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Authors

Pak, Sang S
Jiang, Yuxi
Lituiev, Dmytro S
et al.

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Evaluating associations between social risks and health care utilization in patients with chronic low back pain

Sang S. Pak[a,*], Yuxi Jiang[a], Dmytro S. Lituiev[b], Emilia H. De Marchis[c], Thomas A. Peterson[b,d]

Abstract

Introduction: Care and outcomes for patients with chronic low back pain (cLBP) are influenced by the social risk factors that they experience. Social risk factors such as food insecurity and housing instability have detrimental effects on patient health and wellness, healthcare outcomes, and health disparities.

Objectives: This retrospective cross-sectional study examined how social risk factors identified in unstructured and structured electronic health record (EHR) data for 1,295 patients with cLBP were associated with health care utilization. We also studied the impact of social risk factors, controlling for back pain–related disability on health care utilization.

Methods: Included patients who received outpatient spine and/or physical therapy services at an urban academic medical center between 2018 and 2020. Five identified social risks were financial insecurity, housing instability, food insecurity, transportation barriers, and social isolation. Outcomes included 4 categories of health care utilization: emergency department (ED) visits/hospitalizations, imaging, outpatient specialty visits related to spine care, and physical therapy (PT) visits. Poisson regression models tested associations between the presence of identified social risks and each outcome measure.

Results: Identified social risks in 12.8% of the study population (N = 166/1,295). In multivariate models, social isolation was positively associated with imaging, specialty visits, and PT visits; housing instability was positively associated with ED visits/hospitalizations and imaging; food insecurity was positively associated with ED visits/hospitalizations and specialty visits but negatively associated with PT visits; and financial strain was positively associated with PT visits but negatively associated with ED visits/hospitalization.

Conclusion: These associations were seen above and beyond other factors used as markers of socioeconomic marginalization, including neighborhood-level social determinants of health, race/ethnicity, and insurance type. Identifying and intervening on social risk factors that patients with cLBP experience may improve outcomes and be cost-saving.

Keywords: Social risk factors, Chronic low back pain, Health care utilization, Social determinants of health, Physical therapy rehabilitation

1. Introduction

Social risk factors, also known as adverse social determinants of health, such as food insecurity and housing instability, have detrimental effects on patient health and wellness, health care outcomes, and health disparities.[2,47,54] Social and neighborhood-level risk factors contribute to health risk behaviors, pain-related disability, longer hospital lengths of stays, and readmission rates.[34,53,55,58,66,68] Less is known about how

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

[a] *Department of Physical Therapy and Rehabilitation Science, School of Medicine, University of California San Francisco, San Francisco, CA, USA,* [b] *Bakar Computational Health Sciences Institute, University of California San Francisco, San Francisco, CA, USA,* [c] *Department of Family & Community Medicine, University of California San Francisco, San Francisco, CA, USA,* [d] *Department of Orthopaedic Surgery, University of California San Francisco, San Francisco, CA, USA*

**Corresponding author. Address: Department of Physical Therapy and Rehabilitation Science, School of Medicine, University of California San Francisco, 1500 Owens St Suite 400, San Francisco, CA 94158. Tel.: 415-353-2570. E-mail address: sam.pak@ucsf.edu (S. S. Pak).*

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neighborhood and social risk factors affect chronic low back pain (cLBP) care.[36]

A recent systematic review calls out the independent and interdependent relationships between social risks and cLBP,[36] a leading cause of disability worldwide.[22,76,78] Despite the biopsychosocial model's comprehensive approach to understanding cLBP,[19] which integrates biological, psychological, and social aspects of health, prior studies on nonsurgical cLBP treatments have emphasized patients' biological and cognitive aspects while giving less attention to broader social factors.[43]

Previous studies of social risks and cLBP care have focused on a limited set of factors (eg, socioeconomic status and race).[29,62] Inclusion of additional social risk factors has been constrained by their underidentification by clinical teams, underreporting by patients, and underdocumentation in structured fields within electronic health records (EHR).[72,77] While there is a growing push to collect and document individual-level patient social risk factor information,[23,27,49,56] existing patient social risk data in EHRs are primarily found within free text notes and not easily extractable.

Promising new approaches leveraging machine learning are being developed to extract social risk data from free text notes.[42] Our study team previously created an annotated corpus of clinical notes using natural language processing (NLP) to evaluate the following individual-level social risk factors: housing instability, food insecurity, transportation barriers, utilities, insecurity, and social isolation.[42] Leveraging NLP models, we identified 45% more social risks using free text notes than structured data alone.[42] This work was conceptualized to enable researchers within our health system to extract patient social risk data from multiple EHR sources to enrich our understanding of the social risks our patients experience and the impact of these risks on their care.

Building upon our prior work,[42] this study aims to explore the associations between individual-level social risk factors identified within the EHR and their impact on health care utilization among patients with cLBP. We evaluated 4 primary utilization outcomes: emergency department (ED) visits or hospitalization, imaging, outpatient specialty visits related to cLBP, and physical therapy (PT) visits. We tested a set of models within our observational dataset to investigate the potential causal factors influencing health care utilization. Our data account for back pain–related disability measured using the Start Back Screening Tool (SBST) taken at the baseline visit, considering only the forward causality of back pain–related disability on health care utilization. We assume no iatrogenic effects of health care utilization on comorbidity scores during the study period, particularly as comorbidities are considered chronic in nature.

2. Methods

2.1. Data sources and patient characteristics

We conducted a retrospective cross-sectional study of adult patients with cLBP. To be included, patients had to have (1) a diagnosis of low back pain lasting at least 3 months[16] and (2) received care with our nonsurgical interdisciplinary care team for patients with cLBP between January 1, 2018 and January 1, 2020 at an urban academic medical center (University of California, San Francisco). The patients who received care from an interdisciplinary team were first seen and referred by primary care providers. Electronic health records data were queried and extracted for patients aged between 18 and 80 years with diagnosis of back pain lasting at least 3 months using related structured International Classification of Diseases-10 codes such as dorsalgia, lumbago, radiculopathy, or sciatica (Supplementary Table S1, http://links.lww.com/PR9/A250). Patients with diagnoses of cancer or other serious pathologic disorders, such as cauda equina syndrome or osteomyelitis (Supplementary Table S2, http://links.lww.com/PR9/A250 for full list), were excluded to minimize the confounding effects of these conditions on health care utilization for patients with cLBP.[4] The dataset consisted of key patient-level demographics, including age, sex, race, ethnicity, and primary health insurance type (**Table 1** for a full list of variable categories).

2.2. Individual-level social risk factors

Social risk factors were identified and extracted from both structured and unstructured EHR data.[42] We included 6 social risk factors: housing instability, food insecurity, transportation barriers, utility insecurity, financial strain, and social isolation. These domains were selected based on 4—housing, food, transportation, and utilities—being social risk domains required for reporting by the 2024 Center for Medicare & Medicaid Services Inpatient Quality Reporting measures.[23] We included financial strain as an overarching marker of difficulty accessing basic resources and social isolation, given its salient associations with adverse health and mortality outcomes[39,52,57,64] (Supplementary Table S3, http://links.lww.com/PR9/A250 for definitions of each social risk factor). Social risk data were derived by 3 methods of extraction: (1) structured data fields, including ICD-10 codes; (2) unstructured data identified by manual annotation; or (3) fields inferred by NLP hybrid model from unstructured free text clinical notes as described in a previous publication.[42] In addition to separate variables for each social risk factor, for exploratory data analysis, we created a dichotomized variable for the presence of one or more of the 6 risk factors and a continuous variable to evaluate a cumulative number of social risks (range 0–6) (**Table 1**).

2.3. Neighborhood-level social determinants

Neighborhood-level data were identified and collected from a publicly available dataset and geocoded information from primary residential ZIP (postal) codes within the EHR to provide additional contextual information for patients' socio-geographical environment. Neighborhood-level measures were (1) historical redlining (scores range 1–4; higher scores indicate greater historical redlining)[33] and (2) national Area Deprivation Index (ADI) (scores rank neighborhoods' socioeconomic disadvantage at the national level and range 10–100; higher scores indicate greater socioeconomic disadvantage at the census block group level)[50] (Supplementary Table S4, http://links.lww.com/PR9/A250 for additional detail).

2.4. Control variables

Our analyses controlled for patient demographics, health status, back pain–related disability, and chronic opioid use; all known to be associated with health care utilization for patients with cLBP.[3,17] These variables were captured through structured EHR data and 2 standardized patient-reported outcome measures collected at the initial integrated spine service or PT visit: Patient-Reported Outcomes Measurement Information System (PROMIS) and SBST. PROMIS-10 Global Health is a 10-item measure of health status that spans physical, mental, and social domains from the patient's perspective.[30] Start back screening tool is a clinical assessment tool to identify subgroups of 3 risk

Table 1

Characteristics of the 1,295 study patients with chronic low back pain.

Variables	N (%)	Median (25, 75 percentile)	Mean ± SD
Total	1,295 (100)		
Demographics			
Sex			
Male	515 (39.8)		
Female	777 (60.0)		
Unknown	3(0.2)		
Age (y)		54 (38, 68)	53.7 ± 17.5
18–34	229 (17.7)		
35–49	327 (25.3)		
50–64	323 (25.0)		
65–79	325 (25.1)		
80+	89 (6.9)		
Body mass index		25.4 (22.7, 29.5)	26.1 ± 7.2
BMI ≥25		703 (54.3)	
CCI score*		0 (0, 1)	0.6 ± 1.3
0	928 (71.7)		
1–2	262 (20.2)		
3–4	82 (6.3)		
≥5	23 (1.8)		
Race and ethnicity†			
White	573 (44.2)		
Asian	274 (21.2)		
Hispanic	147 (11.4)		
Black	124 (9.6)		
Native Hawaiian/other pacific Islander	22 (1.7)		
American Indian/Alaska native	5 (0.4)		
Other	94 (7.3)		
Declined	48 (3.7)		
Missing	8 (0.6)		
Primary insurance types			
Commercial	702 (54.2)		
Medicare	358 (27.6)		
Medi-Cal	180 (13.9)		
Uninsured	23 (1.8)		
Covered California	22 (1.7)		
Workers' Compensation	8 (0.6)		
Other	2 (0.2)		
Individual-level social risk factors‡			
Housing instability	56 (4.3)		
Food insecurity	51 (4.0)		
Transportation barriers	26 (2.0)		
Financial strain	59 (4.6)		
Social isolation	31 (2.4)		
1+ social risks	165 (12.8)		
Cumulative number of social risks		0 (0, 0)	0.2 ± 0.5
0	1,130 (87.3)		
1	117 (9.0)		
2	39 (3.0)		
3	7 (0.5)		
4	2 (0.2)		
5+	0 (0.0)		
Neighborhood-level social drivers			
Historic redlining score		3.2 (2.7, 3.8)	3.2 ± 0.8
National ADI rank		3.0 (2.4, 5.7)	5.2 ± 6.8
Health status			
STarTback baseline score			
Low risk	497 (38.4)		
Medium risk	471 (36.4)		
High risk	319 (24.6)		
Missing	8 (0.6)		
PROMIS physical T-score		42.3 (34.9, 47.7)	41.7 ± 8.6
PROMIS mental T-score		48.3 (41.1, 53.3)	47.0 ± 10.1
Health use of service			
Chronic opioid prescription	396 (30.6)		
Primary outcomes			
ED visits/hospitalizations		0 (0, 0)	0.4 ± 1.3
0 ED visits/hospitalization	1063 (82.1)		
1 ED visits/hospitalization	106 (8.2)		
≥2 ED visits/hospitalization	126 (9.7)		

(*continued on next page*)

Table 1 (*continued*)

Characteristics of the 1,295 study patients with chronic low back pain.

Variables	N (%)	Median (25, 75 percentile)	Mean ± SD
Imaging orders		0 (0, 2)	1.4 ± 2.9
0 imaging orders	866 (66.9)		
1 imaging orders	32 (2.5)		
≥2 imaging orders	397 (30.7)		
Specialty visits		1 (0, 6)	6.2 ± 13.0
0 specialty visits	626 (48.3)		
1 specialty visits	85 (6.6)		
≥6 specialty visits	361 (27.9)		
PT visits		5 (3, 9)	6.8 ± 6.6
3 PT visits	177 (13.7)		
5 PT visits	94 (7.3)		
≥9 PT visits	336 (25.9)		

* Charlson Comorbidity Index.

† Race is indicated for non-Hispanic individuals; Hispanics includes all races.

‡ Social risk data included were identified from any of the 3 sources of EHR data: structured data, unstructured data by manual annotation, and unstructured data by NLP.

ADI, area deprivation index; BMI, body mass index; PROMIS, patient-reported outcomes measurement information system; PT, physical therapy.

levels (low, medium, high) for patients with back pain–related disability to map prognostic physical and psychological factors using 9 screening items.[6,74] A marker of medical comorbidity was assessed by EHR-documented diagnosis codes using the Charlson Comorbidity Index (CCI).[12]

There is increasing evidence on the harms of opioid analgesics for cLBP.[13,40] We controlled for the chronic opioid use, defined as patients prescribed or dispensed opioid medications for more than 90 days during the course of the study period.[18] Data came from the UCSF opioid registry within the EHR vendor Epic Systems Corporation. The registry represents all patients in the health system with one or more documented opioid prescriptions filled between 2018 through 2020.

2.5. Primary outcomes

Health care utilization outcomes included (1) ED visits/hospitalization, (2) imaging, (3) outpatient visits with specialists relevant to cLBP, and (4) physical therapy (PT) visits. Utilization metrics had to occur during the study period and were captured only if they occurred within our study academic medical center. Imaging was defined as any completed imaging that included any MRI, CT scan, or X-ray of any body region since patients with cLBP have high rates of chronic pain at nonback pain sites.[25,26] Specialty care relevant to cLBP included a completed outpatient visit with one or more of the following specialists: orthopedic spine, neuro spine, pain management, orthopedic surgery, and neurosurgery. Completed PT visits were studied as a separate outcome variable. All outcome variables were treated as continuous measures.

2.6. Statistical analyses

We first computed descriptive statistics for all variables of patient cohort characteristics. We then performed univariate, bivariate, and multivariate analysis by using *t* test, correlation coefficients, and regression models.

Spearman rank correlation coefficients and point-biserial correlation coefficients[31] were used to examine pairwise relationships between each of our 4 health care utilization outcome measures and explanatory variables, including demographic information, social risk factors, health status, and neighborhood-level social determinants. Heat mapping was used to visually delineate the strongest correlated variables with each primary outcome measure (Supplementary Figure S1, http://links.lww.com/PR9/A250).

A series of Poisson regression models were constructed using R glm and stats packages where our 4 health care utilization measures were regressed on all explanatory variables. This approach was chosen due to better model fit and better convergence properties compared to negative binomial and zero-inflated models. We excluded social risk factors related to utilities from our analysis, as only one observation pertaining to this variable was captured in our cohorts. We controlled for patient demographics, health status, and chronic opioid use (Supplementary Table S5 and Table S6, http://links.lww.com/PR9/A250). The incidence rate ratios[37] were obtained along with 95% confidence intervals. We controlled for patient demographics, health status, and chronic opioid use (Supplementary Table S5 and Table S6, http://links.lww.com/PR9/A250). *P*-values were adjusted using Benjamini–Hochberg procedure.[1] ANOVA was used to assess the impact of SBST score and social risk factors on the primary outcomes. A proportional odds logistic regression model[20] was used to assess the association between SBST score and social risk factors. Lastly, we investigated causal and correlational relationships between explanatory variables on health care utilization outcomes using structural equation modeling[10] with the Lavaan R package.[15] As the package allows for Gaussian linear regression only, we transformed health care utilization variables to log2 (y + 1). We encoded relationships between the variables based on our assumptions outlined in Supplementary Figure S2, http://links.lww.com/PR9/A250. This study protocol was approved by the University of California San Francisco Institutional Review Board (19-29016).

3. Results

3.1. Study population

Table 1 describes our cohort comprised of 1,295 adult patients with a median age of 54 years (SD = 17.5). Sixty percent were female (N = 777), 44.2% non-Hispanic White (N = 573), 21.2% non-Hispanic Asian (N = 274), and 11.4% Hispanic (N = 147). Most patients had commercial insurance (54.2%), followed by Medicare (27.6%) and Medi-Cal (13.9%). Over 10% of patients (12.8%, N = 165) had at least one social risk factor identified from our 3 data extraction methods (Supplementary Figure S3, http://links.lww.com/PR9/A250). Of the 6 social risk factors, financial strain was the most commonly identified across all the data extraction methods (4.6%, N = 59). For neighborhood characteristics, close to half (43.9%, N = 568) of patients had residential addresses in regions with historic redlining scores greater than 3.

Over 90% of patients (90.9%, N = 1177) had resident addresses linked to national ADI rankings score under 10.

Individual patient health care utilization varied across our 4 primary outcomes. Physical therapy and specialty visits had the highest mean values (mean = 6.8, SD = 6.6; mean = 6.2, SD = 13.0, respectively), followed by imaging (mean = 1.4, SD = 2.9) and ED visits/hospitalization (mean = 0.4, SD = 1.3). Almost 10% of our cohort (9.7%, N = 126) had greater than one ED visit/hospitalization; 30.7% (N = 397) had greater than one completed imaging orders; 27.9% (N = 361) had greater than 5 spine health–related specialty visits; and 25.9% (N = 336) had greater than 8 PT visits. Further, nearly 38% (N = 491) used one instance of health care utilization (Supplementary Table S7, http://links.lww.com/PR9/A250).

3.2. Association of health care utilization with social risk factors and control variables

In multivariate Poisson regression, several individual social risk factors were significantly associated with our 4 health care utilization outcomes (**Fig. 1**). Social isolation was positively associated with 3 utilization outcomes: imaging (IRR = 2.02, $P < 0.01$), specialty (IRR = 1.41, $P < 0.01$), and PT visits (IRR = 1.36, $P < 0.01$); housing instability was positively associated with ED visits/hospitalizations (IRR = 2.10, $P < 0.01$) and imaging (IRR = 1.41, $P < 0.01$); food insecurity was positively associated with ED visits/hospitalizations (IRR = 2.01, $P < 0.01$) and specialty visits (IRR = 1.50, $P < 0.01$) but negatively associated with PT visits (IRR = 0.68, $P < 0.01$); financial strain was positively associated with PT visits (IRR = 1.19, $P < 0.01$) but negatively associated with ED visits/hospitalizations (IRR = 0.26, $P < 0.01$). For neighborhood-level factors, historic redlining was positively associated with ED visits/hospitalizations (IRR = 1.34, $P < 0.01$).

Among other factors commonly used as proxies of social risks, commercial (IRR = 0.32, $P < 0.01$) and Medicare (IRR = 0.37, $P < 0.01$) insurance types were both negatively associated with ED visits/hospitalization. However, Workers' Compensation payer type was positively associated with both imaging utilization (IRR = 1.68, $P = 0.03$) and PT visits (IRR = 1.70, $P < 0.01$) but negatively associated with specialty visits (IRR = 0.53, $P < 0.01$). Significant differences and variations were observed among race and ethnicity groups associated with each primary outcome: patients identified as American Indian or Alaska Native (IRR = 7.85, $P < 0.01$), Black and African American (IRR = 2.26, $P < 0.01$), and Hispanic or Latino (IRR = 1.80, $P < 0.01$) had significantly more ED visits/hospitalizations compared to patients identified as White. While having higher risk of hospitalization, Hispanic or Latino patients had significantly lower utilization of all other health care resources (imaging: IRR = 0.58, $P < 0.01$; specialty visits: IRR = 0.60, $P < 0.01$; and PT visits: IRR = 0.88, $P < 0.01$). Hawaiian/Pacific Islander and Asian patients had significantly fewer specialty (Hawaiian/Pacific Islander: IRR = 0.35, $P < 0.01$; Asian: IRR = 0.58, $P < 0.01$) and PT visits (Hawaiian/Pacific Islander: IRR = 0.71, $P < 0.01$; Asian: IRR = 0.71, $P < 0.01$). Both historic redlining (IRR = 0.96, $P < 0.01$) and higher ADI values (IRR = 0.97, $P < 0.01$) were associated with lower utilization of PT care. Historic redlining was also associated with lower use of specialty care (IRR = 0.93, $P < 0.01$) and higher hospitalization/ED visit rate (IRR = 1.34, $P < 0.01$).

Among control variables, chronic opioid prescription showed the strongest association across all health care utilization outcomes (ED visits/hospitalizations: IRR = 1.77, $P < 0.01$; imaging: IRR = 1.99, $P < 0.01$; specialty visits: IRR = 2.29, $P < 0.01$; PT visits: IRR = 1.29, $P < 0.01$). Surprisingly, higher CCI was associated with lower utilization of imaging (IRR = 0.93, $P < 0.01$), specialty (IRR = 0.93, $P < 0.01$), and PT care (IRR = 0.97, $P = 0.02$). Bivariate model results were summarized in Supplementary Table S8 and Table S9, http://links.lww.com/PR9/A250 and largely agree with the multivariate model available in Supplementary Table S10 and Table S11, http://links.lww.com/PR9/A250.

The ANOVA analysis showed that the health care utilization outcomes were affected by cumulative number of social risks when controlling for back pain–related disability from the SBST score (Supplementary Tables S12a-e, http://links.lww.com/PR9/A250). These results remained consistent after further adjustment for demographic variables (eg, age, sex, CCI score, and race/ethnicity). Health care utilization outcomes were also affected by CCI score when controlling for cumulative social risks and back pain–related disability. Further, the transportation barriers were positively associated with the SBST score (Supplementary Table S13, http://links.lww.com/PR9/A250).

3.3. Causal relations discovered through structural equation modeling

Our structural equation models showed that older age had a strong negative impact on comorbidities (measured by CCI) and a positive impact on all health care utilizations except PT visits. Among race/ethnicity factors, White patients had more specialty visits, while Black patients had more ED visits/hospitalizations. In addition, patients who identified as Asian had fewer PT visits. Back pain–related disability contributed significantly to higher health care utilization except for PT visits. No significant association was found between back pain–related disability and comorbidities. Further, among individual-level social risk factors, housing instability contributed to higher rates of ED visits/hospitalizations; social isolation contributed to higher utilization of imaging; financial insecurity contributed to fewer ED visits/hospitalizations.

4. Discussion

Our study is the first, to our knowledge, to evaluate associations between health care utilization outcomes and patient-level social risk factors identified from structured EHR fields and free text clinical notes in patients with chronic low back pain (cLBP). We studied causal inference using structural equation models between both back pain–related disability and social risk factors with health care utilization. Overall, we identified social risks in just over 10% of our cLBP patient cohort. Our multivariate models demonstrated that specific social risk factors, such as patient-level housing instability and food insecurity, in addition to neighborhood-level historic redlining, were associated with increased ED visits/hospitalizations, above and beyond other factors commonly associated with health care disparities, including identifying as a racial/ethnic group that has been subject to systemic/systematic racism/discrimination and under-insurance.[55] Our findings indicate that social risk factors and back pain–related disability (ie, SBST scores) independently influence health care utilization outcomes (Supplementary Table S12c-d, http://links.lww.com/PR9/A250). This effect remained significant even when controlling for the other factor. The CCI scores also significantly affected health care utilization when considering both social risk and SBST (Supplementary Tables S12a-e, http://links.lww.com/PR9/A250). While level of disability status has been shown to increase health care utilization in patients with cLBP,[21] our study results suggest that it is important to also account for social risk factors beyond sociodemographics and disability

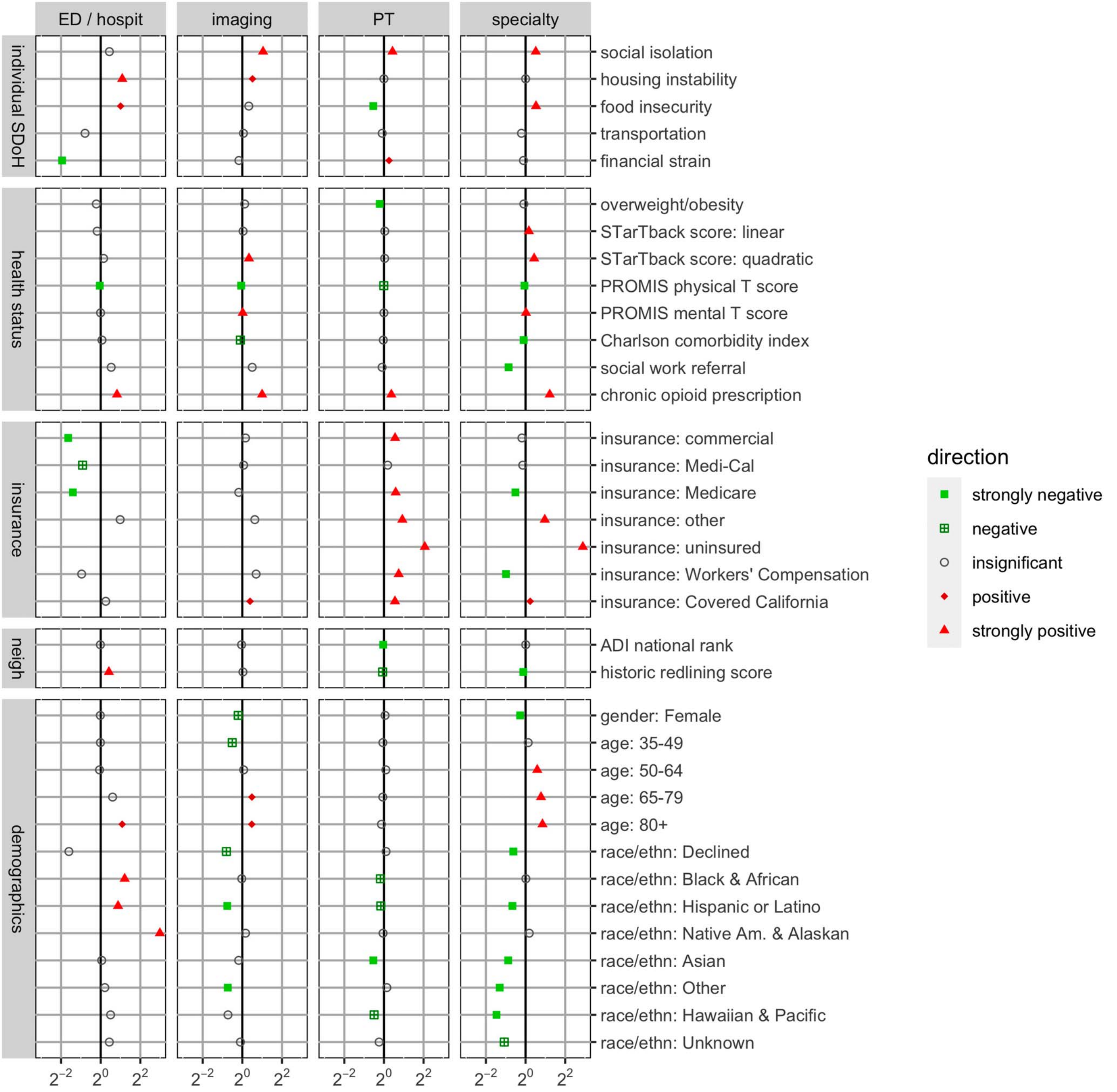

Figure 1. Multivariate associations between individual-level social risk and neighborhood-level factors with 4 health care utilization outcomes: ED visits/hospitalizations and imaging (N = 1,295 patients with cLBP). IRR (incident rate ratio) values are presented along the x-axis on a log scale. IRR values with adjusted *P*-values < 0.001 are highlighted as highly positive or negative association. For demographic variables, the reference group was non-Hispanic White ethnicity, male gender, and age under 35 years. For StartBack score, medium risk was taken as reference group for comparison. cLBP, chronic low back pain; ED, emergency department.

status (Supplementary Figure S2, http://links.lww.com/PR9/A250). Increased ED and hospital utilizations can be significant cost drivers, with over 10 times higher expenses than care delivered in urgent or primary care clinics.[73] Prior studies have demonstrated associations between increased hospital utilization in patients experiencing housing instability who have mental, behavioral, and neurodevelopmental disorders.[61] Food insecurity has similarly been associated with higher health care costs and utilization.[8] Our study suggests similar associations in patients with cLBP.

Both housing instability and social isolation were associated with receiving more imaging. As imaging is often ordered during ED visits/hospitalizations, it is not surprising that housing instability would be associated with both ED visits/hospitalizations and imaging. Social isolation trended toward more ED visits/hospitalizations, but this was not statistically significant. The existing literature has found positive associations between social isolation and higher hospitalization rates, primarily in older adult populations.[5,44,60,75] While specific studies on the association between imaging utilization and social isolation are limited, current evidence in cLBP studies suggests that non-adherence to clinical practice guidelines for early imaging orders increases unnecessary costs for outpatient services, excessive surgery, and other procedures and worse outcomes.[28,35,51]

Housing instability and social isolation were also both associated with more specialty visits. Both social isolation and financial strain were associated with more PT visits, which may be a marker of more severe cLBP but could also suggest greater engagement in self-management. Food insecurity and housing instability were associated with fewer PT visits. Previous studies in other populations, including pediatrics,[71] adults with multiple chronic diseases,[70] and patients with diabetes,[7] have also suggested that food insecurity and housing instability contribute to the development of cLBP.[59]

Our findings suggest that identifying individual patient-level social risk factors may help future studies to understand associations with utilization, given these results were significant in models that controlled for other variables commonly associated with utilization, including medical comorbidities and age,[32,63] and those that are used as proxies for health disparities, including race/ethnicity.[41] Growing efforts to identify patients' social risk factors[27] may provide future opportunities to further study on the upstream factors that may contribute to avoidable/adverse utilization (eg, ED visits/hospitalizations) while increasing access to others (eg, PT visits) to improve cLBP outcomes.

Neighborhood-level social determinants were also associated with our utilization outcomes and the aforementioned individual-level social risks.[67] Only living in areas of historic redlining was associated with more ED visits/hospitalizations in our multivariable models. Living in areas of historic redlining was negatively associated with visits to spine health–related specialty care, and both markers of adverse neighborhood-level social determinants (ie, ADI and historic redlining) were associated with fewer PT visits. A scoping review by Swope et al. outlined evidence of the association between historical redlining and current health outcomes.[69] Recent research suggests that multiple chronic conditions are affected by historical redlining, including diabetes, hypertension, stroke, poorer mental health,[46] and asthma.[45] While further research is needed to account for other potential causal factors, to our knowledge, this is the first study suggesting associations between historical redlining and utilization in patients with cLBP.

The consistent associations between adverse neighborhood-level social determinants and completing fewer PT visits may relate to different upstream factors on access to care.[99] Previous studies using area-based measures have shown that regions with higher ADI scores had population characteristics associated with decreased non-ER or preventative care, such as lower health literacy[38] and limited physical activities.[79] While other potential upstream factors, such as transportation barriers, may influence how individuals utilize care, our study showed that individual-level transportation social risk did not yield statistically significant results. This finding may suggest that data on adverse neighborhood-level determinants of health may better capture patients' overall risk of access barriers than what our patient-level data extraction techniques were able to identify in our health system's EHR data. However, prior research has demonstrated that neighborhood-level data alone is inadequate at capturing patients' individual experiences with social risk factors compared to social risks identified through standardized screening, which our study health system was not conducting during the study period.[11,14] It is possible that as data collection on individual social risks expands, we will see both a higher level of social risks in our patient population and different associations with utilization.

The biopsychosocial model within conservative cLBP literature has a limited focus on social factors, including employment, family relationships, and socioeconomic factors.[43] Additional social risks, such as living situations and environmental factors, have been less commonly reported.[42,43] Our study indicates that while social risk factors in general are associated with health care utilization in patients with cLBP, certain social risk factors may have greater impacts on specific types of utilizations evidenced by the strong association between social isolation and ED visits/hospitalizations (Supplementary Figures S4 and S5, http://links.lww.com/PR9/A250). These utilization metrics can be costly and burdensome on patients and are not always evidence-based.[28,51] Growing awareness of the importance of patients' social risk factors on health and wellness has led to recent incentives for health systems to increase the identification of, and subsequent intervention on patients' social risk factors, with the underlying goal of improving health equity.[27] Increasing health care team awareness of patients' social contexts—including individual-level social risk factors and neighborhood-level social determinants—can help identify patients who may benefit from further elicitation concerning their priorities and desires for assistance, leading to more shared decision making in the delivery methods and treatment options.[24,48,60,65]

4.1. Limitations

There are several study limitations. First, our dataset identified low prevalence of social risk factors in our patient cohort across all EHR data sources. This may be related to underidentification of social risk factors and/or a low prevalence of social risks our study population experienced and/or disclosed. Further, they received care from a multidisciplinary team and may have had more access to care compared to those out-of-care patients with cLBP. This difference may have resulted in selection bias related to a lower experience of SDoH compared to other patients with cLBP. While we used social risk data extracted from both structured and unstructured data, NLP techniques are still in the research stage. Second, our patient cohort was limited to a single large urban medical center; our findings may not be generalizable to other settings. Third, our study data could not distinguish between the types of utilization for our study outcomes (eg, some ED visits/hospitalizations may be unavoidable and/or may have been unrelated to patients' cLBP care). While we narrowed the types of specialty visits to be more specific to cLBP care, we could not verify that specialty visits were specific to patients' cLBP care. Similarly, we did not narrow imaging beyond MRIs, CT scans, X-rays, and having a diagnosis of cLBP. Further, we could not verify that PT visits were only for patients' cLBP. However, since patients with cLBP often have chronic overlapping pain conditions, this PT utilization metric will still capture overall PT utilization. To our knowledge, this study remains the first to explore patients with cLBP's individual social risk factors identified from multiple sources of EHR data, as well as neighborhood-level social determinants. It is important to understand how patients' social contexts affect their utilization outcomes.

5. Conclusion

Our study demonstrated that multiple patient-level social risk factors were associated with higher rates of often avoidable/unnecessary utilization outcomes in patients with cLBP, including ED visits/hospitalizations and imaging, while associated with lower preventative utilization outcomes, such as PT visits. Social risks contributed above and beyond other markers of experience of socioeconomic marginalization and discrimination, including race/ethnicity, insurance type, and living in areas of historic redlining. This study supports the growing quality incentives around identifying and intervening on patient's social risk factors.

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Data: The dataset generated and/or analysed during the current study is not publicly available due to data owned and compiled by UCSF but is available from the corresponding author on reasonable request.

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References

[1] Akaike H. A new look at the statistical model identification. IEEE Trans Automat Contr 1974;19:716–23.

[2] Alderwick H, Gottlieb LM. Meanings and misunderstandings: a social determinants of health lexicon for health care systems. Milbank Q 2019; 97:407–19.

[3] Allen-Watts K, Sims AM, Buchanan TL, DeJesus DJB, Quinn TL, Buford TW, Goodin BR, Rumble DD. Sociodemographic differences in pain medication usage and healthcare provider utilization among adults with chronic low back pain. Front Pain Res 2021;2:806310.

[4] Amundsen PA, Evans DW, Rajendran D, Bright P, Bjørkli T, Eldridge S, Buchbinder R, Underwood M, Froud R. Inclusion and exclusion criteria used in non-specific low back pain trials: a review of randomised controlled trials published between 2006 and 2012. BMC Musculoskelet Disord 2018;19:113.

[5] Barnes TL, MacLeod S, Tkatch R, Ahuja M, Albright L, Schaeffer JA, Yeh CS. Cumulative effect of loneliness and social isolation on health outcomes among older adults. Aging Ment Health 2022;26:1327–34.

[6] Beneciuk JM, Fritz JM, George SZ. The STarT Back Screening Tool for prediction of 6-month clinical outcomes: relevance of change patterns in outpatient physical therapy settings. J Orthop Sports Phys Ther 2014;44: 656–64.

[7] Berkowitz SA, Kalkhoran S, Edwards ST, Essien UR, Baggett TP. Unstable housing and diabetes-related emergency department visits and hospitalization: a nationally representative study of safety-net clinic patients. Diabetes Care 2018;41:933–9.

[8] Berkowitz SA, Seligman HK, Meigs JB, Basu S. Food insecurity, healthcare utilization, and high cost: a longitudinal cohort study. Am J Manag Care 2018;24:399–404.

[9] Bharmal N, Derose KP, Felician M, Weden MM, Health R. Understanding the upstream social determinants of health. Santa Monica: Rand Corporation; 2015.

[10] Bollen KA. Structural equation models with observed variables. Structural equations with latent variables. Hoboken: John Wiley & Sons, Ltd; 1989: 80–150.

[11] Brown EM, Franklin SM, Ryan JL, Canterberry M, Bowe A, Pantell MS, Cottrell EK, Gottlieb LM. Assessing area-level deprivation as a proxy for individual-level social risks. Am J Prev Med 2023;65:1163–71.

[12] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373–83.

[13] Cherkin DC, Sherman KJ, Balderson BH, Cook AJ, Anderson ML, Hawkes RJ, Hansen KE, Turner JA. Effect of mindfulness-based stress reduction vs cognitive behavioral therapy or usual care on back pain and functional limitations in adults with chronic low back pain: a randomized clinical trial. JAMA 2016;315:1240–9.

[14] Cottrell EK, Hendricks M, Dambrun K, Cowburn S, Pantell M, Gold R, Gottlieb LM. Comparison of community-level and patient-level social risk data in a Network of community health centers. JAMA Netw Open 2020; 3:e2016852.

[15] CRAN: package lavaan. Available at: https://cran.r-project.org/web/packages/lavaan/index.html. Accessed May 20, 2024.

[16] Deyo RA, Dworkin SF, Amtmann D, Andersson G, Borenstein D, Carragee E, Carrino J, Chou R, Cook K, Delitto A, Goertz C, Khalsa P, Loeser J, Mackey S, Panagis J, Rainville J, Tosteson T, Turk D, Von Korff M, Weiner DK. Report of the NIH Task Force on research standards for chronic low back pain. Phys Ther 2015;95:e1–18.

[17] Deyo RA, Von Korff M, Duhrkoop D. Opioids for low back pain. BMJ 2015; 350:g6380.

[18] Dowell D, Ragan KR, Jones CM, Baldwin GT, Chou R. CDC clinical practice guideline for prescribing opioids for pain—United States, 2022. MMWR Recomm Rep 2022;71:1–95.

[19] Engel GL. The need for a new medical model: a challenge for biomedicine. Science 1977;196:129–36.

[20] Everitt B. Book reviews. In: Chambers JM, Hastie TJ, eds. Statistical models in S. California: Wadsworth and Brooks/Cole. ISBN 0 534 16765-9. London: Sage Publications; 1992:1:220–1.

[21] Fatoye F, Gebrye T, Mbada CE, Useh U. Clinical and economic burden of low back pain in low- and middle-income countries: a systematic review. BMJ Open 2023;13:e064119.

[22] Ferreira ML, de Luca K, Haile LM, Steinmetz JD, Culbreth GT, Cross M, Kopec JA, Ferreira PH, Blyth FM, Buchbinder R, Hartvigsen J, Wu A-M, Safiri S, Woolf AD, Collins GS, Ong KL, Vollset SE, Smith AE, Cruz JA, Fukutaki KG, Abate SM, Abbasifard M, Abbasi-Kangevari M, Abbasi-Kangevari Z, Abdelalim A, Abedi A, Abidi H, Adnani QES, Ahmadi A, Akinyemi RO, Alamer AT, Alem AZ, Alimohamadi Y, Alshehri MA, Alshehri MM, Alzahrani H, Amini S, Amiri S, Amu H, Andrei CL, Andrei T, Antony B, Arabloo J, Arulappan J, Arumugam A, Ashraf T, Athari SS, Awoke N, Azadnajafabad S, Bärnighausen TW, Barrero LH, Barrow A, Barzegar A, Bearne LM, Bensenor IM, Berhie AY, Bhandari BB, Bhojaraja VS, Bijani A, Bodicha BBA, Bolla SR, Brazo-Sayavera J, Briggs AM, Cao C, Charalampous P, Chattu VK, Cicuttini FM, Clarsen B, Cuschieri S, Dadras O, Dai X, Dandona L, Dandona R, Dehghan A, Demie TGG, Denova-Gutiérrez E, Dewan SMR, Dharmaratne SD, Dhimal ML, Dhimal M, Diaz D, Didehdar M, Digesa LE, Diress M, Do HT, Doan LP, Ekholuenetale M, Elhadi M, Eskandarieh S, Faghani S, Fares J,

Fatehizadeh A, Fetensa G, Filip I, Fischer F, Franklin RC, Ganesan B, Gemeda BNB, Getachew ME, Ghashghaee A, Gill TK, Golechha M, Goleij P, Gupta B, Hafezi-Nejad N, Haj-Mirzaian A, Hamal PK, Hanif A, Harlianto NI, Hasani H, Hay SI, Hebert JJ, Heidari G, Heidari M, Heidari-Soureshjani R, Hlongwa MM, Hosseini M-S, Hsiao AK, Iavicoli I, Ibitoye SE, Ilic IM, Ilic MD, Islam SMS, Janodia MD, Jha RP, Jindal HA, Jonas JB, Kabito GG, Kandel H, Kaur RJ, Keshri VR, Khader YS, Khan EA, Khan MJ, Khan MAB, Khayat Kashani HR, Khubchandani J, Kim YJ, Kisa A, Klugarová J, Kolahi A-A, Koohestani HR, Koyanagi A, Kumar GA, Kumar N, Lallukka T, Lasrado S, Lee W-C, Lee YH, Mahmoodpoor A, Malagón-Rojas JN, Malekpour M-R, Malekzadeh R, Malih N, Mehndiratta MM, Mehrabi Nasab E, Menezes RG, Mentis A-FA, Mesregah MK, Miller TR, Mirza-Aghazadeh-Attari M, Mobarakabadi M, Mohammad Y, Mohammadi E, Mohammed S, Mokdad AH, Momtazmanesh S, Monasta L, Moni MA, Mostafavi E, Murray CJL, Nair TS, Nazari J, Nejadghaderi SA, Neupane S, Neupane Kandel S, Nguyen CT, Nowroozi A, Okati-Aliabad H, Omer E, Oulhaj A, Owolabi MO, Panda-Jonas S, Pandey A, Park E-K, Pawar S, Pedersini P, Pereira J, Peres MFP, Petcu I-R, Pourahmadi M, Radfar A, Rahimi-Dehgolan S, Rahimi-Movaghar V, Rahman M, Rahmani AM, Rajai N, Rao CR, Rashedi V, Rashidi M-M, Ratan ZA, Rawaf DL, Rawaf S, Renzaho AMN, Rezaei N, Rezaei Z, Roever L, Ruela G de A, Saddik B, Sahebkar A, Salehi S, Sanmarchi F, Sepanlou SG, Shahabi S, Shahrokhi S, Shaker E, Shamsi M, Shannawaz M, Sharma S, Shaygan M, Sheikhi RA, Shetty JK, Shiri R, Shivalli S, Shobeiri P, Sibhat MM, Singh A, Singh JA, Slater H, Solmi M, Somayaji R, Tan K-K, Thapar R, Tohidast SA, Valadan Tahbaz S, Valizadeh R, Vasankari TJ, Venketasubramanian N, Vlassov V, Vo B, Wang Y-P, Wiangkham T, Yadav L, Yadollahpour A, Yahyazadeh Jabbari SH, Yang L, Yazdanpanah F, Yonemoto N, Younis MZ, Zare I, Zarrintan A, Zoladl M, Vos T, March LM. Global, regional, and national burden of low back pain, 1990–2020, its attributable risk factors, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. Lancet Rheumatol 2023;5:e316–29.

[23] FY 2024 hospital inpatient prospective payment system (IPPS) and long-term care hospital prospective payment system (LTCH PPS) final rule—CMS-1785-F and CMS-1788-F fact sheet. CMS. Available at: https://www.cms.gov/newsroom/fact-sheets/fy-2024-hospital-inpatient-prospective-payment-system-ipps-and-long-term-care-hospital-prospective-0. Accessed October 3, 2023.

[24] Garg A, Boynton-Jarrett R, Dworkin PH. Avoiding the unintended consequences of screening for social determinants of health. JAMA 2016;316:813–4.

[25] Giesecke T, Gracely RH, Grant MAB, Nachemson A, Petzke F, Williams DA, Clauw DJ. Evidence of augmented central pain processing in idiopathic chronic low back pain. Arthritis Rheum 2004;50:613–23.

[26] Gore M, Sadosky A, Stacey BR, Tai KS, Leslie D. The burden of chronic low back pain: clinical comorbidities, treatment patterns, and health care costs in usual care settings. Spine (Phila Pa 1976) 2012;37:E668–77.

[27] Gottlieb LM, DeSilvey SC, Fichtenberg C, Bernheim S, Peltz A. Developing national social care standards. Washington, DC: Heal Affairs Forefront; 2023; doi:10.1377/FOREFRONT.20230221.857308.

[28] Graves JM, Fulton-Kehoe D, Jarvik JG, Franklin GM. Health care utilization and costs associated with adherence to clinical practice guidelines for early magnetic resonance imaging among workers with acute occupational low back pain. Health Serv Res 2014;49:645–65.

[29] Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, Hoy D, Karppinen J, Pransky G, Sieper J, Smeets RJ, Underwood M, Lancet Low Back Pain Series Working Group. What low back pain is and why we need to pay attention. Lancet (London, England) 2018;391:2356–67.

[30] Hays RD, Bjorner JB, Revicki DA, Spritzer KL, Cella D. Development of physical and mental health summary scores from the patient-reported outcomes measurement information system (PROMIS) global items. Qual Life Res 2009;18:873–80.

[31] Hazra A, Gogtay N. Biostatistics series module 6: correlation and linear regression. Indian J Dermatol 2016;61:593–601.

[32] Hirsch O, Strauch K, Held H, Redaelli M, Chenot J-F, Leonhardt C, Keller S, Baum E, Pfingsten M, Hildebrandt J, Basler H-D, Kochen MM, Donner-Banzhoff N, Becker A. Low back pain patient subgroups in primary care: pain characteristics, psychosocial determinants, and health care utilization. Clin J Pain 2014;30:1023–32.

[33] Historic redlining scores for 2010 and 2020 US census tracts. Available at: https://www.openicpsr.org/openicpsr/project/141121/version/V2/view. Accessed September 18, 2023.

[34] Hu J, Kind AJHH, Nerenz D. Area deprivation Index predicts readmission risk at an urban teaching hospital. Am J Med Qual 2018;33:493–501.

[35] Jacobs JC, Jarvik JG, Chou R, Boothroyd D, Lo J, Nevedal A, Barnett PG. Observational study of the downstream consequences of inappropriate MRI of the lumbar spine. J Gen Intern Med 2020;35:3605–12.

[36] Karran EL, Grant AR, Moseley GL. Low back pain and the social determinants of health: a systematic review and narrative synthesis. PAIN 2020;161:2476–93.

[37] Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research : Principles and quantitative methods. New York: John Wiley & Sons, Inc., 1982.

[38] Knighton AJ, Brunisholz KD, Savitz ST. Detecting risk of low health literacy in disadvantaged populations using area-based measures. EGEMS (Washington, DC) 2017;5:7.

[39] Kotwal AA, Holt-Lunstad J, Newmark RL, Cenzer I, Smith AK, Covinsky KE, Escueta DP, Lee JM, Perissinotto CM. Social isolation and loneliness among San Francisco bay area older adults during the COVID-19 shelter-in-place orders. J Am Geriatr Soc 2021;69:20–9.

[40] Krebs EE, Gravely A, Nugent S, Jensen AC, DeRonne B, Goldsmith ES, Kroenke K, Bair MJ, Noorbaloochi S. Effect of opioid vs nonopioid medications on pain-related function in patients with chronic back pain or hip or knee osteoarthritis pain: the SPACE randomized clinical trial. JAMA 2018;319:872–82.

[41] Lett E, Asabor E, Beltrán S, Cannon AM, Arah OA. Conceptualizing, contextualizing, and operationalizing race in quantitative health Sciences research. Ann Fam Med 2022;20:157–63.

[42] Lituiev DS, Lacar B, Pak S, Abramowitsch PL, De Marchis EH, Peterson TA. Automatic extraction of social determinants of health from medical notes of chronic lower back pain patients. J Am Med Inform Assoc 2023;30:1438–47.

[43] Mescouto K, Olson RE, Hodges PW, Setchell J. A critical review of the biopsychosocial model of low back pain care: time for a new approach? Disabil Rehabil 2022;44:3270–84.

[44] Mosen DM, Banegas MP, Tucker-Seeley RD, Keast E, Hu W, Ertz-Berger B, Brooks N. Social isolation associated with future health care utilization. Popul Health Manag 2021;24:333–7.

[45] Nardone A, Casey JA, Morello-Frosch R, Mujahid M, Balmes JR, Thakur N. Associations between historical residential redlining and current age-adjusted rates of emergency department visits due to asthma across eight cities in California: an ecological study. Lancet Planet Health 2020;4:e24–31.

[46] Nardone A, Chiang J, Corburn J. Historic redlining and urban health today in U.S. cities. Environ Justice 2020;13:109–19.

[47] National Academies of Sciences and Medicine; National Academy of Medicine. In: Flaubert JL, Le Menestrel S, Williams DR, Wakefield MK, eds. Committee on the Future of Nursing 2020–2030 E. The Future of Nursing 2020-2030: Charting a Path to Achieve Health Equity. Washington (DC): National Academies Press (US), 2021. doi: 10.17226/25982

[48] National Academies of Sciences E and M. Integrating Social Care into the Delivery of Health Care: Moving Upstream to Improve the Nation's Health. Washington, DC: National Academies Press; 2019:1–177.

[49] NCQA updates & releases new quality measures for HEDIS® 2023 with a focus on health equity. NCQA. Available at: https://www.ncqa.org/news/ncqa-updates-releases-new-quality-measures-for-hedis-2023-with-a-focus-on-health-equity-stratifying-measures-by-race-ethnicity-and-affirming-gender-identity-helps-tackle-health-disparities/. Accessed October 3, 2023.

[50] Neighborhood atlas—home. Available at: https://www.neighborhoodatlas.medicine.wisc.edu/. Accessed May 17, 2023.

[51] Owens JD, Hegmann KT, Thiese MS, Phillips AL. Impacts of adherence to evidence-based medicine guidelines for the management of acute low back pain on costs of worker's compensation claims. J Occup Environ Med 2019;61:445–52.

[52] Pantell M, Rehkopf D, Jutte D, Syme SL, Balmes J, Adler N. Social isolation: a predictor of mortality comparable to traditional clinical risk factors. Am J Public Health 2013;103:2056–62.

[53] Pantell MS, Kaiser SV, Torres JM, Gottlieb LM, Adler NE. Associations between social factor documentation and hospital length of stay and readmission among children. Hosp Pediatr 2020;10:12–9.

[54] Park Y, Mulligan N, Gleize M, Kristiansen M, Bettencourt-Silva JH. Discovering associations between social determinants and health outcomes: merging knowledge graphs from literature and electronic health data. AMIA Annu Symp Proceedings AMIA Symp 2021;2021:940–9.

[55] Pérez-Stable EJ, Webb HM. The pillars of health disparities science—race, ethnicity, and socioeconomic status. JAMA Heal Forum 2023;4:e234463.

[56] R3 Report Issue 36. New requirements to reduce health care disparities | the joint commission, Available at: https://www.jointcommission.org/standards/r3-report/r3-report-issue-36-new-requirements-to-reduce-health-care-disparities/. Accessed October 3, 2023.

[57] Records C. On the RS and BD and M for EH, practice B on PH and PH, medicine I of. Capturing social and behavioral domains and measures in

electronic health records. Capturing Soc Behav Domains Meas Electron Heal Rec Phase 2015;2:1–351.

[58] Rigdon J, Montez K, Palakshappa D, Brown C, Downs SM, Albertini LW, Taxter AJ. Social risk factors influence pediatric emergency department utilization and hospitalizations. J Pediatr 2022;249:35–42.e4.

[59] Rinaldo L, McCutcheon BA, Gilder H, Kerezoudis P, Murphy M, Maloney P, Hassoon A, Bydon M. Diabetes and back pain: markers of diabetes disease progression are associated with chronic back pain. Clin Diabetes 2017;35:126–31.

[60] Role of the health care system—social isolation and loneliness in older adults—NCBI bookshelf. Available at: https://www.ncbi.nlm.nih.gov/books/NBK557964/. Accessed October 16, 2023.

[61] Rollings KA, Kunnath N, Ryus CR, Janke AT, Ibrahim AM. Association of coded housing instability and hospitalization in the US. JAMA Netw Open 2022;5:e2241951.

[62] Roseen EJ, Smith CN, Essien UR, Cozier YC, Joyce C, Morone NE, Phillips RS, Gergen Barnett K, Patterson CG, Wegener ST, Brennan GP, Delitto A, Saper RB, Beneciuk JM, Stevans JM. Racial and ethnic disparities in the incidence of high-impact chronic pain among primary care patients with acute low back pain: a cohort study. Pain Med 2023;24:633–43.

[63] Rundell SD, Resnik L, Heagerty PJ, Kumar A, Jarvik JG. Comparing performance of comorbidity indices in predicting functional status, health-related quality of life, and total health care use in older adults with back pain. J Orthop Sports Phys Ther 2020;50:143–8.

[64] Sepúlveda-Loyola W, Rodríguez-Sánchez I, Pérez-Rodríguez P, Ganz F, Torralba R, Oliveira DV, Rodríguez-Mañas L. Impact of social isolation due to COVID-19 on health in older people: mental and physical effects and recommendations. J Nutr Health Aging 2020;24:938–47.

[65] Shaw JG, Farid M, Noel-Miller C, Joseph N, Houser A, Asch SM, Bhattacharya J, Flowers L. Social isolation and Medicare spending: among older adults, objective social isolation increases expenditures while loneliness does not. J Aging Health 2017;29:1119–43.

[66] Social determinants of health—global. Available at: https://www.who.int/teams/social-determinants-of-health. Accessed May 20, 2024.

[67] Social risk factors: definitions and data—accounting for social risk factors in Medicare payment—NCBI bookshelf. Available at: https://www.ncbi.nlm.nih.gov/books/NBK436060/. Accessed May 20, 2024.

[68] Solé E, Racine M, Tomé-Pires C, Galán S, Jensen MP, Miró J. Social factors, disability, and depressive symptoms in adults with chronic pain. Clin J Pain 2020;36:371–8.

[69] Swope CB, Hernández D, Cushing LJ. The relationship of historical redlining with present-day neighborhood environmental and health outcomes: a scoping review and conceptual model. J Urban Health Bull New York Acad Med 2022;99:959–83.

[70] Tarasuk V, Mitchell A, McLaren L, McIntyre L. Chronic physical and mental health conditions among adults may increase vulnerability to household food insecurity. J Nutr 2013;143:1785–93.

[71] Tham SW, Law EF, Palermo TM, Kapos FP, Mendoza JA, Groenewald CB. Household food insufficiency and chronic pain among children in the US: A national study. Child (Basel) 2023;10:185.

[72] Torres JM, Lawlor J, Colvin JD, Sills MR, Bettenhausen JL, Davidson A, Cutler GJ, Hall M, Gottlieb LM. ICD social codes: an underutilized resource for tracking social needs. Med Care 2017;55:810–6.

[73] Trends in the utilization of emergency department services, 2009-2018\textbar {ASPE}. Available at: https://aspe.hhs.gov/reports/trends-utilization-emergency-department-services-2009-2018. Accessed December 18, 2023.

[74] Unsgaard-Tøndel M, Vasseljen O, Nilsen TIL, Myhre G, Robinson HS, Meisingset I. Prognostic ability of STarT Back Screening Tool combined with work-related factors in patients with low back pain in primary care: a prospective study. BMJ Open 2021;11:e046446.

[75] Valtorta NK, Moore DC, Barron L, Stow D, Hanratty B. Older adults' social relationships and health care utilization: a systematic review. Am J Public Health 2018;108:e1–10.

[76] Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, Shibuya K, Salomon JA, Abdalla S, Aboyans V, Abraham J, Ackerman I, Aggarwal R, Ahn SY, Ali MK, Alvarado M, Anderson HR, Anderson LM, Andrews KG, Atkinson C, Baddour LM, Bahalim AN, Barker-Collo S, Barrero LH, Bartels DH, Basáñez MG, Baxter A, Bell ML, Benjamin EJ, Bennett D, Bernabé E, Bhalla K, Bhandari B, Bikbov B, Bin Abdulhak A, Birbeck G, Black JA, Blencowe H, Blore JD, Blyth F, Bolliger I, Bonaventure A, Boufous S, Bourne R, Boussinesq M, Braithwaite T, Brayne C, Bridgett L, Brooker S, Brooks P, Brugha TS, Bryan-Hancock C, Bucello C, Buchbinder R, Buckle G, Budke CM, Burch M, Burney P, Burstein R, Calabria B, Campbell B, Canter CE, Carabin H, Carapetis J, Carmona L, Cella C, Charlson F, Chen H, Cheng ATA, Chou D, Chugh SS, Coffeng LE, Colan SD, Colquhoun S, Colson KE, Condon J, Connor MD, Cooper LT, Corriere M, Cortinovis M, de Vaccaro KC, Couser W, Cowie BC, Criqui MH, Cross M, Dabhadkar KC, Dahiya M, Dahodwala N, Damsere-Derry J, Danaei G, Davis A, De Leo D, Degenhardt L, Dellavalle R, Delossantos A, Denenberg J, Derrett S, Des Jarlais DC, Dharmaratne SD, Dherani M, Diaz-Torne C, Dolk H, Dorsey ER, Driscoll T, Duber H, Ebel B, Edmond K, Elbaz A, Ali SE, Erskine H, Erwin PJ, Espindola P, Ewoigbokhan SE, Farzadfar F, Feigin V, Felson DT, Ferrari A, Ferri CP, Fèvre EM, Finucane MM, Flaxman S, Flood L, Foreman K, Forouzanfar MH, Fowkes FGR, Franklin R, Fransen M, Freeman MK, Gabbe BJ, Gabriel SE, Gakidou E, Ganatra HA, Garcia B, Gaspari F, Gillum RF, Gmel G, Gosselin R, Grainger R, Groeger J, Guillemin F, Gunnell D, Gupta R, Haagsma J, Hagan H, Halasa YA, Hall W, Haring D, Haro JM, Harrison JE, Havmoeller R, Hay RJ, Higashi H, Hill C, Hoen B, Hoffman H, Hotez PJ, Hoy D, Huang JJ, Ibeanusi SE, Jacobsen KH, James SL, Jarvis D, Jasrasaria R, Jayaraman S, Johns N, Jonas JB, Karthikeyan G, Kassebaum N, Kawakami N, Keren A, Khoo JP, King CH, Knowlton LM, Kobusingye O, Koranteng A, Krishnamurthi R, Lalloo R, Laslett LL, Lathlean T, Leasher JL, Lee YY, Leigh J, Lim SS, Limb E, Lin JK, Lipnick M, Lipshultz SE, Liu W, Loane M, Ohno SL, Lyons R, Ma J, Mabweijano J, MacIntyre MF, Malekzadeh R, Mallinger L, Manivannan S, Marcenes W, March L, Margolis DJ, Marks GB, Marks R, Matsumori A, Matzopoulos R, Mayosi BM, McAnulty JH, McDermott MM, McGill N, McGrath J, Medina-Mora ME, Meltzer M, Mensah GA, Merriman TR, Meyer AC, Miglioli V, Miller M, Miller TR, Mitchell PB, Mocumbi AO, Moffitt TE, Mokdad AA, Monasta L, Montico M, Moradi-Lakeh M, Moran A, Morawska L, Mori R, Murdoch ME, Mwaniki MK, Naidoo K, Nair MN, Naldi L, Narayan KMV, Nelson PK, Nelson RG, Nevitt MC, Newton CR, Nolte S, Norman P, Norman R, O'Donnell M, O'Hanlon S, Olives C, Omer SB, Ortblad K, Osborne R, Ozgediz D, Page A, Pahari B, Pandian JD, Rivero AP, Patten SB, Pearce N, Padilla RP, Perez-Ruiz F, Perico N, Pesudovs K, Phillips D, Phillips MR, Pierce K, Pion S, Polanczyk GV, Polinder S, Pope CA 3rd, Popova S, Porrini E, Pourmalek F, Prince M, Pullan RL, Ramaiah KD, Ranganathan D, Razavi H, Regan M, Rehm JT, Rein DB, Remuzzi G, Richardson K, Rivara FP, Roberts T, Robinson C, De Leòn FR, Ronfani L, Room R, Rosenfeld LC, Rushton L, Sacco RL, Saha S, Sampson U, Sanchez-Riera L, Sanman E, Schwebel DC, Scott JG, Segui-Gomez M, Shahraz S, Shepard DS, Shin H, Shivakoti R, Singh D, Singh GM, Singh JA, Singleton J, Sleet DA, Sliwa K, Smith E, Smith JL, Stapelberg NJC, Steer A, Steiner T, Stolk WA, Stovner LJ, Sudfeld C, Syed S, Tamburlini G, Tavakkoli M, Taylor HR, Taylor JA, Taylor WJ, Thomas B, Thomson WM, Thurston GD, Tleyjeh IM, Tonelli M, Towbin JA, Truelsen T, Tsilimbaris MK, Ubeda C, Undurraga EA, van der Werf MJ, van Os J, Vavilala MS, Venketasubramanian N, Wang M, Wang W, Watt K, Weatherall DJ, Weinstock MA, Weintraub R, Weisskopf MG, Weissman MM, White RA, Whiteford H, Wiersma ST, Wilkinson JD, Williams HC, Williams SRM, Witt E, Wolfe F, Woolf AD, Wulf S, Yeh PH, Zaidi AKM, Zheng ZJ, Zonies D, Lopez AD, Murray CJL, AlMazroa MA, Memish ZA, Murray CJL. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380:2163–96.

[77] Wang M, Pantell MS, Gottlieb LM, Adler-Milstein J. Documentation and review of social determinants of health data in the EHR: measures and associated insights. J Am Med Inform Assoc 2021;28:2608–16.

[78] WHO releases guidelines on chronic low back pain. 2023. Available at: https://www.who.int/news/item/07-12-2023-who-releases-guidelines-on-chronic-low-back-pain. Accessed December 17, 2023.

[79] Xu J, Lawrence KG, O'Brien KM, Jackson CL, Sandler DP. Association between neighbourhood deprivation and hypertension in a US-wide Cohort. J Epidemiol Commun Health 2022;76:268–73.