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James L. Rudolph, MD, SM

The Intersection of Aging and Social Determinants of Health (SDoH)

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As a geriatrician, I have the privilege of caring for older individuals, whose health has been impacted by a combination of genetic influences, environmental factors, and social determinants. While broad conditions, such as social determinants, are out of the control of myself or my patients, I have a responsibility to assess, intervene and improve function whenever possible – including on people's social needs. Preserved function and resilience are critical to overcoming the increasing burden of disease and mortality with age. As individuals age, they are less able to respond to the stress of the social determinants. The combination of the aging process and social determinants can result in negative outcomes such as premature mortality, additional comorbidity, social isolation, and suffering.

Social frailty

The intent of the compilation in this issue of the *Rhode Island Medical Journal* is to further define the concepts that will empower additional research by examining the intersection of social determinants and aging. One example of this is social frailty, presented in "**The Intersection of Physical and Social Frailty in Older Adults,**" by Quach, et al**.** In its most basic definition, frailty is a decreased resilience to stressors. The past two decades have built a literature and the supporting science around physical frailty – the decreased ability to return to physical function after stress such as acute illness, cognitive decline, or death of a caregiver. Our clinical experience is that physical frailty is exacerbated by social frailty. For instance, the location of hospital discharge is often dictated by the availability of social supports.

Dementia/homelessness

Dementia is an example of a medical condition where social need is heightened, as examined in "**Incidence of Homelessness among Veterans Newly Diagnosed with Alzheimer's Disease and Related Dementias,**" by Jutkowitz, et al. Cognitive decline limits the ability to complete tasks that are essential to self-care and navigating daily life. Caregivers of individuals experiencing dementia are likely to report more depression, anxiety, poor health maintenance, reduced quality of life, and burnout. When a caregiver becomes overwhelmed by the needs of the individual, the outcome is often placement in a facility. However, in cases of limited social support (social frailty), the disease can further disintegrate and disenfranchise tenuous bonds resulting in outcomes such as housing instability and homelessness for the person who is cognitively impaired.

Food insecurity

Food insecurity, or the inability to obtain adequate food, is particularly dangerous for older adults who may be taking medications or have health conditions that require specific nutritional intake. For older adults with physical or cognitive impairments, particularly those lacking social support, it can be an insurmountable challenge to overcome the transportation, planning, and preparation required to meet nutritional needs. This inability often results in a worsening of health outcomes. While community programs such as Meals on Wheels exist, accessibility is location dependent, coverage in rural areas is sparse, providers must possess awareness of these resources, and the referral process must be completed. "**An Exploratory Framework to Interpret County-Level Indicators of Food Insecurity,**" by Tucher, et al combines multiple data sources to index food insecurity.

Home-based primary care

Similar to the food insecurity framework, the area deprivation index (ADI) provides important insights into who is being served through home-based services within the VA. The ADI is a relatively new tool to identify neighborhood income, which can then be used to examine components of healthcare within that region. By comparing service delivery, health systems can examine how the biases of income may influence access to care. For example, in the presented analysis, "**Association of Home-Based Primary Care Enrollment with Social Determinants of Health for Older Veterans,**" by Montano, et al shows that individuals experiencing homelessness were less likely to get home-based primary care, but the program does not enroll individuals without a home. However, those with housing instability were five times more likely to receive home-based services. This finding suggests that housing is a logistical challenge, but the system is adapting to the needs of those with marginal stability.

Measures such as the area deprivation index provide important information when providing care for older adults, but additional factors also need to be considered. The impact

of social frailty on health outcomes for older adults in relation to race and ethnicity is beyond the scope of this paper and is a critical area for future research.

The complexities of social determinants are unique to each individual. One measurement system, one social need, or one survey will not present a comprehensive picture of all social determinants. As clinicians our responsibility is to mitigate disease, improve function, and reduce suffering while trying to understand the factors that influence the well-being of our patients beyond the walls of the clinic.

Guest editor

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The Intersection of Physical and Social Frailty in Older Adults

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ABSTRACT

Frailty, a vulnerability to stressors, has been increasingly woven into the clinical understanding of older people who are unable to respond to the impact of diseases, disability, and age-related decline. While the literature has focused on physical frailty, social frailty has been conceptualized within the domains of social needs (social and emotional support, loneliness), resources (income, food, housing, medical care, etc), social fulfillment (engagement in work and activities), and self-management (cognitive function, mental health, advance planning). This review outlines the assessment of the four domains of social frailty within the structure of clinical visits, particularly annual wellness and advance care planning. Increasing connectivity with the community, health system, and government support is the primary recommended intervention. On a policy level, expanding opportunities to connect socially frail people with resources may help mitigate the vulnerability of physical frailty.

KEYWORDS: frailty, physical frailty, social frailty

INTRODUCTION

Frailty decreases resiliency and reserves, which renders people vulnerable to the stress of disease, disability, or social change. Physical frailty has dominated medical literature for the past 20 years. With prevalence estimates of up to 45% among adults 85 years or older,[1] physical frailty increases the risk of low functional status, hospitalization, and mortality.[2] Despite its high prevalence, physical frailty is not a normal process of aging, and many have postulated that frailty can be prevented or treated.[3]

Over the past two decades, physical frailty measurements have emerged: 1) the clinically favorable frailty phenotype and 2) the data-focused frailty index (accumulation of deficits). The phenotype of frailty by Fried et al. (2001) includes five criteria: weight loss, reduced activities, grip strength, gait speed, and exhaustion. Clinically, the objective measurement of the frailty phenotype is possible within the context of an office visit and is billable, starting in 2021, with the R54 ICD-10 code. In contrast, the frailty index presents a model of deficit accumulation.[4] With the breadth of comorbidities, disabilities, and age-related decline, each additional deficit results in the patient being less able to rebound from stressors. For example, a patient with many comorbidities, including dementia, is going to be less able to rebound from the stress of acute hospitalization. Frailty indexes incorporate clinical information, such as that from an assessment of function, cognition, depression, physical ability, and comorbidities. For clinicians with access to electronic medical record data, the frailty index can be calculated with fields completed in the course of clinical care.

The social frailty gap

In examining the fundamental definition of frailty – a decrease in resiliency and reserves, clinicians invariably recognize that numerous social factors beyond those contributing to the phenotype of frailty index definitions play a substantial role in patient function. For example, if a person lacks financial resources for food (a socially-anchored process), solely capturing strength loss in the physical frailty phenotype does not account for social factors that may be largely responsible for frailty in nonphysical domain. Thus, there is a gap in the narrow definitions of physical frailty that does not include the broader perspective of social frailty – a gap that has clear ramifications for improving patient care, and even potentially mitigating negative outcomes. Therefore, social frailty should be considered in concert with broader frailty definition. Social frailty has been defined as a progressive loss of resources, activities, or the ability to participate in social activities to fulfill basic social needs.[5]

Social frailty often manifests with clinical stressors such as the response to a new diagnosis or acute hospitalization, when the system supporting the patient may get overwhelmed or break down. Other symptoms of social frailty include limited social support, a smaller social network, poor living conditions, fewer socially-oriented leisure activities, and risk of losing resources.[5] Other features may include unhealthy social behaviors (lack of physical exercise, poor diet, alcohol use, and smoking), social isolation, and loneliness.[5] Social frailty is a broad but highly medically relevant construct. Yet, clinical tools for identifying social frailty remain elusive.

The purpose of this article is to describe the intersection of physical frailty and social frailty and utilize existing social frailty literature to describe a framework for building a clinical checklist of social frailty.

The social frailty framework: measurement and integration into care and treatment

Figure 1 highlights the intersection of physical and social frailty. This intersection is influenced by biological, psychological, social, and environmental factors. Prior systematic reviews of social frailty have developed a framework of four social frailty domains[5] including 1) social needs; 2) general resources; 3) social fulfillment; and 4) self-management to provide a more comprehensive view of the system supporting people living with frailty. Social needs encompass social and emotional support. General resources include life essentials such as housing, food, water, air, and income. Social fulfillment describes a person's ability to interact and engage in activities that allow survival and thriving. Self-management is the autonomous component of social frailty that includes self-determination and motivation necessary to achieve equilibrium among the other social frailty domains and potentially avoid physical frailty.

This conceptual framework of social frailty is based on a combination of different theories including: 1) Loneliness Theory,[6] which refers to an individuals' social network and relationships being less satisfactory than expected; 2) The convoy theory of social relations,[7] which refers to individuals receiving social support throughout their life by members of their cohort; 3) Self Determination Theory,[8] which refers to the status of motivation or autonomy and control, and 4) Social Production Functions Theory,[9] which refers to individuals who maximize their psychological and environmental factors or resources for physical and social well-being.

Table 1 describes the relationship between social frailty domains and physical frailty. An analysis conducted by Woo et al. in 2005 found that increasing social support was associated with lower frailty.[10] Weight loss from physical frailty phenotype, has been associated with the resource domain of social frailty (occupation, race, gender, and educational level, neighborhood deprivation, and individual socioeconomic status).[5,11] The social fulfillment domain highlights that components of frailty such as exhaustion can be associated with depression and slow gait speed leading to reduced social engagement.[5,10] Similarly, the self-management domain has a strong relationship with cognitive function and can be associated with weakness, resulting from reduced exercise and poor disease management among people with cognitive impairment.[5,11]

Figure 1. Frailty and social frailty framework

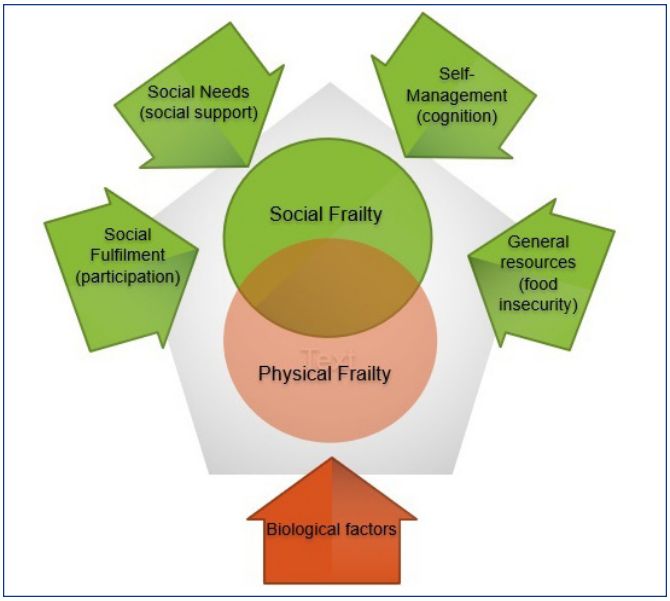

Table 1. The relationship between social frailty and physical frailty domains, along with clinical examples.

Social Frailty Domains	Connection to Physical Frailty Domains	Clinical Example(s)
Social Needs	Weakness/decreased grip strength	Lack of emotional and social support for daily activities
General Resources	Weight loss	Food insecurity results in food vs. housing decision, with housing taking precedence
Social Fulfillment	Exhaustion Slow gait speed	Depression leads to reduced social engagement and social participation
Self-management	Physical activities	Cognitive impairment results in reduced exercise and disease management leading to further sarcopenia

Clinical recommendations for integrating frailty and social frailty into treatment

Incorporation of yet another assessment into an already busy clinical practice has potential to benefit patients with physical frailty, but should be accomplished with an eye toward minimizing additional clinical burden. There are components of social frailty that could be built into pre-visit assessments, annual wellness visits, advance care planning, or pre-procedure shared decision making. The purpose would be to facilitate clinical responses when stressors affect the social infrastructure of a patient, rather than simply rote completion of assessment fields. This approach emphasizes that medicine is within the control of the provider.

Table 2 presents a framework for a social frailty checklist with example measures based on a multi-component model of social frailty that includes social isolation, loneliness (social needs), social exercise and participation (social fulfillment), housing, food (resources), behavior, and motivation (self-management). The checklist identifies key elements of social frailty (but is not comprehensive), assessments of the element, and clinical opportunities to complete the assessment. This checklist may assist providers and multidisciplinary teams in coordinating evaluation at the early stages of frailty or addressing frailty in older adults.

Table 2. Social frailty checklist

Domain	Element	Assessment	Clinical Assessment Timing
Social Needs	Social Supports	Perceived support when needed[12]	Demographic information
	Loneliness	UCLA loneliness[13]	Annual Wellness
General Resources	Food Security	Not able to afford the food in household in the last 12 months[14]	Annual Wellness
	Housing Security	Have any housing problems[11]	Annual Wellness
	Elder Abuse	Neglect, physical abuse, psychological abuse, financial abuse[15]	Annual Wellness
	Discrimination	Perceived Discrimination Scale[16]	Annual Wellness
Social Fulfillment	Leisure time activities	IADLs[17] Internet accessibility	Introduction to Medicare visit/ Annual Wellness
	Mental Health	PHQ-9[18]	Annual Wellness
Self-management	Cognitive Function	See AA Cog screening[19]	Annual Wellness
	Care Planning	Physical exercise and Physical Activity Scale for the Elderly (PASE)[20] Health care proxy; and instruction directives[21] (types of treatment do not want if facing a medical crisis)	Advance Care Planning

Clinical research directions

While the physical frailty phenotype has dominated the medical literature, the study of social frailty is less developed.[4] The demonstrated association of physical frailty and adverse health outcomes with biological underpinnings strongly suggests that the conceptualizations of physical frailty are appropriate. However, the lack of incorporation of social domains suggests that the overall concept of frailty needs reconsideration. Recent research has systematically examined the association of physical frailty with elements of social frailty domains.[11] Additional work is needed to target interventions in social frailty domains using existing infrastructure (e.g., meals on wheels, home, and community-based services, etc.) to determine if modifying social frailty can impact physical frailty. While pharmaceuticals may address biological deficits, larger-scale interventions are necessary to influence social determinants. Fortunately, social support programs could permit or encourage such interventions (e.g., Meals on Wheels, Program of All-Inclusive Care of the Elderly, VA Homeless Programs, State Medicaid home, and community-based services, etc.). Finally, the breadth of social frailty is beyond the ability of a single provider to overcome all aspects. As a result, physicians, providers, researchers, and policymakers should collaborate to find innovations to social frailty that span health systems, social support agencies, and government services.

CONCLUSIONS

Social frailty contributes to reduced resiliency and ability to maintain independence. Using a literature-based conceptual model of social frailty, this manuscript identifies potential opportunities to assess social frailty. Because there is clear overlap between physical and social frailty, integrating a broader and socially-sensitive view of frailty into medical practice may be useful to identify factors that could impact frailty (both physical and social) and maybe amenable to interventions to improve patient outcomes.

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Incidence of Homelessness among Veterans Newly Diagnosed with Alzheimer's Disease and Related Dementias

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ABSTRACT

BACKGROUND: To determine the incidence of homelessness among Veterans diagnosed with Alzheimer's disease and related dementias (ADRD).

METHODS: We used Veterans Affairs (VA) administrative records to identify Veterans with a new ADRD diagnosis anytime between 2010-2019. Among these Veterans, we calculated the incidence of homelessness, and estimated the association between demographics, comorbidities and hazard of homelessness.

RESULTS: The incidence rate of homelessness was highest for Veterans diagnosed with ADRD between 18–49 years of age (14.9 per 1,000 person-years; 95%CI: 13.6, 16.3) and lowest for Veterans diagnosed with ADRD at 90+ years (0.3 per 1,000 person-years; 95%CI: 0.2, 0.4). The adjusted hazard ratio of homelessness was higher for unmarried Veterans, and those with alcohol use disorder, substance use disorder, liver disease, depression, hypertension, lung disease, post-traumatic stress disorder and psychoses.

CONCLUSIONS: Younger age and being unmarried at the time of ADRD diagnosis are associated with a greater risk of experiencing homelessness.

KEYWORDS: housing insecurity, veterans, dementia, ADRD

INTRODUCTION

In 2019 approximately 37,085 Veterans in the US experienced homelessness, which is almost 50% less than the 73,362 Veterans who experienced homelessness in 2009.[1] The reduction in homelessness among Veterans is credited to US Department of Veterans Affairs' (VA) investments in outreach, supportive housing, and specialized clinical services.[2,3] Although the VA has made substantial progress in reducing homelessness, Veterans remain overrepresented among the US homeless population.[4] Homelessness continues to be a costly public health challenge that is associated with poor health outcomes and mortality.[5–7] In addition, the homeless Veteran population is aging,[8,9] which presents new challenges to manage the long-term care needs of housing insecure Veterans.

VA providers proactively screen and document Veterans' housing status in their medical record;[10] however, there is still much unknown about the factors affecting homelessness among Veterans. One study found that 3.7% of Veterans experienced a homeless episode within 5 years of military discharge.[11] Younger age, lower military pay grade, and a mental health condition (including substance disorder) or traumatic brain injury documented at the time of discharge were associated with an increased risk of experiencing homelessness. Another study found that the one-year incidence of homelessness among Veterans referred to specialty mental health care was highest (9.3%) for Veterans between 46-55 years of age.[12] This group's largest risk factors for homelessness was a diagnosed substance use disorder and not being married. Work to further understand Veteran circumstances and populations most at-risk of experiencing homelessness can inform the targeting of resources.

Many of the risk factors for homelessness are also risk factors for Alzheimer's disease and related dementias (ADRD).[4,11,13] For example, low-socioeconomic status, traumatic brain injury, post-traumatic stress disorder, and substance use are highly correlated with homelessness and ADRD.[13] Furthermore, Black, indigenous, and persons of color are over-represented in both homeless and ADRD populations.[14,15] In certain circumstances ADRD may be a risk factor for homelessness. People living with ADRD experience losses in cognition and functional independence.[16] Family caregivers may need to help manage finances and assist with bathing, dressing, and toileting.[17] Without a family caregiver, people living with ADRD may be unable to live safely in the community, navigate their care needs, and manage their finances. These factors may increase their risk of becoming homeless.

We used VA data to provide the first estimates on the risk of Veterans newly diagnosed with ADRD subsequently experiencing homelessness. We expected that age of ADRD diagnosis is inversely associated with incidence of homelessness. Consistent with prior studies, we also expected that Veterans unmarried at the time of their ADRD diagnosis, or those with a diagnosis for alcohol use disorder, substance use disorder, psychoses, post-traumatic stress disorder, or traumatic brain injury are at a greater risk of eventually experiencing homelessness.

METHODS

Data

We used the U.S. Department of Veterans Affairs (VA) Corporate Data Warehouse and the Medicare Chronic Conditions ADRD algorithm (See **Appendix 1**, at end, for list of ADRD ICD-9/10 codes) to identify whether a Veteran ever received an ADRD diagnosis between 2010 and 2019. The VA Corporate Data Warehouse includes encounter coded diagnoses by VA providers and from contracted community providers. The first occurrence of an ADRD diagnosis served as the cohort entry or index date. We followed Veterans after their first ADRD diagnosis to determine whether they ever received a diagnosis for homelessness, died (either before or after a homeless diagnosis), or survived the entire follow-up period with or without a homeless diagnosis. We excluded Veterans who ever had a homeless diagnosis before an ADRD diagnosis and Veterans <18 years of age. We used ICD9 (V60.0) and ICD10 (Z59.0) codes ("Homelessness") to determine a Veteran's housing status (1 = ever homeless in the follow up period; 0 = never homeless in the follow up period).

Demographic Characteristics and Comorbidities at Time of ADRD Diagnosis

We determined the age, sex, race, marital status, degree of service-connected disability (Priority 1 or other), prior combat service, and rural or urban residential area of Veterans at the time of cohort entry. Service-connected disability determines a Veteran's eligibility for VA paid long-term care and disability pension. At cohort entry, we also determined whether a Veteran had a diagnosis in the previous year for comorbidities associated with ADRD and homelessness including alcohol dependence, substance abuse, rheumatic disease, kidney disease, liver disease, depression, diabetes, hypertension, congestive heart failure, lung disease, stroke, post-traumatic stress disorder, schizophrenia/psychosis, or traumatic brain injury.

Statistical Analysis

We calculated descriptive characteristics of the sample at cohort entry, and we compared the demographic characteristics of Veterans who experienced homelessness after an ADRD diagnosis to those who remained stably housed using χ^2 and *t* tests. We calculated the crude incidence rate of homelessness by age of ADRD diagnosis (18–49 years, 50-59 years, 60–69 years, 70–79 years, 80–89 years, 90+ years) per 1,000 person-years. To estimate incidence rates, we calculated the denominator as the number of person-years from cohort entry until a Veteran received a homeless ICD-9/10 code (event of interest), death (prior to a homeless ICD-9/10 code), or reached the end of the follow-up period. The numerator was the number of Veterans who received a homeless diagnosis during the follow up period. Finally, we estimated a cox proportional hazards model to determine the association between demographic characteristics, comorbidities, and risk of homelessness. We graphically examined the proportional hazards assumption.

Our study was approved by the Providence VAMC Institutional Review Board and Research and Development committees.

RESULTS

We identified 383,478 with a new ADRD diagnosis between 2010 and 2019. The average (SD) age of Veterans at time of ADRD diagnosis was 78.5 (10.9), most were men (97.5%), white (77.2%), and married (63.3%) (**Table 1**). Among these Veterans, 3,200 (0.83%) eventually received a homeless diagnosis. There were notable differences between Veterans who received a homeless diagnosis compared to those who remained stably housed (**Table 1**). At cohort entry, Veterans who eventually received a homeless diagnosis were significantly younger (63.7 [SD = 15.2] vs. 78.7 [SD = 10.8]; p<0.001), more likely to be Black (22.7% vs. 10.4%; p<0.001), and more likely to be unmarried (71.6% vs. 36.4%; p<0.001) than their stably housed counterparts. In addition, Veterans who received a homeless diagnosis were more likely to have a diagnosis for alcohol abuse (14.7% vs. 2.9%; p<0.001), substance abuse (6.1% vs. 1.0%; p<0.001), liver disease (6.0% vs. 2.2%; p<0.001), depression (35.7% vs. 16.5%; p<0.001), hypertension (55.5% vs. 53.6%; p=0.001), lung disease (17.8% vs. 14.9%; p<0.001), post-traumatic stress disorder (19.3% vs. 8.5%; p<0.001), psychosis (30.6% vs. 9.1%; p<0.001), traumatic brain injury (8.6% vs. 2.4%; p<0.001), and valvular disease (3.7% vs. 4.8%; p=0.003) than Veterans who remained stably housed.

The crude incidence rate of homelessness decreased as age of ADRD diagnosis increased (**Table 2**). Specifically, the incidence rate of homelessness among Veterans diagnosed with ADRD between 18-49 years of age was 14.9 (95% CI: 13.6, 16.4) per 1,000 person-years. For Veterans diagnosed with ADRD who were 90+ years, the incidence of homelessness was 0.3 (95% CI: 0.2, 0.4) per 1,000 person-years.

The adjusted hazard ratios (HR) for age and being unmarried at the time of an ADRD diagnosis were 0.94 (95%CI: 0.93, 0.94) and 3.30 (95%CI: 3.04, 3.58), respectively. (**Table 3**). The hazard of homelessness was higher for Black Veterans (HR 1.67, 95%CI: 1.52, 1.82) compared to White Veterans. In addition, the hazard of homelessness was higher for Veterans who had a diagnosis for alcohol use disorder (HR 1.87, 95%CI: 1.67, 2.10), substance use disorder (HR 2.15, 95%CI: 1.84, 2.53), liver disease (HR 1.24, 95%CI: 1.06, 1.45), depression (HR 1.41, 95%CI: 1.30, 1.53), hypertension (HR 1.22, 95%CI: 1.12, 1.33), lung disease (HR 1.12, 95%CI: 1.02, 1.24), post-traumatic stress disorder (HR 1.26, 95%CI: 1.13, 1.40) and psychoses (HR 1.63, 95%CI: 1.49, 1.77).

Table 1. Demographic Characteristics of Veterans at Time of ADRD Diagnosis

	Total	Veterans with ADRD who Eventually Received a Homeless Diagnosis	Veterans with ADRD who Never Received a Homeless Diagnosis
	N=383,478	N=3,200	N=380,278
Age, mean (SD)	78.55 (10.93)	63.70 (15.16)	78.67 (10.80)***
Male, n (%)	373,716 (97.45%)	3,047 (95.22%)	370,669 (97.47%)***
Race, n (%)			
White	296,027 (77.20%)	2,195 (68.59%)	293,832 (77.27%)***
Black	40,219 (10.49%)	727 (22.72%)	39,492 (10.39%)***
Other	47,232 (12.32%)	278 (8.69%)	46,954 (12.35%)***
Not Married, n (%)	132,641 (36.66%)	2,156 (71.56%)	130,485 (36.37%)***
Service-Connected Disability (Priority 1 Status), n (%)	82,786 (21.67%)	620 (19.53%)	82,166 (21.69%)**
Served in Combat, n (%)	48,802 (12.73%)	535 (16.72%)	48,267 (12.69%)***
Rural, n (%)	123,327 (32.18%)	742 (23.21%)	122,585 (32.26%)***
Comorbidities, n (%)			
Alcohol	11,732 (3.06%)	471 (14.72%)	11,261 (2.96%)***
Substance abuse	4,011 (1.05%)	196 (6.12%)	3,815 (1.00%)***
Rheumatic disease	6,140 (1.60%)	46 (1.44%)	6,094 (1.60%)
Renal disease	41,479 (10.82%)	244 (7.62%)	41,235 (10.84%)***
Liver disease	8,511 (2.22%)	193 (6.03%)	8,318 (2.19%)***
Depression	63,689 (16.61%)	1,143 (35.72%)	62,546 (16.45%)***
Diabetes	101,978 (26.59%)	835 (26.09%)	101,143 (26.60%)
Hypertension	201,905 (52.65%)	1,775 (55.47%)	200,130 (52.63%)**
Congestive Heart Failure	34,650 (9.04%)	244 (7.62%)	34,406 (9.05%)**
Lung Disease	57,179 (14.91%)	570 (17.81%)	56,609 (14.89%)***
Post-Traumatic Stress Disorder	32,746 (8.54%)	618 (19.31%)	32,128 (8.45%)***
Psychoses	35,434 (9.24%)	978 (30.56%)	34,456 (9.06%)***
Traumatic Brain Injury	9,464 (2.47%)	274 (8.56%)	9,190 (2.42%)***
Valvular disease	18,271 (4.76%)	117 (3.66%)	18,154 (4.77%)**
Stroke	47,771 (12.46%)	470 (14.69%)	47,301 (12.44%)**

Notes: P-values compare homeless to stably housed and at-risk to stably housed:
* p<0.05
** p<0.01
*** p<0.001

Table 2. Incidence Rates of Homelessness Among Veterans Diagnosed with Alzheimer's Disease and Related Dementias

Age at ADRD Diagnosis	Number of Veterans Diagnosed with ADRD	Number of Veterans with a Homeless Diagnosis following an ADRD Diagnosis	Person-years	Homeless Incidence Per 1,000 Person-Years (95% CI)
18–49 Years	7,300	466	31,277	14.9 (13.6, 16.3)
50–59 Years	10,479	602	48,255	12.5 (11.5, 13.5)
60–69 Years	53,082	984	251,041	3.9 (3.7, 4.2)
70–79 Years	105,189	670	462,265	1.4 (1.3, 1.6)
80–89 Years	159,507	414	807,070	0.5 (0.4 0.6)
90+	47,921	64	209,854	0.3 (0.2, 0.4)

Table 3. Hazard ratio for the Association between Sociodemographic Characteristics, Comorbidities, and Homelessness (N=383,478)

	Hazard Ratio (95% Confidence Interval)
Age	0.94 (0.93, 0.94)
Male	1.34 (1.13, 1.59)
Race (ref = white)	
Black	1.67 (1.52, 1.82)
Other	0.89 (0.78, 1.02)
Not married	3.30 (3.04, 3.58)
Service-Connected Disability (Priority 1 Status)	0.54 (0.49, 0.60)
Combat experience	0.69 (0.62, 0.78)
Rural	0.67 (0.62, 0.73)
Comorbidities	
Alcohol use disorder	1.87 (1.67, 2.10)
Substance use disorder	2.15 (1.84, 2.53)
Rheumatic disease	0.99 (0.73, 1.34)
Renal disease	0.78 (0.67, 0.90)
Liver disease	1.24 (1.06, 1.45)
Depression	1.41 (1.30, 1.53)
Diabetes	1.08 (0.98, 1.18)
Hypertension	1.22 (1.12, 1.33)
Congestive heart failure	0.95 (0.82, 1.11)
Lung disease	1.12 (1.02, 1.24)
Post-traumatic stress disorder	1.26 (1.13, 1.40)
Psychoses	1.63 (1.49, 1.77)
Traumatic brain injury	0.98 (0.86, 1.13)
Valvular disease	0.91 (0.74, 1.11)
Stroke	0.95 (0.85, 1.05)

DISCUSSION

We provide the first estimates on the incidence of homelessness among Veterans following a new ADRD diagnosis. Only a few studies have examined the incidence of homelessness among Veterans and they do so in a population referred to mental health services and a population discharged from the military.[11,12] Compared to these studies, we find high absolute rates of homelessness among younger Veterans diagnosed with ADRD and low rates of homelessness among older Veterans diagnosed with ADRD. We also find similar sociodemographic (e.g., not being married) and comorbid (e.g., alcohol and drug diagnoses) risk factors are strongly correlated with experiencing homelessness.

There were noticeable differences between Veterans who eventually received a homeless diagnosis compared to those who remained stably housed. As hypothesized, we found that age of ADRD diagnosis was inversely associated with homelessness, and unmarried Veterans had a greater risk of experiencing homelessness. Younger Veterans with an ADRD diagnosis may have less time to accumulate financial and social/family resources to safely age in the community. For example, a younger Veteran with alcohol use disorder and ADRD may lack strong social supports (e.g., children not old enough to provide caregiving; not married). Limited social ties is a notable risk factor for homelessness,[18] and risks may be amplified among people who cannot independently engage in community activities. Providing Veterans with resources to build social supports may reduce the risk of homelessness. Finally, younger people with an ADRD diagnosis may not have health insurance outside of their VA benefits, they may not have stable income, and because of their care needs may be prone to spend down their assets. Furthermore, their cognitive impairments and potentially limited family resources may make it challenging to navigate Medicaid and Social Security Disability benefits.

Our findings highlight the importance of screening for housing instability for Veterans living with ADRD. The VA has integrated a homeless screening instrument into clinical practice,[10] but screening is dependent on a Veteran seeking care or being identified during outreach efforts. Not all Veterans regularly receive their care from the VA. In addition, Veterans with ADRD and without a family caregiver may be less likely to engage with the healthcare system;[19] yet, these are the Veterans at greatest risk of experiencing homelessness. Systematically identifying whether a Veteran has a caregiver may help pinpoint those with minimal social support. The importance of identifying strategies to mitigate homelessness among potentially isolated people living with ADRD is highlighted by changing demographics. In the coming decades more people are expected to be living alone with ADRD.[20,21] Finally, we examined the risk of homelessness after an ADRD diagnosis. An important next step is understanding the risk of ADRD following a homeless diagnosis.

As ADRD is a disease of progressive functional decline, people living with ADRD eventually need full-time care. Full-time in-home care is costly and may not be possible without family caregivers, adequate financial resources, or stable housing.[22] For some Veterans living with ADRD and without family/financial resources, nursing homes could provide housing and care needs. Nursing homes must be prepared for the unique needs of Veterans at risk for homelessness.[23] This includes being able to manage substance abuse and complex mental health diagnoses. The VA also has home and community-based services which could help Veterans with ADRD and at-risk for homelessness live in the community longer.

Our study has several limitations. We used administrative data to identify Veterans with an ADRD and homeless diagnosis. ADRD is underdiagnosed in administrative data, providers do not systematically screen for ADRD, and diagnosed ADRD is different than true disease prevalence.[24] In addition, an ADRD diagnosis code may be used as a catch-all for

multiple cognitive disorders. Finally, ADRD diagnosis codes do not reflect severity of cognitive or factional activity limitations. The VA proactively seeks to identify Veterans experiencing homelessness, but we still likely underestimate the true incidence of homelessness because receiving a diagnosis is dependent on seeking care or being identified during outreach efforts. Importantly, administrative data does not have measures on contextual factors (availability caregivers, number/age of children, financial resources) which may contribute to the risk of becoming homeless. Finally, we do not have data on healthcare utilization or diagnoses outside the VA.

CONCLUSIONS AND IMPLICATIONS

In conclusion, age at time of ADRD diagnosis is inversely associated with the risk of eventually experiencing homelessness. Not being married, diagnosis for alcohol use disorder, substance use disorder, post-traumatic stress disorder, and psychoses are also associated with a greater risk of a Veteran living with ADRD experiencing homelessness. Efforts should be made to systematically identify family resources of Veterans at the time of an ADRD diagnosis. Nursing homes or community housing with wraparound clinical services could help prevent homelessness among Veterans with ADRD and less family/financial resources.

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Conflict of Interest Disclosures

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Appendix 1. Chronic Condition Warehouse Alzheimer's Disease and Related Dementias (ADRD) ICD-10 Codes

ICD-10 Code	Description
F01.50	Vascular dementia without behavioral disturbance
F01.51	Vascular dementia with behavioral disturbance
F02.80	Dementia in other diseases classified elsewhere without behavioral disturbance
F02.81	Dementia in other diseases classified elsewhere with behavioral disturbance
F03.90	Unspecified dementia without behavioral disturbance
F03.91	Unspecified dementia with behavioral disturbance
F04	Amnestic disorder due to known physiological condition
G13.8	Systemic atrophy primarily affecting central nervous system in other diseases classified elsewhere
F05	Delirium due to known physiological condition
F06.1	Catatonic disorder due to known physiological condition
F06.8	Other specified mental disorders due to known physiological condition
G30.0	Alzheimer's disease with early onset
G30.1	Alzheimer's disease with late onset
G30.8	Other Alzheimer's disease
G30.9	Alzheimer's disease, unspecified
G31.1	Senile degeneration of brain, not elsewhere classified
G31.2	Degeneration of nervous system due to alcohol
G31.01	Pick's disease
G31.09	Other frontotemporal dementia
G94	Other disorders of brain in diseases classified elsewhere
R41.81	Age-related cognitive decline
R54	Age-related physical debility
ICD-9 Code	
331.0	Alzheimer's disease
331.11	Pick's disease
331.19	Other frontotemporal dementia
331.2	Senile degeneration of brain
331.7	Cerebral degeneration in diseases classified elsewhere
290.0	Senile dementia, uncomplicated
290.10	Presenile dementia
290.11	Presenile dementia with delirium
290.12	Presenile dementia with delusional features
290.13	Presenile dementia with depressive features
290.20	Senile dementia with delusional features
290.21	Senile dementia with depressive features
290.3	Senile dementia with delirium
290.40	Vascular dementia, uncomplicated
290.41	Vascular dementia, with delirium
290.42	Vascular dementia, with delusions
290.43	Vascular dementia, with depressed mood
290.0	Senile dementia, uncomplicated
294.10	Dementia in conditions classified elsewhere without behavioral disturbance
294.11	Dementia in conditions classified elsewhere with behavioral disturbance
294.20	Dementia, unspecified, without behavioral disturbance
294.21	Dementia, unspecified, with behavioral disturbance
294.8	Other persistent mental disorders due to conditions classified elsewhere
797	Senility without mention of psychosis

An Exploratory Framework to Interpret County-Level Indicators of Food Insecurity

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ABSTRACT

In 2017, 12.5% of the population was estimated to be food insecure (FI) with wide regional variation. County-level FI is closely associated with, but likely more complex, than the county-level poverty rates. Therefore, we sought to identify a more nuanced framework for understanding factors contributing to FI. In an exploratory design, we studied 32 counties stratified by high and low FI and poverty, which were defined in terms of the national averages. Once stratified, counties were analyzed across 14 metrics within four summary domains: food access, food affordability, overall health environment, and county innovation. Having a stronger health environment was correlated with lower FI; correlations between the remaining three summary domains and FI were not significant. This was an initial effort to conceptualize potential markers of FI into a coherent framework using publicly available population-level health metrics. Future research could expand the sample and add additional metrics.

KEYWORDS: food insecurity, framework, social determinants of health

INTRODUCTION

In 2017, an estimated 12.5% of United States households were food insecure.[1] Food insecurity (FI) is defined as a "lack of consistent access to enough food for an active, healthy life."[2] FI contributes to the selection of poorer quality foods, delaying necessary medical care and medications, increased emergency department use, and increased hospitalizations.[3,4] In the US, there are wide county-level variations in FI, ranging from a high of 36% in Jefferson County, MS, to only 2.9% in Steele County, ND.[5] FI disproportionately impacts specific areas of the country including the South, rural areas, and low-income areas.[5]

The Supplemental Nutrition Assistance Program (SNAP) is the nation's largest federal food assistance program.[6] However, while SNAP has been shown to significantly reduce FI, beneficiaries can remain food insecure even while enrolled in SNAP.[6] Beyond federal food assistance programs like SNAP, WIC, funding through the Older Americans Act, and the School Meal Program, there are many local, regional, state, and national organizations working to combat FI. This ranges from national anti-hunger organizations such as Feeding America,[5] to local food pantries and soup kitchens, to innovative non-profits like Health Leads which works with health systems to connect at-risk patients to social services including food,[7] to progressive health systems such as Cincinnati Children's[8] and Boston Medical Center that have developed in-hospital food pantries and food prescription programs.[9] There are also a number of novel insurer-non-profit initiatives.[10,11]

While there are many innovative efforts across the country aiming to reduce FI, the scope, degree, and reach of these programs varies widely. Given the complex nature of FI and the variation in the availability of resources, health systems, policy makers, non-profits, and other entities need to understand qualities contributing to a county's ability to address FI in order to prioritize the development and piloting of interventions and community partnerships for at-risk populations. To better understand the characteristics that may contribute to counties' ability to address FI, we first examined the correlation between county FI rates and county poverty rates. Recognizing that there are many other factors also impacting food availability and access, we developed a set of 14 metrics across four domains we hypothesized would be associated with FI rates. We then examined how these characteristics varied across 32 counties within the four summary domains: counties with low FI rates and low poverty rates, low FI and high poverty, high FI and low poverty, and high FI and high poverty.

METHODS

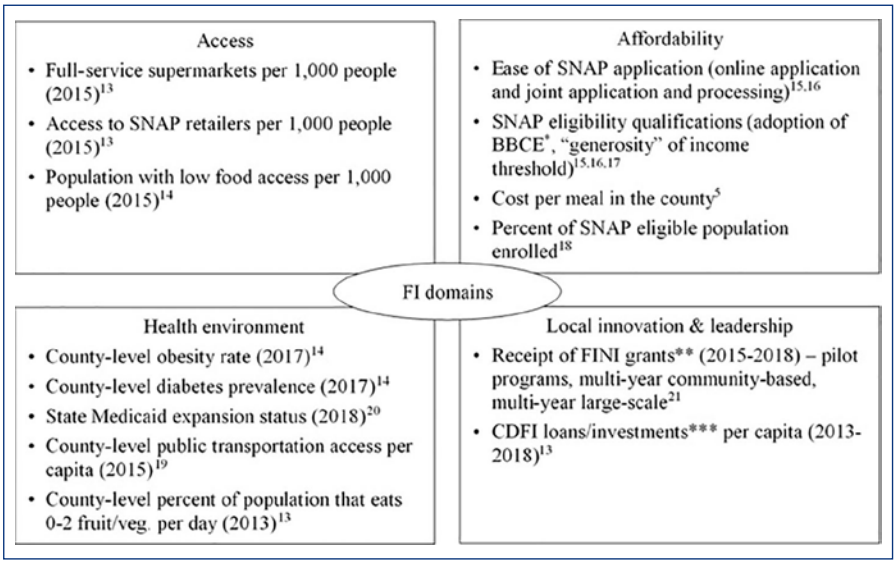
Food Insecurity Framework

Counties with low FI were defined as those with FI rates below the 2017 national average of 12.5%;[5] high FI was defined as being above the national average. Low poverty counties were defined as those with poverty rates below the national average of 12.3%; high poverty counties were above the national average.[12] County-level food insecurity data were obtained from Feeding America's Map the Meal Gap,[5] and county-level poverty data were obtained from the U.S. Census Bureau's Small Area Income and Poverty Estimates.[12] We then sampled 32 counties nationally from urban and rural geographies stratified across four summary

domains: counties with low FI rates and low poverty rates, counties with low FI and high poverty, counties with high rates of FI and low poverty, and counties with high FI and high poverty.

A member of the research team (ET) conducted exploratory key informant interviews with a resource coordinator from a large food bank, peer navigators from a community non-profit that helps connect food insecure individuals with local resources, and a physician at a major academic medical center that has led several initiatives to address patient food insecurity. Informed by relevant literature and findings from these exploratory interviews, we then developed a framework to further contextualize county-level indicators of FI using 14 metrics across four domains: access to food, affordability of food, overall health environment, and local innovation/leadership (**Figure 1**).

Figure 1. Food Insecurity (FI) Framework



Notes:

* Broad-based Categorical Eligibility (BBCE) is defined as when states opt to enable individuals and households to become categorically eligible for SNAP if they qualify for other non-cash Temporary Assistance for Needy Families or state Maintenance-of-Effort programs (e.g., earned income tax credits, subsidized employment, Head Start, etc.).[17] Counties received 1 point if they are within a state that has adopted any form of BBCE and 0 if they adopted none.

** Receipt of FINI grants (2015-2018): established in the 2014 Farm Bill and administered by the USDA's Food and Nutrition Service and National Institute of Food and Agriculture; it is designed to incentivize the purchase of fruits and vegetables by SNAP clients; awards are given to farmers markets, supermarkets, convenience stores, and retail food stores; awards are either pilot programs (1 year, up to $100,000), multi-year community-based projects (up to $500,000), and multi-year large-scale projects ($500,000 or greater)[21]

*** CDFI loans and investment per capita (2013-2016): Investments to programs that is designed to finance food retailers that opt to locate in an area that otherwise lacks healthy food access[13]

Measures and Data Sources

Access Domain

The access domain was comprised of the following county-level measures:

- Number of full-service supermarkets
- Number of SNAP retailers
- Number of residents with "low food access," defined as the prevalence of limited supermarket access per 1,000 residents in a county

Data for these measures were obtained from the Robert Wood Johnson Foundation's (RWJF's) Healthy Food Access Portal.[13,14] Raw county-level numbers for each measure were divided by county population to create a rate per 1,000 inhabitants to facilitate comparison across counties. Measures were binary, with values above the county mean for each measure coded as "1" and values below the mean coded as "0." Scoring for these and all subsequent measures are detailed in **Appendix Table 1**.

Affordability Domain

The affordability domain was comprised of the following measures:

- Ease of applying for SNAP
- SNAP eligibility qualifications
- Percent of SNAP eligible population enrolled
- Average cost per meal

Each of these measures was assessed at the state-level with the exception of average cost per meal, which was available at the county-level.

Ease of applying for SNAP was a composite variable defined by whether a state 1) allowed online applications and 2) allowed joint application and processing of Medicaid and SNAP applications. Data were sourced from the USDA's Food and Nutrition Service 2017 SNAP State Options report.[15]

A state's SNAP eligibility qualifications was a composite measure defined as 1) whether a state had adopted some form of Broad-Based Categorical Eligibility (BBCE) and 2) the SNAP eligibility threshold for gross income as a percent of the federal poverty level (FPL, baseline federal criteria is gross income <130% of the FPL).[5] Data were obtained from the USDA State Options Report and the Economic Research Service's SNAP policy database.[15,16] BBCE

enables individuals and households to become categorically eligible for SNAP if they qualify for other cash assistance programs such as Temporary Assistance for Needy Families (TANF) or state Maintenance-of-Effort programs (e.g., earned income tax credits, subsidized employment, Head Start, etc.).[17] 84% percent of the counties were in states that had adopted some form of BBCE.[17] Increases of the gross income limit for SNAP eligibility beyond 130% of the FPL reflect the additional leniency adopted by states enabled by BBCE.[17]

The percent of a states' eligible beneficiaries enrolled in SNAP was determined using a Mathematica report on enrollment trends among eligible beneficiaries in 2015.[18] We focused on SNAP rather than other federal food assistance programs that target FI (i.e., The Special Supplemental Nutrition Program for Women, Infants, and Children [WIC], school-sponsored lunch programs, etc.) as SNAP has been shown to substantially reduce FI and provides a metric for all US households rather than only households with children.[6]

County-level cost per meal was determined using data from Feeding America's Map the Meal Gap, which is calculated using the average dollar amount spent on food per week by food-secure individuals divided by 21 meals and weighted for the national average cost per meal and local cost-of-food indices.[5]

Health Environment Domain

The health environment domain included the following measures:

- County-level obesity rate (2017)
- County-level diabetes prevalence (2017)
- State Medicaid expansion status (2018)
- County-level public transportation access per capita (2015)
- County-level percent of population that eats 0-2 fruit/veg. per day (2013)

Each of the variables was assessed at the county-level except for Medicaid expansion status as of 2018, which was assessed at the state level. We reviewed RWJF's Healthy Food Access portal reports contain data on fruit/vegetables consumption as well as their 2017 "County Health Rankings" detailing the county-level diabetes and adult obesity prevalence.[13,14] To classify the access to public transportation, we reviewed the 2015 Unlinked Passenger Trips Per Capita data published by the American Public Transportation Association to assess the number of unlinked passenger trips, which we then divided by the total population.[19]

The Kaiser Family Foundation provides data on the Medicaid expansion status as of 2018.[20]

Local Innovation and Leadership Domain

The local innovation and leadership domain was comprised of the following measures:

- Receipt of FINI grants (2015–2018) – pilot programs, multi-year community-based, multi-year large-scale
- CDFI loans/investments per capita (2013–2018)

Receipt of USDA Food Insecurity Nutrition Incentive (FINI) grants between 2015-2018 was assessed at the state level while Community Development Finance Institution (CDFI) loans/investments per capita between 2013 and 2018 were assessed at the county level. FINI grants were chosen as an indicator of the presence of SNAP incentive programs as they are awarded for projects aimed at increasing and incentivizing the purchase of fruits and vegetables by SNAP beneficiaries.[21] CDFI loans and investment per capita (2013-2016) were selected as they were viewed as investments designed to finance food retailers that opt to locate in an area that otherwise lacks healthy food access.[13] They were detailed in the RWJF Healthy Food Access portal reports.[13]

Statistical Analyses

Descriptive data for each of the 32 counties in the framework were compiled for each of the 14 metrics. Counties were then given a summary score across each of the four domains, which are summarized in **Table 1**. The summary score indicates the county's performance within the four domains. Scoring criteria are detailed in **Appendix Table 1**. County-level outcomes for each of the 14 metrics are available in **Appendix Table 2**.

To assess the relationship between each category and the county-level food insecurity rates, we analyzed the correlation coefficients with a threshold for statistical significance defined as $p<0.05$. Analyses were conducted using R version 4.0. This project used publicly available county data and met criteria for research exemption 4 under the Revised Common Rule of 2018.

RESULTS

Sample Characteristics

Among the 32 counties studied, rates of food insecurity ranged from a low of 5.4% to a high of 36.3% (mean 14.4%). Poverty rates ranged from 5.0% to 39.9% (mean 16.0%). Counties represented 26 states from throughout the country with less representation (2/32) from the East Coast. Full sample characteristics are listed in **Appendix Table 2**.

Relationship between FI and the 4 Domains of Food Access, Food Affordability, Health Environment, and Local Innovation

We found a statistically significant, positive correlation between FI rates and poverty rates across the 32 counties ($r=0.78$, $p<.001$) (**Appendix Figure 1**). We scored each county, and determined there was no single criteria sufficient (in isolation) to conclude whether a county had a high or low FI rate (**Table 2**). Figure 2 highlights the association between the four summary domains for FI and the county-level FI rates. Overall, **Figure 2** supports the conclusions from **Table 2** that there is no sufficient indicator to explain the variation in FI rates across poverty categories. However, we see that

Table 1. Summary of County-Level Food Insecurity across Four Domains

		Food insecurity summary domains			
		Access	Affordability	Health Environment	Local Innovation & Leadership
		max score 3	max score 6	max score 5	max score 2
High resources and low food insecurity	Adams, CO	1	2	5	2
	Carlton, MN	2	5	4	2
	Carroll, MD	1	6	4	2
	Monmouth, NJ	1	5	5	1
	Rio Blanco, CO	3	3	5	2
	Aurora, SD	2	1	4	2
	Eureka, NV	0	4	4	0
	San Diego, CA	1	5	5	2
High resources and high food insecurity	Washington, UT	0	3	5	2
	Ray, MO	1	3	3	0
	Okaloosa, FL	0	6	2	2
	Brazoria, TX	1	4	1	2
	Camas, ID	0	3	4	1
	Dewey, OK	2	4	1	1
	Keweenaw, MI	1	6	2	2
	Tuolumne, CA	1	5	3	2
Low resources and low food insecurity	Northumberland, VA	3	3	4	2
	Adams, WI	0	5	1	1
	Blackford, IN	3	4	3	0
	Rabun, GA	3	3	1	2
	Liberty, MT	1	4	5	1
	Caledonia, VT	3	5	5	2
	Traverse, MN	2	4	3	2
	Polk, OR	0	5	2	2
Low resources and high food insecurity	Jefferson, MS	3	3	0	1
	Greene, AL	2	4	1	1
	Edgecombe, NC	2	5	1	2
	Lake, TN	2	2	1	0
	Houston, TX	2	4	2	1
	Vanderburgh, IN	2	4	2	1
	Somerset, MD	0	5	1	2
	Apache, AZ	0	4	2	2

the health environment was negatively associated with food insecurity.

Access: For access, there was a non-significant, slightly positive association between higher Food Access scores (i.e. better access to full-service super markets and SNAP retailers, and a lower population with low food access) and higher FI rates ($r = 0.16$, $p = 0.37$) (**Figure 2, panel A).**

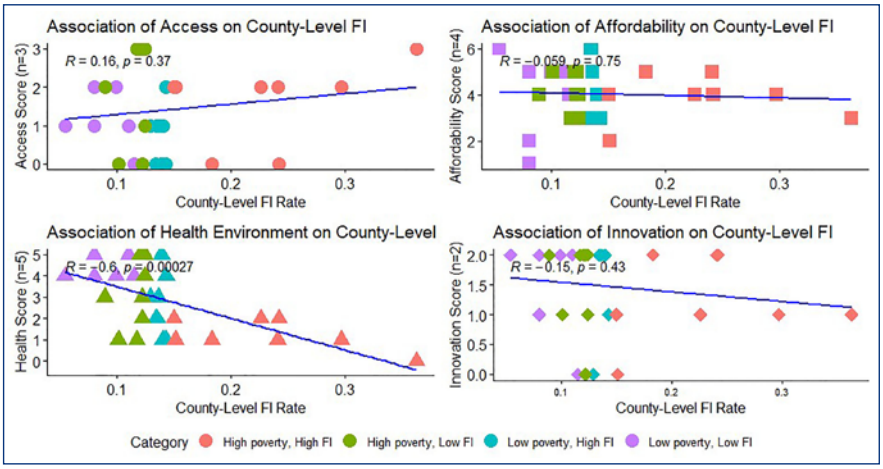
Affordability: We did not find a significant relationship between our summary affordability domain (defined by SNAP eligibility, application qualifications, and enrollment rates and the cost per meal in the county) and FI rates ($r = -0.07$, $p = 0.72$) (**Figure 2, panel B**). While counties with low FI rates and low poverty tended to have the highest affordability scores, there were counties with low poverty and high FI rates and high poverty and low FI rates that also scored highly in the affordability domain.

Health: There was a statistically significant negative correlation between a higher Health Environment score and a higher FI rate ($r= -0.6$, $p<.001$; **Figure 2, panel C**). Counties that scored higher in the Health Environment criteria (i.e., had a lower prevalence of adult obesity and diabetes, a lower percentage of the population eating only 0–2 servings of fruits and vegetables per day, more use of public transportation (which we viewed as a proxy of better access), and were in Medicaid Expansion states had lower FI rates. This inverse relationship is exemplified by Jefferson County, MS, which had a FI rate of 36% and a corresponding 0 points in the Health Environment category.

Innovation: There was a non-significant negative correlation between our summary Local Innovation and Leadership domain and FI rates ($r = -0.15$, $p = 0.43$). Counties with low FI and low poverty were highly prevalent among those with the highest Innovation scores. (**Figure 2, panel D**). Whereas counties high FI and high poverty rates were less likely to have received FINI or CDFI grant funding, which could spur innovative interventions to reduce FI.

Figure 2. Outcome of County-Level Food Insecurity Analyses across 32 Counties, Four Domains, and 14 Metrics

Source: County-level FI rate analyzed from Feeding America's 2017 Map the Meal Gap data[5]



DISCUSSION

In this work we used publicly available data to characterize local FI. Specifically, we combined county- and state-level measures of the food environment, health environment, state-level policies, and local leadership into a coherent framework. We found that while poverty rates are highly correlated with FI rates, of the other domains we had hypothesized would be correlated with FI, only the health environment had a statistically significant relationship with FI. This underscores the complex nature of food insecurity, and the difficulty of distilling non-financial aspects of food insecurity such as limited access to foods or local leadership into composite scores or metrics. While many of the metrics used were not independently associated with FI, a more nuanced scoring system and/or modelling to adjust for multiple covariates may have allowed for a better understanding of these relationships. Analysis of our framework highlights that across metrics, counties with low FI did not have universally high scores whereas counties with high FI did not have universally low scores across summary domains. This heterogeneity across metrics accentuates both the complexity of FI and also that a well-coordinated response requires a network of state policy makers, initiatives, and investments.

There were several limitations to this research. First, counties were selected based on poverty and FI rates, and therefore they often represented regions that were more extreme. This selection criteria also likely influences the relationship between the summary domains and county-level FI. Second, some of the metrics may be collinear and we did not standardize scoring across metrics, which collectively might either over-weight or under-weight the influence of certain concepts in our scorings. Third, in many instances we dichotomized continuous measures, which may have masked variability in those measures across the 32 counties. Fourth, the findings are based on 32 counties out of 3,141 counties nationally, which may limit the external validity.[22] Although in this exploratory study several of our summary domains were not significantly associated with FI, it is possible results would vary with a larger national sample. Fifth, our findings are observational and reflect associations, not causation. Finally, none of the criteria directly measure the degree or number of agencies seeking to address FI in each county. Future research could build on these findings to further understand the key determinants of county-level FI to help address the wide disparities we see in FI rates across the country.[5]

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Association of Home-Based Primary Care Enrollment with Social Determinants of Health for Older Veterans

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ABSTRACT

BACKGROUND: Home-based Primary Care (HBPC) provides comprehensive primary care to Veterans who may be at risk of adverse health outcomes due to their social determinants of health. Area Deprivation Index (ADI) can be used as a surrogate measure of a Veteran's social needs.

OBJECTIVE: To estimate the effect of neighborhood disadvantage, as measured by ADI, on HBPC enrollment for a sample of Veterans.

METHODS: We estimated a linear multivariate model in which the exposure was ADI and the outcome was enrollment in HBPC. Controls included clinical and demographic characteristics.

RESULTS: In a final sample of 12,005,453 observations (total Veteran months) on 353,485 individual Veterans, 18.4% lived in high-deprivation neighborhoods (ADI greater than 80). Mean monthly probability of new HBPC enrollment was 0.0061. Controlling for clinical characteristics, housing instability, and distance from the medical center, Veterans residing in high-deprivation neighborhoods were 1.4% to 14.8% less likely to enroll in HBPC, though the association was not statistically significant.

CONCLUSIONS: More research is needed to determine the relationship between Veterans' social needs and HBPC enrollment.

KEYWORDS: Veterans, social determinants of health, Home-Based Primary Care

BACKGROUND

Socioeconomic disparities continue to exist within health systems and it is imperative to investigate and dismantle these disparities. Wong and colleagues assert that eliminating disparities will require an examination of social determinants of health (SDH).[1] One critical SDH is the neighborhoods in which people live. Neighborhoods with lower socioeconomic status typically have more factors that negatively affect health such as fewer healthy food options, fewer recreational spaces, more crime, and subpar housing.[2-3] One measure of neighborhood socioeconomic disadvantage is the Area Deprivation Index (ADI). Previous research has demonstrated that patients residing in more disadvantaged neighborhoods have significantly higher 30-day hospital readmission risks than those residing in less disadvantaged neighborhoods.[4-5] While ADI has been used to predict readmission risk, little is known about the association between ADI and enrollment in other comprehensive primary care services.

The Department of Veterans Affairs (VA) Home Based Primary Care (HBPC) program was established in 1972 to provide in-home interdisciplinary care to chronically ill or disabled Veterans with complex social, behavioral, or medical needs.[6] The primary goal of the HBPC program is to promote maximum functioning and independence of the Veteran in their home to maintain quality of life and reduce institutionalization, hospitalization, and emergency room visits.[7-8] Veterans are referred by their primary care physician or upon hospital discharge and are subsequently evaluated for admission by HBPC staff using a standardized screening tool.[9] HBPC becomes the primary care provider and this role is fulfilled by the HBPC medical director alone or in collaboration with a nurse practitioner or physician assistant. The frequency of home visits depends on the composition and structure of the team, which is ultimately determined by the needs of the Veteran.[8] The interdisciplinary care team assesses the enrollees, develops a plan of care, provides all necessary primary care services, and refers enrollees to other services as needed. The HBPC interdisciplinary teams are comprised of the physician, nurse practitioners (NPs) or physician assistants (PAs), nurses, social workers, rehabilitation therapists, psychologists, dieticians, pharmacists, and administrative personnel.[10]

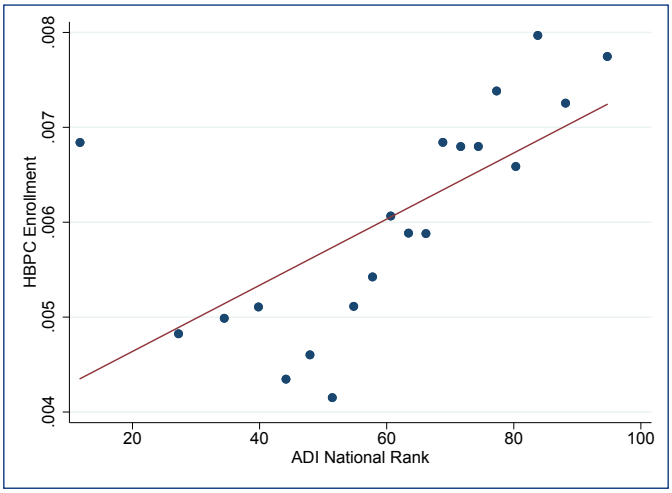
Veterans enrolled in HBPC are predominantly male, over the age of 75, with more than eight chronic conditions.[8] The number of Veterans aged 85 and older tripled between 2000 and 2012, and the HBPC census increased from 7,300 to 30,000.[11] Edwards and colleagues found that the further a Veteran lived from a HBPC site, the less likely that they were to be enrolled in HBPC and that those Veterans enrolled in HBPC had the highest quartile of medical complexity with significantly lower odds of ambulatory care-sensitive condition hospitalizations.[7] Thus far, the impact of a Veteran's neighborhood socioeconomic status on HBPC enrollment has not been examined.

As a first step to investigating socioeconomic disparities in HBPC enrollment, we assessed associations between

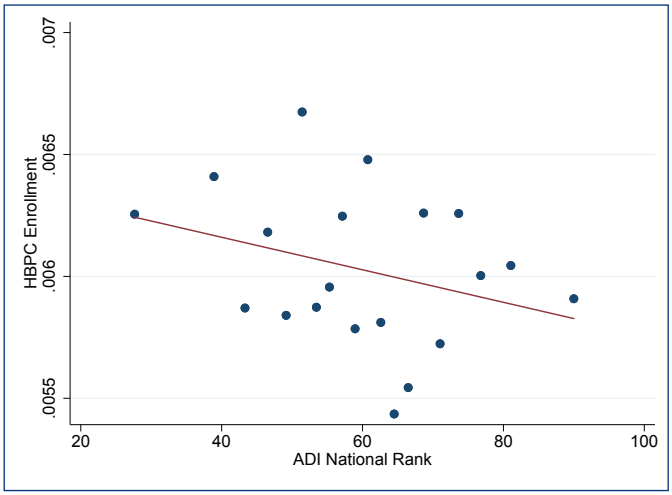
neighborhood disadvantage and HBPC enrollment for a sample of older Veterans. Thus, we aimed to address the question: What is the effect of neighborhood socioeconomic status, as measured by ADI, on enrollment in the VA's HBPC program? The authors hypothesize that Veterans in neighborhoods with lower socioeconomic status, or high-deprivation, are less likely to enroll in HBPC than Veterans in higher SES, or low-deprivation, neighborhoods at the same VA Medical Center (VAMC). (**Figures 1 A, B)**

Figure 1. Association of Veteran Neighborhood National ADI on Probability of Enrollment in the VA's Home-Based Primary Care Program.

Panel A. Unadjusted regression



Panel B. Covariate-adjusted regression



Notes: These graphs are visual representations of a multivariate regression, with 12,005,453 Veteran months, of the change in probability of enrolling in home-based primary care (HBPC) at different values of a Veteran's neighborhood area deprivation index (ADI). Panel A represents the linear regression of HBPC enrollment on neighborhood ADI without adjustments, while Panel B represents the regression of controlling for Veteran demographic and clinical characteristics (see Table 1). To create Panel B, we regressed ADI and HBPC on the set of control variables, and generated residuals from these regressions. We then grouped these residuals into 20 equal-sized bins, computed the mean of ADI and HBPC enrollment in each bin, and created a scatter plot of these 20 data points. Panel A shows the average HBPC enrollment for a given level of ADI; and Panel B shows HBPC enrolment for a given level of ADI, holding the controls constant.

METHODS

Sample

Data were obtained from the VA's Corporate Data Warehouse. The study sample began with Veterans age 65 and older who received primary care at one of 156 sites (VA medical centers or outpatient clinics) that participated in a Social Work PACT Staffing Program[12] and had an active HBPC program in the period from October 1, 2016 to September 30, 2019. Veterans who had primary care visits at more than one site were assigned to the site where they had the most primary care visits in that year. Observations were at the Veteran-month level. Clinical characteristics were identified within 12 months of an index date, either the fifteenth of a calendar month or the day of their first primary care visit in that month. In order to identify new enrollment, Veterans were excluded from the sample if they had any HBPC visits in the 12 months prior to the study start date. We also excluded Veterans who died within the month of their index date or if they resided in a nursing home for greater than 90 days within the previous 120 days of their index month. Veterans with prolonged nursing home stays were excluded from the sample as these Veterans were likely still residing in nursing homes and not eligible for enrollment in HBPC.

Outcome

We measured one main outcome: Veteran enrollment in HBPC. We measured this outcome over a thirty-day period from the index date.

Exposure

We operationalized neighborhood deprivation using the area deprivation index (ADI), a composite measure of census variables related to health outcomes reported as a percentile rank among census blocks.[16] We used the national ADI measure. We defined exposure as living in a "high deprivation" neighborhood in three ways: the 50th, 80th, and 95th percentile or higher, compared to the lower percentiles. In order to assign ADI to the census tract in which a Veteran lived, we took the average ADI of the census blocks within a tract and matched it to the federal information processing system (FIPS) code associated with a Veteran's home address in file in the VA record.

Covariates

Demographic characteristics were included from each Veteran's enrollment file, and included sex, race, age, number of hospitalizations in the prior year, Rural-Urban Commuting Area code of the Veteran's home residence, driving distance from closest VAMC and VA enrollment priority group for a service-connected disability. We operationalized age in 5-year bins in the OLS model. Based on diagnoses recorded in the electronic health record within twelve months before the index date, we included indicators for congestive heart failure, hypertension, complicated hypertension, lymphoma, fluid

Table 1.* Demographic and Clinical Characteristics and HBPC Enrollment, Stratified by Neighborhood Disadvantage Levels

Characteristics	Overall (n= 12,005,453)	ADI Grouping of the Patient's Neighborhood of Residence	
		Least Disadvantaged (National ADI Rank <80) (n=9,799,012)	Most Disadvantaged (National ADI Rank >80) (n=2,206,411)
Age	74.90 (7.43)	74.89 (7.36)	74.24 (7.21)
Sex			
Male	12,467,336 (97.87%)	9,600,937 (97.98%)	2,158,217 (97.81%)
Race			
White	10,871,366 (85.34%)	8,502,797 (86.77%)	1,781,779 (80.75%)
Black	517,115 (4.06%)	267,464 (2.73%)	229,242 (10.39%)
Unknown Race	930,894 (7.31%)	710,480 (7.25%)	146,569 (6.64%)
Native Hawaiian or Other Pacific Islander	151,201 (1.19%)	107,562 (1.10%)	11,282 (0.51%)
Asian	161,096 (1.26%)	145,285 (1.48%)	982 (0.04%)
American Indian or Alaska Native	106,808 (0.84%)	65,424 (0.67%)	36,587 (1.66%)
Comorbidity			
Congestive Heart Failure	647,423 (5.08%)	465,562 (4.75%)	136,609 (6.19%)
Hypertension	7,136,665 (56.02%)	5,529,485 (56.43%)	1,372,805 (62.22%)
Anemia	1,029,546 (8.08%)	741,381 (7.57%)	232,300 (10.53%)
Renal Failure	1,086,400 (8.53%)	806,099 (8.23%)	220,754 (10.00%)
Stroke	637,665 (5.01%)	476,838 (4.87%)	129,771 (5.88%)
Hypothyroidism	1,094,583 (8.59%)	844,941 (8.62%)	208,261 (9.44%)
Peripheral Vascular Disease	894,137 (7.02%)	675,948 (6.90%)	178,096 (8.07%)
Depression	1,273,940 (10.00%)	969,447 (9.89%)	261,607 (11.86%)
Post-traumatic Stress Disorder	1,096,126 (8.60%)	848,081 (8.65%)	220,347 (9.99%)
Psychiatric Diagnosis	2,395,800 (18.81%)	1,845,650 (18.84%)	472,717 (21.42%)
Obesity	1,462,809 (11.48%)	1,155,659 (11.79%)	270,074 (12.24%)
Diabetes Mellitus	3,082,909 (24.20%)	2,347,855 (23.96%)	626,386 (28.39%)
Pulmonary Disease	2,017,033 (15.83%)	1,497,169 (15.28%)	427,124 (19.36%)
Dementia	396,950 (3.12%)	295,446 (3.02%)	67,269 (3.05%)
Alzheimer's Disease and Related Dementias	402,359 (3.16%)	300,976 (3.07%)	66,753 (3.03%)
Substance Use Disorder	507,064 (3.98%)	377,573 (3.85%)	112,553 (5.10%)
Alcohol Use	411,606 (3.23%)	310,421 (3.17%)	86,735 (3.93%)
Current Smoker	1,587,615 (12.46%)	1,155,699 (11.79%)	373,591 (16.93%)
Former Smoker	2,914,525 (22.88%)	2,274,671 (23.21%)	518,146 (23.48%)
Homeless	55,885 (0.44%)	37,866 (0.39%)	15,751 (0.71%)
Unstably Housed	191,601 (1.50%)	133,157 (1.36%)	45,337 (2.05%)
VA Priority group			
Group 1: Service-Connected Disability (>50% disabling)	3,136,027 (25.28%)	2,448,800 (24.99%)	586,934 (26.60%)
Veteran Residence Rural-Urban Commuting Area			
Urban	4,229,849 (33.21%)	3,356,760 (34.26%)	641,253 (29.06%)
Rural	7,195,575 (56.49%)	5,463,717 (55.76%)	1,322,058 (59.92%)
Highly Rural	1,262,530 (9.91%)	978,535 (9.99%)	243,130 (11.02%)
HBPC Enrollment	78,151 (0.61%)	55,978 (0.57%)	16,391 (0.74%)

and electrolyte imbalances, obesity, coagulopathy, stroke, traumatic brain injury, psychoses, valvular disease, renal failure, peripheral vascular disease, depression, post-traumatic stress disorder, paralysis, other neurological conditions, hypothyroidism, liver disease, peptic ulcer disease, pulmonary hypertension, human immunodeficiency virus, diabetes, complicated diabetes, substance use disorder, psychiatric diagnosis, metastatic cancer, solitary tumor, rheumatoid arthritis, weight loss, blood loss anemia, and anemia. (**Table 1**)

Analysis

To estimate the effect of neighborhood disadvantage on HBPC enrollment, we estimated the following linear probability model:

$$HBPC_{ijkt} = \beta_0 + \beta_1 HighDep_j + X_{ijt}\gamma + Y_t + \lambda_k + \epsilon_{ijt}$$

In this model, i indexes the individual Veteran, j is the census tract, k is the site where the Veteran gets their primary care, and t is month. $HBPC_{ijkt}$ is a binary variable that is 1 if a Veteran enrolls in HBPC visits in month t, and 0 otherwise, and $HighDep$ is an indicator for national ADI rank >=80. We also estimated specifications with high deprivation as ADI>50 and ADI>95. The main coefficient of interest, β_1, represents the difference in probability in a given month that a Veteran from a high-deprivation neighborhood will enroll in HBPC, compared to Veterans in lower-deprivation neighborhoods. X_{ijt} is a vector of Veterans' demographic and clinical characteristics, λ_k are fixed effects for the VA medical center to control for differences between hospital systems in their HBPC programs, and Y_t are year fixed effects. To account for serial correlation of a Veteran's outcomes, we estimated robust standard errors clustered at the Veteran level.

Datasets were assembled using SQL and R. Regression models were estimated and binscatter plots were generated using Stata version 15. The binscatter plots serve as visual representations of the multivariate regression of the change in probability of enrolling in HBPC at different values of a Veteran's neighborhood ADI. We used one panel (Panel A) to represent the linear regression of HBPC enrollment on neighborhood ADI without adjustments, and a second panel (Panel B) to represent the regression of controlling for Veteran demographic and clinical characteristics. To create Panel B, we regressed ADI and HBPC on the set of control variables, and generated residuals from these regressions. We then grouped these residuals into 20 equal-sized bins, computed the mean of ADI and HBPC enrollment in each bin, and created a scatter plot of these 20 data points.

As part of quality-improvement activities, this work was determined exempt from review by the Providence VA Medical Center institutional review board.

RESULTS

In our final analytic sample, we had 12,005,453 observations on 353,485 individual Veterans, 18.4% of whom have addresses in high-deprivation (ADI greater than 80) neighborhoods. Veterans had slightly higher prevalence of chronic conditions in high-deprivation neighborhoods than in low-deprivation neighborhoods, such as hypertension (62.2% vs. 56.4%), diabetes (28.3% vs. 23.9%) psychiatric diagnosis (21.4% vs. 18.8%), and substance use disorders (5.1% vs. 3.8%). Veterans in high-deprivation neighborhoods were also more likely to be unstably housed (2.0% vs. 1.3%) and homeless (0.7% vs. 0.3%). The unadjusted rate of enrollment in the high-deprivation neighborhoods was 0.74% per month and in low-deprivation neighborhoods was 0.57% per month, and 0.61% overall.

Table 2 shows our adjusted estimates for the effect of selected Veteran characteristics on probability of HBPC enrollment, per month. Each estimated coefficient can be interpreted as the difference in probability of a Veteran enrolling in the program per month, compared to the reference group, adjusting for demographic and clinical characteristics. In high-deprivation neighborhoods where ADI is greater than 80, Veterans had a 0.00008 lower likelihood of enrolling in HBPC in a month (a 1.4% difference from the overall mean of .0061) than those in neighborhoods with ADI less than 80 (95% confidence interval: [–0.00059, 0.00043]).

Table 2. Association of SDH with HBPC Enrollment By ADI Ranking of the Veteran's Neighborhood of Residence (n=12,005,453)

	High-deprivation definition		
	ADI>50	**ADI>80**	**ADI>95**
High-deprivation neighborhood	–0.00039* (–0.00081, 0.00002)	–0.00008 (–0.00059–0.00043)	–0.00096 (–.00223–0.00031)
Homeless	–.0296*** (–.0327, –.0265)	–.02958*** (–.03267, –.02649)	–.02957*** (–.03266, –.02647)
Unstably housed	.04433*** (.04046, 48.20)	.04349*** (.03962, .04736)	.04350*** (.03963, .04737)
Driving distance to nearest VAMC	–0.00002*** (–0.00003, –0.01)	–0.00002*** (–0.00003, –0.00001)	–0.00002*** (–0.03, –0.00001)

*** p<0.01, ** p<0.05, * p<0.1

Notes: Each column represents a linear multivariate model of the probability of enrolling in HBPC with different specifications for high-deprivation neighborhoods. Model covariates not shown included: age, sex, race, Veteran residence Rural-Urban Commuting Area, service connection, hospitalizations, congestive heart failure, hypertension, lymphoma, fluid and electrolyte imbalances, obesity, coagulopathy, stroke, traumatic brain injury, psychoses, complicated hypertension, valvular disease, renal failure, peripheral vascular disease, depression, post-traumatic stress disorder, paralysis, pulmonary hypertension, other neurological conditions, hypothyroidism, liver disease, peptic ulcer disease, human immunodeficiency virus, diabetes, complicated diabetes, substance use disorder, psychiatric diagnosis, metastatic cancer, solitary tumor, rheumatoid arthritis, weight loss, blood loss anemia, and anemia. HBPC = Home-Based Primary Care. SDH = Social Determinants of Health. ADI = Area Deprivation Index. VAMC=Veterans Administration Medical Center.

In high-deprivation neighborhoods where ADI is greater than 95, Veterans had a 0.0009 lower likelihood of enrolling in HBPC in a given month (a 14.8% difference from the overall mean) than those in neighborhoods with ADI less than 95 [–.00223, 0.00031]. In neighborhoods with ADI greater than the median, Veterans had a .00039 lower likelihood of HBPC enrollment (a 6.4% difference from the overall mean) than below the median [–0.00081, 0.00002]. In Figure 1 we show two plots that illustrate the relationship between National ADI Rank and the likelihood of HBPC enrollment for our sample of Veterans. In Panel A, the unadjusted association is positive, suggesting that as neighborhood deprivation increases, so does HBPC enrollment. However, when we adjust for demographic and clinical characteristics in Panel B, the correlation of ADI with HBPC enrollment is weakly negative.

Distance and other social factors significantly affected enrollment. For every additional mile a Veteran lived from a VAMC, probability of HBPC enrollment decreased by 0.00002 (a 0.3% difference from the overall mean). Homeless Veterans had .0296 lower likelihood of enrollment [–.03267, –.02649] than Veterans with stable housing, a more than fourfold difference from the overall mean; while Veterans with unstable housing had .044 higher likelihood of enrolling [.03962, .04736] than Veterans with stable housing, more than seven times the average rate of enrollment.

DISCUSSION

This analysis of the impact of ADI on HBPC enrollment serves as an example of a novel utilization of ADI to examine the influence of SDH on HBPC enrollment. Clinicians can evaluate Veterans' social needs utilizing measures of SDH, such as ADI, to broaden access to those Veterans most in need of comprehensive primary care services. Although our results were not statistically significant, we found a slight decrease in enrollment associated with living in a higher-deprivation neighborhood, suggesting that after controlling for clinical characteristics, neighborhood characteristics may present some obstacles to participation in the HBPC program.

Unadjusted differences showed that the marginal probability of enrolling in HBPC increases with neighborhood deprivation, which is consistent with the goals of the HBPC program because Veterans in more deprived neighborhoods also had more chronic conditions, hospital admissions, and overall acuity than Veterans in less-deprived neighborhoods. The engagement of HBPC with unstably housed Veterans suggests consideration of the social fragility necessary to manage their care. The logistic concerns of managing HBPC programs likely limit enrollment of Veterans experiencing homelessness, which is supported by this analysis. HBPC teams do not generally enroll homeless Veterans, as they do not have an address or physical residence at which to provide the care in the home. However, Veterans who are unstably housed and residing in high-deprivation neighborhoods may have more complex medical needs and be most in need of HBPC services. This is consistent with findings from previous work that Veterans who are frail or have complex medical needs are likely to benefit more from HBPC, but that more research is needed to determine who benefits most from HBPC services.[18] Our findings are also consistent with previous reports that the farther a Veteran resides from a HBPC site, the less likely they are to be enrolled.[9]

Two mechanisms drove our hypothesis regarding ADI and HBPC enrollment. First, ADI served as a surrogate measure of Veteran socioeconomic status and second, ADI served as a surrogate of actual neighborhood effects such as environmental health, food deserts, housing safety, and perceived safety of the HBPC team. It is important to note that area level measures, such as ADI, are aggregate measures of individual-level statuses of people living in that area. Consequently, not all Veterans living in high-deprivation neighborhoods have high social needs and conversely, there may be Veterans living in low-deprivation neighborhoods that have high social needs. Generally, our findings support the hypothesis that a surrogate measure for SDH, such as ADI combined with other social needs identified in the health record, may be useful for health care planning and clinical practice in order to identify Veterans in need of social support or to flag potential barriers of access to care.[17]

It is important to acknowledge that Veterans residing in lower-deprivation neighborhoods or urban areas surrounding VAMCs may have more access to HBPC, yet those Veterans in highest need of comprehensive primary care management may reside in higher-deprivation neighborhoods or highly rural areas. Therefore, by serving Veterans residing closest to HBPC sites, and potentially not serving highly rural Veterans, HBPC may not be not serving the Veterans with the greatest need for in-home medical care.

Other barriers related to access to care for Veterans in high-deprivation neighborhoods near urban centers may include the ability of clinicians to obtain parking nearby Veteran's homes and traffic congestion in urban neighborhoods. These barriers are especially challenging to HBPC clinicians who are caring for Veterans surrounding VAMCs in major cities, where VAMCs are often located. VA employees are not reimbursed for, and therefore do not utilize, public transportation when travelling to Veteran homes, so traffic and lack of available and affordable parking present barriers to care in high-deprivation or urban neighborhoods surrounding VAMCs within cities.

Perceived safety for clinicians providing home-care services may also present a barrier to enrollment in HBPC. While there is limited literature systematically measuring home health care workers' perceived safety of neighborhoods where they provide care, reports of home health care workers experiencing violence in dangerous or urban neighborhoods

or feeling threatened by neighbors, family or weapons in the home are prevalent.[19-20] These threats may contribute to a decreased likelihood of enrollment in HBPC of at-risk Veterans residing in high-deprivation or urban neighborhoods. Telehealth HBPC services could mitigate some of these risks to HBPC clinicians and improve access to HBPC services for Veterans residing in these communities.

Our findings have potential implications for clinical practice, not only for the clinicians in the HBPC program but perhaps more so for the providers who may wish to refer their patients in to the program. In the VA, primary care is organized into interprofessional teams called Patient Aligned Care Teams (PACTs). Rarely would a Veteran independently seek to enroll in HBPC; instead, a member of the Veteran's PACT often identifies a patient who is homebound and/or has complex medical needs, and refers them to the program. Therefore, issues that potentially affect access to HBPC are particularly salient to any members of the PACT – such as primary care physicians, nurse care managers, specialists, or social workers – who are in a position to recognize a Veteran's need for more comprehensive services. PACT social workers play a pivotal role in assessing the SDH that present barriers to timely and appropriate care. Social workers can serve as a bridge between the Veteran's primary care provider and the HBPC team. Because PACT social workers identify social needs and develop rapport with a Veteran, they are well positioned for a warm hand-off to the HBPC social worker if a Veteran chooses to enroll in HBPC. Thus, a strong connection between the PACT social worker and the HBPC interdisciplinary team can improve access to care. Physicians, too, should be aware that their social workers can play this pivotal role in reducing barriers to access for Veterans with social needs.

The Covid-19 pandemic has also presented a unique opportunity for HBPC programs to utilize and improve home telehealth services for at-risk Veterans. Anecdotally, HBPC clinicians have utilized telephone and video encounters to bridge the gap between Veteran care needs and the risks of providing and receiving in-person care during the Covid-19 pandemic. This presents a broader opportunity for HBPC to establish sustainable and effective home telehealth encounters for Veterans who live farther away from HBPC programs or who may encounter barriers to HBPC as a result of their neighborhood of residence. There remains room for improvement with regards to Veteran access to these home telehealth services due to the complexity of home telehealth interventions, the lack of home telehealth adaptability and usability, and adherence issues for Veterans.[21] Shigekawa and colleagues identified that video telehealth in HBPC may be underutilized, as well.[22] Veterans residing in highly rural areas may experience a lack of access to traditional in-person HBPC because the long drive times from an HBPC site to their homes make home visits burdensome for HBPC staff. Home telehealth encounters in HBPC could serve to improve care for rural and highly rural at-risk Veterans or those residing in high-deprivation neighborhoods. Utilizing ADI as a measure of SDH is a novel approach to examining access to HBPC for older Veterans.

LIMITATIONS

Limitations are important to note. First, we linked Veterans' addresses to census tracts blocks and used the mean ADI of the census blocks associated with that tract. By introducing (likely random) measurement error, this may have attenuated our estimates toward zero. Second, although we included an extensive list of diagnoses, there were many aspects of their frailty and medical acuity that we did not control for in our model. For instance, we did not have a measure of functional status. If Veterans in high-ADI neighborhoods also have more need for HBPC in unmeasured ways, that also would bias our estimates toward the null. Third, in terms of external validity, although the VAMCs that participate in the Social Work PACT Staffing Program represent a broad, national sample, they may not be representative of the VA as a whole. In order to participate in the program, VAMCs must serve some rural Veteran populations, and they may have higher PACT social work staffing levels than non-participating sites.

CONCLUSIONS

The VA HBPC program provides beneficial comprehensive, primary care services to Veterans at risk of poor health outcomes. However, a Veteran's SDH could prevent enrollment. More research is needed to explore the relationship between social needs and access to services such as HBPC.

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