ORIGINAL RESEARCH

Health-Related Social Needs and Increased Readmission Rates: Findings from the Nationwide Readmissions Database

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ABSTRACT:

BACKGROUND: While health-related social needs (HRSN) are known to compromise health, work to date has not clearly demonstrated the relationship between clinically acknowledged social needs, via ICD-10 Z-codes, and readmission.

OBJECTIVE: Assess the rate of 30-, 60-, and 90-day readmission by the level of ICD-10-identified social need. In addition, we examined the associations between demographics, social need, hospital characteristics, and comorbidities on 30-day readmission.

DESIGN: Retrospective study using the 2017 Nationwide Readmission Database

PARTICIPANTS: We identified 5 domains of HRSN from ICD-10 diagnosis codes including employment, family, housing, psychosocial, and socioeconomic status (SES) and identified how many and which an individual was coded with during the year.

MAIN MEASURES: The proportion of patients with 30-, 60-, and 90-day readmission stratified by the number of HRSN domains with a multivariable logistic regression to examine the relationship between the number/type of and readmission adjusting for sex, age, payer, hospital characteristics, functional limitations, and comorbidities.

KEY RESULTS: From 13,217,506 patients, only 2.4% had at least one HRSN diagnosis. Among patients without HRSN, 11.5% had a 30-day readmission, compared to 27.0% of those with 1 domain, increasing to 63.5% for patients with codes in 5 domains. Similar trends were observed for 60- and 90-day readmission; 78.7% of patients with documented HRSN in all 5 domains were hospitalized again within 90 days. The adjusted odds ratio for readmission for individuals with all 5 domains was 12.55 (95% CI: 9.04, 17.43). Housing and employment emerged as two of the most commonly documented HRSN, as well as having the largest adjusted odds ratio.

CONCLUSIONS: There is a dose-response relationship between the number of HRSN diagnoses and hospital readmission. This work calls attention to the need to develop interventions to reduce readmissions for those at social risk and demonstrates the significance of ICD-10 Z-codes in health outcomes studies.

KEY WORDS: social determinants of health; health-related social needs; health equity; health disparities; readmission; utilization.

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INTRODUCTION

The relationship between health-related social needs (HRSN) and health outcomes is widely recognized, and in recent years, we have seen this relationship become more explicit and quantified.[1–11] As a result of this deepening understanding of how HRSN such as food insecurity, social isolation, and housing instability impact health, most hospitals report screening patients for social factors and interventions are being developed.[12–17] In addition to limited training for providers on HRSN, including screening and documentation, interventions are presently not reimbursable. Thus, positive screens are rarely coded using specific, existing ICD-10 diagnostic codes developed to capture patient social factor data. Indeed, a recent study by CMS found that among 33.7 million Medicare fee-for-service beneficiaries, these codes, which begin with the letter Z (hence, referred to as Z-codes), were present in just 1.4% of claims filed in 2017.[18–22]

Recently, there has been a growing focus on expanding the use and utility of Z-codes.[23–25] This focus is largely driven by research demonstrating that data on patients' HRSN can improve population health management efforts and may eventually be used to adjust publicly reported quality measures to better isolate true differences and avoid unfairly penalizing safety net providers caring for clinically and socially complex patients.

If one thing threatens to stymie these quality adjustment efforts, however, it is the lack of available, valid, standardized, and systematically collected data on individual-level HRSN, a gap that Z-codes seem well poised to fill.[23,25,26] Most recently, leading healthcare organizations including the American Medical Association (AMA) and United Healthcare have partnered to advocate for the expansion of Z-codes to capture HRSN while concurrently encouraging research to better refine and develop interventions.[27,28]

Unplanned hospital readmission (hereafter referred to as "readmission") is a quality metric for which HRSN data might be particularly salient. Both HRSN (e.g., whether a patient has social support, whether the patient has access to stable housing) and the social determinants in the community to which that patient is discharged (e.g., air

quality, reliable public transportation) could result in readmission regardless of the quality of care received during the initial inpatient stay. Indeed, a number of studies have demonstrated the relationship between social determinants of health (SDOH) and health-related social needs and hospital readmission.[29–33] Specifically, this body of work has frequently examined area-level measures of social determinants of health (e.g., area deprivation index, census tract, ZIP code, and county-level factors), and the specific subset of studies that do examine the effect of social needs at the individual level often rely on data extracted from notes rather than from formal diagnostic codes.[29,31–41] To more precisely estimate the effect of SDOH or HRSN, the statistical models used in this body of work often control for a common set of covariates including sex, race, age, marital status, comorbidities, social determinants of health or social risk, and hospital or site characteristics.[29,30,34–37,42,43] The effect of SDOH or HRSN has varied, but studies have identified that 34% of patients with two HRSN and 24.5% of patients with housing instability have hospital readmission, and for those who live in areas of high deprivation, the odds ratio of readmission was 1.7.[29,32,36] Together, these studies have demonstrated the importance of SDOH and HRSN and their association with readmission.

In this manuscript, we quantify the relationship between HRSN and readmission within a large national sample using ICD-10 Z-codes as the means for identifying HRSN, while adjusting for the aforementioned common covariates, as well as functional limitations which have been documented as a key driver of readmission.[44]

METHODS

From the nationally representative 2017 Nationwide Readmission Database, part of the Healthcare Cost and Utilization Project (HCUP) family of databases, we identified 5 domains of health-related social needs (HRSN) from ICD-10 Z-codes: employment, family, housing, psychosocial (e.g., problems related to primary support group), and socioeconomic status (SES). The diagnostic Z-codes for each domain were identified and grouped following a framework established by Reidhead (2018) and can also be found in Supplemental Table 1.[19] We then calculated the total number of the domains that an individual had been coded with within the year, while also identifying whether or not an individual ever had another hospitalization within 30, 60, and 90 days. For example, if an individual were to have 3 hospitalizations in the year and have one domain of HRSN coded on just one discharge record, they would be considered to have "1 domain." Extending this, if an individual had 3 hospitalizations, and 2 of the discharge records each had an HRSN diagnosis, but they were different domains, this person would be considered to have "2 domains." If two of these hospitalizations were within 30 days, this person would be said to have had a 30-day readmission. For the readmission analysis, individuals whose only hospitalization for the year had a known disposition as death were excluded. Additionally, the 30-day readmission excluded anyone whose first discharge was in December, as they did not have full 30 days of follow-up. For 60 days, we excluded those in November and December and for 90 days excluded those in October, November, and December.

We conducted multivariable logistic regression to examine the relationship between the number of HRSN domains and ever having a 30-day readmission after adjusting for select covariates. Following previous work, we identified covariates that are potential confounders of the relationship between social needs and readmission, including sex (reference: female), payer (reference: privately insured), hospital control (reference: private, investor-owned), hospital teaching status (reference: metropolitan, teaching), and the validated Elixhauser comorbidities. Race and ethnicity were not available in these data. The Elixhauser comorbidities are commonly used in analyses of administrative data and are associated with death in hospital, increased length of stay, and increased charges.[45] We used all available hospitalizations and all available diagnosis code slots (40 on each discharge) to identify comorbidities. Each comorbidity was coded as present or absent and entered into the model as its own covariate. In an effort to account for functional limitations, another important predictor of readmission, we utilized another subset of ICD-10 codes beginning with the prefix Z that refer to aspects of limitations in activities and care provider dependency including "Z736X" and "Z74XX," where X represents all sub-codes. For the primary payer covariate, "no charge" and "other" were combined to a single variable, "other." Age was taken as age in years, as a continuous variable, at first hospitalization in the dataset. Finally, hospital control and teaching status, as two separate variables, were taken from the first hospitalization. The number of HRSN was included as a single, multi-categorical variable where 0 HRSN was the reference level.

To examine the impact of specific HRSN on readmission, we repeated the above-described multivariable logistic regression, including each of the domains (employment, family, housing, psychosocial, and SES) as their own variables, each coded as yes or no. This model was further stratified into those with only 1 recorded HRSN (model 2a) and those with 2 or more

Table 1 Characteristics of Individuals With and Without Health-Related Social Needs (HRSN)

	Percent of all patients, $N = 13,217,506$	Percent of patients with HRSN, $N = 314,151$
HRSN Z-code domain*		
Employment, $n = 54,440$	0.4	17.3
Family, $n = 69,639$	0.5	22.2
Housing, $n = 152,567$	1.2	48.6
Psychosocial, $n = 27,969$	0.2	8.9
SES, $n = 70,242$	0.5	22.4
Number of HRSN domains, ever		
0 Domains, $n = 12,903,355$	97.6	——
1 Domain, $n = 265,997$	2.0	84.7
2 Domains, $n = 37,644$	0.3	12.0
3 Domains, $n = 8,624$	0.1	2.7
4 Domains, $n = 1670$	0.01	0.5
5 Domains, $n = 196$	0.001	0.1
	Patients with no HRSN, $N = 12,903,355$; n (%)	**Patients with any HRSN, $N = 314,151$; n (%)**
Male	5,241,776 (40.6)	178,078 (56.7)
Age: median [IQR]	57 (32–72)	45 (30–57)
Payer		
Private Insurance	4,025,713 (31.2)	49,270 (15.7)
Medicaid	2,691,808 (20.9)	138,665 (44.1)
Medicare	5,299,326 (41.1)	79,170 (25.2)
Other	451,999 (3.5)	18,996 (6)
Self-pay	434,509 (3.4)	28,050 (8.9)
Site of first hospitalization		
Government, nonfederal	1,510,993 (11.7)	56,833 (18.1)
Private, not-profit	9,628,471 (74.6)	212,336 (67.6)
Private, investor-owned	1,763,891 (13.7)	44,982 (14.3)
Metropolitan, teaching	8,783,784 (68.1)	227,410 (72.4)
Metropolitan, non-teaching	3,084,018 (23.9)	66,419 (21.1)
Nonmetropolitan	1,035,553 (8.0)	20,322 (6.5)
Functional limitations		
Functional limitations	101,476 (0.8)	2357 (0.8)
Comorbidities		
Congestive heart failure	1,187,134 (9.2)	23,432 (7.5)
Valvular disease	541,826 (4.2)	9653 (3.1)
Pulmonary circulation disorders	104,372 (0.8)	3009 (1.0)
Peripheral vascular disorders	749,141 (5.8)	13,263 (4.2)
Paralysis	418,590 (3.2)	9070 (2.9)
Other neurological disorders	108,3811 (8.4)	42,775 (13.6)
Chronic pulmonary disease	2,310,672 (17.9)	75,930 (24.2)
Diabetes	1,400,558 (10.9)	31,111 (9.9)
Diabetes with complications	1,623,837 (12.6)	33,205 (10.6)
Hypothyroidism	1,487,931 (11.5)	24,598 (7.8)
Renal failure	1,566,759 (12.1)	23,945 (7.6)
Liver disease	523,129 (4.1)	30,549 (9.7)
Peptic ulcer disease	120,141 (0.9)	3872 (1.2)
HIV/AIDS	23,392 (0.2)	3042 (1.0)
Lymphoma	87,651 (0.7)	1072 (0.3)
Metastatic cancer	289,136 (2.2)	3235 (1.0)
Solid tumor w/o metastasis	295,355 (2.3)	4533 (1.4)
Rheumatoid arthritis	358,236 (2.8)	6083 (1.9)
Coagulation deficiency	821,177 (6.4)	23,053 (7.3)
Obesity	2,075,910 (16.1)	45,821 (14.6)
Weight loss	790,775 (6.1)	27,912 (8.9)
Fluid and electrolyte disorders	3,436,551 (26.6)	100,637 (32)
Blood loss anemia	449,948 (3.5)	5,982 (1.9)
Deficiency anemias	2,195,739 (17)	61,662 (19.6)
Alcohol abuse	531,463 (4.1)	72,788 (23.2)
Drug abuse	521,323 (4.0)	101,578 (32.3)
Psychoses	429,068 (3.3)	50,731 (16.1)
Depression	1,581,814 (12.3)	81,207 (25.8)

**The "percent of patients with HRSN" will total to more than 100%, given patients with multiple domains of HRSN; p values are not displayed, due to the overwhelming sample size. In this analysis, all p values, using chi-squared tests for all comparisons except age, which was compared using a Kruskal-Wallis test, were significant (< 0.001, except functional limitations < 0.05), but that is largely due to sample size and provides little information on the meaningfulness of these differences*

HRSN (model 2b). In both models, 2a and 2b, the reference population consisted of individuals without a documented HRSN.

The analysis was conducted in SAS Version 9 and visualized using R version 3.6.0. This work was deemed as exempt by the Institutional Review Board (IRB # EM-14-30).

RESULTS

In 2017, there were 17,978,754 total hospitalizations of 13,217,506 unique patients in the Nationwide Readmission Database (NRD). From these, 2.4% (314,151) of patients had at least one HRSN recorded including, at the patient level: housing 1.2% (152,567); socioeconomic status (SES) 0.5% (70,242); family situations 0.5% (69,639); employment 0.4% (54,440); and psychosocial factors 0.2% (27,969) (Table 1). Among those with HRSN, 48.6% had housing-related needs; 22.4% SES; 22.2% family; 17.3% employment; 8.9% psychosocial. Two of the most common HRSN, and nearly all of individuals within the housing and employment domains respectively, were documented to experience homelessness (149,983, 98.3%) and unemployment (48,868, 89.8%). The complete list and description of codes included in the domains, as well as the number of patients with the specific codes can be found in Supplemental Table 1. For individuals with documented HRSN compared to those without HRSN, there was a higher proportion of males (56.7 vs. 40.6%), a higher proportion insured via Medicaid (44.1% vs 20.9%), and a higher proportion were seen at government, nonfederal hospitals (18.1% vs 11.7%).

There was a dose-response relationship between the number of domains ever coded and the percent of those patients readmitted within 30, 60, or 90 days. While the overall 30-day readmission rate was just 11.9%, for those with 1 domain it rose substantially to 27.0%, then steadily increased to 34.2%, 38.5%, 51.0%, and 63.5% for patients with 2 through 5 domains, respectively (Table 2, Fig. 1). This trend was observed with both 60- and 90-day rates with 78.7% of those patients with 5 domains being readmitted within 90 days, compared to only 18.1% of patients without documented HRSN (Table 2, Fig. 1).

The first multivariable logistic regression (model 1) revealed that being male and on Medicaid and all Elixhauser comorbidities were positively associated with having at least one readmission within 30 days (Table 3, Fig. 2). Among the comorbidities, cancer, solid tumors, and lymphoma had the largest effect size. After adjusting for sex, payer, comorbidities, functional limitations, and hospital characteristics, the number of domains remained positively associated with readmission with adjusted odds ratios ranging from 2.16 (95% CI: 2.13, 2.18) for those individuals with 1 domain to 12.55 (95% CI: 9.04, 17.43) for those with all 5 domains (Table 3, Fig. 2). These results were consistent in a sensitivity analysis where we used a multilevel logistic regression model with random effects at the facility level.

The second multivariable logistic regression, model 2, revealed that housing and employment HRSN had the highest adjusted odds ratios of 2.29 (95% CI: 2.26, 2.32) and 2.28 (95% CI: 2.23, 2.33) respectively (Table 4, Fig. 2). When this model was stratified to those with just 1 HRSN (model 2a) and those with 2 or more (model 2b), we saw a decrease in individual adjusted odds ratios for HRSN in model 2b compared to model 2a, except for housing, which rose to 3.04 (95% CI: 2.93, 3.16) (Table 4, Fig. 2).

DISCUSSION

To our knowledge, this study is one of the first, and the first using all-payer national data, to demonstrate a dose-response relationship between HSRN and readmission; specifically, as the magnitude of social need increases, so does the readmission rate (Fig. 1). Previous work has identified a relationship between high, compared to low, social need and readmission, while another found no dose-response relationship with mortality.[38,41] Our findings on this dose-response relationship further stand apart as the first paper of which we know where social need was captured and recorded in a clinical setting, at the individual level, using ICD-10 Z-codes. The observed relationship highlights that those with documented social needs are at an increased risk for hospital readmission, at much greater rates than those without documented needs (Fig. 1 and Table 2). This relationship is still present even after adjusting for sex, payer, comorbidities, functional limitations, and hospital characteristics with those individuals with HRSN in all 5 domains having 12.5 times the odds of having a 30-day readmission than those without any HRSN (Fig. 2 and Table 3). This work provides evidence of the utility

Table 2 Percent of Patients with a Readmission by the Number of Health-Related Social Needs (HRSN)

	Patients readmitted within:					
Number of HRSN domains, ever	30 days		60 days		90 days	
	Eligible	%	Eligible	%	Eligible	%
0	11,734,148	11.5	10,817,395	15.4	9,858,005	18.1
1	249,843	27.0	234,336	35.6	217,016	39.6
2	35,879	34.2	33,973	42.4	31,760	47.7
3	8276	38.5	7881	47.2	7419	52.2
4	1626	51.0	1568	60.1	1510	65.4
5	192	63.5	187	72.2	178	78.7
Overall	12,029,964	11.9	11,095,340	16.0	10,115,888	18.7

The eligible columns represent the number of individuals eligible for a readmission for that time frame, while the % columns represent the percent with a readmission

of ICD-10 Z-codes to document HRSN for intervention and research, by presenting estimates of readmission that are largely consistent with previous literature.[29]

When evaluating the role of specific HRSN, rather than the number of documented HRSN, we observed lower adjusted odds ratios than was found when considering the number of domains in model 1 (Table 4, Fig. 2). When this analysis was further stratified to those with 1 HRSN and those with 2 or more HRSN, we saw that for most HRSN, the adjusted odds ratio was even lower. The exception to this was for housing, which was higher. The increased odds ratios for model 2a underscore that while these individuals are *documented* to have only 1 HRSN, they likely have more than just 1. Specifically, in model 2a, there is likely confounding by other HRSN, which were not documented. This confounding is partially eliminated in model 2b, as it excludes individuals with just 1 documented HRSN. These findings further demonstrate the impact of having multiple, co-occurring HRSN and that when controlling for other HRSN domains, the effect size of a single HRSN is reduced. The direction of change for housing, while in the opposite direction as the others, confirms its critical role as a HRSN and its impact on readmission. This analysis also reaffirms that future work should continue to expand our understanding of the combinations of HRSN and the total effect on health and health outcomes.

Our findings also support the need to direct resources and interventions to this population and their communities in order to improve their health and wellbeing and reduce readmissions.[26,46] As two of the most common HRSN were homelessness and unemployment, and those two domains had the highest adjusted odds ratios in our models, interventions that focus on these two areas, such as permanent supportive housing and employment assistance, should be particularly emphasized.[47] However, the dose-response relationship in this study would also support the previously recognized need for programs that are prepared and equipped to address multiple domains of health-related social needs.[10] Hospitals should continue to expand efforts to connect patients with social needs to these programs and community partners.

From a healthcare administration and policy perspective, the expanded use of Z-codes would allow for the documentation of patients with complex social needs and ensure that hospitals are not unfairly penalized for care delivered when structural or social factors contribute to readmission. Recently, the Department of Health and Human Services recommended that outcome measures *not* be adjusted for social risk, citing a myriad of factors including lack of data collection and interoperability, and instead suggest "additional payments or bonuses" to safety net providers.[26] The expanded use of Z-codes could not only address the data collection and interoperability issue,

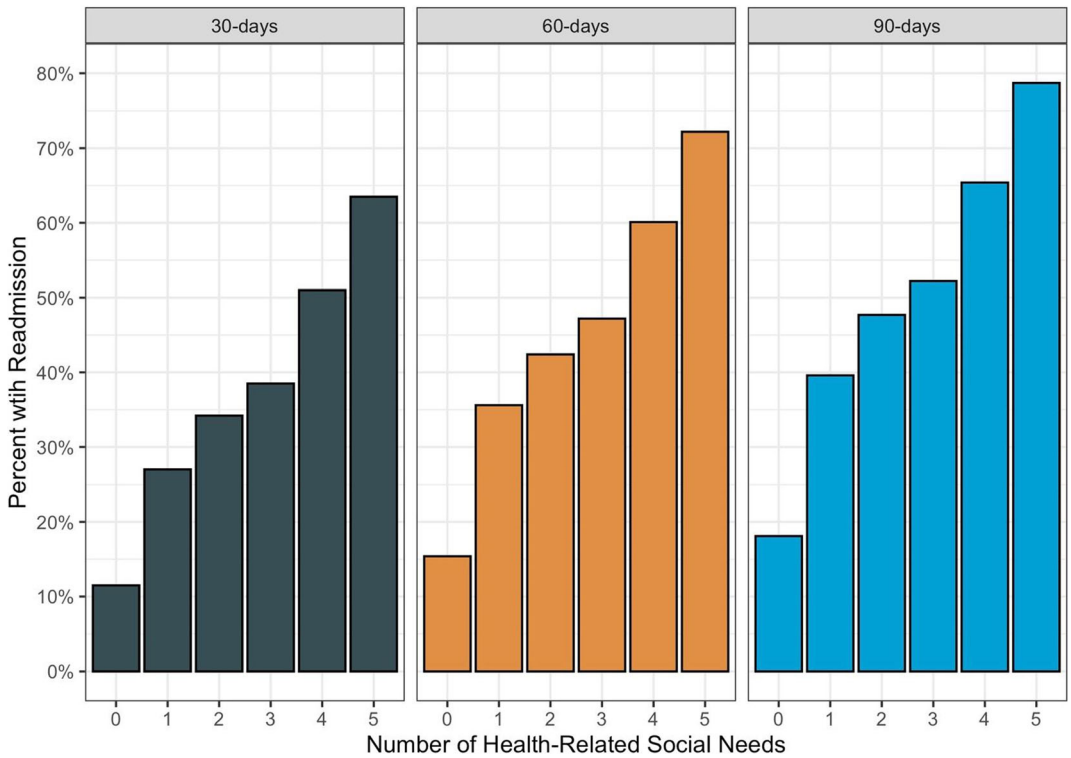

Figure 1 The relationship between the number of clinically acknowledged health-related social needs, via ICD-10 Z-codes, and percent of patients with a readmission

Table 3 Model 1 Unadjusted Odds Ratios, Adjusted Odds Ratios, and 95% Confidence Intervals for Ever Having a 30-day Readmission

	Model 1: number of HRSN	
Term	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Health-related social need domain counts		
0 HRSN domains (reference)	———	———
1 HRSN domain	2.84 (2.81, 2.87)	2.16 (2.13, 2.18)
2 HRSN domains	4.00 (3.91, 4.09)	4.14 (4.04, 4.25)
3 HRSN domains	4.82 (4.61, 5.04)	5.34 (5.08, 5.62)
4 HRSN domains	8.00 (7.26, 8.82)	8.03 (7.20, 8.96)
5 HRSN domains	13.26 (9.89, 17.78)	12.55 (9.04, 17.43)
Demographics		
Male	———	1.17 (1.16, 1.17)
Age	———	1.00 (1.00, 1.00)
Private insurance (reference)	———	———
Medicaid	———	1.09 (1.08, 1.09)
Medicare	———	1.05 (1.04, 1.05)
Other	———	0.96 (0.95, 0.98)
Self-pay	———	1.00 (0.98, 1.01)
Hospital characteristics		
Private, investor-owned (reference)	———	———
Government, nonfederal	———	1.03 (1.02, 1.03)
Private, not-profit	———	0.92 (0.91, 0.92)
Metropolitan, teaching (reference)	———	———
Metropolitan, non-teaching	———	0.95 (0.95, 0.96)
Nonmetropolitan	———	0.92 (0.91, 0.93)
Functional limitations		
Functional limitations	———	1.48 (1.46, 1.50)
Comorbidities		
Congestive heart failure	———	1.76 (1.75, 1.77)
Valvular disease	———	1.51 (1.50, 1.53)
Pulmonary circulation disorders	———	2.20 (2.16, 2.23)
Peripheral vascular disorders	———	1.70 (1.68, 1.71)
Paralysis	———	1.51 (1.50, 1.52)
Other neurological disorders	———	1.61 (1.60, 1.62)
Chronic pulmonary disease	———	1.51 (1.50, 1.51)
Diabetes	———	1.75 (1.74, 1.76)
Diabetes with complications	———	1.30 (1.30, 1.31)
Hypothyroidism	———	1.20 (1.19, 1.20)
Renal failure	———	1.50 (1.49, 1.51)
Liver disease	———	1.38 (1.37, 1.40)
Peptic ulcer disease	———	1.87 (1.84, 1.90)
HIV/AIDS	———	1.64 (1.59, 1.69)
Lymphoma	———	2.28 (2.25, 2.32)
Metastatic cancer	———	2.61 (2.58, 2.63)
Solid tumor w/o metastasis	———	2.37 (2.35, 2.40)
Rheumatoid arthritis	———	1.38 (1.37, 1.39)
Coagulation deficiency	———	1.49 (1.48, 1.50)
Obesity	———	1.35 (1.34, 1.35)
Weight loss	———	2.01 (2.00, 2.02)
Fluid and electrolyte disorders	———	2.36 (2.35, 2.37)
Blood loss anemia	———	1.55 (1.53, 1.57)
Deficiency anemias	———	2.00 (1.99, 2.00)
Alcohol abuse	———	1.26 (1.25, 1.27)
Drug abuse	———	1.88 (1.86, 1.89)
Psychoses	———	1.62 (1.61, 1.63)
Depression	———	1.64 (1.63, 1.65)

Model 1 evaluated the total number of health-related social needs (HRSN). Functional limitations and comorbidities were each included as their own variable, with the reference level being not having limitations or the respective comorbidity

as they are collected and stored in a standard format, but would also allow for a more clear and comparable analysis of the specific social needs patients at a given hospital, practice, or provider. Our work reaffirms the important relationship between social risk and outcomes.

This study is limited by the nature of administrative data, including lack of clinical depth and delay in data availability as well as limited demographic data available, notably race. However, this omission is consistent with recommendations to not use race in risk adjustment as a proxy for social risk as race is a socially constructed (and not biological) concept and therefore not a risk factor.[23,48] Unfortunately, the data used for this study capture only inpatient hospitalizations during a single year, and lack information regarding other care utilization (such as emergency department visits that do not result in hospitalization), prescription drug utilization, and other health histories. While the Elixhauser comorbidities are the gold standard in health services research and cover a broad range of conditions, they may not provide a complete picture of the specific comorbidities and health needs of those with documented HRSN. Future work should continue to examine the role of comorbidity and multimorbidity (the co-occurrence of chronic conditions, functional limitations, and/or geriatric syndromes[49]), as well as its association with outcomes, for this population. This may include expanding these often-used comorbidities to include conditions that are particularly important for this population.

A further limitation, and important to this analysis, is the underreporting of Z-codes, as they are not presently billable and not well known to providers. Reimbursement policies relevant to HRSN will likely lead to more complete documentation of Z-codes, and therefore, a better assessment of the health care needs in subgroups of the population with complex social needs. As mentioned above, there are almost certainly individuals who do not have any HRSN clinically documented but do in fact have these needs. This potential bias does not just exist at the individual level, but it is quite plausible that certain facilities or providers will be more likely to document HRSN with Z-codes than others or that certain facilities see a higher volume of patients with social needs and thus are more acutely aware of their coding. For this reason, these estimates of readmission may, in fact, be conservative, not representative of all patients with social needs, and the true dose-response relationship stronger than presently observed. On the other hand, the possibility exists that patients who have frequent admissions and frequent contact with care providers may be more likely to be assigned an HRSN code than patients who have fewer admissions and contacts. This reverse causality may partially inflate the observed relationship. Additionally, it is possible that social factors may be indirectly captured in other diagnosis codes, particularly related to a cause of injury and violence; however, this study sought to examine the use of codes dedicated for HRSN. While the use of Z-codes is still rare, this limitation provides an area for future research. First, to understand potential motivating factors of

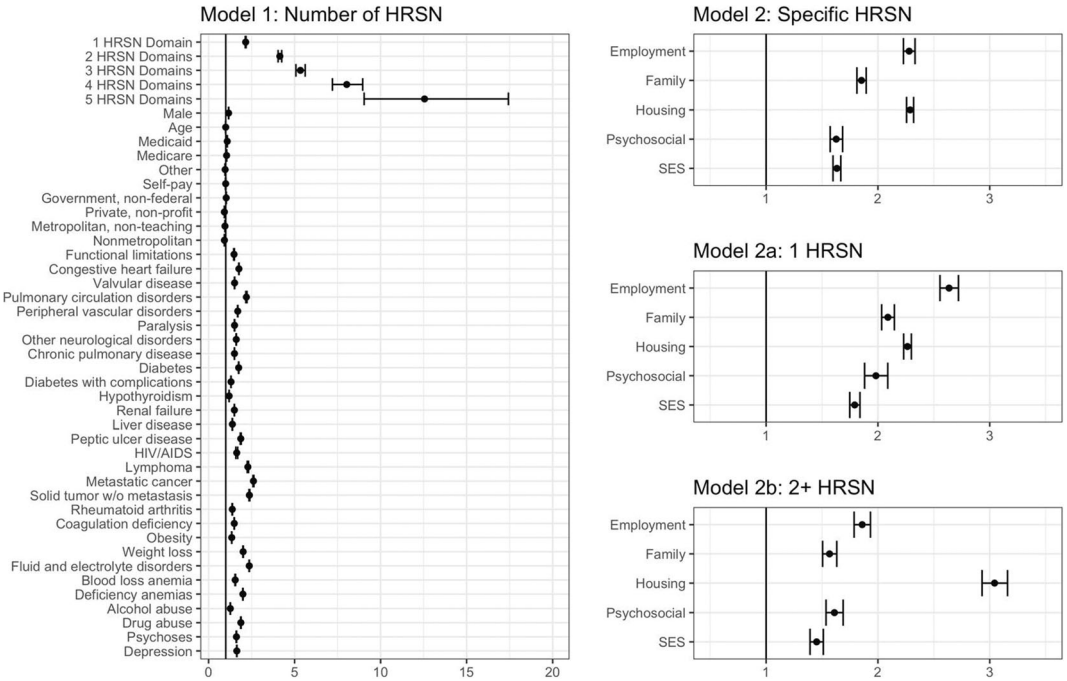

Figure 2 Odds ratios and 95% confidence intervals for logistic regression models, with an outcome of ever having a 30-day readmission adjusted for sex, age, payer, hospital characteristics, functional limitations, Elixhauser comorbidities, and the number of HRSN domains (model 1) and the specific HRSN domains (model 2). Model 2 was adjusted with the same covariates, which are not displayed due to nearly identical estimates and odds ratios (Supplemental Table 2). Model 2 was further stratified to those with only 1 HRSN (model 2a) and those with 2 or more HRSN (model 2b). Across models, reference levels include female, private insurance, private investor-owned, metropolitan teaching, and 0 documented HRSN (model 1 only)

documenting HRSN using Z-codes, as well as approaches that could estimate the current under-coding, including work to harness previous approaches (e.g., chart review, area-level measures) in combination with Z-codes as we continue to see their expanded use. In addition, care providers should continue to be made aware and trained in the use of Z-codes and the opportunity for documenting HRSN using standard ICD-10 codes.

In conclusion, the relationship between the number of documented HRSN domains and readmission remains even after adjusting for sex, age, payer, functional limitations, comorbidities, and hospital characteristics. This work should motivate the use of ICD-10 Z-codes to better identify and intervene for those who have social needs and promote utilizing these Z-codes to expand the body of knowledge on the impact of social needs and their associated community-level social determinants of health. Finally, this work should encourage change in reimbursement policies and quality improvement initiatives to continue addressing health-related social needs.

Table 4 Model 2, 2a, and 2b Unadjusted Odds Ratios, Adjusted Odds Ratios, and 95% Confidence Intervals for Ever Having a 30-day Readmission

Health-related social needs components[1]	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
	Model 2: specific HRSN	
Employment	3.42 (3.36, 3.49)	2.28 (2.23, 2.33)
Family	2.05 (2.02, 2.09)	1.85 (1.81, 1.90)
Housing	4.07 (4.03, 4.12)	2.29 (2.26, 2.32)
Psychosocial	2.54 (2.47, 2.61)	1.63 (1.57, 1.68)
SES	2.76 (2.71, 2.81)	1.63 (1.60, 1.67)
	Model 2a: 1 HRSN	
Employment	———	2.64 (2.56, 2.72)
Family	———	2.09 (2.03, 2.15)
Housing	———	2.26 (2.23, 2.30)
Psychosocial	———	1.98 (1.88, 2.09)
SES	———	1.79 (1.75, 1.84)
	Model 2b: 2+ HRSN	
Employment	———	1.86 (1.79, 1.93)
Family	———	1.57 (1.51, 1.63)
Housing	———	3.04 (2.93, 3.16)
Psychosocial	———	1.61 (1.54, 1.69)
SES	———	1.45 (1.39, 1.51)

[1]The HRSN component variables were each their own yes/no, and therefore, the unadjusted results come from 5 different unadjusted logistic regression models. Model 2 evaluated specific health-related social needs (HRSN). We display here only the variables of interest, as the covariate-adjusted odds ratios were nearly identical to model 1. They can be found in Supplemental Table 2

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