, this does not hold true for other health care systems.[7]

- **Clinical characteristics**

There is considerable heterogeneity in the variety of clinical conditions and presenting complaints of FUEDs.[2] For instance, in urban areas alcoholism and mental illness significantly predict frequent use of EDs but this is not always true in rural areas.[18,85,90] Many studies have shown them to exhibit a higher burden of chronic diseases such as diabetes mellitus, [47,59] heart failure[95,97] and pulmonary conditions such as COPD and asthma,[1,40] and mental illness. [7,86] The most common type of clinical presentation depends on the age group of FUEDs: younger patients (<65 years) have a higher prevalence of mental illness diagnoses while older patients have more cardiovascular, gastrointestinal and nephrotic related illnesses.[2] In the Medicaid population, the top three primary diagnosis types in FUEDs were mental health, substance abuse and abdominal pain.[18]

Injuries are a significant reason for ED visits[98] but the literature on the association of injuries to frequent ED utilization is scant and conflicting. There is some evidence that specific SDH risk factors that FUEDs experience can predispose them to injury.[99] For instance, FUEDs are disproportionately homeless[100] and homeless people have higher rates of both unintentional injuries and trauma from assaults.[39,101–103] In one study on homeless FUEDs the most common group diagnosis was the musculoskeletal system followed by substance abuse, with trauma being the chief diagnoses 8.3% of the times in the ED.[100] Both substance abuse and mental illness, common diagnoses among FUEDs, predispose patients to trauma and injury. [101,104] Cook et al. observe that 30% of FUEDs became persistent ED utilizers,[105] who tend to present to the ED with the same reason, and mostly have injury related complaints or headaches.[2,105] On the other hand, the

literature is not consistent. Bieler et al. found substance abuse as the primary ED diagnoses for 12.3% of FU compared to 6.5% of other patients[30] but found 50% fewer cases of injury among FUEDs compared to non-FUEDs, similar to Fuda and Immekus.[18] Mandelberg et al. also report FUEDs as less likely to visit for all kinds of trauma.[90]

- **Social Determinants of Health (SDH)**

The complex health concerns and outcomes of individuals that frequently attend emergency departments (ED) are strongly associated with the socio-economic environment they experience.[47,106] While FUEDs may be clinically and socio-demographically diverse, research shows that the majority of FUEDs experience common socio-economic insecurities that adversely affect their health.[7,26,30,31] FUEDs tend to have a low level of education and income and have a high prevalence of substance abuse. [7,23,26,30–33] They face barriers to basic necessities such as food, shelter, mental health and substance abuse treatment, all of which exacerbate FUED.[7,23,26,30–33] FUEDs have also been described to be socially isolated.[107] Exposure to adverse SDH contributes to poor health outcomes in FUEDs which influences their health care utilization.[108] When people are unable to meet their basic human needs (shelter, food, utilities), health needs tend to become secondary until a life-threatening emergency strikes and acute care utilization becomes unavoidable.[109]

The significance of SDH is corroborated by a growing body of research which points to the marked health benefits of interventions that take into account the "upstream" social context of health care delivery and related socio-economic factors.[110,111] Taylor et al. describe the positive outcomes of 32 interventions around social determinants in terms of health improvements and reductions in health care spending.[112] Housing support has been

shown to lower ED use and associated health care costs among the homeless.[113] Evaluation of a service-enriched housing program comprising of care coordination, advance planning and medication management in 1135 low income adults in publicly subsidized housing found significant improvement in health outcomes, lower ED visits and fewer hospitalizations.[114] The Low Income Home Energy Assistance Program (LIHEAP) was associated with lower hospital admission rates and lower obesity probability for children.[115] Other interventions in the areas of income support[116] and care coordination[117,118] also have resulted in improved health and reduced health care costs. Such evidence demonstrates the benefit of addressing the complex clinical and social needs of individuals experiencing SDH to lower health care utilization such as ED visits. Identifying the relationship between social needs and clinical needs, more clinical providers, hospitals and payers are incentivized to address non-medical determinants to achieve health care cost-savings and improved health outcomes in the most vulnerable of patients such as FUEDs.[111]

2.2.2. Health care Utilization and FUED

The majority of FUEDs visit multiple ED sites.[18] However, in addition to greater utilization of ED services, FUEDs also have a higher utilization of other health care resources compared to non-FUEDs. This section provides a review of the inpatient and outpatient health care utilization by FUEDs. In addition, it summarizes the literature on the role of continuity of care on ED utilization by FUEDs.

- **Inpatient Health Care Utilization: Number of Hospitalizations**

FUEDs are known to have greater number of hospital admissions, greater number of in-

patient days and increased ambulance transports.[2,31,84,96,119] Such pre-hospital and hospital utilization significantly increases the health care costs attributable to FUEDs.[1] Health care utilization patterns suggest that FUEDs are also more likely to have recent hospital discharges.[84] Sun et al. found individuals who had been hospitalized in the last 3 months to be 6 times more likely to be FUEDs.[85] Other studies have found hospitalizations in the previous year to increase the risk of frequent ED use.[97,120]

- **Ambulatory Health Care Utilization**

Although lack of access to regular primary care can be a driver of frequent ED use,[27] FUEDs have been found to have >=10 outpatient visits in a year[2] and twice as many primary care visits than infrequent ED visitors.[121] FUEDs have been found to make more visits to their primary care provider, and a higher proportion use community welfare services, social services, substance abuse counselling and psychiatric services.[31] Concurrent high levels of outpatient health care in addition to ED visits is indicative of inappropriate, inadequate and discontinuous healthcare delivery rather than issues of access.[29,86,122] Discontinuous health care can aggravate unmet health needs of patients which further contributes to higher utilization of health care services.[28,122] It is therefore necessary to better understand FUEDs' experience or lack of care continuity in health care and its impact on their frequent ED utilization.

- **Continuity of Care**

Definitions and Impact

The concept of care continuity has evolved over the years and is often used interchangeably with other related concepts such as care coordination. Care continuity is "the degree to which a series of discrete healthcare events is experienced as coherent and

connected and consistent with the patient's medical needs and personal context".[123] Coordination represents "the delivery of services by different care providers in a timely and complementary manner in order to achieve connected and cohesive patient care".[123,124]Continuity is different from coordination of care, though care "coordination follows from continuity"[123] and lack of coordination of care can compromise the continuity of care. Both these concepts have in common 3 major themes that include (i) a personal relationship between patient and provider that is maintained through (ii) communication between providers and (iii) cooperation between them.[125] Continuity of care results from a sustained relationship between a patient and a provider over time, during which the provider coordinates all aspects of care through his/her and other providers the patient sees and through transitions from care in different settings.[126] There are 3 types of care continuity: relationships, management and informational. Present measures of care continuity are limited in their explicit measure of these. Most measure some aspect of continuity in terms of the concentration of ambulatory visits to different providers.[126–128]

Care continuity has been identified as an integral part of health care delivery reform by the Institute of Medicine[129] and the National Quality Forum.[130] Numerous health care delivery transformation reforms aiming at improving health outcomes and curbing health care incorporate care coordination to achieve better care continuity.[131] Studies have shown the beneficial impact of care continuity in improving health outcomes and lowering health care costs.[49] Previous research suggests that continuity of care may be particularly beneficial to patients with chronic diseases such as diabetes.[45] Hussey et al. demonstrate a consistent association between greater levels of care

continuity and lower ED and hospital utilization, improved health outcomes and lower health care costs for chronic diseases such as diabetes mellitus, congestive health failure and chronic obstructive pulmonary disease.[50]

Care continuity can be established through good primary care.[10,132,133] Research shows that communities of Medicaid enrollees that contained Primary Care Service Areas (PCSAs) with twice the capacity had fewer ED visits than areas with lesser primary care capacity.[134] Numerous other studies have reported improved continuity of primary care and lower ED utilization.[46,49,135] Research also points to a strong association between care continuity in primary care and the care coordination experienced by patients.[136]

- **Continuity of Ambulatory Care and FUEDs**

Frequent use of the ED is one manifestation of "latent issues"[137] in the health system that give rise to discontinuous or fragmented health care.[17,13847] Often times FUEDs visit the ED for the management of acute exacerbations of chronic illnesses that ideally need continuous management in the outpatient setting. [7,29]

The 2000-2001 Community Tracking Survey showed FUEDs more likely to report discontinuity of care.[139] FUEDs experience a high burden of chronic diseases and require management by multiple health care providers across diverse settings which predisposes them to disruptions in care continuity.[140] Moreover, FUEDs experience unique social risk factors which contribute to discontinuous care.[141,142] A vulnerable population that experiences fragmented health care will delay care, and experience poorer health outcomes and more costly care of lower quality.[143,144] Discontinuity of care contributes to adverse health outcomes, low treatment adherence, medical errors, inflated health care costs and poor quality of life.[145,146]

Research shows that Medicaid patients experience greater discontinuity of care.[27] Despite a two-fold greater burden of mental illness than the general population, Medicaid patients still experience mental health and substance abuse systems that are disjointed from the physical health system.[147] Moreover, Medicaid patients experience many of the social risk factors that can contribute to discontinuous care. A recent qualitative study demonstrates how numerous clinical and social risk factors combine in the presence of a discontinuous health care system to drive up hospital admissions in Medicaid.[148] A combination of behavioral, socio-economic and health drivers such as financial stress, high prevalence of mental health disorders, medication non-adherence and housing instability are important person level drivers of Medicaid readmissions in vulnerable patients.[148] For patients on Medicaid, discontinuity of care (represented by extreme uncoordinated care) accounts for 30% of program costs.[149] One analysis showed that Medicaid patients with discontinuous care averaged annual costs of $15,100 in comparison to $3,116 for the rest of the population with better care continuity.[149] Additional research shows acute care expenditures to be related to the number of conditions in Medicaid patients,[14] each condition amounting to a greater need for care coordination. For example, among patients with disability, each diagnostic category is associated with an increase in annual acute care expenditure of $8,400.[14]

Improvements in quality of outpatient care through care continuity in non-acute care settings can have a measurable impact on lowering ED utilization.[124] Several FUED interventions have implemented interventions to achieve better continuity of care and lower ED use.[29,32,46,150–152] While some FUED interventions are successful, Soril et al. point out that the impact of most interventions is modest with variable reductions in ED

use[29] because of limitations in care continuity from an inability to create lasting relationships with patients due to certain socio-economic challenges.[47,153] It is important to understand the interplay of these factors upon the care utilization of FUEDs to design successful interventions and policies to address FUED.

- **Preventable ED visits**

Most ED visits by Medicaid patients are for appropriate or needed care,[154] however many ED episodes can be prevented by care elsewhere.[155] These 'potentially preventable ED visits' are for conditions for which timely, appropriate primary care can prevent or reduce the likelihood of an ED visit.[156] One study estimated that between 10% and 30% of ED visits are non-urgent or do not require an ED for management.[157] Another large, national survey of ED patients found 56% of all ED visits were avoidable.[158]

While the total rate of ED visits in the US have increased between 2006 through 2012, the number of potentially preventable ED visits increased at a faster rate than the over ED visits.[159] This rate was greatest for episodes with mental health related complaints. Between 2008 through 2012, the rate of treated and discharged ED visits (treat and release) for mental health related episodes increased by 19.3% while other treat-and-release ED visits (hypertension and diabetes short term complications) increased by 10.6%.[159] During this period, Urinary Tract Infections (UTIs) were the most common diagnoses for preventable ED visits, followed by COPDs. Another analysis using 2010 national data demonstrated non-emergent outpatient visits to be the most common type of ED visit in that year, comprising 30.4%, with potentially avoidable ED visits accounting for 19.6% of ED episodes and costs totaling $64.4 billion.[160]

As something that has been considered wasteful by policymakers,[10,161] the issue of

preventable ED visits is of significance to Medicaid which covers 28% of all ED visits.[19] The number of ED visits for Medicaid patients have increased between 1999 and 2007.[17] Even though recent data suggests that the majority of ED visits by Medicaid patients is for urgent conditions,[19] the number of preventable ED visits for ambulatory care sensitive conditions (ACSC) for Medicaid patients increased from 66.4 per 1000 enrollees in 1999 to 83.9 per 1000 enrollees in 2007 while remaining stable for other insurance categories.[17]

Methods have been developed to help researchers and policy maker better identify and differentiate 'needed' ED visits from visits that are 'preventable'. The prominent NYU algorithm developed by Billings et al.[162] separates ED visits into 3 mutually exclusive categories: non-emergent, ACSC, and emergent. ED visits for ACSC fall into one of 2 groups: (i) those that can be safely managed in a doctor's office (primary care treatable) and (ii) those that can be prevented if adequate or appropriate care was provided (primary care preventable).[163] Other researchers have used variations of the Billings algorithm.[164,165] The Minnesota algorithm is another approach of distinguishing 'preventable' and 'non-preventable' ED visits by applying clinical judgment on the severity of an ED episode.[166] This method avoids some of the limitations of the Billings method such as the exclusion of important clinical diagnoses such as mental illness and substance abuse that are unclassified under the Billings algorithm.[166]

According to these algorithms, an increase in preventable ED visits is an indication of poor access and functioning of primary care. People with disabilities face significant barriers to access and experience fragmented care.[167] Good primary care can lower preventable ED use by establishing good continuity of care (CC).[44,168,169] Moreover,

better access to primary care has been associated with lower unmet medical needs and lower ED use.[170] In addition to CC and efficient primary care, many factors predisposing to increased ED utilization can influence the likelihood of a preventable ED visit such as presence of chronic illness, severity of conditions, socio-economic factors, insurance, and care seeking behavior.[134,155,171,172]

2.2.3. Persistent FUEDs

When frequent utilizers (FUEDs) in a given year continue using the ED frequently (>=4 times/year) in the following year, they are considered to be persistent ED utilizers.[87] Although the factors around FUED have been widely researched, we know comparatively less about factors influencing persistent ED use. FUED is often temporary, resulting from acute illness or injury.[173] However, FUEDs in any given year can be 28% to 38% likely to continue being FU in the next year. [90,174] One study describes a third of FUEDs go on to become persistent FUEDs in the subsequent year.[87] While most FUEDs in 1 year will not have frequent use in the next due to regression to the mean,[18,175,176] those that do become persistent utilizers are likely to be responsible to have high costs in the present and the future and it is prudent to identify them in advance.[177] Even though there is a natural reduction in persistent ED use, the attrition rates decline over subsequent years,[90] and this signifies persistent FUEDs as a high risk group ideal for targeted interventions to prevent future ED use.[86]

The literature reveals that among FUEDs, persistent utilizers represent an especially high risk group with specific characteristics.[178] For instance, Colligan et al. found that compared to those aged 65-74 years, beneficiaries aged 18-34 years had 3

times the risk of persistent ED use, despite a higher mortality in the former group. [87] This translates to a 19.4% probability of a participant in their study becoming a persistent ED user from the year before.[87] The probability for persistent use increased to 49% for FUEDs in the youngest age group who also had mental illness and Medicaid insurance as well. Being female, black, less than 65 years old, eligible for Medicare due to disability or end-stage-renal disease, Medicaid eligible and low continuity of care were found to be risk factors for persistent ED utilizers in the Medicare population. Persistent ED utilizers also had a higher prevalence of heart disease, COPD, mental illness and arthritis compared to non-persistent FUEDs. The burden of mental illness is greater in persistent ED utilizers.[87] They have been found to have between 1.5 and 2 times the rates of depression, bipolar disorder, PTSD and substance abuse.[178]

Their health care utilization patterns are also distinct. Persistent ED utilizers seem to have greater fragmentation of care than non-persistent FUEDs, more missed appointments and more visits to a greater number of primary care providers.[122] By continuing over subsequent years to have higher rates of ED visits and hospitalizations than non-persistent ED utilizers, persistent ED utilizers pose serious health costs due to health problems that are either worsening or not being resolved.[122] Persistent ED utilizers are more likely to use multiple EDs[2], especially those who have substance abuse and mental health issues,[176] are more likely to be uninsured, have the same complaint often related to pain and injury.[105]

2.2.4. Unmet Needs of FUEDs

ED utilization is a reflection of increased health needs of the community served.[98]

While ED use by FUEDs may be unavoidable and necessary,[2] it often results from "persistently unmet needs that culminate in a health crisis".[179,180] Zuckerman et al. found that 19% of FUEDs report unmet medical needs in comparison to 11% of occasional ED utilizers and 6% of non-ED utilizers.[88] Psychiatric related ED utilization is also strongly related to unmet clinical needs.[54]

FUEDs health care utilization behavior is indicative of these unmet needs. Studies report higher use of outpatient services by FUEDs than non-FUEDs suggesting that the former may not be using the ED as a substitute to primary care, but simply have greater health needs that are not being appropriate met elsewhere.[23,181] One study showed that despite having primary care access and provider-relationship length similar to non-FUEDs, FUEDs made twice as many primary care visits and were less likely to report their clinical needs met by their PCP.[121] Furthermore, FUEDs report experiencing dissatisfactory care and stigma within the ED that may impede successful treatment outcomes[47] and prevent needs from being met. Such evidence buttresses the presence of persistent unmet needs in this population.

Research highlights factors that could predispose FUEDs to having greater unmet needs.[2] FUEDs have a higher burden of chronic illness and therefore tend to experience greater clinical needs. One qualitative study on the perceptions of FUEDs revealed complex clinical health needs, including mental health and substance use challenges and physical health concerns.[153] A study by Bagget et al. on the unmet needs of the homeless found that 73% of a national sample of homeless people reported at least one unmet clinical need, that included an inability to obtain medical or surgical care, mental health care and dental care.[28]

FUEDs with mental health and other disabilities can experience higher unmet health needs.[182–184] A systematic review that included psychiatric related frequent ED utilization estimated 28% to 43% of FUEDs presented due to unmet needs and were discharged to community services.[185] Vandyk et al. conclude that FUEDs with mental health conditions have greater unmet needs and may not be accessing existing services in the community.[185] FUEDs with mental health issues are hard to treat since they may not follow after care plans and disengage from services.[186] The need for care continuity in such patients is great.

In addition to unmet clinical needs, FUEDs also experience unmet social needs which in turn can create or exacerbate their clinical needs. Analysis of data from the Medical Expenditures Panel Survey (MEPS) and numerous other studies demonstrate the presence of poverty puts an individual at greater risk of FUED.[2,26,88,187] Poverty, and its associated deprivation of material circumstances such as housing and food are associated with increased unmet needs.[22,28,183,188] These findings are meaningful in light of research showing homelessness predisposes patients to frequent ED utilization.[39] Research shows that a significant proportion of adults with chronic disease that face economic related unmet needs such as food insufficiency also experience cost-related medication underuse.[188] Significant predictors of unmet clinical needs in the literature include social needs such as food insufficiency.[28] These social needs add another level of complexity on top of the clinical needs of FUEDs who attempt to address unmet needs by using multiple health care services, in addition to the ED.[86]

Research points to the impact of non-clinical interventions on clinical unmet needs. There is evidence to show that fulfilling unmet social needs by providing strong

social support services such as transportation can lead to lower health care utilization and costs.[141,189] Providing residential stability has been shown to reduce unmet physical health care needs and lower ED utilization among homeless individuals.[190] Researchers and policy makers are in agreement that better information about the nature of patients' unmet needs will enable appropriate strategies at resolving them. For example, a WellPoint study on 3,000 Medicaid patients found that 46% experienced 1 social need, and 63% faced multiple social and clinical needs.[191] A clear understanding of those needs by community health workers allowed them to connect patients and their families to appropriate resources. Evidence of health improvements and cost savings from the intervention guided the New Mexico Department of Health's policy for Managed Care Organizations (MCOs) to provide their Medicaid enrollees with community health workers. While the literature sheds light on the co-occurrence of clinical and social unmet needs, it is still sparse on the specific types of needs and how they relate to or are predicted by specific social and clinical determinants.

2.2.5. Knowledge Gaps

A recent FUED research agenda highlighted the need to "identify factors that are subject to intervention and explore specific differences among populations by condition" in order "to predict which patients are at risk for becoming or remaining frequent users" and implement "both ED- and non–ED-based interventions".[192] This research will address several existing knowledge gaps to respond to such inquiries.

- **SDH and Unmet Needs of FUEDs**

While there is much research on the predictive factors of frequent ED utilization and the

multi-faceted characteristics of FUEDs, the field is lacking a comprehensive description of the different types of unmet needs and SDH experienced by FUEDs. To address this, researchers have called upon service providers and policy makers to take account of FUEDs' vulnerable patient profiles in their attempts to meet their health care needs.[31,193] Currently, there is an absence of research on the relationships between unmet needs and while also accounting for clinical determinants. It is important to understand how SDH factors contribute to a variety of unmet social and medical needs since unmet needs promote increased health care utilization.[179,194] An estimate on the magnitude of these relationships would be a significant driver of policy change in how FUEDs experience care delivery inside and outside the ED, which includes both clinical care and social services. To our knowledge, no study has assessed the relationships between SDH, clinical and unmet needs in the Medicaid population. Aim 1 of this research specifically addresses these knowledge gaps.

I hypothesize that SDH can contribute to unmet medical and social needs, but that SDH are distinct from unmet needs. While research shows that poverty, homelessness and food insecurity are associated with unmet needs, there is little description of these unmet needs and the circumstances leading to these. For instance, people who are homeless may or may not express an unmet need of housing if they have access to a regular shelter or accommodation. People experiencing food insecurity, may or may not necessarily have an unmet food (social) need if they have access to food stamps, but could experience unmet medical needs when buying food takes priority over buying medicines. How can FUEDs express unmet medical needs despite access to regular primary care? A more nuanced understanding of unmet social needs in the presence of

access to social service programs can give insight to the appropriateness of services in addressing these needs. The dearth of sustainable interventions for FUEDs[29,111] is indicative of a gap between FUEDs needs and the capacity of the health care system to respond to them.[195] Information gleaned from this research will guide in designing interventions to meet the needs of FUEDs.

- **Non-ED Health Care Utilization Patterns of Medicaid FUEDs**

The literature describes FUEDs as a group that has higher utilization of all types of health care services, ambulatory as well as inpatient. It also debunks the myths around non-urgent use of the EDs by FUEDs.[2,8,154,163] However, a knowledge gap exists regarding the health care utilization patterns of Medicaid FUEDs outside of the ED. For instance, Pham et al. present a comprehensive description of Medicare patients' care patterns in terms of the number of physicians, and practices seen annually, and the percentage of care received from the assigned providers or practices.[196] Such information is crucial to understanding the suitability of the care delivery landscape for interventions geared at care continuity to thrive. A similar granular investigation into the ambulatory care of Medicaid FUEDs, including primary care and specialist care, preventive and mental health, is missing and much needed. Such an inquiry could tease out aspects of FUEDs' ambulatory care which are amenable to change and potential opportunities for intervention.

- **Relationship between care continuity (CC) and preventable ED utilization in FUEDs**

Even though there has been considerable research on the relationship between care continuity and ED utilization, there remains a significant gap in understanding whether

and how care continuity influences preventable ED utilization in FUEDs. Such information is necessary to implement both the ED based and non-ED based interventions for FUED that are being suggested by researchers.[192] Vandyk et al. highlight the need for more work to explore the relationship between continuity of care and frequent ED use especially with regards to mental illness where unmet needs are high. Such inquiry requires an informed approach to incorporate care continuity programs that are appropriate to the social context of FUEDs. While evaluating FUEDs' CC, it is also important to differentiate the types of ED visits made by them based on their preventability or need. Although the literature review shows the impact of care continuity (CC) on over all ED use, there are few studies on the influence of CC on 'preventable ED use' in the Medicaid population. Such an inquiry could further dissect the role of ambulatory care on ED use in Medicaid FUEDs.

- **Persistent FUEDs in Medicaid and the role of injuries**

In comprehending the full landscape of frequent ED use in Medicaid, it is vital to better understand persistent FUEDs. Such knowledge could provide a predictive edge to prevent FUEDs from becoming persistent ED utilizers. Moreover, the literature is conflicting with regards to the role of clinical illness severity in frequent ED use, and lacking in its role, if any, in persistent ED use. There have been several studies around persistent ED use in the Medicare population[87] and in local ED settings.[18,197] Colligan et al report younger age, African American race, Medicaid enrollment, mental illness and end-stage renal disease to be significantly associated with persistent ED use in the general Medicare population.[87] However, the Medicare population is significantly different from the Medicaid population and local ED studies can miss alternative ED site

use by FUEDs and therefore are methodologically limited in ascertaining persistent ED use.[198] To our knowledge, no studies have considered persistent ED use in Medicaid patients using state based Medicaid claims data, specifically in relation to predictors such as SDH, care coordination and clinical illness severity. Understanding the role of these factors on persistent ED use is necessary to identify high risk patients[192] especially as payers are being asked to consider using SDH in risk adjustment models.[199] Aim 3 of this research specifically scrutinizes this topic. Similar to the rationale of Smits et al.,[197] a better understanding of typical predictors of persistent FUEDs of the ED, as opposed to 1 year FUEDs, and non-FUEDs, will generate information regarding modifiable factors around which new interventions may be designed. This is especially relevant to the Medicaid program which has a higher burden of specific predictors of persistent ED use, namely mental illness and substance abuse.

Chapter Three: Methods

3.1.1. Overview of the Study

The Frequent User Study (FUS) is a prospective cohort study that enrolled patients who presented to the George Washington University Hospital (GWUH) Emergency Department (ED) for medical care, were identified as having DC Medicaid insurance and had at least three ED visits prior to the index ED visit during the past year. Enrolled subjects completed an interview during the ED visit that included questions about social determinants of health (SDH), use of public services, and unmet medical and social needs. The study team also obtained a copy of their DC Medicaid claims data for a two-year period prior to the index ED visit. The study was approved by the GWUH Institutional Review Board.

3.1.2. Study Setting and Population

Setting. The study was conducted at the GWUH ED. The GWUH is a 370 bed, for-profit, academic tertiary care hospital with a level 1 trauma center. The annual volume of the GWUH ED is approximately 75,000 patients and approximately 23% are admitted to the hospital.

Sample. To be eligible for the study, ED patients had to meet the following criteria: (1) 18 years of age or older; (2) insured by the DC Medicaid program; and (3) have a history of ≥ 3 ED visits during the past year. To determine past ED visits, the research assistants (RAs) used the Chesapeake Regional Information System for our Patients (CRISP). All acute care hospitals in Maryland and the District of Columbia (DC) provide CRISP with

basic patient, clinical and treatment information on every acute care hospitalization and ED visit that occurs at their facility in real time. ED staff has access to CRISP and the RAs used it to look up potentially eligible patients for the study to determine if they had made at least 3 previous ED visits to a hospital in the area during the past calendar year.

Patients were excluded if they had an HIV or AIDS diagnosis, had a ED episode acuity level 1 (emergent), did not speak English, resided in a nursing home/institutional facility or were unable to understand consent. It should be noted that we did not exclude patients if they were also covered by Medicare insurance.

Research assistants (RAs) who work in the GWUH ED every day of the week, between the hours of 9AM and 10PM screened and enrolled 496 subjects for this study over a 14 month period beginning October 1, 2015 and ending November 7, 2016. RAs approached eligible subjects, described the study and asked for consent. Subjects who agreed to participate signed a written consent form. By consenting, subjects agreed to complete a face to face interview with the RA during the ED visit and gave permission to the study team to obtain a copy of their DC Medicaid claims for a 2 year period (prior to the index ED visit). Subjects who completed the interview were given a $5 gift card for their participation in the study.

Of the total number of subjects enrolled in the study, the final sample for this research included data for 474 participants after accounting for available claims data and duplicate enrollees.

3.1.3 Data Sources

This study relies primarily on data collected from two sources: (1) interview; and

(2) DC

Medicaid claims data.

Interview Data. The interview took approximately 15 minutes to complete and included the following topics: (1) structural and intermediary social determinants of health (SDH); (2) health and health care utilization; (3) use of public services; and (4) unmet social and medical needs. More detail on each domain follows. The survey containing all relevant interview items is also detailed in Appendix A.

Subjects were asked about the following structural and intermediary social determinants of health information in the interview: highest educational level completed, marital status, social support (emotional, financial and practical), whether they had any children and if so, did they live with them, employment, military duty status, history of jail/prison, total monthly income, housing status and food insecurity.

The interview included questions about general health, mental health, substance use and health care services utilization. Subjects were asked to rate their overall health as well as whether they had a usual health care provider and a case manager. Subjects were asked if they had experienced serious depression, anxiety or tension, hallucinations, trouble understanding, remembering or concentrating, trouble controlling violent behavior and experienced serious thoughts of suicide during the past 12 months.

Subjects were asked if they drank alcohol every day and whether they used drugs other than those prescribed for medical reasons. If they did either, they were asked if their alcohol (or drug) use was a problem for them, if they wanted to seek treatment and when the last time was that they had received alcohol or drug treatment.

The interview included questions about cash benefits that subjects might be

receiving from different sources (i.e. supplemental social security income, social security disability income, temporary assistance for needy families, unemployment compensation). They were also asked about assistance from non-cash programs such as housing vouchers, food stamps, food pantries, soup kitchens, drop in centers, or the low income home energy assistance program.

Subjects were also asked if they needed help with medical or social issues during their ED visit. They were read a list of 24 possible needs and asked to tell the RA if they wanted help with any of these specific issues. After the RA went through the list, subjects were asked to rank their top three needs. The social needs included getting food, transportation, clothing, assistance with legal issues, help finding a job, etc. The medical needs included finding a doctor, dentist or case manager, help with managing medications, and treatment for mental health and/or substance abuse problems. Subjects were also asked if they had any other needs they needed help with that were not specifically asked about. The RAs documented the additional needs in an open text field. For a complete list of the 24 medical and social needs, please see Appendix A, Part 5, Q4.

Medicaid Claims. During the ED visit, the RAs also documented the type of DC Medicaid insurance subjects had (i.e. Prime or managed care organization) and their beneficiary number. After study enrollment ended, the Medicaid IDs were given to staff at the DC Department of Health Care Finance and Delivery who used the IDs to extract a copy of their claims for a two year period prior and including the day of enrollment. The study team obtained all inpatient, outpatient, pharmacy, and professional claims. The claims data include diagnosis and procedure codes, dates of service, provider

identification, place of service, and reimbursement amounts. The claims data also include enrollment information such as age, gender, race, ward, reason for eligibility and dates of enrollment.

3.2. Aims and Hypotheses

3.2.1. Aim 1 and Hypotheses

The purpose of the first aim is to describe the clinical and social unmet needs that FUEDs report and examine the association between unmet needs and a) Social determinants (SDH) - structural and intermediary; and b) Clinical determinants (access to ambulatory care and clinical illness).

The following hypotheses are tested:

- H1a: FUEDs who have attained less than high school education report more unmet needs compared to those who have completed high school, controlling for other SDH and clinical determinants.
- H1b: Better social support is associated with fewer unmet needs, controlling for other SDH and clinical determinants.
- H1c: FUEDs with a behavioral health condition have significantly more unmet needs than those who don't, controlling for other clinical determinants and SDH.

3.2.2. Aim 2 and Hypotheses

The second aim of this research is to assess the influence of SDH and Care Continuity (CC) upon: a) total ED utilization; b) preventable ED utilization. In addition, descriptive statistics will be conducted to characterize ambulatory care (i.e. primary care,

specialist, preventive care, behavioral health, dental care, home health care, etc.) and acute care (i.e. inpatient admissions, ED visits, and ambulance utilization) of FUEDs.

The following hypotheses are tested:

- H2a: There will be a significant association between physical illness severity and ED utilization, controlling for other clinical determinants and SDH.
- H2b: Greater ambulatory CC is associated with fewer ED visits, controlling for other clinical determinants and SDH.
- H2c: The presence of poorer social support is associated with greater preventable ED visits, controlling for other SDH and clinical determinants.

3.2.3 Aim 3 and Hypotheses

The third aim of this research is to identify the factors that are associated with persistent ED use (over a two year period). Through this aim, I (1) describe differences between FUEDs who are persistent vs not persistent and (2) examine the characteristics of persistent ED utilizers with respect to a) structural and intermediary social determinants including duration of unemployment; b) clinical determinants including physical illness severity, behavioral health status and care continuity.

The following hypotheses are tested:

- H3a: Patients with longer duration of unemployment are more likely to be persistent FUEDs, controlling for other SDH and clinical determinants.
- H3b: Patients with cumulative homelessness are more likely to be persistent FUEDs, controlling for other SDH and clinical determinants.

- H3c: Patients with greater physical clinical illness severity are more likely to be persistent FUEDs, controlling for other clinical determinants and SDH.

3.3. Variable Construction: Dependent (Outcome) Variables

3.3.1 Aim 1 Outcome Variable: Number of Unmet Needs

The main outcome for Aim 1 is the total number of unmet needs which includes social and medical unmet needs. It is based on self-report and was collected during the interview. This variable was operationalized from the interview question that inquired "Is there anything that you need help with now?" and includes both medical and social unmet needs. Participants were given 24 distinct options (Appendix A, Part 5, Q4) to report from which were categorized in two ways to generate the number of unique unmet needs and a second outcome variable – the domains of unmet needs (categorical). Forty participants (8.4%) mentioned at least one 'other' unmet need. The RAs documented the additional needs in an open text field. During data cleaning, these 'other' needs were assessed and re-categorized into the 24 categories.

a) Total Number of Unmet Needs: The total number of unmet needs experienced by a participant is a continuous variable and is the sum of the total number of different unmet needs reported by each FUED, with a range of 0 – 24.

b) Unique categorical domains: I used factor analysis and expert judgment to collapse the 24 distinct response options into four domains: 1) Material resources, 2) Health management and literacy, 3) Family-related, and 4) Employment.

Factor Analysis (FA) is a statistical method of discovering underlying patterns in data to identify items that measure a similar construct.[200] Factor analysis can be used to

aggregate data into a smaller number of constructs. For this study, I used factor analysis to identify domains of unmet needs based on the 24 medical and social needs that subjects were asked about during the interview. Factor analysis is usually performed on items that are continuous or ordinal in nature. Since the unmet needs are binary, I applied a polychoric correlation matrix that is suitable for dichotomous or ordinal variables. After creating the correlation matrix, factor extraction and orthogonal factor rotation aided in interpreting how the different variables grouped into unique factors. Both FA and expert judgment on construct validity guided in the final specification of the unmet needs domains. Twenty-four unmet needs grouped into 4 distinct factors (Table 1) that were used to create 4 unique unmet need domains: Material Resource Needs, Healthcare Management and Literacy Needs, Family-related Needs and Employment-related Needs. The polychoric matrix that was used to extract the factors enabled us to visualize the correlation between different types of unmet needs. These correlation coefficients were also used in assessing the reliability of the factor groupings. Items that grouped together in the same factor had a relatively high correlation coefficient. Factor validity was further established by conducting reliability testing using Cronbach's alpha. Items that grouped together in a factor exhibited a reliability coefficient greater than 0.64 (Table 2).

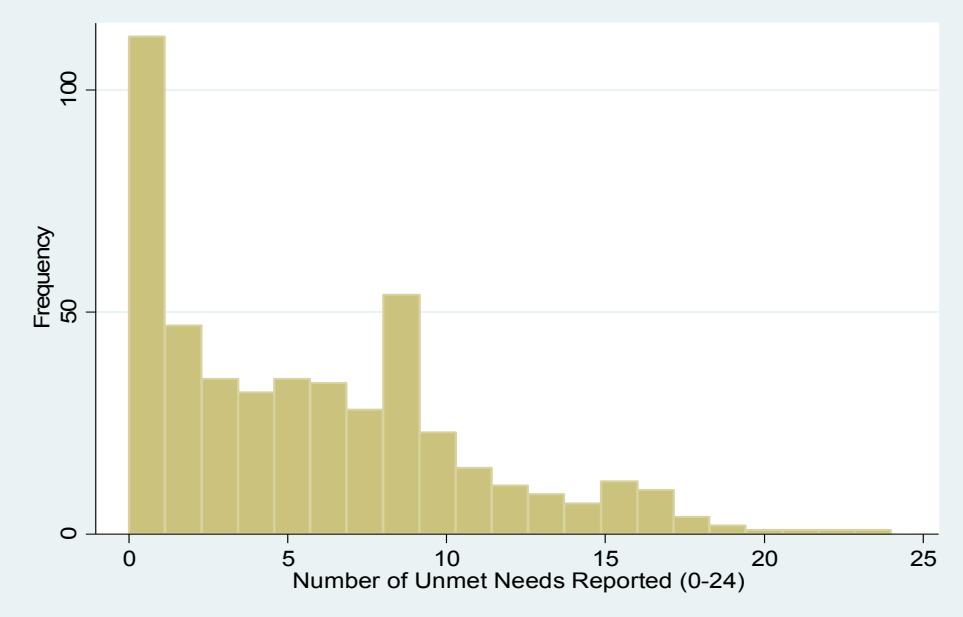

Figure 3: Distribution of Variable "Number of Unmet Needs"

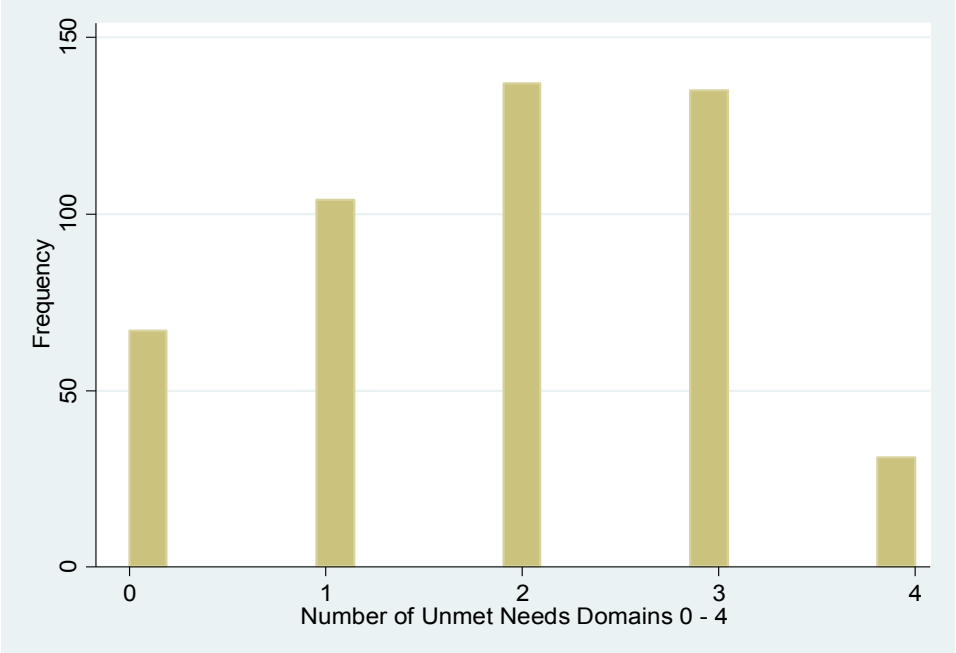

Figure 4: Distribution of Variable "Number of Unique Unmet Need Domains"

Table 1: Factor Loadings of Different Unmet Needs Among FUEDs

Variables/ Type of Unmet Needs	Factor 1 (Material Resource Needs)	Factor 2 (Health care Manage-ment and Literacy Needs)	Factor 3 (Family-related Needs)	Factor 4 (Employ ment-related Needs)
Getting food	0.7191	0.3701	0.1471	0.0587
Getting clothing	0.5868	0.4385	0.1662	0.0729
Transportation	0.5540	0.3246	0.2612	0.0767
Legal issues	0.5273	0.3707	0.4191	0.0723
Getting public benefits	0.7474	0.2504	0.1285	0.2084
Finding affordable housing	0.6578	0.1676	0.0453	0.2760
Paying rent, utilities	0.7486	-0.0300	0.2327	0.2427
Landlord or housemate issues	0.4794	0.2776	0.2161	0.1679
Money/cash	0.5954	0.0851	0.3174	0.3676
Availability of resources	0.6025	0.2510	0.3338	0.2086
Medical care	0.4652	0.5969	0.0848	0.1503
Getting / managing medications	0.4639	0.5176	0.1950	0.0955
Treatment for substance abuse	0.1172	0.7107	0.3885	0.0687
Dental care	0.3193	0.7498	-0.0114	0.2481
Psychiatric services	0.2609	0.5686	0.1978	0.1884
Ability to read or write	0.1375	0.7380	0.0728	0.2332
GED/ education	0.1507	0.6074	0.1075	0.4784
Parenting	0.1317	0.2469	0.8032	0.2976
Child care services and costs	0.2804	-0.0268	0.8815	0.1129
Enrolling children in school	0.1003	0.0545	0.8464	0.2469
Domestic violence	0.0505	0.5444	0.6601	-0.1018
Finding a job	0.1555	0.0996	0.1769	0.8552
Job training	0.1928	0.2146	0.2279	0.8525
Managing money	0.3238	0.2234	0.3121	0.4730

Table 2: Reliability Testing of Domains of Unmet Needs

Factor	Scale reliability coefficient	Inter-item Covariance	No. of items
1 Material Resource Needs	0.81	0.06	10
2 Health care Management and Literacy Needs	0.72	0.04	7
3 Family-related Needs	0.65	0.01	4
4 Employment-related Needs	0.67	0.08	3

3.3.2. Aim 2 Outcome Variables: Total and Preventable ED Utilization

The main outcomes for Aim 2 are: (a) number of total ED visits and (b) number of preventable ED visits.

A. Total Number of ED visits

The first outcome is total number of ED visits. This is a continuous variable comprising the total number of ED visits made by each FUED in the past one year (both admitted and discharged ED visits) and is measured from the DC claims data.

There is no standardized method of identifying ED visits from claims data. I used the approach recommended by Venkatesh et al. [201] and outlined in Figure 3. First, I identified all professional claims (carrier claims) associated with an ED provider by the evaluation and management codes of 99281-99285 or the critical care codes of 99291-99292 and place of location as emergency room. Second, I identified all facility claims associated with an ED visit by the revenue codes of 0450-0459 or 0981 (emergency room). Third, to avoid double counting ED visits, I considered a professional ER claim and a facility ER claim that was within one day of each other as the same ED visit. If two claims were within one day of each other but the facilities are different or the evaluation and management codes are different, I considered them separate ED visits because it is possible that a person can have more than one ED visit on the same day. Finally, if there was a professional or a facility claim but not both, it was counted as an ED visit. Using this definition, the total number of ED visits in our FUED sample ranges from 4 to 264 within the past year of the index ED visit.

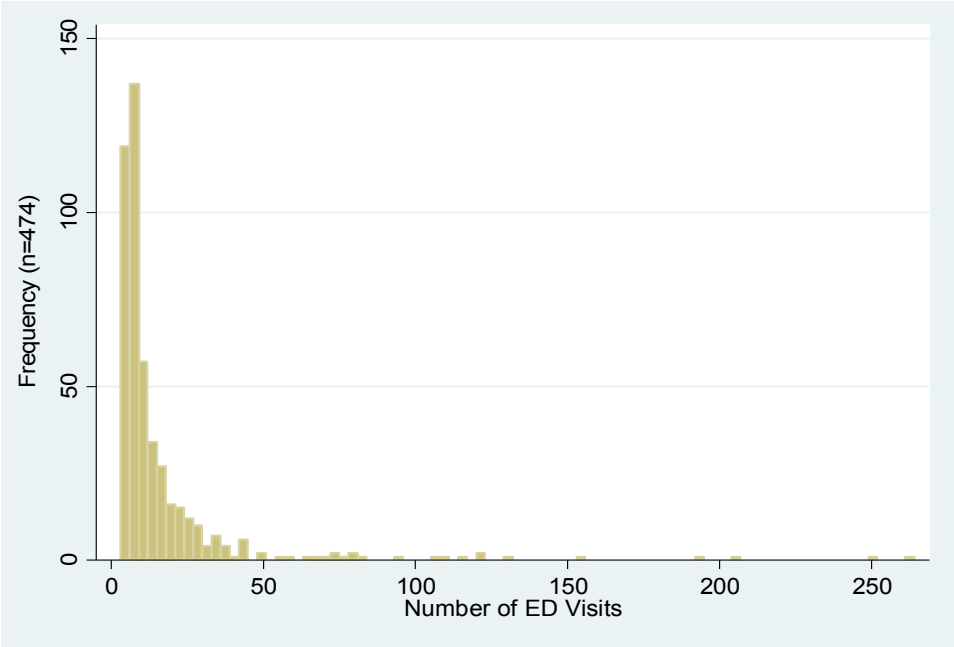

Figure 5: Distribution of Variable "Number of ED Visits"

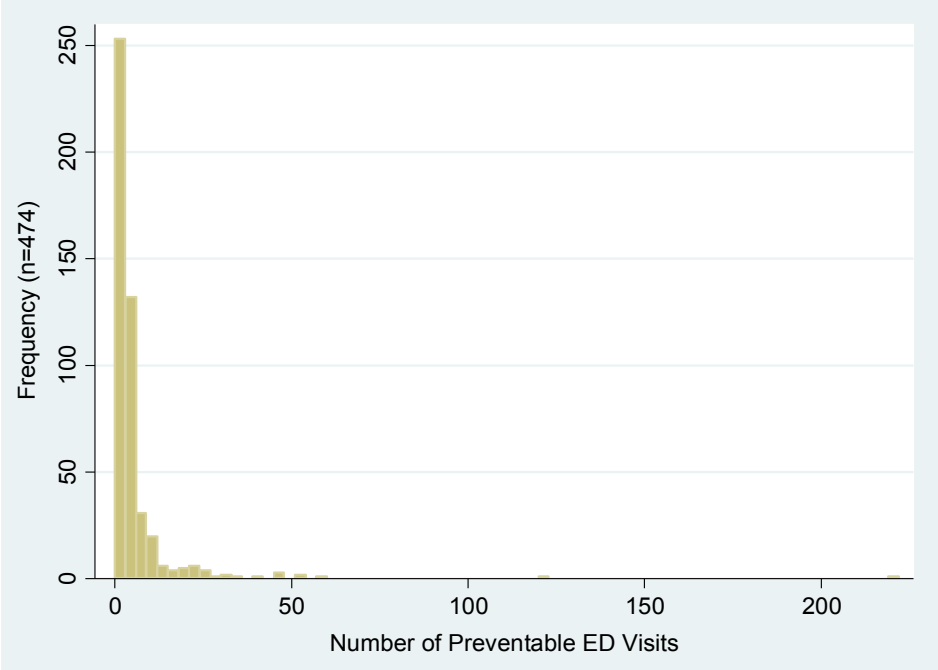

Figure 6: Distribution of Variable "Number of Preventable ED visits"

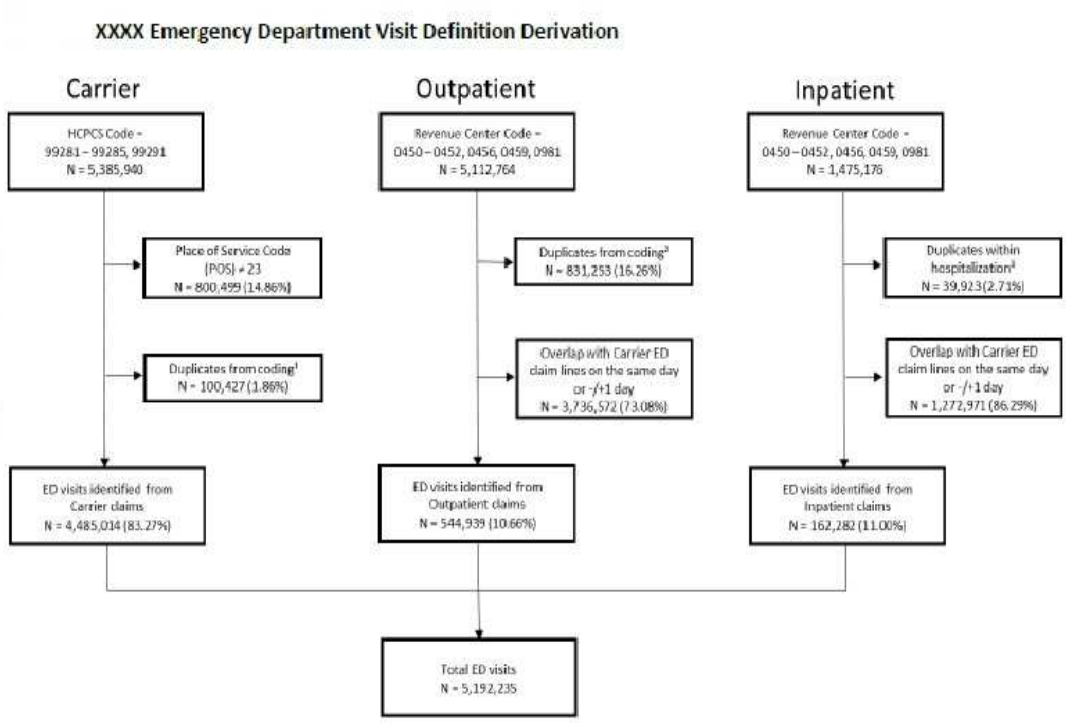

Figure 7: Derivation of ED visit definition

B: Preventable ED Visits.

A description of the second outcome, total number of preventable ED visits follows. I used the Minnesota algorithm[166] to classify ED visits as preventable. The Minnesota algorithm is based on information available in administrative claims data. It categorizes ED visits as either ED care needed or primary care treatable (see Figure 3 below). The Minnesota classification system is based on ED disposition, evaluation and management (E & M) codes and the procedures rendered during the visit. If the patient is admitted or the E & M codes reflect relatively high complexity (i.e. 99284-99285) or critical care services were rendered (i.e. 99291-99292) then the ED visit is considered ED care needed. If the E & M codes reflect intermediate complexity (i.e. 99282-99283) and the patient received a procedure that is commonly performed in the ED but not in the

primary care setting, the visit was classified as ED care needed. These procedures are listed under the ED Indicator Procedure List (Appendix B). If the intermediate E & M codes were not accompanied by an ED indicator procedure, the Minnesota algorithm classifies the ED visit as primary care treatable. Finally, the lowest complexity ED visit, an E & M code of 99281, is classified as primary care treatable.

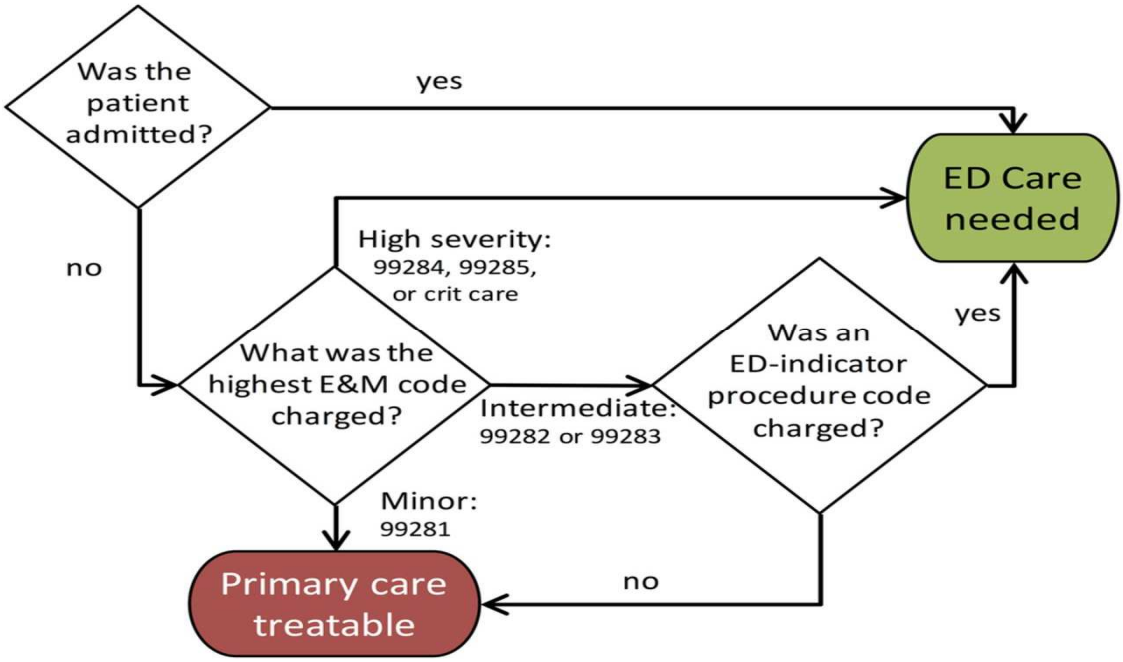

Figure 8: Minnesota Algorithm Flow Chart

3.3.3. Aim 3 Outcome Variable: Persistent ED Use (PED)

Looking retrospectively at two years of claims data, we created a categorical variable for persistent frequent use of the ED (PED). Claims for all patients in the 1st year lookback (n=474) were assessed for ED use in the prior year (2nd year look back). A total of 450 participants out of our sample that were enrolled for both periods were retained for analysis. Based on the 2nd year look back ED use, participants were categorized accordingly:

1 “persistent frequent utilizers” (262, 58.2%) if they had >=4 ED visits in the 2nd year lookback and >=4 visits in the subsequent year

2 “non-persistent frequent utilizers” (188, 41.8%) if they had 0-3 ED visits in the 2nd year lookback, but >= 4 visits in the subsequent year

3.4. Variable Construction: Independent Variables

Table 3 below summarizes independent variables for the analyses and specifies which aims they pertain to. A description of the variables follows.

Table 3: Description of Independent Variables

MEASURES	SOURCE	DESCRIPTION	FINAL VARIABLES	AIM
Age	ED visit	Date of birth	Age	1,2,3
Gender	ED visit	Observed	Gender	1,2,3
SDH – structural				
Educational level	Interview Part 8, Q1.	Highest level of education completed	High-school Attainment (Y/N)	1,2,3
Employment status	Interview Part 8, Q10	Currently working	Currently employed (Y/N)	1,2
Unemployment Duration	Interview Part 8, Q9	Duration of time when last worked for pay	Duration of unemployment 0 currently employed 1 unemployed < 2 yrs 2 unemployed >=2 yrs	3
Income	Interview Part 8, Q13	Total monthly income in past 30 days	Income: 1 Less than $100 2 Between $100 - $499 3 Between $500 - $999 4 $1000 or more	1,2,3
SDH – Intermediary				
Currently homeless	Interview Part 3, Q1-10.	Lives in transitional housing/outside	Access to food and shelter: 0 Access to both	1,2,3
Food insecurity	Interview Part 4, Q1-2.	Does not always get enough food to eat		1,2,3

			1 No access to food (food insecure) 2 No access to shelter (currently homeless) 3 No access to both food and shelter (homeless and food insecure)	
Social support	Interview Part 8, Q3a-3c.	Do you have someone to: Lend you $100; Someone to Go to doctor with you; Help with emotional crisis	Social support score (0-3) 0 None 1 (1 of social support categories) 2 (2 of social support categories) 3 (all 3 of social support categories)	1,2,3
Marital status	Interview Part 8, Q2.	Never married, married or living with/widowed, separated, divorced.	Marital status 0 Never married 1 Currently married 2 Widowed 3 Divorced/separated	1
Children	Interview Part 8, Q7.	No. of children living with subject	Have children (Y/N)	1
Public Benefits				
Cash assistance	Interview Part 5, Q1a-e.	Receipt of SSI, SSDI, TANF, disability, unemployment or survivors benefits	Public benefits assistance 0 (None) 1 (Cash assistance only) 2 (Non-cash assistance only) 3 (Both cash and non-cash assistance)	1,2,3
Non-cash assistance	Interview Part 5, Q2a-d	Housing voucher or subsidy, LIHEAP, SNAP, food pantries or both		
Medicaid insurance	ED visit	Managed care (MCO) vs. fee-for-service (FFS)	Medicaid insurance 1 (FFS) 2 (MCO)	1,2,3
Clinical Determinants				
Care Continuity	Claims	Continuity of Care Index	Care Continuity tertiles 0 (unassessed group – people with less than 3 ambulatory care visits) 1 (Low CC)	2,3

			2 (Moderate CC) 3 (High CC)	
Access: Usual care provider	Interview Part 1, Q2.	Particular provider you usually go to	Access to regular care 0 (None) 1 (Social worker only) 2 (Doctor only) 3 (Both doctor and social worker)	1,2,3
Access: Predominant doctor type	Claims data	Specialty of doctor most visited using plurality provider algorithm	Predominant provider type: 0 None (no providers seen) 1 Specialist 2 Primary care provider	2
Clinical illness severity (physical health status)	Claims data	CDPS Risk Score	Quartiles of CDPS score (without behavioral health conditions): 1 Low 2 Moderate 3 High 4 Severe	1,2,3
Mental illness	a) Interview Part 2, Q1. b) Claims	Serious depression; anxiety/tension; hallucinations; controlling violent behavior; thoughts of suicide ICD9 and ICD10 codes for mental health disorders captured by CDPS in psychiatric illness category	Behavioral health status using clinical diagnosis of mental illness and substance abuse: 0 No behavioral health problems diagnoses 1 Substance abuse diagnosis only 2 Mental illness diagnosis only 3 Both diagnosed substance abuse and mental illness	1,2,3
Substance use	a) Interview Part 6, Q1-3; Part 7 Q1-3. b) Claims	Drink alcohol every day; Use drugs other than those medically prescribed Clinical diagnosis of substance use disorder captured by CDPS in substance abuse category		

3.4.1. Social Determinants of Health (SDH).

The relationship between SDH, both structural and intermediary, and total number of unmet needs is of primary interest in Aim 1. In addition to patient's characteristics such as age and gender, the main structural determinants of health I examined were educational attainment, employment status and income. Race is a structural SDH but is not included in the analysis because there is little variation in the sample. Over 90% of the subjects are black. Of particular interest is the duration of unemployment on persistent ED use. We hypothesize that patients with unemployment will lack access to regular health care services and will utilize the ED more. The intermediary determinants of health include housing, food, social support, marital status and number of children living with subject. A variable capturing varying levels of access to food and shelter was created from the two separate measures of homelessness and food insecurity. A social support scale was constructed with a possible range of 0 to 3 depending on whether subjects report they have someone who will lend them $100, take them to the doctor and/or help them with an emotional crisis.

3.4.2. Public Benefits

Subjects were asked during the interview whether they received different types of cash benefits such as Temporary Assistance for Needy Families (TANF). Subjects were also asked if they received any social services such as housing or fuel assistance and food assistance. A variable that captures access to either cash or non-cash assistance, both types or neither type of assistance was created. During the index ED visit, the research assistants (RAs) documented the type of Medicaid insurance they had. Using this

information, we can assess whether unmet needs are more common among FUEDs that are not receiving medical and social services.

3.4.3. Clinical Conditions

When examining the relationship between SDH and unmet needs as well as SDH and ED utilization, it will be important to control for subjects' physical and behavioral health. The patient's clinical condition was measured by the Chronic Illness and Disability Payment System (CDPS). The CDPS is a diagnosis-based risk adjustment system that was developed to predict future health care costs. The CDPS was originally developed for the Medicaid program and is based on the Medicaid claims of each beneficiary. The software maps ICD diagnostic codes and prescription drug data from the Medicaid claims to 58 CDPS categories within 20 major categories corresponding to major body systems or type of diseases. Within each diagnostic category, the software further categorizes the disease conditions into severity levels (i.e. low, medium and high). It also generates an overall risk score. The higher the score, the higher the severity of clinical illness, poorer health and higher the predicted health care costs.

a) Physical health

The overall score or an adapted score (i.e. omitting mental health and diagnosed substance abuse conditions) is used as a measure of overall physical health in our analyses.

b) Behavioral health

Health behavior variables indicate whether the subject has mental illness or drinks alcohol every day/uses drugs other than those prescribed for medical reasons. Subjects

were asked during the interview if they had experienced different types of mental health problems during the past year. In addition, the Medicaid claims data was used to identify mental health conditions for which subjects received treatment or were documented as co-morbidities. Similarly, we have a self-reported measure of substance abuse from the interview in addition to diagnosed substance abuse from claims data. Since both sources can suffer from underreporting, we compared the extent of agreement between the two results based on one source or the other as well as both sources. For mental illness, there was close agreement on frequencies from both sources (kappa 0.42, agreement 72%). For substance use, there was considerable under-reporting on the self-report measure in comparison to the claims measure (kappa 0.22, agreement 63%). For these reasons, I decided on using the claims based measure for diagnosed mental illness and substance abuse. These measures were used to create a categorical variable of behavioral health status that considers having none, either or both of these diagnoses.

3.4.4. Care Continuity (CC)

CC is a reflection of "the extent to which a given individual's total number of visits for an episode of illness or a specific time period are with a single or group of referred providers."[202] There are a variety of measurement approaches for CC. I utilized the Bice-Boxerman Continuity of Care Index (COCI)[203] which is the most common index used for claims based measurement of care continuity. It has been found to be a stable measure in prior research[48,204,205] and is considered suitable for populations that have multiple morbidities since it captures the concentration of visits to individual providers.[133] It also shows good correlation with other measures of CC.[128] The index

ranges from 0 (no continuity) to 1(perfect continuity). CC is affected by both the volume of providers seen as well as the volume of visits.

CC will be measured using the following formula for COCI:

$$\frac{\left(\sum_{i=1}^{p} n_i^2\right) - n}{n(n-1)}$$

n= total number of visits in a defined period
n_i is the number of visits to provider i
p is the total number of providers

I did not calculate a CC score for subjects who did not have at least 3 or more of the provider visits in 1 year because continuity cannot be well assessed with few visits.[133,136,203,206] Subjects with few visits are likely to attain a score of 0 or 1 if they only have 1 or 2 physician visits. These subjects were categorized as an 'unassessed CC group' and included in the analyses since they comprised a large proportion of the sample (30.6%). This group cannot be assumed to have a care continuity of "0" since it does not capture dispersion of visits and CC levels include a measure of dispersion in addition to the number of visits. However, I assumed this group would represent a worse category in terms of risk for ED utilization than the lowest category of CC.

Ambulatory provider visits were defined as a face-to-face evaluation and management (E&M) visit in an outpatient setting. These provider visits were identified using evaluation and management codes identified by the Berenson-Eggers Type of Service (BETOS) classification system, in addition to Place of Service (POS) codes to determine the ambulatory setting of the visit. The BETOS system classifies each procedure code in the Health Care Financing Administration Common Procedure Coding System (HCPCS) into one of seven categories: Evaluation and Management (E&M), Procedures, Imaging, Tests, Durable Medical Equipment, Other and Exceptions/Unclassified. This coding system has an advantage over regular CPT codes

because it consists of readily understood clinical categories and is relatively stable in event of minor changes in technology and practice patterns. I include visits that occurred in an office, hospital outpatient department, or home. I excluded nursing home, custodial care and all ED visits. The codes used to identify the face-to-face E & M visits and POS codes are listed in Appendix C.

The number of different physicians seen by each patient in a year were determined using provider taxonomy codes contained within the facility and revenue (carrier file) specialty codes. Eligible providers included all physicians as well as the following non-physician providers: nurse practitioners, physician's assistant, clinical nurse specialist, mental health provider, optometrist, podiatrist. Visits to pathologists, dentists, registered nurses and medical technicians were excluded. Appendix C includes the list of taxonomy codes that were classified as primary and specialty care. COCI was calculated and converted into a categorical measure because of the proportion of subjects with an unassessed COCI. I used tertile cut points that were constructed from the study sample distribution of the continuous COCI plus a category of unassessed to construct a four level COCI variable.

3.4.5. Access to regular care

a) Regular doctor or social worker

During the interview, the RAs asked each subject about medical resources including whether they had a health care provider they usually went to for their health concerns and whether they had someone to help them manage their health problems. A variable measuring access to regular care was created using self-reported information on whether

the subject had no access to either a social worker or physician, only access to a social worker, only access to a regular doctor or access to both a social worker and a regular doctor.

b) Predominant provider

The plurality provider algorithm was used to estimate the total proportion of FUEDs that had a primary care provider[196,207]. This algorithm assigns a beneficiary to the physician or practice that billed for the greater number of that beneficiary's evaluation and management visits in a given year. Even though this variable was not included in the multivariate models because of its correlation with continuity of care, it provided insight into the number of participants that had no ambulatory care and therefore no predominant provider (11.8%), had a specialist as their predominant provider (21.9%) and a primary care physician as a predominant provider (66.2%).

3.5. Correlation and Endogeneity

Correlations between independent variables, as well as between dependent (number of unmet needs) and independent variables were evaluated through bivariate analyses and chi-square testing in addition to polychoric correlation matrices. This enabled us to detect high correlations between the following variables:

- Homelessness and food insecurity (correlation 0.58): Both these variables were used to create a composite variable to capture access to food and shelter.
- Mental illness and substance abuse (correlation 0.59): A composite variable was created to capture different levels of behavioral health using both these variables.
- Access to food and shelter and behavioral health: There is moderate correlation between these variables (0.47).

- Public assistance and behavioral health: There is moderate correlation between these variables (0.32).
- We assessed the possibility that specific independent variables (eg. homelessness and food insecurity) would be highly correlated with unique components of the dependent variable (housing need, food need). Polychoric correlations depicted that homelessness and food insecurity had similar magnitude of correlations with many other types of unmet needs (besides housing and food) including transportation, clothing, parenting needs and medical care. Homelessness had higher correlation with both material resource needs (0.61) and health care literacy and management needs (0.41) than with family related needs (0.24) and employment related needs (0.23).

Endogeneity can occur if a variable or process, observed or unobserved, (included or not included in our model) can determine the state of an independent variable in the model. With the nature of our study there is potential for endogeneity between different types of SDH, between SDH and clinical determinants and between our predictors and outcome. According to the theoretical framework for the study, most SDH and clinical determinants perform as mediating variables and therefore endogeneity cannot be avoided. We assessed endogeneity by using forward step-wise modelling adding in first the structural SDH and then the intermediary SDH, and by running separate models including only clinical determinants and only SDH. We also included as many 'observable' measures of SDH and clinical determinants in our model. Comparing the resulting models enabled decisions in final model specifications and in considering the intrinsic endogeneity to minimize misinterpretations of the results.

3.6. Data Analysis

3.6.1. Aim 1 Data Analysis

The purpose of the first aim is to describe the clinical and social unmet needs that FUEDs report and examine the association between unmet needs and a) Social determinants (structural and intermediary); and b) Clinical determinants (access to ambulatory care and clinical illness). For Aim 1, the analysis was conducted in three phases. I conducted descriptive analysis of the prevalence and types of different unmet needs (Table 4). Then I assessed the bivariate associations of the number of unmet needs across different social and clinical determinants (Table 5). I also compared self-reported mental health problems to mental health conditions documented in the DC Medicaid claims data. Similarly, self-reported substance abuse measures were compared to diagnosed substance abuse in the DC Medicaid claims data. Since there was significant underreporting in the self-reported measure, we used the claims based measures. In addition, I examined the bivariate relationships of different predictor variables to each other because there is likely to be significant correlation among the predictor variables. For these bivariate relationships, chi-square analysis was used when the two variables were categorical in nature (e.g. receipt of food stamps and food insufficiency), and ANOVA was used when examining the relationship between a categorical and continuous variable (e.g. employment status and total number of unmet needs). In addition, a polychoric correlation matrix allowed me to assess high correlation between the categorical independent variables as well as potential endogeneity issues between our independent and dependent variables. (Appendix D supplementary table 2). In the final

phase of the analysis of Aim 1, I conducted unadjusted and adjusted multivariate linear regression.

Since the distribution of the dependent variable was not normally distributed (Figures 3 and 4) but the assumption of normality of residuals was met (Figure 9), I used OLS linear regression as the main approach, to test the relationship between the total number of unmet needs and: a) Social Determinants, b) Clinical Determinants, and c) Both Social and Clinical Determinants. However, I also conducted a sensitivity analysis using poisson regression since the main outcome, total of unmet needs, are count data and its distribution is positively skewed.

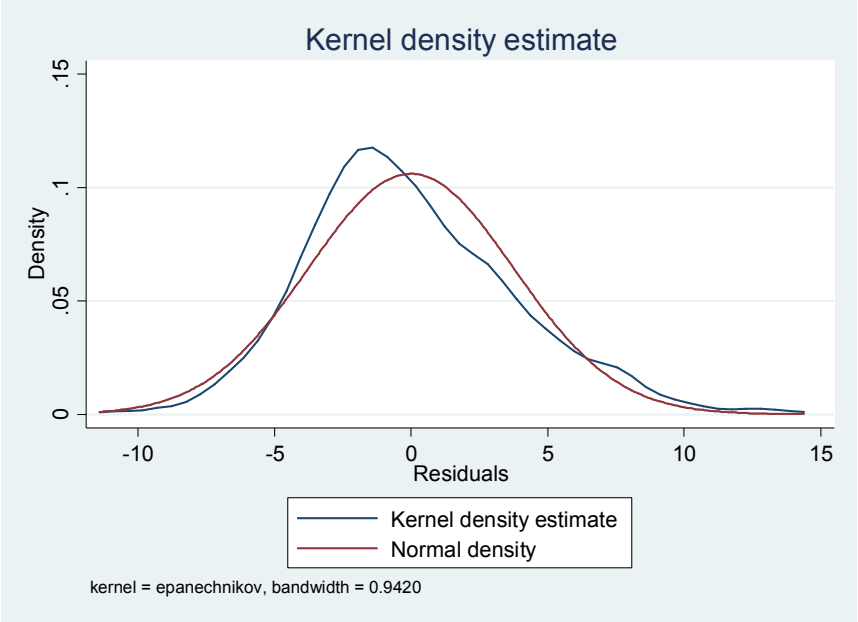

Figure 9: Normal Distribution of Residuals (Assumption of Normality)

Separate OLS models were tested to estimate the influence that Social and Clinical Determinants, respectively, had on the variance in the number of unmet needs (see Appendix D, supplementary table 1). Significant bivariate relationships, step-wise model adjustment and fit statistics were used to guide final model specifications. These

models were used to test my hypotheses. Post regression tests confirmed the assumptions of linearity and determined normality of residuals. Presence of heteroskedasticity was detected but considered mild. Robust estimates of the model showed no significant difference in coefficients or t-test values and thereby it was considered mild. Variance Inflation Factor test was used to ensure there was no multicollinearity among the model variables. Model specification tests were conducted to avoid misspecification errors.

Sensitivity analyses were also conducted using linear regression to assess the association of the variables included within the final model with the number of unmet need domains (0-4) rather than total number of unmet needs (0-24). I also considered conducting ordinal logistic regression using the number of unmet needs domains (0-4) as the outcome variable, however the assumption of proportional odds was not met.

3.6.2. Aim 2 Data Analysis

The second aim is to evaluate the influence of social determinants and care continuity (CC) upon a) total ED utilization; b) preventable ED utilization. Descriptive statistics, including frequency, percentage, mean and standard deviations were computed for all acute and ambulatory care encounters, particularly ambulatory physician visits, total and preventable ED visits and hospitalizations. In addition, median and inter-quartile range (IQR) were computed for the outcome variables: total and preventable ED utilization. The predominant provider was computed using the plurality provider algorithm.[196] Bivariate associations between a) SDH and number of ED visits (total and preventable), and b) CC and number of ED visits (total and preventable), were tested using the non-parametric Kruskal Wallis test. The variation and significance of these

associations, along with associations of ED utilization with clinical risk scores including behavioral health status was assessed in preparation for multivariate model specification.

Since the distribution of the number of total ED visits and preventable ED is skewed to the right, with a conditional variance that is greater than the mean, and is by nature count data in our sample, negative binomial regression was used to examine the association between the total and preventable number of ED visits in the past year and a) SDH and b) CC. Interaction effects between CC and clinical illness risk were tested. Goodness of fit tests verified the most appropriate model. Coefficients were reported as incident rate ratios (IRR) that represent the ratio of the count of events (ED visits) for the variable of interest to its reference group. In addition, I calculated the marginal effects of each independent variable upon the predicted number of total and preventable ED visits. Selected parameters and combinations of independent variables were used to create scenarios illustrating the real-world impact upon ED visits that could result.

3.6.3. Aim 3 Data Analysis

The third aim is to identify factors that are associated with persistent ED use. To assess the proportion of patients that are persistent and non-persistent, we compared the bivariate associations between persistent FUEDs and various structural and intermediary SDH, care continuity, mental illness and other health care related factors. Correlations between variables, chi-square tests of significance in bivariate analyses and step-wise regression were used to guide final model specification in the multivariate analysis.

Logistic regression models were constructed to evaluate the factors that are associated with persistent FUEDs. Models controlled for age, gender, educational

attainment, employment status/duration of unemployment, cumulative homelessness, type of Medicaid plan, CC, and clinical illness severity. In addition, I estimated the marginal probability of persistent FUEDs for select predictor variables that showed a strong association with persistent ED use, while holding other covariates at their mean (continuous variables) or base/reference category (categorical variables).

Chapter Four: Results

4.1. Aim 1 Results

Characteristics of the Population and Bivariate Associations (Tables 4, 5 and 6)

The study population comprises of predominantly female participants (60.3%), with a mean age of 43.4 years (SD 13.3). Most participants are currently unemployed (65%) and 48% have been unemployed for more than 2 years. The majority (41.3%) report a monthly income in the range of $500-$999. Twenty percent are currently homeless. Of the 80% currently not homeless, 40% have faced homelessness in the past. Twenty one percent of the sample report facing food insecurity in the past 30 days. Most participants have access to public non-cash/programmatic benefits (69%) but fewer have access to public cash benefits (45.9%). The majority (58.3%) have Medicaid insurance through a Medicaid Managed Care Organization (MCO). A large proportion have a diagnosed mental illness (62%) and 44% have a clinical diagnosis of substance abuse. Over 50% reported going to a regular doctor, while 24.6% had access to both a regular provider and a social worker. About 12% did not see any ambulatory care clinical provider in the past year, while about 66% had a primary care provider and 21.9% had a specialist as their predominant provider.

This population faces a considerable number of unmet social and clinical needs (Table 4). The mean number of unmet needs experienced among this group of FUEDs is 5.7 needs (SD 4.8). Eighty percent report material resource needs. Some of the top priorities that participants reported are in this category (housing, food, transportation). About 56% report needs related to Health Care Management and Literacy (HCML)

which include dental needs (30%), medical care needs (22%) and psychiatric related needs (20%). A large proportion also reported employment related needs (44.5%).

Bivariate analyses between the number of unmet needs and independent variables (Table 5) demonstrate that participants who are female, have at least a high school level education, are currently employed, have higher incomes, higher social support are significantly associated with fewer unmet needs. On the other hand, inadequate food and shelter, behavioral health problems, FFS Medicaid, and lack of a regular health care provider are all significantly associated with greater number of unmet needs. Greater number of unmet needs is significantly associated with access to certain benefits. People with access to cash and non-cash assistance have greater number of unmet needs than those with neither assistance. In addition, people who have access to a social worker have significantly greater number of unmet needs compared to those who have only a regular doctor or no regular care provider.

As a result of factor analyses described earlier (Chapter 3, section 3.3.1), the 24 unmet needs were categorized into 4 domains. Table 6 illustrates the bivariate relationships between the independent variables and 4 unique domains of unmet needs: 1) Material resource; 2) Health care Management and Literacy (HCML); 3) Family related; 4) Employment related. Employment status and social support are negatively associated with all 4 domains, while inadequate food and shelter and behavioral health problems are positively associated with all 4 types of needs. Physical illness severity is not significantly associated with any domain. A greater proportion of people with access to both cash and program benefits report all 4 domains of unmet needs. Table 6 provides greater clarity on the relationship of specific SDH on different types of unmet needs and

enables us to evaluate risks of endogeneity. For instance, it is interesting to note that inadequate access to food and shelter is significantly associated with all types of unmet needs (not just housing and food needs), including HCML and job related and not just housing-related/material resource needs.

Multivariate Associations (Tables 7, 8 and 9)

Forward step-wise modelling was applied to tease apart the influence of structural and intermediary SDH upon the number of unmet needs (Appendix D, supplementary table 1). Among structural determinants, high school attainment, current employment status and higher income levels are associated with fewer unmet needs. The effect of education diminishes and is no longer significant when intermediary SDH are included in the model. The presence of homelessness and food insecurity are associated with 4 additional unmet needs. There is strong correlation between the structural and the intermediary determinants of health and when both are in the model, the more distal factors (i.e. the intermediary factors) have a stronger association to unmet need than the more proximal variables (i.e. structural determinants).

Table 7 describes the multivariate association of social and clinical determinants with the number of unmet needs being tested separately (Models 1 and 2) and simultaneously (Model 3). Model 2 with clinical determinants explains 18% of the variance in unmet needs, with behavioral health being positively and significantly associated with the number of unmet needs. Access to a regular doctor is associated with 1.6 fewer unmet needs compared to not having any regular provider. The model with only social determinants (Model 1) explains 37% of the variance in the number of unmet needs with income, access to food and shelter, public assistance being positively

associated with the number of unmet needs, and social support being negatively associated with the number of unmet needs. The final model (Model 3) adjusts for both social and clinical determinants and explains 39% of the variance in the number of unmet needs. The final model illustrates the significant influence of income, food and shelter, social support, public assistance (cash and non-cash) and behavioral health issues on the number of unmet needs. Of note is that physical illness severity and access to a regular provider are not significantly associated with the number of unmet needs reported.

With reference to our hypotheses, these results determine that FUEDs who have not completed high school report more unmet needs compared to those to have completed high school when we do not adjust for other structural or intermediary SDH. This association becomes non-significant when we adjust for current employment status and income levels. Although education and income are not perfectly correlated, they are strongly related. When looking at the relationship between education and unmet needs, it is largely explained by income.

Every increase in the level of social support is associated with 0.9 fewer unmet needs on average. Moreover, mental illness is associated with an average increase of 1.2 unmet needs compared to those without any behavioral health problems and controlling for physical health and SDH. If substance abuse coexists with mental illness, it is associated with an increase in unmet needs - 1.7 more unmet needs. It is interesting to note that physical illness severity is not significantly associated with the number of unmet needs in this population as was noted in both bivariate and multivariate analyses (Tables 5 and 6).

These results need to be interpreted with caution due to the complex inter-

relationships between the predictors (correlations) as well as between the predictors and the outcome (endogeneity). For instance, people with mental illness and people with both substance abuse and mental illness have greater number of unmet needs (significant) while people with only substance abuse have fewer number of unmet needs compared to the referent group (no behavioral health issues). There is strong correlation between other social determinants (for instance, adequate food and shelter) and behavioral health problems which should be considered when interpreting this information. A greater proportion of people with greater behavioral health problems, as well as dire food and shelter circumstances also receive cash and non-cash assistance which mean that public assistance is serving as a surrogate for the most needy. Moreover, there is also the potential for endogeneity, and these results do not guide in determining which came first – unmet needs or the social determinants associated with them.

Sensitivity analyses (Table 8) conducted using Poisson regression are similar to the results of linear regression in both magnitude and direction of social and clinical correlates of the number of unmet needs. Of note, is the significance of variables ($p<0.05$) that were insignificant in the primary analyses: education level, current employment status, access to cash benefits, and access to programmatic benefits. This may be explained by the different estimation procedures applied: OLS is able to capture a statistical measure of shared variance in the outcome variable that is explained through R2, and step-wise regression (Supplementary Table 1) detected loss of the significance of structural (education, employment status) SDH variables when intermediary SDH variables are added to the model. On the other hand, the maximum likelihood estimation approach of poisson regression and its underlying assumptions of distribution to generate

the difference in logs of expected counts does not distinguish structural and intermediary SDH in this way. Secondly, the estimates from OLS regression are additive in nature, but poisson regression estimates the difference in logs of expected counts of the parameters.

Additional sensitivity analyses using a reduced version of the number of unmet needs (number of unmet needs domains) supports these findings (Table 9). In addition, employment status is inversely associated with the number of domains of unmet needs. While most of the afore-mentioned associations from Table 7 are retained, we lose the effects of behavioral health in the sensitivity analyses. This may be explained by the high level of positive correlation (0.48) between the variables 'food and shelter' and 'behavioral health'. Moreover, behavioral health also has a moderate negative correlation with employment status (-0.43). Reduced variance in the number of domains (0-4) in the sensitivity analyses, in comparison to the variance that existed in the original analyses (number of unmet needs 0-24) makes it more challenging to separate out effects of these moderate/high correlated variables thereby rendering the influence of 'behavioral health status' non-significant.

Table 4: Description and Prevalence of Unmet Needs of FUEDs (n=474)

	Category	Prevalence %
A	**Material Resource Needs**	80.0
1.	Food	43.0
2.	Clothing	36.1
3.	Transportation	26.8
4.	Legal	22.6
5.	Public Benefits	37.0
6.	Affordable housing	50.4
7.	Paying rent, mortgage or utilities	31.4
8.	Problems with landlord or housemates	8.9
9.	Money or cash	30.8
10.	Availability of resources	30.0
B.	**Health Management and Literacy Needs**	54.6
11.	Ability to read or write	9.3
12.	GED or education	22.2
13.	Medical care	24.1
14.	Getting or managing medications	16.5
15.	Treatment for alcohol or drugs	9.5
16.	Dental care	31.2
17.	Services for emotional/psychiatric problems	20.0
C.	**Family related Needs**	12.2
18.	Help with parenting	5.5
19.	Childcare services and payment of costs	5.5
20.	Enrolling children in school	3.2
21.	Domestic violence	4.9
D.	**Employment Related Needs**	44.5
22.	Finding a job	31.9
23.	Job training	26.2
24.	Managing money	20.7
	Priority Unmet Needs (% reporting as first priority)	n=379
1.	Affordable housing	29.0
2.	Food	10.6
3.	Finding a job	10.6
4.	Money or cash	5.5
5.	Transportation	5.0
6.	Medical care	4.8

Table 5: Description of Patient Characteristics, Social Determinants and Clinical Determinants of Health Among FUEDs (n=474)

	Frequency (%)	Mean # of Unmet Needs (SD)
Age(years)		
18-26	66 (14.0)	4.6 (4.9)
27-35	91 (19.2)	5.9 (5.1)
36-45	84 (17.8)	5.8 (4.7)
46-55	136 (28.8)	5.9 (4.9)
56-65	88 (18.6)	6.2 (4.6)
>65	8 (1.7)	2.6 (2.3)
Gender***		
Male	188 (39.7)	6.6 (5.0)
Female	285 (60.3)	5.1 (4.6)
STRUCTURAL (sSDH)		
Education Level***		
Less than high school	150 (31.8)	7.1 (5.3)
High school or higher	322 (68.2)	5.05 (4.46)
Employment Status (In the past 30 days have you had a job that paid?)***		
No	318 (67.5)	6.5 (4.93)
Yes	153 (32.5)	3.96 (4.12)
Income (Monthly income in the past 30 days $)***		
Less than $100	74 (18.6)	7.43 (5.18)
100 – 499	75 (18.9)	6.39 (4.55)
500 – 999	164 (41.3)	5.47 (4.38)
1000 and more	85 (17.9)	3.91 (3.74)
INTERMEDIARY (iSDH)		
Access to food and shelter***		
0 Access to both	322 (68.7)	4.1 (3.9)
1 No access to food (food insecure)	51 (10.9)	9.1 (4.3)
2 No access to shelter (currently homeless)	48 (10.2)	9.1 (5.8)
3 No access to both food and shelter (homeless and food insecure)	48 (10.2)	9.5 (4.3)
Social support score***		
0 None	73 (15.8)	8.3 (5.9)
1 Low	56 (12.1)	7.3 (4.9)
2 Moderate	129 (27.9)	6.7 (4.4)
3 High	205 (44.3)	3.8 (3.8)
Children		
0 No	139 (29.4)	5.8 (4.8)
1 Yes	334 (70.6)	5.6 (4.9)
PUBLIC BENEFITS***		
0 None	108 (22.8)	3.7 (4.0)
1 Cash assistance only	37 (7.8)	5.8 (4.6)
2 Non-cash assistance only	148 (31.3)	6.2 (5.1)
3 Both cash and non-cash assistance	180 (38.1)	6.4 (4.8)

CLINICAL DETERMINANTS		
Physical Illness Severity (CDPS score - quartiles)		
Low	119 (25.1)	4.8 (4.9)
Moderate	118 (24.9)	5.7 (4.9)
High	119 (25.1)	6.3 (4.9)
Severe	118 (24.9)	5.8 (4.5)
Behavioral Health***		
0 No behavioral health problems diagnoses	143 (30.2)	3.4 (3.3)
1 Substance abuse diagnosis only	37 (7.8)	3.9 (4.0)
2 Mental illness diagnosis only	118 (24.9)	6.0 (4.7)
3 Both diagnosed substance abuse and mental illness	176 (37.1)	7.7 (5.2)
Type of Medicaid*		
FFS	194 (41.7)	6.24 (4.70)
MCO	271(58.3)	5.23 (4.91)
Usual Source of Care***		
None	84 (17.8)	6.54 (5.63)
Social worker/ Case manager	29 (6.1)	7.43 (5.32)
Regular doctor	243 (51.5)	4.55 (4.13)
Both	116 (24.6)	7.02 (4.95)
Significance levels: *** $p<0.001$, **$p<0.01$, *$p<0.05$		

Table 6: Bivariate relationship between specific domains of unmet needs and Social and Clinical determinants

Patient Characteristics and Social Determinants of Health	Frequency (%)	Specific Unmet Needs Domains (%)			
		Material Resources	Health Manage-ment and Literacy	Family related	Emplo y-ment related
AGE (years)		<0.01			
18-26	66 (14.0)	12.1	12.0	17.2	16.2
27-35	91 (19.2)	17.9	18.1	25.9	23.3
36-45	84 (17.8)	18.7	17.8	17.2	15.2
46-55	136 (28.8)	29.6	29.3	27.6	26.2
56-65	88 (18.6)	20.8	21.2	10.3	18.6
>65	8 (1.7)	0.8	1.5	1.7	0.5
GENDER			<0.01		
Male	188 (39.7)	41.2	46.7	34.5	42.2
Female	285 (60.3)	58.8	53.3	65.5	57.8
STRUCTURAL (sSDH)					
Education Level		<0.01	<0.001		
Less than high school	150 (31.8)	35.1	41.7	41.4	30.5
High school or higher	322 (68.2)	64.9	58.3	58.6	69.5
Employment Status (In the past 30 days have you had a job that paid?)		<0.001	<0.001	<0.05	<0.001
No	318 (67.5)	73.0	75.2	81.0	75.6
Yes	153 (32.5)	27.0	24.8	19.0	24.4
Income (Monthly income in the past 30 days $)		<0.001			<0.001
Refused/Don't know	75 (15.9)	13.2	16.2	19.0	15.6
Less than $100	74 (15.6)	17.4	18.9	17.2	19.9
100 – 499	75 (15.9)	18.2	17.0	15.5	21.3
500 – 999	164 (34.7)	35.6	31.7	34.5	32.7
1000 or more	85 (18.0)	15.5	16.2	13.8	10.4
INTERMEDIARY (iSDH)					
Access to food and shelter:		<0.001	<0.001	<0.05	<0.001
0 Access to both	322 (68.7)	61.5	56.0	48.3	57.2
1 No access to food, access to shelter (food insecure only)	51 (10.9)	13.5	15.2	19.0	16.3
2 No access to shelter, access to food homeless only)	48 (10.2)	12.2	13.6	19.0	15.4
3 No access to both food and shelter (homeless and food insecure)	48 (10.2)	12.7	15.2	13.8	11.1
Social support score		<0.001	<0.001	<0.01	<0.001
None	73 (15.8)	17.7	20.8	27.6	20.1

Low	56 (12.1)	13.9	14.1	8.6	16.3
Moderate	129 (27.8)	30.8	32.2	37.9	29.2
High	205 (44.3)	37.5	32.9	25.9	34.4
Have dependent children				<0.01	
No	139 (29.4)	28.5	30.9	13.8	30.8
Yes	334 (70.6)	71.5	69.1	86.2	69.2
ACCESS TO PUBLIC BENEFITS		<0.001	<0.01	<0.05	<0.05
None	108 (22.8)	17.4	17.8	6.9	18.6
Cash only	37 (7.8)	8.4	5.8	10.3	5.7
Non-cash only	148 (31.3)	33.0	33.6	36.2	36.7
Both cash and non-cash benefits	180 (38.1)	41.2	42.9	46.6	39.1
CLINICAL DETERMINANTS					
Physical Illness Severity					
Low	119 (25.1)	22.4	20.8	20.7	26.5
Moderate	118 (24.9)	25.3	24.3	27.6	26.5
High	119 (25.1)	26.1	27.8	29.3	25.1
Severe	118 (24.9)	26.1	27.0	22.4	21.8
Behavioral Health		<0.001	<0.001	0.001	0.001
None	143 (30.2)	25.3	21.2	13.8	24.6
Substance Abuse only	37 (7.8)	6.6	7.3	0.0	5.2
Psychiatric illness only	118 (24.9)	26.4	26.6	32.8	23.7
Both (Substance Abuse and Psychiatric illness)	176 (37.1)	41.7	44.8	53.4	46.4
Access to Regular Care		<0.01	0.01		
None	84 (17.8)	17.7	20.5	17.2	19.0
Only Social Worker	29 (6.1)	6.9	6.6	5.2	8.6
Only Doctor	243 (51.5)	47.8	44.6	39.7	48.1
Both	116 (24.6)	27.7	28.3	37.9	24.3
Type of MA plan		<0.01	<0.01		
FFS	194 (41.7)	45.4	47.6	42.1	38.3
MCO	271 (58.3)	54.6	52.4	57.9	61.7
*Bivariate relationships assessed using chi square tests.					

Table 7: Influence of Social and Clinical Determinants on Number of Unmet Needs (0-24)

	(1) Social Determinants		(2) Clinical Determinants		(3) Both Social + Clinical	
	β	95% CI	β	95% CI	β	95% CI
Age (Continuous)	-0.03*	[-0.06,-0.00]	-0.002	[-0.04,0.04]	-0.02	[-0.06,0.01]
Gender (Ref. Female)	0.93*	[0.14,1.72]	1.05*	[0.14,1.96]	0.93*	[0.08,1.77]
Education (Highschool Attainment)	-0.70	[-1.51,0.11]			-0.67	[-1.50,0.17]
Currently Employed	-0.94	[-1.93,0.04]			-0.72	[-1.72,0.29]
Income (Ref. <$100)						
Refused/Don't Know	-1.58*	[-2.95,-0.22]			-1.43*	[-2.81,-0.05]
$100 - $499	-1.00	[-2.34,0.35]			-0.92	[-2.29,0.45]
$500-$999	-2.03**	[-3.30,-0.77]			-1.92**	[-3.22,-0.63]
$1000- More	-1.59*	[-3.03,-0.15]			-1.73*	[-3.20,-0.25]
Access to food and shelter						
Food insecure only	4.74***	[3.53,5.95]			4.36***	[3.13,5.59]
Homeless only	3.70***	[2.42,4.99]			3.32***	[1.96,4.68]
Food insecure and homeless	3.48***	[2.17,4.79]			3.12***	[1.78,4.45]
Social Support (Continuous, 0-3)	-0.97***	[-1.33,-0.62]			-0.88***	[-1.24,-0.52]
Children	0.34	[-0.50,1.18]			0.31	[-0.55,1.17]
Access to public benefits						
Cash only	0.82	[-0.83,2.46]			0.86	[-0.85,2.57]
Non-cash only	0.84	[-0.25,1.94]			0.60	[-0.51,1.72]
Both cash and non-cash benefits	1.68**	[0.52,2.85]			1.41*	[0.17,2.66]
Physical Illness Severity (CDPS Score Quartiles) Ref: Low Risk Score						
Moderate			0.38	[-0.80,1.56]	0.45	[-0.61,1.52]
High			0.14	[-1.13,1.41]	0.34	[-0.80,1.48]
Severe			-0.51	[-1.86,0.85]	-0.06	[-1.30,1.18]
Behavioral Health Status						
Substance abuse only			0.14	[-1.55,1.83]	-0.60	[-2.15,0.95]
Mental illness only			2.64***	[1.51,3.76]	1.22*	[0.17,2.27]
Both			3.87***	[2.73,5.01]	1.58**	[0.49,2.66]
Regular Source Of Care (Ref. None)						
Sw Only			-0.08	[-2.00,1.85]	0.18	[-1.55,1.91]

Reg Doc Only			-1.64**	[-2.76,-0.51]	-0.04	[-1.10,1.02]
Doc+Sw			-0.74	[-2.08,0.61]	-0.06	[-1.29,1.17]
Medicaid Plan Type (Ref FFS)			0.07	[-0.87,1.01]	0.42	[-0.54,1.39]
Constant	7.51***	[5.33,9.70]	3.11*	[0.23,5.99]	5.46***	[2.24,8.68]
R-squared	0.369		0.176		0.389	

Significance levels: *** p<0.001, **p<0.01, *p<0.05

Table 8: Sensitivity Analysis – Influence of Social and Clinical Determinants upon Number of Unmet Needs (0-24) using Poisson Regression

	(1) Social Determinants		(2) Clinical Determinants		(3) Both Social + Clinical	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Age (Continuous)	0.99**	[0.99,1.00]	1.00	[1.00,1.00]	1.00*	[0.99,1.00]
Gender (Ref. Female)	1.17***	[1.08,1.27]	1.20***	[1.10,1.30]	1.16**	[1.06,1.27]
Education (Highschool Attainment)	0.91*	[0.84,0.99]			0.91*	[0.84,1.00]
Currently Employed	0.82***	[0.73,0.91]			0.87*	[0.78,0.98]
Income (Ref. <$100)						
Refused/Don't Know	0.76***	[0.66,0.88]			0.78***	[0.68,0.90]
$100 - $499	0.86*	[0.75,0.98]			0.87	[0.76,1.00]
$500-$999	0.71***	[0.62,0.81]			0.73***	[0.64,0.83]
$1000- More	0.74***	[0.63,0.87]			0.72***	[0.61,0.85]
Access to food and shelter (Ref. Both)	1.00	[1.00,1.00]			1.00	[1.00,1.00]
Food insecure only	2.09***	[1.87,2.33]			1.91***	[1.70,2.15]
Homeless only	1.75***	[1.56,1.97]			1.65***	[1.45,1.87]
Food insecure and homeless	1.67***	[1.48,1.89]			1.56***	[1.38,1.77]
Social Support (Continuous, 0-3)	0.85***	[0.82,0.89]			0.87***	[0.83,0.90]
Children	1.06	[0.97,1.16]			1.06	[0.97,1.17]
Access to public benefits (Ref. none)						
Cash only	1.28**	[1.07,1.54]			1.24*	[1.02,1.50]
Non-cash only	1.24**	[1.09,1.42]			1.16*	[1.02,1.33]
Both cash and non-cash benefits	1.49***	[1.30,1.71]			1.37***	[1.18,1.59]
Physical Illness Severity (CDPS Score Quartiles) Ref: Low Risk Score						
Moderate			1.09	[0.97,1.22]	1.10	[0.97,1.24]
High			1.04	[0.92,1.17]	1.09	[0.96,1.23]
Severe			0.94	[0.82,1.06]	1.01	[0.88,1.15]
Behavioral Health Status (Ref. Good)						
Substance abuse only			1.09	[0.90,1.32]	0.97	[0.79,1.18]
Mental illness only			1.78***	[1.58,2.01]	1.34***	[1.18,1.52]
Both			2.12***	[1.88,2.38]	1.39***	[1.22,1.58]
Regular Source Of Care (Ref. None)						
SW Only			0.96	[0.82,1.13]	1.04	[0.88,1.23]
Reg Doc Only			0.74***	[0.67,0.83]	1.00	[0.90,1.12]
Doc+SW			0.88*	[0.79,0.99]	1.01	[0.90,1.15]
Medicaid Plan Type (Ref FFS)			1.01	[0.93,1.10]	1.05	[0.94,1.17]

Table 9: Sensitivity Analyses – Influence of Social and Clinical Determinants on No. of Domains of Unmet Needs (0-4)

	(1) Social Determinants		(2) Clinical Determinants		(3) Both Social + Clinical	
	β	95% CI	β	95% CI	B	95% CI
Age (Continuous)	-0.01**	[-0.02,-0.00]	0.00	[-0.01,0.01]	-0.01*	[-0.02,-0.00]
Gender (Ref. Female)	0.17	[-0.03,0.37]	0.16	[-0.06,0.39]	0.19	[-0.03,0.40]
Education (Highschool Attainment)	-0.19	[-0.40,0.01]			-0.20	[-0.41,0.01]
Currently Employed	-0.40**	[-0.65,-0.16]			-0.36**	[-0.61,-0.11]
Income (Ref. <$100)						
Refused/Don't Know	-0.37*	[-0.72,-0.03]			-0.38*	[-0.73,-0.03]
$100 - $499	0.02	[-0.32,0.36]			0.04	[-0.30,0.39]
$500-$999	-0.28	[-0.60,0.04]			-0.31	[-0.63,0.02]
$1000- More	-0.20	[-0.56,0.16]			-0.24	[-0.61,0.14]
Access to food and shelter (Ref. Both)						
Food insecure only	0.96***	[0.66,1.27]			0.91***	[0.59,1.22]
Homeless only	0.66***	[0.34,0.99]			0.61***	[0.27,0.96]
Food insecure and homeless	0.39*	[0.06,0.72]			0.37*	[0.03,0.71]
Social Support (Continuous, 0-3)	-0.22***	[-0.31,-0.13]			-0.22***	[-0.31,-0.13]
Children	0.13	[-0.09,0.34]			0.13	[-0.08,0.35]
Access to public benefits (Ref. none)						
Cash only	-0.05	[-0.46,0.37]			-0.08	[-0.51,0.35]
Non-cash only	0.22	[-0.06,0.49]			0.17	[-0.11,0.45]
Both cash and non-cash benefits	0.30*	[0.01,0.59]			0.22	[-0.09,0.54]
Physical Illness Severity (CDPS Score Quartiles) Ref: Low Risk Score						
Moderate			0.14	[-0.16,0.43]	0.20	[-0.07,0.47]
High			0.05	[-0.26,0.37]	0.17	[-0.12,0.46]
Severe			-0.08	[-0.42,0.25]	0.07	[-0.24,0.39]
Behavioral Health Status (Ref. Good)						
Substance abuse only			-0.04	[-0.46,0.38]	-0.20	[-0.60,0.19]
Mental illness only			0.53***	[0.25,0.81]	0.19	[-0.08,0.45]
Both			0.75***	[0.47,1.03]	0.20	[-0.08,0.47]
Regular Source Of Care (Ref. None)						
SW Only			0.00	[-0.47,0.48]	0.01	[-0.42,0.45]
Reg Doc Only			-0.22	[-0.50,0.06]	0.12	[-0.15,0.38]
Doc+SW			-0.08	[-0.41,0.25]	0.04	[-0.27,0.35]

Medicaid Plan Type (Ref FFS)			-0.03	[-0.26,0.20]	-0.02	[-0.26,0.23]
Constant	2.63***	[2.08,3.19]	1.58***	[0.87,2.29]	2.38***	[1.57,3.20]
R-squared	0.29		0.11		0.30	

Significance levels: *** p<0.001, **p<0.01, *p<0.05

4.2. Aim 2 Results

Description of Health Care Utilization and Bivariate Associations

Table 10 summarizes the utilization patterns of the population over the past one year from their enrollment. The average number of ED visits was 16.2 (SD 27.2), median was 8, with a range maximum of 264 visits in a year. The average number of preventable ED visits in a year were 5.1, median of 2, with a maximum of 221 visits in a year. Of the total number of ED visits made by the participants in a year (7663), 31.5% were preventable (2416). The average number of inpatient hospitalizations were 2.3 hospitalizations, with a maximum of 37. People with mental illness have 10.5 ambulatory care visits in a year, compared to those without mental illness (7.8), of which 1.8 are specifically for psychiatric evaluation and management (E& M). The average clinical illness severity (physical and behavioral illness CDPS risk scores combined) score is 5.2, with maximum of 26.6. The average care continuity (CC) (COCI score) is 0.33 among those with at least 3 ambulatory care visits in the past year.

Additional analyses show that 66.2% of participants had a primary care provider as the predominant care provider, 21% had a specialist as the predominant provider and 11.8% did not have any predominant care provider. Patients with a specialist predominant provider experienced lower levels of CC (mean 0.30), while patients with a primary care predominant provider experienced a slightly higher level of CC on average (mean 0.34)

but this was not significant. There was also no significant difference in the clinical risk scores of the patients with either type of predominant provider.

Bivariate analyses reveal that male FUEDs had higher total ED utilization but lower preventable ED utilization compared to females (see Table 11). Patients who had better social and living circumstances such as greater levels of education and were currently employed had fewer total ED visits on average compared to those who did not. Patients with adequate food and shelter had a median of 7 total ED visits compared to those having neither (17 ED visits). Worsening food and shelter access is also associated with greater number of total and preventable ED visits. People with better levels of social support had fewer total and preventable ED visits, while people with access to cash and non-cash assistance had more total ED visits compared to those without access to public assistance (see Table 10). In terms of exposure to clinical determinants, FUEDs with greater physical and behavioral illness severity had more total ED visits. There were no significant differences in the number of preventable ED visits based on physical illness severity, but patients with both mental illness and substance abuse had a greater number of preventable ED visits (median of 3) compared to subjects with neither (median of 2). People with FFS type of Medicaid also had greater total ED visits compared to FUEDs with MCO type of Medicaid, but there were no significant differences in the proportion of preventable ED visits between them (see Table 10).

Multivariate Associations

Multivariate negative binomial regression results reveal that male gender, inadequate food and shelter, and the presence of both mental illness and substance abuse problems are associated with a positive incidence rate ratio (IRR) of total and preventable

ED utilization (Table 12). The IRR for subjects who experience homelessness and food insecurity is higher when the outcome is preventable ED visits (i.e. IRR= 2.4; 95% CI 1.6, 3.6) compared to when the outcome is total ED visits (i.e. IRR=1.8; 95% CI 1.4, 2.3). With each increasing level of social support, the IRR of preventable ED utilization is decreased by 14%. Every unit increase in the physical illness severity increases the IRR of total ED utilization by 15%. (This is a large effect considering the range of CDPS score is large). Behavioral health illnesses increase the IRR of total ED utilization between 24% and 74% depending on if the subject has only substance abuse, mental illness or both. In contrast, the IRR of preventable ED utilization is significantly increased only in the presence of both mental illness and substance abuse (i.e. IRR=1.6; 95% CI 1.1, 2.3).

Physical illness severity and CC have a significant interaction effect that is positively associated with total and preventable ED utilization (see Table 12). Figures 9 and 10 illustrate the interaction effect between CC and physical illness and how this influences the predicted number of total and preventable ED visits. Better CC lowers the number of both total and preventable ED visits. Figure 9 shows that better levels of care continuity are associated with fewer ED visits at every level of physical illness severity. Low, moderate and high CC are associated with fewer total ED visits compared to the unassessed group, regardless of the physical illness severity. The effect of CC and physical illness upon preventable ED use is more complex (Figure 10). Unassessed CC and low CC are associated with increased preventable ED visits as physical illness severity increases. However, greater physical illness is associated with fewer preventable ED visits in the presence of moderate and high CC. Both figures depict the unassessed

CC group as the most at risk at increased total and preventable ED utilization at all levels of physical illness severity.

Table 13 shows the marginal changes in the number of total and preventable ED visits based on the marginal change of each independent variable, taking into account the interaction effects and relationships with other independent variables. Holding all other factors at their mean, the model estimates that male FUEDs have 3 additional ED visits and 1.7 additional preventable ED visits compared to female FUEDs. FUEDs who experience both homelessness and food insecurity have 9 more ED visits and 4.5 more preventable ED visits compared to people with adequate food and shelter. Every unit increase in social support score significantly decreases the number of preventable ED visits (-0.58; 95% CI -1.02, -0.14). Combined mental illness and substance abuse problems in FUEDs are associated with an increase of 7 more total ED visits (95% CI 4.4, 9.7), and 1.9 more preventable ED visits (95% CI 0.5, 3.3). Compared to unassessed patients or patients with less than 3 ambulatory care visits a year, people with low CC have 1 more ED visit, while moderate CC and high CC lowers the number of total ED Visits (not significant). Every increase in physical illness severity increases total ED utilization by 1 additional visit (95% CI 0.61, 1.26).

To produce interpretations that are more actionable for policymakers, I calculated the marginal effects (Table 14) of selected scenarios upon total and preventable ED utilization. The scenarios transition from best to worst, to demonstrate how varying combinations of the most influential independent variables detected in the regression analysis (food and shelter, behavioral health, physical illness severity and CC) are associated with the number of ED visits by a 43 year old male FUED. Comparing

scenarios 3 to 5, we see there is a positive gradient in ED utilization as physical illness severity increases. There is an inverse gradient in ED utilization with improving levels of CC, with higher CC predicting lower ED utilization (scenario 4 compared to scenario 5 and 6). As noticed earlier, the unassessed CC group has the greatest increase in the number of total and preventable ED use (scenario 7). These results signal the need to identify these patients who seem to have limited access to ambulatory care (<2 visits) and are frequently attending the ED for their needs. They also seem to be much sicker and may really benefit from care coordination or home health care.

Using these results, I can test my hypotheses and conclude that, physical illness is positively associated with ED utilization, better CC is associated with lower ED utilization and social support is associated with fewer preventable ED visits. In addition, this analysis revealed strong interaction effect of CC with physical illness. This explains the observation that the influence of CC on preventable ED utilization is more effective at severe physical illness than at lower physical illness severity (Table 14, scenario 4 compared to scenario 3). Behavioral health conditions have a strong influence on total ED utilization, but only a combination of mental illness and substance abuse are associated with greater preventable ED use.

Table 10: Utilization measures of FUEDs, n=474

Variable	Mean	SD	Median	Range
Number of ED Visits	16.2	27.2	8	4 -264
Number of Preventable ED visits	5.1	13.5	2	0-221
Number of Inpatient hospitalizations	2.3	4.8	1	0 – 37
Total number of Ambulatory care visits (outpatient hospital and office)	9.5	9.3	7	0-55
Number of Psychiatric evaluation visits	1.2	4.4	0	0-45
Continuity of Care Index (Provider)	0.33	0.25	0.29	0-1
CDPS clinical risk score (overall)	5.2	3.5	4.5	0.33 – 26.6

Table 11: Bivariate Associations between Independent Variables and ED Utilization

	Frequency (%)	Number of total ED visits median (IQR)	Number of Preventable ED visits median (IQR)
AGE (years)			
18-26	66 (14.0)	8 (6-14)	3 (2-4)
27-35	91 (19.2)	8 (5-17)	2 (1-4)
36-45	84 (17.8)	8 (6-20.5)	3 (1-5)
46-55	136 (28.8)	8 (5-13)	2 (1-4)
56-65	88 (18.6)	8.5 (6-16)	2 (1-4.5)
>65	8 (1.7)	8 (5-17)	3 (5-9.5)
GENDER***		<0.001	<0.001
Male	188 (39.7)	10.5 (6-20)	2 (1-4)
Female	285 (60.3)	7 (5-12)	3 (1-6)
STRUCTURAL (sSDH)			
Education Level*		<0.05	<0.05
Less than high school	150 (31.8)	9 (6-18)	3 (1-5)
High school or higher	322 (68.2)	8 (5-14)	2 (1-4)
Employment Status (In past 30 days had a paying job?)***		<0.001	
No	318 (67.5)	9 (6-17)	2 (1-5)
Yes	153 (32.5)	7 (5-10)	2 (1-4)
Income (Monthly income in the past 30 days $)			
Refused/Don't know	75 (15.9)	9 (6-17)	2 (1-4)
Less than $100	74 (15.6)	9 (6-16)	2 (1-5)
100 – 499	75 (15.9)	7 (5-13)	2 (1-4)
500 – 999	164 (34.7)	8 (6-15.5)	2 (1-4)
1000 -more	85 (18.0)	8 (5-12)	2 (1-4)
INTERMEDIARY (iSDH)			
Access to food and shelter***		<0.001	<0.001
0 Access to both	322 (68.7)	7 (5-12)	2 (1-4)
1 No access to food (food insecure)	51 (10.9)	10 (6-18)	3 (1-4)
2 No access to shelter (currently homeless)	48 (10.2)	11 (6.5-25)	4 (2-8)
3 No access to both food and shelter (homeless and food insecure)	48 (10.2)	17 (7-29.5)	4 (1-8)
Social support score		<0.05	<0.05
0 None	73 (15.8)	12 (6-24)	3 (2-8)
1 Low	56 (12.1)	8 (6-15.5)	2 (1.5 – 4)
2 Moderate	129 (27.9)	8 (6-14)	2 (1-4)
3 High	205 (44.3)	8 (5-13)	2 (1-4)
Children			
0 No	139 (29.4)	8 (6-15)	3 (1-5)
1 Yes	334 (70.6)	8 (5-15)	2 (1-4)

ACCESS TO PUBLIC BENEFITS		<0.001	
0 None	108 (22.8)	7 (5-10)	2 (1-3)
1 Cash assistance only	37 (7.8)	9 (6-20)	2 (1-4)
2 Non-cash assistance only	148 (31.3)	9 (6-16.5)	3 (1-5)
3 Both cash and non-cash assistance	180 (38.1)	8 (6-17)	2 (1-5)
CLINICAL AND HEALTH CARE DETERMINANTS			
Physical Illness Severity***		<0.001	
Low	119 (25.1)	6 (5-9)	3 (1-4)
Moderate	118 (24.9)	7 (5-15)	2 (1-4)
High	119 (25.1)	8 (6-17)	2 (1-4)
Severe	118 (24.9)	11 (7-28)	2 (1-5)
Behavioral Health***		<0.001	<0.001
None	143 (30.2)	6 (5-8)	2 (1-3)
Substance Abuse only	37 (7.8)	8 (5-15)	2 (1-4)
Psychiatric illness only	118 (24.9)	8 (5-14)	2 (1-4)
Both (Substance Abuse and Psychiatric illness)	176 (37.1)	13 (7-25)	3 (1-7)
Care Continuity (CC)*			<0.05
None (Unassessed)	145 (30.6)	8 (6-18)	3 (1-5)
Low	110 (23.2)	8 (5-18)	2 (1-4)
Moderate	111 (23.4)	8 (5-12)	2 (0-3)
High	108 (22.8)	8 (6-15)	3 (1-4)
Access to Regular Care			
None	84 (17.8)	8 (6-16)	2 (1-4)
Only Social Worker	29 (6.1)	8 (5-21)	3 (1-5)
Only Doctor	243 (51.5)	8 (5-13)	2 (1-4)
Both	116 (24.6)	8.5 (6-18)	3 (1-5.5)
Type of MA plan*		<0.001	
FFS	194 (41.7)	9 (6-19)	2 (1-6)
MCO	271 (58.3)	7 (5-13)	2 (1-4)

Significance levels: *** p<0.001, **p<0.01, *p<0.05

Table 12: Multivariate Regression Associations of Social and Clinical Determinants with Total and Preventable ED Utilization

	Total ED Utilization		Preventable ED Utilization	
	IRR	95% CI	IRR	95% CI
Age (Continuous)	0.99***	[0.98,0.99]	0.99	[0.98,1.00]
Gender (Ref. Female)	1.26**	[1.07,1.48]	1.42*	[1.08,1.86]
Education (Highschool Attainment)	1.01	[0.86,1.18]	1.01	[0.77,1.32]
Currently Employed	0.96	[0.81,1.14]	1.04	[0.79,1.38]
Access to food and shelter (Ref. Both)				
Food insecure only	1.03	[0.82,1.29]	1.24	[0.85,1.81]
Homeless only	1.43**	[1.12,1.84]	2.01**	[1.33,3.06]
Food insecure and homeless	1.80***	[1.41,2.29]	2.37***	[1.58,3.55]
Social Support (Continuous, 0-3)	0.94	[0.88,1.01]	0.86**	[0.77,0.96]
Access to public benefits (Ref. none)				
Cash only	1.54**	[1.12,2.11]	1.39	[0.80,2.41]
Non-cash only	1.11	[0.91,1.36]	0.99	[0.70,1.39]
Both cash and non-cash benefits	1.16	[0.93,1.44]	1.17	[0.81,1.70]
Physical Illness (CDPS score - continuous)	1.15***	[1.11,1.21]	1.04	[0.97,1.11]
Behavioral Health Status (Ref. Good)				
Substance abuse only	1.47*	[1.10,1.99]	1.26	[0.77,2.06]
Mental illness only	1.24*	[1.02,1.52]	1.26	[0.89,1.79]
Both	1.74***	[1.41,2.14]	1.62**	[1.12,2.33]
Continuity of Care (ref. unassessed)				
Low	1.54**	[1.12,2.13]	1.12	[0.67,1.88]
Moderate	1.30	[0.93,1.81]	1.38	[0.81,2.35]
High	1.68**	[1.18,2.38]	1.64	[0.93,2.89]
Physical Illness Score # Continuity of Care				
CDPS Score # Low COC	0.93**	[0.88,0.98]	0.99	[0.90,1.08]
CDPS Score # Moderate COC	0.90***	[0.85,0.96]	0.89*	[0.81,0.97]
CDPS Score # High COC	0.88***	[0.82,0.94]	0.90	[0.81,1.00]
Regular Source Of Care (Ref. None)				
Social Worker Only	0.85	[0.62,1.16]	1.02	[0.60,1.74]
Reg Doc Only	1.03	[0.84,1.26]	1.14	[0.80,1.63]
Doc+Social Worker	0.88	[0.70,1.10]	1.06	[0.71,1.59]
Medicaid Plan Type (Ref FFS)	0.83*	[0.70,0.99]	0.78	[0.58,1.05]

Significance levels: *** p<0.001, **p<0.01, *p<0.05

Table 13:Marginal Change in Total and Preventable ED Utilization Based on Marginal Changes in each Independent Variable Level from the Base Category (holding all other covariates at their means)

	Total ED Utilization		Preventable ED Utilization	
Independent Variables	Marginal Change (dy/dx)	95% CI	Marginal Change (dy/dx)	95% CI
Age (Continuous)	-0.19***	[-0.27,-0.11]	-0.03	[-0.07,0.01]
Gender (Ref. Female)	2.93**	[0.88,4.99]	1.37*	[0.31,2.42]
Education (Highschool Attainment)	0.14	[-1.88,2.17]	0.02	[-1.03,1.08]
Currently Employed	-0.52	[-2.70,1.66]	0.15	[-0.94,1.25]
Access to food and shelter (Ref. Both)				
Food insecure only	0.35	[-2.31,3.01]	0.79	[-0.68,2.27]
Homeless only	5.01*	[1.04,8.97]	3.30*	[0.73,5.87]
Food insecure and homeless	9.21***	[4.46,13.96]	4.45**	[1.55,7.35]
Social Support (Continuous, 0-3)	-0.74	[-1.60,0.11]	-0.58**	[-1.02,-0.14]
Access to public benefits (Ref. none)				
Cash only	6.06*	[1.07,11.04]	1.40	[-1.16,3.96]
Non-cash only	1.26	[-1.09,3.61]	-0.04	[-1.26,1.18]
Both cash and non-cash benefits	1.78	[-0.88,4.44]	0.62	[-0.82,2.06]
Physical Illness (CDPS score - continuous)	0.94***	[0.61,1.26]	-0.08	[-0.24,0.08]
Behavioral Health Status (Ref. Good)				
Substance abuse only	4.53*	[0.62,8.44]	0.77	[-1.02,2.56]
Mental illness only	2.31*	[0.17,4.44]	0.79	[-0.41,1.99]
Both	7.03***	[4.35,9.70]	1.87*	[0.45,3.30]
Continuity of Care (ref. unassessed)				
Low	1.35	[-1.41,4.12]	0.26	[-1.11,1.64]
Moderate	-2.31	[-4.75,0.14]	-0.78	[-2.03,0.48]
High	-0.52	[-3.04,2.00]	0.10	[-1.24,1.44]
Regular Source Of Care (Ref. None)				
Social Worker Only	-2.02	[-5.73,1.70]	0.09	[-1.84,2.01]
Reg Doc Only	0.38	[-2.31,3.06]	0.52	[-0.79,1.82]
Doc+Social Worker	-1.54	[-4.35,1.26]	0.23	[-1.24,1.70]
Medicaid Plan Type (Ref FFS)	-2.35*	[-4.60,-0.10]	-0.95	[-2.10,0.20]

Significance levels: *** p<0.001, **p<0.01, *p<0.05

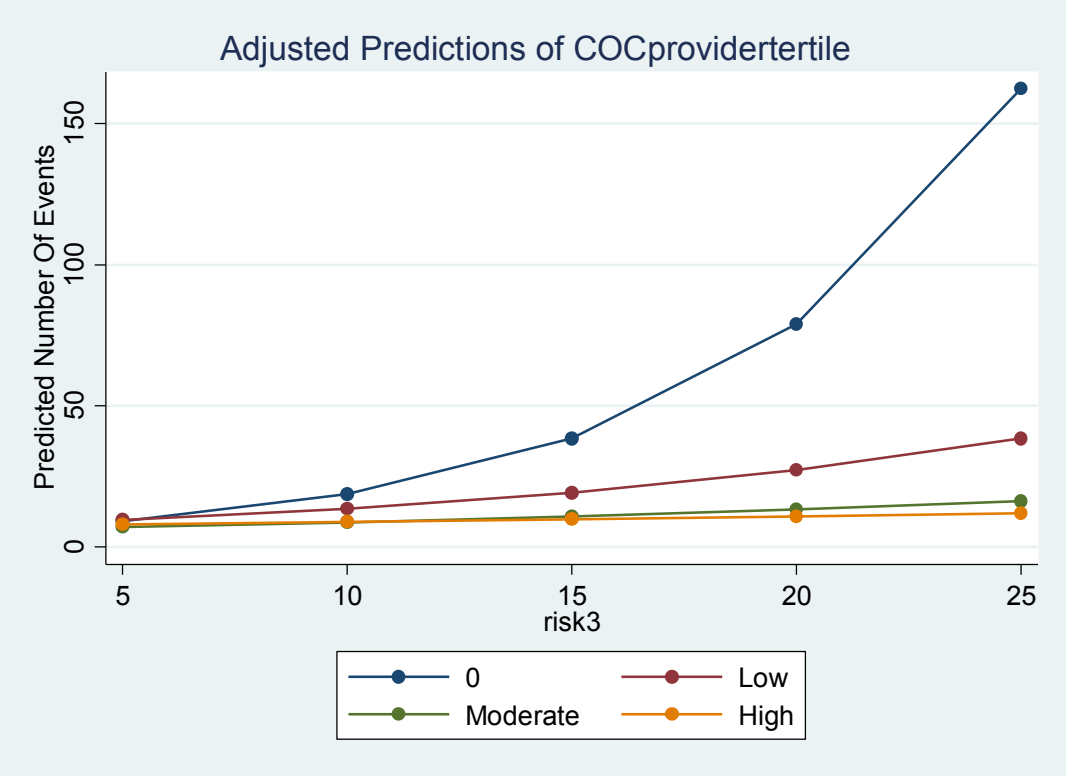

Figure 10: Predicted Number of Total ED Visits By Continuity of Care and Physical Illness Severity Levels.

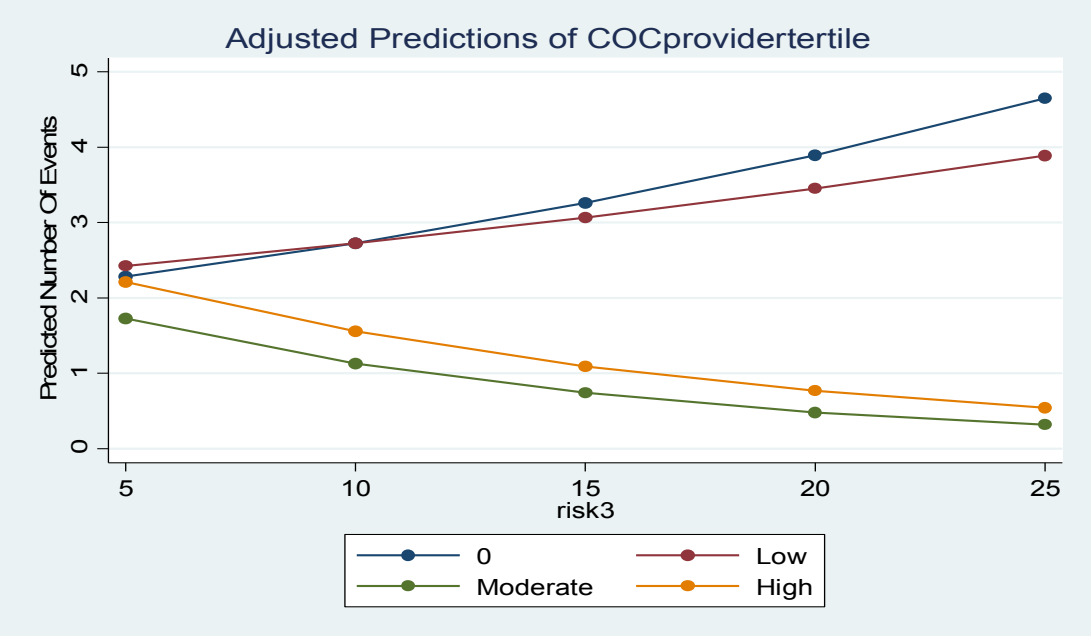

Figure 11: Predicted Number of Preventable ED Visits by CC and Physical Illness Severity.

Table 14:Predicted Change in Number of ED Visits for Different Scenarios

A 43 year old male Medicaid patient, with at least a high school education and currently employed, experiencing the following scenarios:	Predicted Increase in Total Number of ED Visits (95% CI)	Predicted Increase in Number Of Preventable ED visits (95% CI)
• Adequate food and shelter • No behavioral health issues • Low physical illness severity • High CC	7.2*** (5.1, 9.3)	3.1*** (1.6, 4.5) 1
• Homeless and food insecure • No behavioral health issues • Low physical illness severity • High CC	13.0*** (8.5, 17.4)	7.2*** (3.2, 11.3) 2
• Homeless and food insecure • Behavioral health – mental illness and substance abuse • Low physical illness severity • High CC	22.5*** (14.3, 30.7)	11.7*** (4.6, 18.7) 3
• Homeless and food insecure • Behavioral health – mental illness and substance abuse • High physical illness severity • High CC	32.3* (2.6, 61.9)	3.1 (-1.7, 7.8) 4
• Homeless and food insecure • Behavioral health – mental illness and substance abuse • High physical illness severity • Low care continuity	80.8** (26.6, 135.0)	13.8 (-1.6, 29.1) 5
• Homeless and food insecure, • Behavioral health – mental illness and substance abuse • Severe physical illness • Low care continuity with some programmatic non-cash assistance, and high social support	75.0** (23.1,127.0)	10.9 (-1.7, 23.4) 6
• Homeless and food insecure • Behavioral health issues – mental illness and substance abuse • Severe physical illness • Unassessed care continuity (<3 ambulatory care visits)	234** (60.1, 409.1)	15.5 (-1.97, 32.99) 7

BEST

WORST

Significance levels: *** p<0.001, **p<0.01, *p<0.05

4.3. Aim 3 Results

Characteristics of the Population and Bivariate Associations

Out of the study population, 450 participants were enrolled in both lookback periods and therefore were retained for analysis for Aim 3. Fifty-six percent (262) of the sample for this analysis are persistent FUEDs. In terms of exposure to social and clinical determinants, they are significantly different from non-persistent FUEDs. Table 15 illustrates that most persistent ED utilizers are male (59.4%) and in the age group 46-55 years (29.1%). About 73% of persistent FUEDs are currently unemployed. Over 55% have been unemployed for greater than 2 years, and 17.8% report unemployment between 1 month and 2 years. Compared to non-persistent FUEDs, a significantly larger proportion of persistent FUEDs have less than high school educational attainment (36.9% vs 25%), are currently unemployed (73.4% vs 60%), have been unemployed for greater duration, have current and past experience of homelessness (61% vs 41.5%), low social score and access both cash and non-cash public benefits (44% vs 32%). A greater proportion of persistent FUEDs are enrolled in the FFS Medicaid plan (49%) compared to non-persistent FUEDs (35%) and have behavioral health problems. Most persistent FUEDs have either high (27%) or severe (30%) levels of physical illness.

Additional analyses (not shown) reveal that persistent FUEDs have a significantly greater number of inpatient hospitalizations (mean 3, SD 5.7) compared to non-persistent FUEDs (mean 1.4, SD 3.3). Persistent FUEDs have a mean of 22.4 ED visits in a year (SD 34.4) compared to non-persistent FUEDs that have a mean of 8.22 ED visits in a year (SD 8.3). They also have a significantly greater average number of preventable ED visits (mean 7, SD 17.4) compared to non-persistent FUEDs (mean 2.7, SD 5.0). They

have slightly lower average of ambulatory care visits (mean 7.9, SD 8.8) compared to non-persistent FUEDs (mean 8.6, SD 8.8) but this difference is not statistically significant.

Multivariate Associations

Forward step-wise logistic regression was conducted to separate out effects of specific social and clinical determinants upon the odds of being a persistent FUED (Table 16). Model 1 shows that high-school attainment is associated with 37% lower odds of being a persistent FUED. In addition, model 1 shows that duration of unemployment for greater than 2 years is associated with 75% increased odds of persistent FUED while cumulative homelessness is associated with 88% increased odds of being a persistent FUED. After adjusting for public assistance (Model 2), these effects become non-significant except for cumulative homelessness which remains significant.

In model 3, which adjusts for only clinical determinants, an increase in physical illness severity is associated with a two-fold increase in odds of being a persistent FUED (compared to low physical illness severity). Having both mental illness and substance abuse also increases the odds of persistent ED use by 1.9 times. It is interesting to note that the unassessed group is associated with lower odds of being a persistent FUED (see Table 14) when CC for the 2nd lookback period is used, but the unassessed group is associated with greater odds of being a persistent FUED when CC for the 1st lookback period is used (see Supplementary Table S6). This suggests that people who are unassessed in the 2nd year look back period includes people at lower risk who may be

healthier than people who are unassessed in the 1st year look back period. It would be interesting to stratify this group further to assess differential risk within people who have under-utilization of ambulatory care.

The only variables that remain significant in the final model (5), adjusted for social and clinical determinants, are physical illness severity and public assistance even though the magnitude of previously significant variables remains directionally the same. Compared to low physical illness severity, moderate severity increases the odds of persistent ED use by 94%, high severity increases the odds by 129%, and severe clinic severity increases the odds by 131%. In terms of marginal probabilities (Table 17), moderate clinical illness increases the probability of becoming a persistent ED user by 15 percentage points, high clinical illness increases the probability by 20 percentage points and severe clinical illness increase the probability of being a persistent ED user by 27 percentage points. These results signal that persistent FUEDs are more likely to be sicker, and despite the influence of certain risk factors, the main driver of persistent ED use is the physical illness severity. It is interesting to note that when we remove access to public assistance from the model (Model 4), the influence of cumulative homelessness becomes significant and is positively associated with increased odds of persistent FUED (55%) as does the influence of having both mental illness and substance use, which becomes significant and associated with a two-fold increase in odds of persistent FUED. These changes may be also explained by some degree of correlation between cumulative homelessness, behavioral health and public assistance.

Testing of our hypotheses through this analysis provides the following conclusions: greater duration of unemployment is significantly associated with persistent

ED use, however most of these effects become non-significant when adjusting for access to public assistance. Moreover, greater physical illness severity is strongly associated with persistent ED use. Cumulative homelessness is also significantly associated with persistent ED use, however, adjusting for access to public assistance renders it non-significant. Public assistance is strongly and positively associated with over two-fold increased odds of persistent ED use, and may buffer the influence of cumulative homelessness and severe behavioral illness on the odds of persistent ED use. However, this is not a definitive conclusion due to strong correlation detected on bivariate analysis: 43% of people facing cumulative homelessness have assistance and the majority with cash and non-cash assistance (60%) have experienced cumulative homelessness.

Table 15: Comparison of Frequency Distribution of Persistent and Non-Persistent FUEDs with respect to social and clinical determinants

Key independent variables	Frequency (%)	Persistent FUEDs (n=450)	
		No n=188 (%)	Yes n=262 (%)
AGE (years)			
18-26	63 (14.0)	16.0	12.6
27-35	84 (18.7)	16.5	20.3
36-45	77 (17.2)	17.6	16.9
46-55	131 (29.2)	29.3	29.1
56-65	86 (19.2)	18.6	19.5
>65	8 (1.8)	2.1	1.5
GENDER			
Male	176 (39.2)	62.8	59.4
Female	273 (60.8)	37.2	40.6
STRUCTURAL (sSDH)			
Education Level***			
Less than high school	143 (31.9)	25.0	36.9
High school or higher	305 (68.1)	75.0	63.1
Employment Status (In past 30 days)***			
No	303 (67.8)	60.1	73.4
Yes	144 (32.2)	39.9	26.6
Duration of unemployment**			
0 (currently employed)	144 (32.2)	39.9	26.6
1 month to 2 years	81 (18.1)	18.6	17.8
Greater than 2 years	222 (49.7)	41.5	55.6
Income (per month in past 30 days $)			
Don't know/refused	71 (15.8)	13.8	17.2
Less than $100	66 (14.7)	16.0	13.8
100 – 499	72 (16.0)	14.9	16.9
500 – 999	159 (35.4)	35.1	35.6
1000 and more	81 (18.0)	20.2	16.5
INTERMEDIARY (iSDH)			
Access to food and shelter	p=0.07		
Access to both	307 (68.8)	75.5	64.0
No access to food, access to shelter (food insecure only)	51 (11.4)	9.0	13.2
No access to shelter, access to food homeless only)	44 (9.9)	7.4	11.6
No access to both food and shelter (homeless and food insecure)	44 (9.9)	8.0	11.2
Cumulative Homelessness***			
No	211 (47.1)	58.5	38.5
Yes	237 (52.9)	41.5	61.2
Social support score*			

None	71 (16.2)	12.9	18.6
Low	53 (12.1)	9.7	13.8
Moderate	119 (27.1)	24.2	29.2
High	196 (44.7)	53.2	38.3
Children			
No	131 (29.2)	33.0	26.4
Yes	318 (70.8)	67.0	73.6
BENEFITS			
0 None	99 (22.1)	34.6	13.0
1 Cash assistance only	37 (8.2)	5.3	10.3
2 Non-cash assistance only	138 (30.7)	28.2	32.6
3 Both cash and non-cash assistance	175 (39.0)	31.9	44.1
CLINICAL DETERMINANTS			
Physical illness severity (CDPS score) ***			
Low	106 (23.6)	33.0	16.8
Moderate	113 (25.1)	23.9	26.0
High	116 (25.8)	23.9	27.1
Severe	115 (25.6)	19.1	30.2
Behavioral Health***			
0 No behavioral health problems diagnoses	135 (30.0)	40.4	22.5
1 Substance abuse diagnosis only	31 (6.9)	6.9	6.9
2 Mental illness diagnosis only	112 (24.9)	25.5	24.4
3 Both diagnosed substance abuse and mental illness	172 (38.2)	27.1	46.2
Continuity of Care (2nd year lookback)*			
Unassessed	168 (37.3)	43.6	32.8
Low	95 (21.1)	16.5	24.4
Moderate	100 (22.2)	23.4	21.4
High	87 (19.3)	16.5	21.4
Regular Provider			
None	75 (16.7)	14.4	18.4
Only Social Worker	25 (5.6)	5.9	5.4
Only Doctor	235 (52.5)	56.2	49.8
Both	113 (25.2)	23.5	26.4
Type of Medicaid***			
FFS	189 (42.9)	34.8	48.8
MCO	252 (57.1)	65.2	51.2
Significance levels: *** $p<0.001$, **$p<0.01$, *$p<0.05$			

Table 16:Association of Social and Clinical determinants with Persistent ED Use - Step-wise modelling

	Odds Ratios of Persistent Utilization of ED				
	(1)	(2)	(3)	(4)	(5)
Age	0.98	0.98*	0.97	0.97**	0.97***
GENDER (Ref. Female)	1.10	1.14	0.83	0.87	0.93
EDUCATION (Highschool Attainment, Ref. No)	0.65	0.69		0.63	0.67
Duration of Unemployment (Ref=0, currently employed)					
1 month – 2 yr	1.17	0.93		1.09	0.92
> 2 yrs	1.83*	1.20		1.40	1.10
Cumulative homelessness (Ref. No)	2.03***	1.70*		1.62*	1.56
Social Support (0-3)	0.88	0.88			0.88
Access to Public Benefits (Ref. none)					
Cash assistance only		4.94***			3.69*
Non-cash assistance only		2.68**			2.38**
Both cash and non-cash assistance		3.26***			2.24*
Physical Illness Severity (CDPS Score Quartiles) (Ref: Low Risk Score)					
Moderate			2.10*	2.00*	1.94*
High			2.16*	2.29*	2.29*
Severe			2.85**	3.16**	3.11**
Behavioral Health Status (Ref. No mental illness, no substance abuse)					
Substance abuse only			2.23	1.66	1.46
Mental illness only			1.60	1.28	1.28
Both			2.87***	1.99*	1.84
Care Continuity – 2nd yr lookback (Ref: High)					
Unassessed			0.56*	0.60	0.61
Low			1.12	1.23	1.10
Moderate			0.62	0.75	0.76
Regular Source Of Care (Ref. none)					
SW Only			0.77	0.77	0.70
Reg Doc Only			0.71	0.89	0.92
Doc+SW			0.63	0.68	0.64

Medicaid MCO Plan (Ref: FFS)			0.59*	0.72	0.80
Significance levels: *** p<0.001, **p<0.01, *p<0.05					

Table 17: Marginal Probability of Persistent ED Use

	Marginal Probability of Persistent ED Use	95% CI
Age	-0.01***	[-0.01,-0.00]
GENDER (Ref. Female)	-0.00	[-0.12,0.12]
EDUCATION (Highschool Attainment, Ref. No)	-0.10	[-0.22,0.02]
Duration of Unemployment (Ref=0, currently employed)		
1 month – 2 yr	-0.01	[-0.17,0.15]
> 2 yrs	0.02	[-0.13,0.16]
Cumulative homelessness (Ref. No)	0.10	[-0.01,0.21]
Social Support (0-3)	-0.03	[-0.08,0.02]
Access to Public Benefits (Ref. none)		
Cash assistance only	0.31**	[0.10,0.52]
Non-cash assistance only	0.21**	[0.06,0.36]
Both cash and non-cash assistance	0.20*	[0.03,0.37]
Physical Illness Severity (CDPS Score Quartiles) (Ref: Low Risk Score)		
Moderate	0.16*	[0.01,0.31]
High	0.20*	[0.04,0.36]
Severe	0.27**	[0.10,0.44]
Behavioral Health Status (Ref. No mental illness, no substance abuse)		
Substance abuse only	0.09	[-0.13,0.32]
Mental illness only	0.06	[-0.08,0.21]
Both	0.15	[-0.00,0.30]
Care Continuity (Ref:High)		
Unassessed	0.12	[-0.27, 0.03]
Low	0.02	[-0.14,0.18]
Moderate	-0.07	[-0.22, 0.09]
Regular Source Of Care (Ref. none)		
SW Only	-0.09	[-0.34,0.17]
Reg Doc Only	-0.02	[-0.17,0.13]
Doc+SW	-0.11	[-0.28,0.07]
Medicaid MCO Plan (Ref: FFS)	-0.05	[-0.19,0.08]
Significance levels: *** p<0.001, **p<0.01, *p<0.05		

Chapter Five: Discussion

5.1. Interpretation of findings

Findings from this dissertation demonstrate a significant association between specific social (SDH) and clinical determinants of health and: a) unmet needs; b) emergency departments (ED) utilization; and c) persistent ED utilizers in a vulnerable population of Medicaid enrollees who are considered a high-risk and high-cost group due to their frequent utilization of ED.

Results from the first aim elicit a better understanding of the proximal to distal relationship between structural and intermediary social determinants, and the respective influences of social and clinical determinants upon unmet health needs in a vulnerable population. Aim 1 reveals that social determinants can be responsible for up to 37% of the variance in unmet needs in vulnerable patients, while clinical determinants contribute less (18%). Together, they explain 39% of the variance in the number of unmet needs in our sample, with the caveat that some correlation exists between the social and clinical determinants. Social determinants appear as the significant drivers of unmet needs in this population relative to clinical determinants. These social determinants include: income, inadequate food and shelter and lack of social support. Behavioral health status is the only significant clinical determinant of unmet needs and over 60% of our sample have a mental illness diagnosis. Moreover, social determinants are strongly associated with clinical-types of needs such as those in the health care management and literacy (HCML) domain of unmet needs. Attention is also drawn to the strong association of social determinants of low social support, and inadequate food and shelter to the presence of

non-material needs such as HCML needs, family related needs and employment related needs.

While there is sufficient social epidemiological evidence supporting the more significant contribution of social determinants over medical care on health[208], to date there has not been a comprehensive examination of the extent to which social and clinical determinants of health influence unmet needs in vulnerable patients. Experts agree on the significance of unmet needs in detecting gaps in care but despite calls for measuring unmet needs in order to manage them[6,58,193,194] , most studies to date have defined unmet needs quite narrowly leading to a focus on mainly clinical unmet needs and thereby relative inattention to non-clinical/social unmet needs. [28,115,183,185,190,209]Some studies have looked at clinical unmet needs in specific populations facing homelessness, food-insecurity, substance abuse, or disabilities, or have focused only on the influence of clinical determinants on clinical unmet needs[121,170] Stein et al investigated the influence of unmet needs in homeless women that are only clinical needs that are based on health services utilization, and more over do not distinguish social determinants as separate from predisposing factors.[210] In a national study, Baggett et al investigated the relationship of a few non-clinical determinants with mainly clinical unmet needs in a homeless population.[28] Berkowitz et al show the relationship of a specific social determinant (food insecurity) upon cost-related medication under use (unmet need).[188] This dissertation is the first study to measure a comprehensive range of medical and social unmet needs, and also the first to examine the association of both social and clinical (access and illness) determinants with a combination of social and medical needs. In doing so it illustrates: (1) the diverse nature and prevalence of social needs in a

vulnerable population with increased utilization of health care; (2) the strong magnitude of influence of social determinants on a multitude of social AND clinical needs; (3) social determinants remain significant in their association with unmet needs, after adjusting for clinical determinants, whereas access to regular care and physical illness are not significantly associated. Most policy reactions to addressing unmet needs in vulnerable patients have been to increase access to health care services.[211] Results from the first aim suggest an alternative to over-medicalization of health care and balance the roles of social and clinical determinants through quantifying their magnitude of influence upon unmet needs. These findings can help guide policy makers in prioritizing the needs to be addressed as well as the means to doing so.

Secondly, this dissertation sheds light on the relative influence of social (SDH) and clinical determinants on total and preventable ED Utilization. Findings from Aim 2 point towards SDH such as inadequate food and shelter and lack of social support, and clinical determinants such as severe behavioral health problems (mental illness and substance abuse combined), that contribute to increased number of both total and preventable ED visits. Higher social support and better levels of care continuity both can lower the number of total and preventable ED visits. While other studies have gleaned similar influences of these particular factors upon health care utilization and frequent ED utilization,[43,54,141] Aim 2 further contributes to the literature by demonstrating the differentiating impact of these factors upon preventable and non-preventable ED use which is of interest to policymakers. In addition, while many studies have focused either on social determinants of ED use[33,41,108], or the effect of CC[45,212–214] or clinical illness[5,18,215] upon ED use, few have studied both[216] and none have done so in a Medicaid

FUED population. Parul demonstrates the influence of clinical illness and unemployment upon ED utilization in Medicaid patients.[180] Capp et al investigated a wider range of both clinical and social variables but did not include care coordination in their study of reason of ED use in Medicaid FUEDs.[217] Colligan et al evaluated the role of care coordination and clinical illness upon FUEDs in a recent study on Medicare FUEDs, but did not explore the influence of specific SDH in their study and did not test for an interaction effect between care coordination and clinical illness.[198] This is the first study to have jointly looked at both these types of determinants inclusive of care coordination in Medicaid FUEDs. One can thereby gauge the influence of inadequate food and shelter, lack of social support, and access to public assistance in addition to the influence of clinical care continuity, physician and behavioral health upon total and preventable ED utilization in Medicaid FUEDs.

While I attempted to investigate the ability of public assistance to buffer or mitigate the effects of adverse social determinants on the outcomes, the cross-sectional nature of the data impeded this. People with greater public assistance also reported greater unmet needs and more persistent ED utilization, as well as reported experiencing more food insecurity, more homelessness and more behavioral health issues. Removing the variable for public assistance in multivariate analyses did not really affect the other parameter estimates in Aims 1 and 2. In Aim 2, only cash assistance was significantly associated with more total ED visits than non-cash assistance or both. However, results from Aim 3 show the potential effect of all levels of public assistance to buffer the influence of cumulative homelessness and behavioral health status on the odds of being a persistent FUED (see Tables 16 and 17). These findings warrant further research to

investigate: a) whether the public assistance is adequate or falling short for this population, and b) whether access to both types of assistance (cash and non-cash) is a surrogate measure of access/eligibility of the neediest.

It is interesting how physical illness severity and CC moderate the way each influences ED utilization. Physical illness severity independently contributes to increased total ED utilization, but in addition better continuity of care can lower both total and preventable ED utilization for patients with severe physical illness. I did not find any research describing the interaction effect of physical illness and care continuity upon ED utilization in FUEDs. Results point at the potential of CC to lower total ED utilization for patients at every level of physical illness severity. The interaction category associated with the greatest increase in total and preventable ED utilization are the unassessed CC group with severe clinical severity (see Supplementary Table 3). It signals the need to identify these patients who seem to have limited access to ambulatory care (<3 visits) and are frequently attending the ED for their needs. These patients are also much sicker and may benefit from care coordination.

Lastly, this research examined risk factors that could influence persistent frequent use of the ED beyond 1 year. The literature on persistent FUEDs is sparse. Colligan et al concluded that in the Medicare population, being younger, black, having Medicaid, mental illness, disability and end-stage renal disease were significantly associated with persistent frequent ED use.[87] Aim 3 highlights persistent FUEDs as an ultra-high risk subset of FUEDs with greater severity of physical illness. While certain SDH are associated with persistent ED use, their influence is over-shadowed by the influence of physical illness severity. Factors such as increased duration of unemployment,

cumulative homelessness, mental illness combined with substance abuse and low care continuity can all contribute to persistent ED use through their likely contribution to a cumulative long-term worsening of clinical illness. Results draw attention that people who may be currently housed but have been homeless in the past could still be vulnerable to persistent ED utilization.

5.2. Contributions

- **Better measurement and understanding of unmet needs to address social and clinical determinants of health in Medicaid FUEDs**

Unmet needs are important as they signify gaps in service provision which can influence increased and inappropriate use of expensive services at EDs. "Unmet health care needs"—defined as the difference between health care services deemed necessary to deal with a particular health problem and the actual services received is a key indicator of access to care.[194] While measures of access are typically limited to clinical events, such as ED visits, ambulatory care visits and hospitalizations, these measures do not capture information about difficulties vulnerable patients may encounter in effectively and appropriately accessing care.[194] Therefore research capturing measures of access to social services and benefits in addition to health care access and benefits are essential to broaden the definition of unmet needs. This research exhibited the utility of doing this.

By demonstrating that health needs (not just social needs) are closely influenced by SDH, by exploring the prevalence of social and health needs, and assessing the relative roles of specific social and clinical determinants of health upon a variety of social and medical unmet needs, this dissertation contributes to a critical gap in the field. It was

interesting to note the strong association of social determinants and behavioral health determinants with needs related to health care management and literacy, yet the lack of association of physical illness and access to health care with the number of unmet needs experienced by this population. Typically concerns and therefore measures of unmet needs of patients have focused on health care needs while missing a spectrum of social needs. Unless one is obviously already homeless or has severe mental illness, measures of social needs may not be measured in the health care setting. Yet, Aim 1 revealed a large proportion of people who are currently employed, who are not homeless, expressing numerous social needs in addition to clinical needs.

In addition, through demonstrating the link between SDH and ED utilization (Aim 2), this research highlights the potential benefits of capturing information on social determinants and social unmet needs within clinical settings to prevent ED utilization. It has direct relevance to the testing of the Centers for Medicare & Medicaid Services (CMS) Accountable Health Communities Model that aims to address critical gaps between clinical and community services within the current health care delivery system by streamlining action between social services and health care services. In addition, these results provide rationale for broadening of the current CMS Health Related Social Needs (HRSN) screening tool to include measures of education and employment needs. While the CMS HRSN screening tool includes several of the unmet needs captured in this study such as housing and food security, [218] it lacks the ability to capture needs resulting from crucial structural SDH such as education and employment. These upstream SDH are important as they influence many of the downstream intermediary determinants that are reflected in the material resource needs (housing, food security) captured in the HRSN

tool. This research thereby recommends the measurement of education and employment needs in FUEDs.

- **Role of Social Determinants on influencing ED Utilization**

This research provides evidence to encourage further research around the implementation of increased clinical and community linkages to improve health care outcomes and lower utilization and costs for Medicaid FUEDs living in DC. Moreover, it distinguishes the low hanging fruit in terms of modifiable intermediary social determinants, and longer-term goals in terms of influencing the structural social determinants that contribute to intermediary determinants. In line with previous research[9,33,41,43,219], two other high-risk groups that emerge as significant utilizers of the ED are the homeless population, and patients with substance abuse. Since lack of housing and food security hugely impacts both total and preventable ED utilization, this research emphasizes the need to address these SDH. While other research has demonstrated the benefits of addressing material resource needs such as housing, food, utilities, this research is unique in its identification of the significant role of social support in lowering total and preventable ED utilization. It builds on evidence from Aim 1 indicating that social support is negatively associated with health care management and literacy needs. Moreover, social support has a negative correlation with behavioral health status (see Supplementary Table S2). With about 6 in 10 FUEDs having a clinical diagnosis of mental illness, the impact of addressing social determinants on lowering preventable ED utilization by patients with mental illness could be remarkable. This dissertation also lends itself as a hot-spotting opportunity to identify specific sub-groups of patients that have disproportionate and high preventable ED use.

While social determinants are significant contributors of ED utilization, we found clinical determinants, most specifically physical illness severity, to be more strongly associated with persistent use of the ED. There is a strong dose response relationship between these variables. In light of previous research that has established the causal role of long term exposure to social determinants in clinical disease and its exacerbation,[67,72] we can gather that persistent ED utilizers are sicker than non-persistent utilizers and may have experienced a greater duration of exposure to SDH such as cumulative homelessness and greater duration of unemployment. Longer follow up of our sample could further investigate the validity of this deduction. Additional research can build on these results to guide in the incorporation of specific SDH in risk adjustment models for specific sub-groups of FUEDs. It may be that unemployment and lack of care continuity do not impact persistent ED use as much as physical illness, but their influence detected in step-wise modelling posits that these factors could have a cumulative contribution towards long standing deterioration of a person's physical health.

- **Role of Care Continuity (CC) on ED Utilization**

This research is the first to test and find significant interaction between CC and physical illness in this population. Results strongly support the importance of care continuity in lowering and preventing ED utilization, especially in patients with high and severe clinical severity. Moderate and high CC seem to have the greatest influence in lowering total and preventable ED utilization in this sample, compared to low CC and unassessed CC.

On bivariate analyses, I did not find a clear dose-response pattern of the CC variable with ED visits (see Table 11) or with persistent FUEDs (see Table 15). Similarly, there is no clear dose-response pattern between the different CC levels in multivariate analyses for Aim 2 (see Table 13) and Aim 3 (see Tables 15 and 16). Moderate CC is better than low CC, but high CC is not better than moderate CC. On further exploration (Appendix D, Supplementary table S5), I find the FUEDs with high CC significantly had a greater proportion of homelessness and food insecurity, than those with low or moderate CC. This could be one reason that may have weakened the expected influence of high CC and diminished its performance in comparison to moderate CC in Aims 2 (see Table 13) and 3 (see Tables 16 and 17). Further research could elucidate whether SDH have a role in weakening the influence of CC which could be valuable. FUEDs with high CC also have significantly greater physical illness severity than the low and moderate categories. One must consider the fact that the COCI measure used to estimate CC is limited in the ability of gauging physician behavior in referring and managing patients with greater physical illness severity, as well as limited in capturing patient utilization preferences. I posit the possibility that people with different levels of care continuity may be behaving differently in their utilization of the ED that may not be easily captured by the COCI measure. Regardless of the relative influence of different CC levels, this is enough evidence that CC is important in mitigating ED utilization in vulnerable groups with greater physical illness severity. In addition, results encourage the expansion of CC that is currently limited to health care services to include continuity of social services.

To summarize, no previous research has investigated the role of both SDH and clinical determinants upon unmet needs, total and preventable ED utilization, and persistent ED use, in the Medicaid population. This study set out to closely mimic the range of social and clinical systemic influences that our sample of vulnerable patients are exposed to in the real world. Results show that SDH have a greater influence on the number of unmet needs than clinical determinants in FUEDs. Among social determinants driving frequent ED utilization in FUEDs are homelessness, food insecurity and lack of social support. Clinical drivers of ED utilization include severe physical and behavioral illness, and lack of CC. While both SDH and clinical determinants drive total ED utilization, the SDH have a greater influence on preventable ED utilization. These findings suggest that SDH drive unmet needs in this group of patients as well as preventable ED utilization, that FUEDs have significant physical and behavioral health problems driving their total ED utilization, and that tackling ED utilization in a clinical silo through only CC will be inadequate. Utilizing the WHO CSDH framework also enabled us to parse out different types of SDH to guide decisions on which SDH to prioritize, as well as illustrate some of the close interconnectedness of social determinants and social needs.

5.3. Limitations

Some limitations exist with the data and the methods being applied. First, the data from the interview is cross-sectional, and while we can draw associations between specific variables, there is no means of assessing causality or drawing causal inferences. If we had a comparison population, such as those who do not use the ED or use it

infrequently, it would have helped in assessing the causal relationship between SDH and ED use. There also is considerable endogeneity that exists in the dataset due to inter-relatedness of measured and unmeasured factors that is typical in health services research (i.e. unmet needs, clinical severity, access to health care services and utilization of health care services all can influence the occurrence of the other) and the cross-sectional nature of the data. Specifically, with this type of population where mental illness and substance abuse are prevalent, co-occur and impact access and utilization, endogeneity is difficult to eliminate without excluding the variables of interest in this study. Endogeneity between social determinants and social needs (eg. homelessness and housing needs) in Aim 1 was assessed to avoid misinterpretation of the results. Endogeneity could be addressed by applying alternative statistical analytic techniques such as Structural Equation Modelling (SEM), or mediation analysis.

Second, it is important to note that the interview data is captured at a single time during the index ED visit, and there is lack of information on the duration of these unmet needs and SDH except for duration of unemployment and past homelessness. I am making an assumption that the nature of these unmet needs has not changed over the past one year during which utilization information on FUEDs and number of ED visits is being captured but I know that people's circumstances can change in the short-term. Patient-reported information on the predictors of SDH and unmet needs is cross sectional in nature and collected at a single point in time, whereas the outcome variable of persistent ED use is based on retrospective claims description of 2 years of health services. Researchers and readers need to be aware of this temporal discrepancy arising from the different sources of the data. Furthermore, this study is limited to just 2 years

and so we are unable to comment on broader patterns of frequent ED utilization that may occur during a longer period or during a different time frame.

Third, in Aim 1, for the total number of unmet needs, I am weighting each unmet need domain equally. Moreover, some unmet needs could also co-vary. This weakens my assumption of the linear relationship between the total number of unmet needs and independent variables. I address this by using a variable reduction technique to create 4 unmet need domains, by conducting sensitivity analyses to assess the association of the number of specific types of unmet needs with the independent variables in the final model and using bivariate analysis to assess the relative association of the independent variables with unique unmet need domains.

Fourth, in Aim 2, the care continuity measure COCI is limited in its ability to capture non-claims related care continuity that patients may be exposed to for example, through care coordination programs at their providers' offices, some coordination of information through shared EHR or care coordinators provided through managed care. It is a measure based on a time restricted pattern of patient encounters. Therefore, it is limited in its indication of other important constructs of continuity such as patient provider 'interpersonal continuity'. Moreover, increased ED utilization itself can contribute to fragmentation of care and reverse causation/endogeneity may be present between CC and ED utilization. A large proportion of our sample (30%) could not have their CC assessed due to insufficient ambulatory care visits. I decided on keeping them in the analysis and assumed them to be a category worse than low CC. While other research has done the same,[87] this categorization is discrepant from the calculation that was used to generate the other categories (low, moderate, high). However, the unassessed CC

group had the highest ED utilization and strong relationship with adverse SDH which supports the appropriateness of treating the unassessed CC as the poorest CC group. Moreover, I did not assess if CC was associated with more discharged vs admitted ED visits.

Fifth, I was unable to explore the influence of race on total unmet needs and ED utilization due to lack of variation among the study sample which mainly comprises of African American patients.

Sixth, the generalizability of the study is limited by its focus on the DC Medicaid population. Furthermore, the study was a convenient sample of patients attending GWUH and consists almost entirely of frequent ED utilizers.

Seventh, while there is a wealth of diagnostic and clinical information documented in the claims data, claims data may not include a clinical condition if the beneficiary does not receive services for that particular condition during the observation period. The categorization of medical conditions through claims based diagnosis is a reflection of treated conditions rather than the underlying prevalence of disease. In addition, some providers may not document certain types of health problems out of concern that it may cause stigma to the beneficiary (i.e. mental health or substance use). I attempted to overcome this limitation by comparing self-report of mental illness and substance abuse in addition to the clinical diagnosis in the claims data.

5.3. Policy Implications and Recommendations

This research is directly applicable and translatable to DC Medicaid Care Coordination initiatives such as My DC Health Home, and MyHealthGPS, whereby

patients with severe mental illness and multiple chronic illnesses respectively, can receive a care coordination benefit that enables the coordination of a person's full array of health and social service needs.

The results from this research can inform DC Medicaid Health Homes on its potential to curb ED use by specifying the SDH and clinical elements that are most influential on ED use. In addition, it draws attention to the collection of key measures of baseline SDH, clinical determinants and unmet needs to assess risks of increased health care utilization. A structured mechanism to collect data is required to build infrastructure that can connect health care providers and social service providers, as well as evaluate the impact of programs addressing SDH. Such measures of determinants and outcomes as used in this dissertation can prove valuable when evaluating these programs. The integration of social workers and behavioral health providers in Health Home teams is already being implemented. This research provides further direction on the key measures of SDH and unmet social needs that team members can also assist patients with in addition to their clinical needs. As DC moves to implement Health Homes 2.0 that identifies addressing social needs as a priority, this research has value in guiding relevant programmatic implementation and policy development around prioritizing state resource allocation to address specific needs in this population. For example, a patient may be experiencing medication non adherence because of housing instability and once the patient is stably housed, their medication adherence and management of their chronic health condition improves. This research also noted a subgroup of beneficiaries who may be at risk for homelessness. This is an extremely vulnerable group that can benefit from measures to prevent homelessness. The strong association of inadequate food and

homelessness with numerous health related needs, warrants a prevention imperative to ward off many preventable ED visits and future persistent ED use. Measures of unmet needs can therefore guide management action items in care plans. Moreover, for FUEDs with multiple unmet needs, care managers become essential as this research detected a significant proportion of patients without any care managers. Care management and identification of community-based resources to address unmet needs become core principles for achieving improved health outcomes in vulnerable patients such as FUEDs.

While the collection of SDH and unmet needs could be conducted at the health care provider level, I recommend the routine collection and monitoring of SDH by the Medicaid program on a population level. SDH can be measured at first enrollment with repeat measures during re-enrollment providing a dynamic perspective on the socio-economic conditions of participants. This information could provide valuable guidance in policy making and resource allocations to the Medicaid program, as well as be shared with providers who may benefit in their management of the Medicaid population. DC Medicaid applicants share information on several social determinants at time of enrollment for Medicaid (eg. food insecurity, unemployment). A systematic means of channeling such information to health care providers could benefit the program. For example, it could determine the service sectors that are most needed and share this information with other public agencies which could enable decision making across other public sectors. In this way key opportunities to establish partnerships between DC Medicaid and other service sectors can emerge to mitigate social barriers to improving health outcomes as well as energize community development through lower unemployment, lower homelessness, increased literacy and better standards of living.

Understanding the influence of CC on preventable ED use can inform the design of suitable care coordination programs. For instance, insights on the importance of CC and social support on lowering preventable ED use, could be applied to marry the two in a care coordination model that also provides social support. While this research provides distinguishing arguments for the continued provision of integrated care for this population, it also highlights opportunities that could remain unaddressed without some integration and continuity of social services along with continuity of clinical services. Interventions may also benefit from similar research that can more reliably identify patients with both social and clinical risks for preventable ED visits despite existing case management and care coordination programs. Further research can also detect whether and which SDH can interfere with establishing and maintaining CC among high risk patients.

This research also highlights the association of behavioral health with unmet needs, increased ED utilization as well as persistent ED use. A greater proportion of patients with mental illness express family related needs than those without mental illness, which warrants consideration of these needs by the My Health Home program and other clinical-and-social-needs bridging initiatives being consider by Community Based Health Plans.[220] In addition, policy makers should think about provisions to prevent homelessness in the 50% of patients with severe behavioral health problems that currently have adequate food and housing but may be vulnerable to homelessness due to their clinical mental illness. While CC in patients with mental illness is not significantly different from patients without mental illness (0.32 vs 0.34), the former has a higher utilization of ambulatory care with minimal psychiatric specific ambulatory care visits.

Moreover, patients with mental illness have significantly higher clinical risk scores than those without mental illness, signaling increased chronic illness burden in this group. Better access of psychiatric E&M services may also be recommended for patients with mental illness enrolled in the program.

Lastly, this research gleaned insights into the role of public benefits on the various outcomes. Step-wise modelling in Aim 1 revealed cash and programmatic public benefits are positively associated with the number of unmet needs. People on cash assistance also have higher odds of being persistent FUEDs (60%). On adjusting for public assistance in Aim 3, the influence of cumulative homelessness and behavioral health problems on persistent FUED was no longer significant. While these results do not suggest any causal relationships, they draw attention to the role of public benefits on potentially mitigating the influence of certain SDH. Any changes to the welfare system should be cognizant of such relationships in determining downstream consequences of policies. For instance, present Senate and House fiscal year 2018 funding bills for HUD would reduce the number of housing vouchers by 140,000[221] which could dramatically increase risks of homelessness for vulnerable people. Numerous studies have already established the positive outcomes of providing certain benefits such as housing in terms of lowering ED utilization rates and improving health outcomes for high-cost utilizers.[113,190,222] Insights from this research recommend the need to establish creative means of providing housing and other public service stability that can withstand budgetary changes to some extent. A consideration for coordination of public benefits akin and in addition to clinical care coordination could achieve efficiency gains and sustain impact of initiatives such as Heath Homes 1.0 and Health Homes 2.0.

5.4. Conclusion

SDH have long been limited to assessments for purposes of research on their consequences on health or have been evaluated in people who may be already be experiencing consequences of poverty such as homelessness. This research establishes strong grounds for practical attention to and measuring of SDH and social needs in Medicaid patients within the health care service setting for purposes of prevention to lower ED utilization and improve the health status of FUEDs. In addition, contrary to many myths on ED utilization by Medicaid patients, we see a smaller proportion of total ED visits to be preventable (30%), which means most ED care by FUEDs is needed care. The challenge for managing FUEDs then becomes not so much as to prevent them from coming to the ED, but rather preventing exacerbations of their clinical illness, preventing their exposure to unmet needs compounding these exacerbations, and thereby taking notice of the social determinants producing those unmet needs. On the clinical end, better CC and more effective ambulatory care utilization for behavioral health management could also prevent unnecessary frequent ED utilization.

Unlike other studies that only rely on either patient reported survey data or claims data, this research uniquely linked both these sources of data to provide a comprehensive exploration of the role of a range of social and clinical factors on patients' unmet needs and ED utilization. Claims data allowed us to cross validate some of the patient reported clinical outcomes and gauge unmet medical and social needs of FUEDs better. We were able to glean potential reasons for the frequent ED visits in our sample and this can help inform potential interventions. Furthermore, the present research provides a valuable

advantage to the field by offering a more complete understanding of the ambulatory care and ED utilization behavior of FUEDs. Moreover, by examining persistent FUED as a potentially separate and more severe phenomenon of FUED, this study lays the ground for future policies and interventions to be more targeted to FUEDs that may be at risk of becoming persistent ED utilizers. By aiming to prevent both frequent ED use, as well as persistently frequent ED use, we become better strategically placed in responding to decisions pertaining to FUEDs in the Medicaid program.

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Appendix A: Survey Instrument

Study ID: __ __ __ __

Date Completed: __ __ / __ __ / __ __

RA Initials: __ __

Frequent Users Of The Emergency Department

Baseline Interview

Version 6, March 14, 2016

Section 1: General Health

1. Would you say in general your health is…

Excellent.....1
Very good.....2
Good.....3
Fair 4
Poor.....5
DK/RF 9

2. Do you have a particular doctor or healthcare provider that you usually go to when you don't feel well?

Yes.....1
No (Skip to Q4).....2
DK/RF (Skip to Q4).....9

3. Can you tell me the name of this doctor/healthcare provider?

_____

4. Do you have a case manager or social worker that helps you manage your health problems?

Yes, case manager.....1
Yes, someone else.....2
No (Skip to Q6).....3
DK/RF 9

If someone else, specify (_____)

5. How many times have you talked with your {case manager/social worker} in the past six months?

__ __ __

DK/RF 9
99

6. In the past six months, how many times have you used an ambulance to take you to the hospital or emergency room?

__ __ __

7. Why have you had to go to the emergency room recently? (Record verbatim)

_____

_____

8. Have your emergency room visits been for one common problem or multiple different problems?

Same common problem 1
Different problems 2
DK/RF 9

Section 2: Mental Health

1. During the past year, have you experienced any of the following mental health problems? (Check all that apply)

Serious depression	□ Yes	□ No
Serious anxiety or tension	□ Yes	□ No
Hallucinations (heard voices or saw things you could not control but others did not see or hear)	□ Yes	□ No
Trouble understanding, concentrating or remembering	□ Yes	□ No
Trouble controlling violent behavior	□ Yes	□ No
Experienced serious thoughts of suicide	□ Yes	□ No

If any of the above are positive, continue. Otherwise, skip to next section.

2. In the past year, have you been HOSPITALIZED for an emotional or mental health problem?

Yes 1
No 2
DK/RF 9

3. When was the last time that you received counseling or treatment for emotional or mental health problems at a hospital, clinic or office?

Within past 6 months 1
6 months to < 1 year ago ... 2
1 to 2 years ago 3
Greater than 2 years ago ... 4
Never received outpt treatment 5
DK/RF 9

Section 3: HOUSING

1. Where do you live right now? Is it in a … __ __
   2. = House (includes trailers and mobile homes, Skip to Q5A)
   3. = Apartment (Skip to Q5B)
   4. = A room (Skip to Q5B)
   5. = Emergency shelter
   6. = Transitional shelter/housing
   7. = Adult foster care (AFC) home
   8. = Welfare or voucher hotel
   9. = Couch surfing (sleeping at different people's places)
   10. = A car or other vehicle
   11. = An abandoned building
   12. = At a transportation site (bus station, metro station, airport)
   13. = Under a bridge
   14. = At a business (all-night restaurant, farm building, etc)
   15. = Hotel or motel (place with separate rooms where you pay for yourself)
   16. = Dormitory hotel (place without separate rooms where you pay for yourself)
   17. = Anywhere outside (park, riverbed, etc)
   18. = Some place else (please specify_____)
   97=DK; 98=RF

If response is 4 – 17, continue. Otherwise if 1-3, skip to Q5a or 5b.

2. How often do you use this place for sleeping?

Less than 1 week per month 1
One to three weeks per month 2
Every night of the month...3
DK/RF 9

3. How old were you when you FIRST found yourself without regular housing or a regular place to stay? __ __ (age in years)

4. How frequently have you moved from place to place __ __ __
In the past month? DK/RF
999

SKIP TO NEXT SECTION.

5a. Do you own the house you live in?

Yes (Skip to Q7).....1
No (Skip to Q5b) 2
DK/RF (Skip to Q6) 9

5b. Do you rent the {house/apartment/} room you live in?

Yes (Skip to Q7) 1
No.....2
DK/RF (Skip to Q7) 9

6. Who owns {rents} the {house, apartment or room} you live in now? __ __

01 = Parent
02 = Other relative
03 = Friend
04 = Part of a transitional program for homeless people
05 = Other (please specify _____)

7. How long have you lived in this house/apartment/room?

< 6 months.....1
6 months to 1 year 2
1 to 2 years 3
Greater than 2 years ago...4

8. Have you ever been homeless or without regular housing?

Yes.....1
No (Skip to next section) 2
DK/RF (Skip to next section) 9

9. How old were you the FIRST time you found yourself homeless or without a regular place to stay? __ __ (age in years)

10. In the past six months, how many days have you found yourself homeless or without a regular place to stay? __ __ __
DK/RF 999

Section 4: FOOD

1. Do you always get enough food to eat? Yes (Skip to next section)...1
No
2
.....
DK/RF 9

2. In the past 30 days, how many days would you say you did not get enough food to eat? __ __

Section 5: PUBLIC SERVICES

This section of the interview asks about benefits you may receive from different social service programs. We are trying to determine if there are services that you are eligible for but you may not be receiving. This information has nothing to do with paying for your emergency room visit today.

19. In the past month, have you received money from any of the following sources?
(Ask about each source and check all that apply)

Disability compensation or survivors benefits from Social Security (SSDI) □ Yes □
No

Supplemental Social Security (SSI) for Aged, Blind and Disabled □ Yes □
No

Disability compensation or survivors benefits from the VA □ Yes □
No

Unemployment Compensation □ Yes □
No

Temporary Assistance for Needy Families (TANF) □ Yes □
No

2. Do you have enough money to meet all of your expenses on a monthly basis? Yes.....1
No 2
DK/RF 9

3. In the past month, have you received assistance from any of the following sources?
(Ask about each source and check all that apply)

Housing subsidy or housing assistance such as Section 8, public housing, tenant assistance or a housing voucher □ Yes □ No

Food stamps (Supplemental Nutrition Assistance Program-SNAP) □ Yes □ No

Food from a soup kitchen, food pantry, or a mobile food program □ Yes □ No

Help from the Low Income Home Energy Assistance (LIHEAP) program □ Yes □ No

Help from a community outreach program or drop-in center □ Yes □ No

Any other places you have received help from? □ Yes □ No

(Other, specify_____)

4. Is there anything you need help with now? (Check all that apply)

□ Getting food (1) □ Getting clothing (2)

□ Transportation (3) □ Help with legal issues (4)

□ Help with parenting (5) □ Child care services and payment of costs (6)

□ Help with enrolling children in school (7) □ Help with domestic violence problems (8)

□ Ability to read or write (9) □ A GED or other education (10)

□ Help with getting financial or other public benefits (AFDC, food stamps, Section 8, SSDI) (11)

□ Help finding a job (12) □ Job training (13)

□ Help with managing money (14) □ Help finding affordable housing (15)

□ Assistance with paying rent, mortgage or utilities (16)

□ Help to resolve problems with the landlord or person you are living with (17)

□ Medical care for yourself (18) □ Dental care for yourself (19)

□ Help getting or managing medications (20) □ Services for emotional/psychiatric problems (21)

□ Treatment for alcohol or drugs (23) □ Money or cash (24)

□ Finding out availability of resources (25)

□ Other (please specify_____) (26)

□ Check here if subject does not want help with anything. *Skip to next section.*

5. If subject reports more than one, ask him/her to rank their needs.

1st priority: __ __
2nd priority: __ __
3rd priority: __ __

6. You have indicated that you would like help with {…….}, 1 would you like help after we complete this interview? I may be able to help you or I can see if the social worker is available to

Yes
No.....2
DK/RF 9

help you.

Section 6: Substance Abuse: Alcohol

1. Do you drink alcohol every day?
   - Yes.....1
   - No (Skip to next section) ...2
   - DK/RF 3

2. Does the amount of alcohol you drink trouble or bother you?
   - Not at all 1
   - Slightly (a little).....2
   - Moderately 3
   - Considerably 4
   - Extremely.....5
   - DK/RF 9

3. Do you want to receive treatment for your drinking?
   - Yes, now.....1
   - Yes, not but today.....2
   - No 3
   - DK/RF 9

4. When was the last time you received any kind of treatment for alcohol problems?
   - Within past 6 months 1
   - 6 months to < 1 year ago 2
   - 1 to 2 years ago 3
   - Greater than 2 years ago ...4
   - Never received treatment 5
   - DK/RF 9

Section 7: Substance Abuse: Illicit Drugs or Narcotic Prescriptions

1. Do you use drugs other than those prescribed for medical reasons?
   - Yes 1
   - No (Skip to next section) 2
   - DK/RF 9

2. Does your drug use cause you problems or bother you?
   - Yes 1
   - No 2
   - DK/RF 9

3. Do you want to receive treatment now for your drug use?
   - Yes, now.....1
   - Yes, but not today.....2

No 3
DK/RF 9

4. When was the last time you received any kind of treatment for drug problems?

Within past 6 months 1
6 months to < 1 year ago 2
1 to 2 years ago 3
Greater than 2 years ago ...4
Never received treatment 5
.....
DK/RF 9

Section 8: DEMOGRAPHICS

1. How much school have you completed?

Less than 9th grade 1
..... 9th – 12th grade, no diploma 2
.....HS graduate with diploma 3
G.E.D. 4
Vocational training certificate 5
.....Some college but no bachelor's degree 6
..... Bachelor's degree or above 7
.....
DK/RF 9

2. What is your marital status?

Married now 1
Widowed 2
Divorced 3
Separated.....4
Never married.....5
DK/RF 9

3. Do you have someone who is supportive of you?

Yes 1
No 2
DK/RF 9

3a. If you needed to borrow $100 right now, do you have someone that would lend you the money?

Yes.....1
No.....2
DK/RF 9

3b. If you wanted someone to go with you to a medical appointment, do you have someone that would be willing to go with you?

Yes.....1
No.....2
DK/RF 9

3c. Do you have someone to help you during an emotional crisis?

Yes.....1
No.....2
DK/RF

9

3d. Considering everything we have been discussing today, what could help you most right now improve your health?

__ __ __

_____

_____

_____

4. Do you have children?

Yes.....1
No 2
DK/RF 9

5. How many children do you have?

__ __

6. How many of your children are less than 18 years of age?

__ __

7. How many of your children live with you?

__ __

8. During the past 30 days, have you worked at a job that paid you?

Yes (Skip to Q10)
1

No 2
DK/RF 9

9. When did you last work for pay?

Within past 6 months

1

..... 6 months to < one year ago

2

1 to 2 years ago 3

2 – 3 years ago.....4

20. – 5 years ago

5

Greater than 5 years ago...6

Never worked 7

DK/RF 9

SKIP TO QUESTION 11.

10. How long have you worked at your present job?
21. – 6 months
22. months to < one year

Less than 3 months.....1
2
3
1 – 2 years.....4
2 – 5 years.....5
Greater than 5 years.....6
DK/RF 9

11. Have you ever been on active-duty military service in the Armed Forces of the United States or ever been in the 2
Reserves or the National Guard?

Yes 1
No
.....US military
DK/RF 9

12. Have you ever spent time in jail or prison?

Yes 1
No 2
DK/RF 9

13. Over the past 30 days, what was your total monthly income? Was it… $100 1

Less than
$100 - $299 2
$300 - $499 3
$500 - $699 4
$700 - $899 5
$900 – $999....6
$ 1,000 7
DK/RF 9

Those are all the questions I have to ask you. Thank you very much for completing this interview with me.

Section 9: INTERVIEWER IMPRESSIONS

1. Do you think this subject was under the influence of alcohol during the interview?
   - Yes.....1
   - No 2
   - Not sure 3
   - Unable to determine 4

2 . Do you think this subject was under the influence of drugs during the interview?
   - Yes.....1
   - No 2
   - Not sure 3
   - Unable to determine 4

3. Did the subject have active mental health issues during the interview?
   - Yes.....1
   - No 2
   - Not sure 3
   - Unable to determine 4 .....

4. How would you rate the subject's hygiene and appearance on a scale from 1 to 5?

1	2	3	4	5
(dirty and unkempt)				(Clean and neat)

5. How would you rate the subject's cognitive function on a scale from 1 to 5?

1	2	3	4	5
(severely impaired, poor historian)				(Normal, good historian)

6. Would this subject be appropriate to serve as a spokesperson or advocate for the needs of frequent ED users?
   - Yes 1
   - No.....2

7. Did you tell a social worker (SW) that the subject wanted to speak with him/her today?
   - Yes 1
   - No, subject declined SW 2
   - No, could not find SW .3
   - No, other reason 4

_____ No, but left message for SW 5

No, I helped subject instead 6

8. Did you help the subject with any unmet needs? Yes.....1
No,.....2

9. Please check each type of information/services you provided to the subject?

□ Transportation (1)
□ Finding a doctor (2)
□ Substance abuse services (3)
□ Housing/Shelter (4)

□ Other (5)

(IF OTHER, please specify

_____)

APPENDIX B: CODES USED TO DEFINE VARIABLES FROM CLAIMS DATA

Table 1: BETOS Codes and Descriptions for Evaluation and Management Visits		
BETOS Code	**Description**	**Corresponding CPT codes**
M1A	Office Visits – new	99201-99205
M1B	Office Visits – established	99211-99215
M4A	Home Visit – new Home Visit - established	99341-99345 99347-99350
M4B	Nursing Home Visit	99324-99328 99334-99337
M5 **M5 A** **M5 B** **M5 C**	Specialist: Pathology Psychiatry Ophthalmology	 88387, 88388 90801-90865 92002, 92004,92012,92014, 92015, 92018-92020, 92060, 92065, 92070, 92081-92083, 92100, 92120, 92130, 92135
M5D	Specialist – Other	92502-92504, 92506, 92508, 92531-92534
M6	Consultations	99241-99245
N/A	Preventive Visits • New Patient • Established Patient • Individual Counseling • Group Counseling • Other Preventive Medicine Services	99354-99355 99381-99387 99391-99397 99401-99409 99411-99412 99420; 99429

Table 2: Place of Service Codes	
POS code	Description
4	Homeless Shelter
11	Office
12	Home
22	Outpatient Hospital
50	Federal Qualified Health Center
62	Outpatient Rehabilitation
71	State Local Public Health Clinic

Health care provider taxonomy codes classified as primary care:

- General practice: 208D00000X
- Family medicine (restricted to general family medicine, adult medicine, geriatric medicine): 207Q00000X, 207QA0505X, 207QG0300X
- Internal medicine (restricted to general internal medicine, geriatric medicine): 207R00000X, 207RG0300X
- Preventive medicine (restricted to public health and general preventive medicine): 2083P0901X
- Nurse practitioner (restricted to general NP, acute care, adult health, community health, family, gerontology, primary care, women's health): 363L00000X, 363LA2100X, 363LA2200X, 363LC1500X, 363LF0000X, 363LG0600X, 363LP2300X, 363LW0102X
- Clinical nurse specialist (restricted to general, adult health, community health, family health, gerontology, holistic, women's health, home health, acute care, chronic care): 364S00000X, 364SA2200X, 364SC1501X, 364SF0001X, 364SG0600X, 364SH1100X, 364SH0200X, 364SW0102X, 364SA2100X, 364SC2300X
- Physician assistant (restricted to general, medical): 363A00000X, 363AM0700X

Health care provider taxonomy codes classified as specialty care:

- Allergy and immunology: 207K******
- Anesthesiology: 207L******
- Colon and rectal surgery: 208C00000X
- Dermatology: 207N******
- Emergency medicine: 207P******

- Family medicine (excludes those codes listed above in primary care): 207Q******
- Hospitalist: 208M00000X
- Internal medicine (excludes those codes listed above in primary care): 207R******
- Clinical genetics: 207SG0201X
- Neurological surgery: 207T00000X
- Nuclear medicine: 207U******
- Neuromusculoskeletal medicine and OMM: 204D00000X
- Neuromusculoskeletal medicine, sports medicine: 204C00000X
- Obstetrics and gynecology: 207V******
- Ophthalmology: 207W******
- Oral and maxillofacial surgery: 204E00000X
- Orthopedic surgery: 207X******
- Otolaryngology: 207Y******
- Physical medicine and rehabilitation: 2081******
- Plastic surgery: 2082******
- Preventive medicine (excludes those codes listed above in primary care): 2083******
- Psychiatry and neurology: 2084******
- Pain medicine: 208VP*****
- Radiology: 2085******
- Surgery: 2086******
- Thoracic surgery: 208G00000X
- Transplant surgery: 204F00000X
- Urology: 2088******
- Clinical neuropsychologist: 103G******
- Counselor: 101Y******
- Psychologist: 103T******
- Social worker: 1041******
- Chiropractor: 111N******
- Optometrist: 152W******
- Clinical nurse specialist (excludes those codes listed above in primary care): 364S******
- Nurse practitioner (excludes those codes listed above in primary care): 363L******
- Physician assistant (excludes those codes listed above in primary care): 363A******
- Podiatrist: 213E******

APPENDIX C: ED Indicator Procedure Codes for Minnesota Algorithm

	HCPCS_CD	CATEGORY	SHORT DESCRIPTION
1.	J0150	Drugs administered: antiarrhytmics	Injection, Adenosine For Therapeutic Use, 6 Mg
23.	J0282	Drugs administered: antiarrhytmics	Injection, Amiodarone Hydrochloride, 30 Mg
24.	J0295	Drugs administered: antibiotics	Injection, Ampicillin Sodium/Sulbactam Sodium, Per 1.5 Gm
25.	J0456	Drugs administered: antibiotics	Injection, Azithromycin, 500 Mg
26.	J0744	Drugs administered: antibiotics	Injection, Ciprofloxacin For Intravenous Infusion, 200 Mg
27.	J2280	Drugs administered: antibiotics	Injection, Moxifloxacin, 100 Mg
28.	J2543	Drugs administered: antibiotics	Injection, Piperacillin Sodium/Tazobactam Sodium, 1 Gram/0.125 Grams (1.125
29.	J1645	Drugs administered: anticoagulants	Injection, Dalteparin Sodium, Per 2500 Iu
30.	J1650	Drugs administered: anticoagulants	Injection, Enoxaparin Sodium, 10 Mg
31.	J0780	Drugs administered: antiemetics	Injection, Prochlorperazine, Up To 10 Mg
32.	J1790	Drugs administered: antiemetics	Injection, Droperidol, Up To 5 Mg
33.	J1170	Drugs administered: opioid analgesics	Injection, Hydromorphone, Up To 4 Mg
34.	J2270	Drugs administered: opioid analgesics	Injection, Morphine Sulfate, Up To 10 Mg
35.	J2275	Drugs administered: opioid analgesics	Injection, Morphine Sulfate (Preservative--Free Sterile Solution), Per 10 Mg
36.	J3010	Drugs administered: opioid analgesics	Injection, Fentanyl Citrate, 0.1 Mg
37.	J0171	Drugs administered: other drug types	Injection, Adrenalin, Epinephrine, 0.1 Mg
38.	J0330	Drugs administered: other drug types	Injection, Succinylcholine Chloride, Up To 20 Mg
39.	J0360	Drugs administered: other drug types	Injection, Hydralazine Hcl, Up To 20 Mg
40.	J1265	Drugs administered: other drug types	Injection, Dopamine Hcl, 40 Mg
41.	J1610	Drugs administered: other drug types	Injection, Glucagon Hydrochloride, Per 1 Mg

42.	J1630	Drugs administered: other drug types	Injection, Haloperidol, Up To 5 Mg
43.	J2310	Drugs administered: other drug types	Injection, Naloxone Hydrochloride, Per 1 Mg
44.	J2370	Drugs administered: other drug types	Injection, Phenylephrine Hcl, Up To 1 Ml
45.	J2710	Drugs administered: other drug types	Injection, Neostigmine Methylsulfate, Up To 0.5 Mg
46.	J2765	Drugs administered: other drug types	Injection, Metoclopramide Hcl, Up To 10 Mg
47.	J3430	Drugs administered: other drug types	Injection, Phytonadione (Vitamin K), Per 1 Mg
48.	80100	Laboratory tests	Drug Scr Qual Mlt Drug Classes Chrom Ea Px
49.	80196	Laboratory tests	Salicylate
50.	82003	Laboratory tests	Acetaminophen
51.	82009	Laboratory tests	Acetone/Oth Ketone Bodies Serum Qual
52.	82010	Laboratory tests	Acetone/Oth Ketone Bodies Serum Quan
53.	82140	Laboratory tests	Ammonia
54.	82553	Laboratory tests	Creatine Kinase Mb Fxj Only
55.	82803	Laboratory tests	Gases Bld Ph Calculated O2 Saturation
56.	82805	Laboratory tests	Gases Bld Ph Dir Meas Xcpt Pls Oximtry
57.	83605	Laboratory tests	Lactate
58.	83874	Laboratory tests	Myoglobin
59.	84145	Laboratory tests	Assay Of Procalcitonin
60.	84484	Laboratory tests	Troponin Quan
61.	84512	Laboratory tests	Troponin Qual
62.	85378	Laboratory tests	Fibrin Dgradj Produxs D--□Dimer Qual/Semiquan
63.	85379	Laboratory tests	Fibrin Dgradj Produxs D--□Dimer Quan
64.	85380	Laboratory tests	Fibrin Dgradj Produxs D--□Dimer Ultrsens
65.	90945	Other diagnostic and therapeutic procedures	Dial Oth/Thn Hemo 1 Phys Eval
66.	L1830	Other diagnostic and therapeutic procedures	Knee Orthosis, Immobilizer, Canvas Longitudinal, Prefabricated, Includes Fitting and Adjustment
67.	92950	Other diagnostic and therapeutic procedures	Cardiopulm Resuscitation
68.	31500	Other diagnostic and therapeutic procedures	Intubation Endotracheal Emergency Procedure
69.	36430	Other diagnostic and therapeutic procedures	Transfusion Bld/Bld Components

70.	36556	Other diagnostic and therapeutic procedures	Insj Non--□Tun Ctr Cvc Age 5 Yr/>
71.	36569	Other diagnostic and therapeutic procedures	Insj Prph Cvc W/O Subq Port/Pmp Age 5 Yr/>
72.	43247	Other diagnostic and therapeutic procedures	Stomach--□Intestine Scope For Foreign Body Removal
73.	49465	Other diagnostic and therapeutic procedures	Contrast Injection Perq Radiologic Eval Gi Tube
74.	62270	Other diagnostic and therapeutic procedures	Spi Pnxr Lmbr Dx
75.	G0257	Other diagnostic and therapeutic procedures	Unscheduled Or Emergency Dialysis Treatment For An Esrd Patient In A Hospital
76.	A9540	Radiology and related	Technetium Tc--□99M Macroaggregated Albumin, Diagnostic, Per Study Dose, Up To 10
77.	A9558	Radiology and related	Xenon Xe--□133 Gas, Diagnostic, Per 10 Millicuries
78.	70160	Radiology and related	Radex Nsl B1S Compl Minimum 3 Views
79.	70450	Radiology and related	Ct Head/Brn C--□Matrl
80.	70487	Radiology and related	Ct Maxlfcl Area C+ Matrl
81.	70496	Radiology and related	Ct Angiography Head W/Contrast/Noncontrast
82.	70498	Radiology and related	Ct Angiography Neck W/Contrast/Noncontrast
83.	70549	Radiology and related	Mra Nck C--□/C+
84.	71010	Radiology and related	Radex Ch 1 View Frnt
85.	71275	Radiology and related	Ct Angiography Chest W/Contrast/Noncontrast
86.	72125	Radiology and related	Ct Crv Spi C--□Matrl
87.	74010	Radiology and related	Radex Abd Anteropost&Addl Oblq&Cone Views
88.	74022	Radiology and related	Radex Abd Compl Aqt Abd W/S/E/D Views 1 View Ch
89.	78582	Radiology and related	Pulmonary Ventilation (Eg, Aerosol Or Gas) And Perfusion Imaging
90.	78585	Radiology and related	Pulm Pi Part Vntj Rbrthing&Wshot +--□1 Brth
91.	78588	Radiology and related	Pulm Pi Part Vntj Img Aersl 1/Mlt Prjcj
92.	Q9963	Radiology and related	High Osmolar Contrast Material, 350--□399 Mg/Ml Iodine Concentration, Per Ml
93.	Q9965	Radiology and related	Low Osmolar Contrast Material, 100--□199 Mg/Ml Iodine Concentration, Per Ml

94.	94002	Respiratory services	Ventilation Assist & Mgmt Inpatient 1St Day
95.	94644	Respiratory services	Continuous Inhalation Treatment 1St Hr
96.	94660	Respiratory services	Cpap Vntj Cpap Initiation&Mgmt
97.	21800	Treatment of fractures and dislocations	Closed Tx Rib Fracture Uncomplicated Each
98.	23650	Treatment of fractures and dislocations	Clsd Tx Shoulder Dislc W/Manipulation W/O Anes
99.	25605	Treatment of fractures and dislocations	Cltx Dstl Rdl Fx/Epiphysl Sep +--□ W/Mnpj
100.	27265	Treatment of fractures and dislocations	Cltx Post Hip Arthrp Dislc W/O Anes
101.	29505	Treatment of fractures and dislocations	Application Long Leg Splint Thigh Ankle/Toes
102.	12004	Wound repair/suturing	Simple Rpr Scalp/Neck/Ax/Genit/Trunk 7.6--□ 12.5Cm
103.	12005	Wound repair/suturing	Smpl Rpr Scalp/Neck/Ax/Genit/Trunk 12.6--□ 20.0Cm
104.	12006	Wound repair/suturing	Smpl Rpr Scalp/Neck/Ax/Genit/Trunk 20.1--□ 30.0Cm
105.	12007	Wound repair/suturing	Simple Repair Scalp/Neck/Ax/Genit/Trunk >30.0Cm
106.	12011	Wound repair/suturing	Simple Repair F/E/E/N/L/M 2.5Cm/<
107.	12013	Wound repair/suturing	Simple Repair F/E/E/N/L/M 2.6Cm--□5.0Cm
108.	12014	Wound repair/suturing	Simple Repair F/E/E/N/L/M 5.1Cm--□7.5Cm
109.	12015	Wound repair/suturing	Simple Repair F/E/E/N/L/M 7.6Cm--□12.5Cm
110.	12016	Wound repair/suturing	Simple Repair F/E/E/N/L/M 12.6Cm--□20.0Cm
111.	12017	Wound repair/suturing	Simple Repair F/E/E/N/L/M 20.1Cm--□30.0Cm
112.	12018	Wound repair/suturing	Simple Repair F/E/E/N/L/M >30.0Cm
113.	12034	Wound repair/suturing	Repair Intermediate S/A/T/E 7.6--□ 12.5 Cm
114.	12035	Wound repair/suturing	Repair Intermediate S/A/T/E 12.6--□ 20.0Cm
115.	12036	Wound repair/suturing	Repair Intermediate S/A/T/E 20.1--□ 30.0 Cm
116.	12037	Wound repair/suturing	Repair Intermediate S/A/T/E > 30.0 Cm
117.	12044	Wound repair/suturing	Repair Intermediate N/H/F/Xtrnl Gent 7.6--□12.5Cm

118.	12045	Wound repair/suturing	Repair Intermediate N/H/F/Xtrnl Gent 12.6--□20 Cm
119.	12046	Wound repair/suturing	Rpr Intermediate N/H/F/Xtrnl Gent 20.1--□30.0 Cm
120.	12047	Wound repair/suturing	Repair Intermediate N/H/F/Xtrnl Gent >30.0 Cm
121.	12051	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc 2.5 Cm/<
122.	12052	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc 2.6--□5.0 Cm
123.	12053	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc 5.1--□7.5 Cm
124.	12054	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc 7.6--□12.5 Cm
125.	12055	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc 12.6--□20.0Cm
126.	12056	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc 20.1--□30.0Cm
127.	12057	Wound repair/suturing	Repair Intermediate F/E/E/N/L/M&/Muc > 30.0 Cm
128.	13100	Wound repair/suturing	Repair Complex Trunk 1.1 Cm--□2.5 Cm
129.	13101	Wound repair/suturing	Repair Complex Trunk 2.6 Cm--□7.5 Cm
130.	13102	Wound repair/suturing	Repair Complex Trunk Ea 5 Cm/<
131.	13120	Wound repair/suturing	Repair Complex Scalp/Arm/Leg 1.1 Cm--□2.5 Cm
132.	13121	Wound repair/suturing	Repair Complex Scalp/Arm/Leg 2.6 Cm--□7.5 Cm
133.	13122	Wound repair/suturing	Repair Complex Scalp/Arm/Leg Ea 5 Cm/<
134.	13131	Wound repair/suturing	Repair Complex F/C/C/M/N/Ax/G/H/F 1.1 Cm--□2.5 Cm
135.	13132	Wound repair/suturing	Repair Complex F/C/C/M/N/Ax/G/H/F 2.6 Cm--□7.5 Cm
136.	13133	Wound repair/suturing	Repair Complex F/C/C/M/N/Ax/G/H/F Ea 5 Cm/<
137.	13150	Wound repair/suturing	Repair Complex Eyelid/Nose/Ear/Lip 1.0 Cm/<
138.	13151	Wound repair/suturing	Repair Complex Eyelid/Nose/Ear/Lip 1.1--□2.5 Cm
139.	13152	Wound repair/suturing	Repair Complex Eyelid/Nose/Ear/Lip 2.6--□7.5 Cm
140.	13153	Wound repair/suturing	Repair Complex Eyelid/Nose/Ear/Lip Ea 5 Cm/<
141.	G0168	Wound repair/suturing	Wound Closure Utilizing Tissue Adhesive Only

APPENDIX D: SUPPLEMENTARY TABLES

Supplementary Table 1: Multivariate step-wise linear regression models predicting # unmet needs

	sSDH **(model 1)**	**sSDH+iSDH** **(model 2)**	**Clinical determi-nants** **(model 3)**	**all SDH and clinical determi-nants (model 4)**
Age (Continuous)	-0.03	-0.03*	-0.00	-0.02
Gender (Ref. Female)	1.30**	0.93*	1.05*	0.93*
Education (Highschool Attainment)	-1.65***	-0.70		-0.67
Currently Employed	-1.91***	-0.94		-0.72
Income (Ref. <$100)				
Refused/Don't Know	-1.00	-1.58*		-1.43*
$100 - $499	-0.75	-1.00		-0.92
$500-$999	-1.34*	-2.03**		-1.92**
$1000- More	-2.05**	-1.59*		-1.73*
Access to food and shelter				
Food insecure only		4.74***		4.36***
Homeless only		3.70***		3.32***
Food insecure and homeless		3.48***		3.12***
Social Support (Continuous, 0-3)		-0.97***		-0.88***
Children		0.34		0.31
Access to public benefits				
Cash only		0.82		0.86
Non-cash only		0.84		0.60
Both cash and non-cash benefits		1.68**		1.41*
Physical Illness Severity (CDPS Score Quartiles) Ref: Low Risk Score				
Moderate			0.38	0.45
High			0.14	0.34
Severe			-0.51	-0.06
Behavioral Health Status				
Substance abuse only			0.14	-0.60
Mental illness only			2.64***	1.22*
Both			3.87***	1.58**
Regular Source Of Care (Ref. None)				
Sw Only			-0.08	0.18
Reg Doc Only			-1.64**	-0.04
Doc+Sw			-0.74	-0.06
Medicaid Plan Type (Ref FFS)			0.07	0.42
Constant	7.91***	7.51***	3.11*	5.46***

Supplementary Table 2: Polychoric correlation matrix to assess correlations between independent variables

	Care Continuity	Physical illness severity	Behavioral Health	Regular provider	High School attainment	Currently employed	Income	Access to food and shelter	Social support	Public Assistance
Care Continuity	1									
Physical illness severity	0.11	1								
Behavioral Health	-0.04	0.36	1							
Regular provider	0.15	0.13	0.27	1						
High School attainment	0.08	-010	-0.31	-0.32	1					
Currently employed	0.05	-0.34	-0.43	-0.18	0.40	1				
Income	-0.00	-0.01	-0.06	0.05	0.10	0.28	1			
Access to food and shelter	-0.12	0.14	0.47	0.03	-0.30	-0.31	-0.15	1		
Social support	0.11	-0.04	-0.28	0.06	0.14	0.23	0.14	-0.14	1	
Public assistance	0.02	0.27	0.32	0.22	-0.28	-0.52	0.07	0.22	-0.15	1

Supplementary Table 3: The Marginal Effect of CC and Physical Illness Severity Upon ED Utilization

	Total ED visits		**Preventable ED Visits**	
Physical illness severity # CC	Marginal Effects	95% CI	Marginal Effects	95% CI
1#Unassessed	14.3***	12.3, 16.2	4.1***	3.2, 5.0
1#Low	15.1***	13.0, 17.2	4.3***	3.3, 5.4
1#Moderate	11.1***	9.5, 12.7	3.1***	2.3, 3.9
1#High	12.8***	10.9, 14.7	4.0***	3.0, 5.0
2# Unassessed	29.3***	20.7, 37.9	4.9***	2.7, 7.1
2#Low	21.3***	16.3, 26.3	4.9***	2.9, 6.9
2#Moderate	13.7***	10.0, 17.4	2.0***	1.1, 3.0
2#High	14.1***	9.3, 18.8	2.8***	1.2, 4.4
3#Unassessed	60.2***	30.1, 90.3	5.9**	1.5, 10.2
3#Low	30.1***	17.8, 42.5	5.5**	1.7, 9.3
3#Moderate	16.9***	9.0, 24.8	1.3*	0.3, 2.4
3#High	15.5***	6.2, 24.8	2.0	0.0, 4.0
4#Unassessed	123.7**	35.5, 211.9	7.0	-0.4, 14.4
4#Low	42.6**	17.1, 68.1	6.2*	0.0, 12.4
4#Moderate	20.8**	6.7, 34.9	0.9	-0.1, 1.9
4#High	17.0*	2.2, 31.8	1.4	-0.7, 3.4
5#Unassessed	254.2*	18.2, 490.1	8.3	-3.2, 19.9
5#Low	60.2*	12.7, 107.7	7.0	-2.2, 16.1
5#Moderate	25.6*	2.7, 48.5	0.6	-0.3, 1.4
5#High	18.7	-2.7, 40.1	1.0	-0.9, 2.9

Physical illness severity levels and corresponding CDPS risk scores:
1 = 5, 2=10, 3=15, 4=20, 5=25

Supplementary Table 4: Correlation between different Domains of Unmet Needs

	Material Resource	HCML	Family	Employment
Material Resource	1.0			
HCML	0.34	1.0		
Family	0.17	0.14	1.0	
Employment	0.32	0.28	0.20	1.0

Supplementary Table 5: Bivariate Relationship between CC and other independent variables.

	Care Continuity			
Other Independent Variables	**Unassessed**	**Low**	**Moderate**	**High**
Education at least high school				
No	37.50	29.09	23.64	35.19
Yes	62.50	70.91	76.36	64.81
Homeless**				
No	71.33	87.27	82.88	79.63
Yes	28.67	12.73	17.12	20.37
Food insecurity**				
No	70.63	86.36	83.64	77.57
Yes	29.37	13.64	16.36	22.43
Access to food and shelter**				
Adequate	56.34	78.18	77.27	66.36
Food insecure only	14.79	9.09	5.45	13.08
Homeless only	14.08	8.18	6.36	11.21
Both	14.79	4.55	10.91	9.35
Social Support**				
None	25.00	13.08	10.00	12.26
Low	10.71	12.15	11.82	14.15
Moderate	25.00	35.51	21.82	30.19
High	39.29	39.25	56.36	43.40
Physical illness severity *				
Low	35.17	15.45	22.52	24.07
Moderate	25.52	28.18	24.32	21.30
High	21.38	23.64	25.23	31.48
Severe	17.93	32.73	27.93	23.15
Behavioral Health				
Good	24.83	33.64	34.23	29.63
Only Substance Abuse	8.28	6.36	6.31	10.19
Only psychiatric illness	26.90	23.64	28.83	19.44
Both	40.00	36.36	30.63	40.74

Supplementary Table 6: Aim 3 Multivariate Stepwise Logistic Regression Results using CC for 1st lookback period

	Odds Ratios of Persistent Utilization of ED				
	(1)	(2)	(3)	(4)	(5)
Age	0.98	0.98*	0.97	0.97**	0.97***
GENDER (Ref. Female)	1.10	1.14	0.83	0.87	0.93
EDUCATION (Highschool Attainment, Ref. No)	0.63	0.69		0.64	0.67
Duration of Unemployment (Ref=0, currently employed)					
1 month – 2 yr	1.21	0.93		1.11	0.92
> 2 yrs	1.75*	1.19		1.38	1.10
Cumulative homelessness (Ref. No)	1.88**	1.71*		1.64*	1.58
Social Support (0-3)	0.88	0.88		0.90	0.90
Access to Public Benefits (Ref. none)					
Cash assistance only		4.94***			3.59*
Non-cash assistance only		2.65**			2.46**
Both cash and non-cash assistance		3.20***			2.49*
Physical Illness Severity (CDPS Score Quartiles) (Ref: Low Risk Score)					
Moderate			2.31**	2.16*	2.07*
High			2.47**	2.60**	2.55**
Severe			3.42***	3.82**	3.63***
Behavioral Health Status (Ref. No mental illness, no substance abuse)					
Substance abuse only			1.96	1.49	1.36
Mental illness only			1.61	1.30	1.31
Both			2.73***	1.90*	1.77
Care Continuity – 1st. yr lookback (Ref: High)					
Unassessed			1.12	1.08	1.06
Low			1.04	1.07	1.06
Moderate			0.57	0.62	0.62
Regular Source Of Care (Ref. none)					
SW Only			0.63	0.63	0.58
Reg Doc Only			0.81	1.01	1.03
Doc+SW			0.64	0.65	0.62
Medicaid MCO Plan (Ref: FFS)			0.62*	0.75	0.87

Significance levels: *** p<0.001, **p<0.01, *p<0.05