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Are Detailed, Patient-level Social Determinant of Health Factors Associated With Physical Function and Mental Health at Presentation Among New Patients With Orthopaedic Conditions?

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Abstract

Background It is well documented that routinely collected patient sociodemographic characteristics (such as race and insurance type) and geography-based social determinants of health (SDoH) measures (for example, the Area Deprivation Index) are associated with health disparities, including symptom severity at presentation. However, the association of patient-level SDoH factors (such as housing status) on musculoskeletal health disparities is not as well documented. Such insight might help with the development of more-targeted interventions to help address health disparities in orthopaedic surgery.

Questions/purposes (1) What percentage of patients presenting for new patient visits in an orthopaedic surgery clinic who were unemployed but seeking work reported transportation issues that could limit their ability to attend a medical appointment or acquire medications, reported trouble paying for medications, and/or had no current housing? (2) Accounting for traditional sociodemographic factors and patient-level SDoH measures, what factors are associated with poorer patient-reported outcome physical health scores at presentation? (3) Accounting for traditional sociodemographic factor patient-level SDoH measures, what factors are associated with poorer patient-reported outcome mental health scores at presentation?

Methods New patient encounters at one Level 1 trauma center clinic visit from March 2018 to December 2020 were identified. Included patients had to meet two criteria: they had completed the Patient-Reported Outcome Measure Information System (PROMIS) Global-10 at their new orthopaedic surgery clinic encounter as part of routine clinical care, and they had visited their primary care physician and completed a series of specific SDoH questions. The SDoH questionnaire was developed in our institution to improve data that drive interventions to address health disparities as part of our accountable care organization work. Over the study period, the SDoH questionnaire was

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only distributed at primary care provider visits. The SDoH questions focused on transportation, housing, employment, and ability to pay for medications. Because we do not have a way to determine how many patients had both primary care provider office visits and new orthopaedic surgery clinic visits over the study period, we were unable to determine how many patients could have been included; however, 9057 patients were evaluated in this cross-sectional study. The mean age was 61 ± 15 years, and most patients self-reported being of White race (83% [7561 of 9057]). Approximately half the patient sample had commercial insurance (46% [4167 of 9057]). To get a better sense of how this study cohort compared with the overall patient population seen at the participating center during the time in question, we reviewed all new patient clinic encounters (n = 135,223). The demographic information between the full patient sample and our study subgroup appeared similar. Using our study cohort, two multivariable linear regression models were created to determine which traditional metrics (for example, self-reported race or insurance type) and patient-specific SDoH factors (for example, lack of reliable transportation) were associated with worse physical and mental health symptoms (that is, lower PROMIS scores) at new patient encounters. The variance inflation factor was used to assess for multicollinearity. For all analyses, p values < 0.05 designated statistical significance. The concept of minimum clinically important difference (MCID) was used to assess clinical importance. Regression coefficients represent the projected change in PROMIS physical or mental health symptom scores (that is, the dependent variable in our regression analyses) accounting for the other included variables. Thus, a regression coefficient for a given variable at or above a known MCID value suggests a clinical difference between those patients with and without the presence of that given characteristic. In this manuscript, regression coefficients at or above 4.2 (or at and below -4.2) for PROMIS Global Physical Health and at or above 5.1 (or at and below -5.1) for PROMIS Global Mental Health were considered clinically relevant.

Results Among the included patients, 8% (685 of 9057) were unemployed but seeking work, 4% (399 of 9057) reported transportation issues that could limit their ability to attend a medical appointment or acquire medications, 4% (328 of 9057) reported trouble paying for medications, and 2% (181 of 9057) had no current housing. Lack of reliable transportation to attend doctor visits or pick up medications (β = -4.52 [95% CI -5.45 to -3.59]; p < 0.001), trouble paying for medications (β = -4.55 [95% CI -5.55 to -3.54]; p < 0.001), Medicaid insurance (β = -5.81 [95% CI -6.41 to -5.20]; p < 0.001), and workers compensation insurance (β = -5.99 [95% CI -7.65 to -4.34]; p < 0.001) were associated with clinically worse function at presentation. Trouble paying for medications (β = -6.01 [95% CI -7.10 to -4.92]; p < 0.001), Medicaid insurance (β = -5.35 [95% CI -6.00 to -4.69]; p < 0.001), and workers compensation (β = -6.07 [95% CI -7.86 to -4.28]; p < 0.001) were associated with clinically worse mental health at presentation.

Conclusion Although transportation issues and financial hardship were found to be associated with worse presenting physical function and mental health, Medicaid and workers compensation insurance remained associated with worse presenting physical function and mental health as well even after controlling for these more detailed, patient-level SDoH factors. Because of that, interventions to decrease health disparities should focus on not only sociodemographic variables (for example, insurance type) but also tangible patient-specific SDoH characteristics. For example, this may include giving patients taxi vouchers or ride-sharing credits to attend clinic visits for patients demonstrating such a need, initiating financial assistance programs for necessary medications, and/or identifying and connecting certain patient groups with social support services early on in the care cycle.

Level of Evidence Level III, prognostic study.

Introduction

Disparities in healthcare access and outcomes exist in the United States [9]. Socioeconomic patterns are a predominant factor driving this disparity [28]. This broad entity can be organized into social determinants of health (SDoH), which includes economic stability, living environment, educational attainment, as well as access to healthcare and social support. Current research suggests that direct medical care may have less of an impact on healthcare outcomes than SDoH, which may play a more outsized role than previously thought [14, 15, 30]. Indeed, SDoH has been shown to be associated with patient symptoms, access to care, and clinical outcomes [35].

Recent scholarly endeavors have sought to better appreciate the relationship between SDoH factors and musculoskeletal care. For example, prior research on surgical outcomes demonstrates that a number of routinely collected patient sociodemographic characteristics are associated with important differences in resource use and clinical outcomes. Black race (as designated in the Nationwide Inpatient Sample) was found to be associated with greater risk of complications and discharge to a facility (rather than home) after undergoing total joint arthroplasty [1]. Of note, it is important to consider race in context and remember that race is often times a proxy variable for the true underlying factor associated with poorer outcomes or access [21, 22]. Additionally, Medicaid insurance was found to be associated with decreased access to orthopaedic care compared with commercial insurance [19]. Separate efforts have used

geographically organized measures (such as the Area Deprivation Index) [18] to identify disparities in patients presenting with symptoms and undergoing hand surgery [4], spine surgery [5], and surgery in a range of orthopaedic subspecialties [38]. These measures provide additional insight into healthcare disparities, and the inclusion of the national Area Deprivation Index is recommended in orthopaedic studies that consider socioeconomics [8]. However, the use of geographic grouping precludes patient-specific correlations. As the healthcare community continues to address musculoskeletal health disparities, it is important to assess the association between patient-specific SDoH characteristics, such as food insecurity, housing instability, challenges with affording medication, lack of reliable transportation, educational attainment, and employment status, and a patient's ability to cope with and manage symptoms, disease, and injury. When doing so, it is also vital that healthcare professionals remain cognizant of and resistant to the cognitive biases that may be introduced with the assessment of patient-specific SDoH characteristics [36]. Nonetheless, such insight can allow for the development of more targeted initiatives and interventions that may lead to better clinical care and outcomes for patients.

We therefore asked: (1) What percentage of patients presenting for new patient visits in an orthopaedic surgery clinic who were unemployed but seeking work reported transportation issues that could limit their ability to attend a medical appointment or acquire medications, reported trouble paying for medications, and/or had no current housing? (2) Accounting for traditional sociodemographic factors and patient-level SDoH measures, what factors are associated with poorer patient-reported outcome physical health scores at presentation? (3) Accounting for traditional sociodemographic factors and patient-level SDoH measures, what factors are associated with poorer patient-reported outcome mental health scores at presentation?

Patients and Methods

Study Design and Setting

This is a cross-sectional study performed at one Level 1 academic trauma medical center. The institution is located in a large city in the northeastern United States, and patients from all orthopaedic subspecialties were eligible for inclusion.

Participants

We identified all new patients presenting for an orthopaedic surgery clinic visit and who had visited their primary care physician at Massachusetts General Hospital between March 1, 2018, and December 31, 2020, using our institution's patient database. As part of routine orthopaedic clinical care, patients were asked to complete the Patient-Reported Outcomes Measure Information System (PROMIS) Global-10, a 10-question patient-reported outcome measure (PROM) that assesses a patient's overall physical and mental health [13]. In addition, during the study period, patients visiting their primary care physician—if the provider was affiliated with our institution—were asked to complete a series of SDoH questions (Supplementary Digital Content 1; http://links.lww.com/CORR/A963). Thus, patients included in our study met the following two criteria: new patient visit to an orthopaedic surgery clinic at our institution with completion of the PROMIS Global-10 and a primary care visit at our institution with completion of the SDoH questionnaire. Although our institution measured aspects of SDoH for patients before this period, the yearly screening requirement for Medicaid Accountable Care Organizations provided an opportunity for our institution to develop a more comprehensive approach to collect and measure specific SDoH outcomes for all patients seeking primary care services beginning in March 2018 [12, 24]. In the current study, the primary SDoH questions of interest focused on housing insecurity, unemployment, challenges with affording medication, and transportation issues that could limit the patient's ability to attend a medical appointment or acquire medications. Patients who completed the PROMIS Global-10 questionnaire and at least one SDoH question of interest were included. The Area Deprivation Index was not included as a variable, given the overlap between the patient-specific factors used and the factors incorporated into the area-based calculation of the Area Deprivation Index. In addition, the following characteristics were recorded: age (in years), gender (women or men), self-reported race (White, Black, Asian, or other), language (English or non-English/unknown), marital status (married, single, divorced, widowed, or other), payor (commercial, Medicaid, Medicare, workers compensation, and other), questionnaire completion location (office or electronic medical record portal), and orthopaedic subspecialty (hand, foot and ankle, trauma, arthroplasty, oncology, spine, or other).

Because we did not have a way to determine how many patients had both primary care provider office visits and new orthopaedic surgery clinic visits over the study period, we were unable to determine how many patients could have been included. Overall, 9057 patients met our inclusion criteria.

Patients' Baseline Demographics

Among the patients, the mean age was 61 ± 15 years, most were women (61% [5551 of 9057]), and most were White (83% [7561 of 9057]) (Table 1). More than two-thirds of

Table 1. Descriptive characteristics (n = 9057 patients)

Characteristic	Value
Age in years	61 ± 15
Women	61 (5551)
Self-reported race	
White	83 (7561)
Black	3 (298)
Asian	6 (570)
Other	7 (628)
English language speakers	96 (8736)
Marital status	
Married	53 (4804)
Single	30 (2732)
Divorced	8 (751)
Widowed	6 (503)
Other	3 (267)
Payor	
Commercial	46 (4167)
Medicaid	15 (1363)
Medicare	37 (3318)
Workers compensation	1 (134)
Other	0.8 (75)
Questionnaire completion location	
Office	67 (6035)
EMR portal	33 (3022)
Orthopaedic subspecialty	
Hand	33 (3006)
Foot and ankle	12 (1083)
Trauma	18 (1598)
Arthroplasty	17 (1540)
Oncology	7 (628)
Spine	12 (1047)
Other	2 (155)

Data presented as % (n) or mean ± SD; EMR = electronic medical record.

patients completed their PROMs in the outpatient clinic at the time of the encounter (67% [6035 of 9057]), and the remainder completed their assigned PROMs via the electronic medical record portal before the appointment (33% [3022 of 9057]). Our patient sample is similar to the overall orthopaedic patient population treated at this center over the same timeframe (Supplementary Digital Content 2; http://links.lww.com/CORR/A964).

Ethical Approval

This retrospective observational study was approved by our institutional review board.

Statistical Analyses

After descriptive statistics were calculated, two multivariable linear regression models were created. One model included the PROMIS Global Physical Health as the dependent variable and the other had the PROMIS Global Mental Health as the dependent variable. To ensure the models did not include excessive multicollinearity, we used the variance inflation factor. Multicollinearity was considered present if the variance inflation factor was greater than five [17]. Across both multivariable regression models, the variance inflation factor was less than two, suggesting no need to address multicollinearity.

Regression coefficients were considered in the context both of clinical importance and statistical significance. Effect size was evaluated using the minimum clinically important difference (MCID); that is, the minimum change in a given PROM score that represents true clinical improvement (or worsening) appreciated by a patient [16]. For the PROMIS Global Physical Health, we used an MCID of 4.2, which represents an evidence-based anchor-based estimate [6]. For PROMIS Global Mental Health, we used an MCID value of 5.1, which was calculated using the distribution-based approach. We did not find an anchor-based MCID estimate for the PROMIS Global Mental Health. The concept of MCID was used to assess clinical importance in the following way: Regression coefficients represented the projected change in PROMIS physical or mental health symptom scores (that is, the dependent variable in our regression analyses), accounting for the other included variables. Thus, a regression coefficient for a given variable at or above a known MCID value suggests a clinical difference between those patients with and without the presence of that given characteristic. For all analyses, p values < 0.05 were considered significant, whereas regression coefficients at or above 4.2 (or at and below -4.2) for PROMIS Global Physical Health and at or above 5.1 (or at and below -5.1) for PROMIS Global Mental Health were considered clinically important.

Results

Percentage of Patients With Challenging Social Determinants of Health

In this cohort, 8% (685 of 9057) were unemployed but seeking work, 4% (399 of 9057) reported transportation issues that could limit their ability to attend a medical appointment or acquire medications, 4% (328 of 9057) reported trouble paying for medications, and 2% (181 of 9057) had no current housing (Table 2).

Table 2. Patient sample characteristics

Social determinant of health	Value (n = 9057)
Patients who lack transportation	4 (399)
Patients with no current housing	2 (181)
Patients with trouble paying for medications	4 (328)
Patients who are unemployed but looking for work	8 (685)

Data as presented as % (n).

Factors Associated With Poorer Scores for Physical Health

Lack of reliable transportation to attend doctor visits or collect medications (β = -4.52 [95% CI -5.45 to -3.59]; $p < 0.001$) and trouble paying for medications (β = -4.55 [95% CI -5.55 to -3.54]; $p < 0.001$) were associated with worse physical health at presentation (Table 3). Additionally, Medicaid (β = -5.81 [95% CI -6.41 to -5.20]; $p < 0.001$) and workers compensation insurance (β = -5.99 [95% CI -7.65 to -4.34]; $p < 0.001$) were also

Table 3. Multivariable linear regression analysis for PROMIS Global Physical Health

Characteristic	β coefficient (95% CI)	p value
Age	-0.03 (-0.046 to -0.013)	< 0.001
Gender		
Women	Reference	
Men	1.46 (1.08 to 1.84)	< 0.001
Race		
White	Reference	
Black	-1.12 (-2.14 to -0.10)	0.03
Asian	-1.72 (-2.48 to -0.95)	< 0.001
Other	-2.51 (-3.26 to -1.76)	< 0.001
Marital status		
Married	Reference	
Single	-1.24 (-1.69 to -0.79)	< 0.001
Divorced	-2.85 (-3.54 to -2.16)	< 0.001
Widowed	-2.55 (-3.39 to -1.71)	< 0.001
Other	-0.76 (-1.84 to 0.32)	0.17
Payor		
Commercial	Reference	
Medicaid	-5.81 (-6.41 to -5.20)	< 0.001
Medicare	-2.38 (-2.85 to -1.90)	< 0.001
Workers compensation	-5.99 (-7.65 to -4.34)	< 0.001
Other	-1.57 (-3.70 to 0.57)	0.15
Questionnaire completion location		
Office	Reference	
EMR portal	0.32 (-0.071 to 0.70)	0.11
Lack of transportation	-4.52 (-5.45 to -3.59)	< 0.001
No current housing	-3.17 (-4.50 to -1.83)	< 0.001
Trouble paying for medications	-4.55 (-5.55 to -3.54)	< 0.001
Unemployed but looking for work	-1.59 (-2.32 to -0.86)	< 0.001

For categorical variables, the β coefficient reflects the change in PROMIS score that would occur assuming all else remains constant; for example, patients who have troubling paying for medications have a decrease in their PROMIS Global Physical Health score of 4.55. For continuous variables, the β coefficient reflects the change in PROMIS score that would occur assuming all else remains constant for each one-unit change; for example, for each year older, patients have a decrease in their PROMIS Global Physical Health score of 0.03. The r^2 of this regression model is 0.15; this means that the independent variables in this model account for 15% of the observed variance in dependent variable, or PROMIS Global Physical Health; EMR = electronic medical record.

Table 4. Multivariable linear regression analysis for PROMIS Global Mental Health

Characteristic	β coefficient	p value
Age	0.02 (0.004 to 0.040)	0.02
Gender		
Women	Reference	
Men	0.90 (0.49 to 1.31)	< 0.001
Race		
White	Reference	
Black	-2.30 (-3.41 to -1.20)	< 0.001
Asian	-0.81 (-1.64 to 0.01)	0.05
Other	-2.35 (-3.16 to -1.54)	< 0.001
Marital status		
Married	Reference	
Single	-2.77 (-3.26 to -2.28)	< 0.001
Divorced	-4.06 (-4.81 to -3.31)	< 0.001
Widowed	-3.08 (-3.99 to -2.17)	< 0.001
Other	-1.34 (-2.51 to -0.17)	0.03
Payor		
Commercial	Reference	
Medicaid	-5.35 (-6.00 to -4.69)	< 0.001
Medicare	-2.96 (-3.47 to -2.45)	< 0.001
Workers compensation	-6.07 (-7.86 to -4.28)	< 0.001
Other	-6.25 (-8.56 to -3.94)	< 0.001
Questionnaire completion location		
Office	Reference	
EMR portal	1.05 (0.64 to 1.47)	< 0.001
Lack of transportation	-4.19 (-5.19 to -3.18)	< 0.001
No current housing	-4.04 (-5.48 to -2.59)	< 0.001
Trouble paying for medications	-6.01 (-7.10 to -4.92)	< 0.001
Unemployed but looking for work	-2.01 (-2.80 to -1.22)	< 0.001

For categorical variables, the β coefficient reflects the change in PROMIS score that would occur assuming all else remains constant; for example, patients who have troubling paying for medications have a decrease in their PROMIS Global Mental Health score of 6.01. For continuous variables, the β coefficient reflects the change in PROMIS score that would occur assuming all else remains constant for each one-unit change; for example, for each year older, patients have an increase in their PROMIS Global Mental Health score of 0.02. The r^2 of this regression model is 0.16; this means that the independent variables in this model account for 16% of the observed variance in dependent variable, or PROMIS Global Mental Health; EMR = electronic medical record.

associated with worse physical health at presentation. The β coefficients for these four variables met or exceeded the MCID estimate for the PROMIS Global Physical Health, suggesting the effect sizes are clinically important. As a reminder, these findings indicate that patients with a lack of reliable transportation to attend doctor visits or collect medications have PROMIS Global Physical Health scores that represent clinically worse physical function than those who do not have this challenge, even when accounting for other factors.

Factors Associated With Poorer Scores for Mental Health

Trouble paying for medications was associated with worse mental health at presentation (β = -6.01 [95% CI -7.10 to -4.92]; p < 0.001). Medicaid (β = -5.35 [95% CI -6.00 to -4.69]; p < 0.001), workers compensation (β = -6.07 [95% CI -7.86 to -4.28]; p < 0.001), and other insurance type (β = -6.25 [95% CI -8.56 to -3.94]; p < 0.001) were associated with worse presenting mental health (Table 4). The β coefficients for these four variables met or exceeded the

MCID for the PROMIS Global Mental Health, suggesting the effect sizes are clinically important.

Discussion

A growing body of studies in orthopaedic surgery are focusing on understanding health disparities better, but much of this work focuses on broad, nonspecific SDoH variables or traditional sociodemographic factors (such as race) that do not address the core reasons for these disparities. It is important to understand what aspects drive healthcare inequity at a more detailed level to help guide public policy and individual interventions. Additionally, an understanding of these aspects provides an essential context for clinical outcomes research that seeks to improve the value of healthcare. In the present study, we found a minority of patients reported having transportation issues that affected medical care, unstable housing, financial hardship with medications, and unemployment. Nevertheless, extrapolated to the general population, a sizeable number of patients are impacted by unfavorable SDoH factors. We did not see a relationship of housing instability and unemployment with clinically worse physical health or mental health. However, the results from this study indicate that a lack of transportation and trouble paying for medications were associated with worse physical health at presentation. Trouble paying for medications was also associated with worse presenting mental health. Even after accounting for specific SDoH confounders, Medicaid and workers compensation insurance remained associated with worse presenting physical and mental health, suggesting other elements engrained in these insurance variables are important to determine and consider. Implementing initiatives to address these findings may include providing taxi or ride-sharing credits to patients who otherwise do not have reliable transportation and lifting any barriers to timely care access for patients with Medicaid insurance.

Limitations

We acknowledge there are several limitations to this study. First, this study only included patients who visited a primary care provider affiliated with our health system and completed SDoH questionnaires, had a new orthopaedic surgery clinic visit, and completed PROMIS Global Health forms during the study period. This may introduce a component of selection bias. However, we are unaware of specific patient subgroups that would be excluded at higher rates solely based on this set of inclusion criteria. Further, our patient sample was found to be similar to the entire orthopaedic patient population that sought musculoskeletal care at our clinics over the study timeframe. Thus, we believe our sample likely represents patients who seek orthopaedic surgery at our institution and likely—at a minimum—those healthcare institutions with similar patient demographics. In addition, although our institution is an urban academic medical center, it draws from a broad rural, suburban, and urban geographic area and includes a mix of insurance types. Nonetheless, it is important to consider how different healthcare settings and geographic areas may lead to different findings given the variability of social services, for example. Second, only a small minority of patients (< 10%) had the SDoH factors of interest; however, given the large sample size of more than 9000 patients in the present study, we were still able to appropriately detect meaningful differences when present. Third, the request for sensitive social information may have led to social desirability bias, which is the tendency to underreport socially unfavorable characteristics and overreport desirable traits [20]. Therefore, patients may not disclose the sensitive information sought—such as transportation issues—in our questionnaires [34]. However, because patients were assured that this information would be confidential at the patient level as part of routine healthcare privacy regulations, we do not believe this issue would drastically alter our overall findings. Fourth, the SDoH questionnaire was developed at our institution and has not been externally validated. Additionally, the survey has a Flesch-Kincaid Reading Level of 12.9. However, the survey was developed through multiple iterations to assure question clarity, and some of the phrases that are needed in the survey (for example, "medical appointments") to appropriately capture the information substantially raise the reading level by themselves.

There are also a few limitations associated with the use of the MCID in this study. First, there are multiple methods to calculate MCID thresholds without a definitive approach [6, 16, 25]. Although distribution-based methods are simple to calculate, they do not consider how patients perceive their change in symptom severity; thus, when possible, we used an anchor-based estimate, but we were only able to find such an estimate for the PROMIS Global Physical Health [6] not the PROMIS Global Mental Health. However, both estimate techniques are well-documented approaches to estimating the MCID, so we believe our clinical findings are still valid. Second, the MCID is usually used to assess change in scores over time. However, in the current study, we used these estimates to assess whether the presence of a given SDoH factor was associated with a change in PROMIS scores for patients that would be clinically relevant. Although this may not be the typical use of the MCID, we believe it provides greater context to the level of association certain SDoH characteristics have with patient health and well-being. Lastly, MCID estimates are likely context-specific and may differ based on the treatment being assessed. Generally speaking, however,

estimates tend to be similar across conditions, and we believe using the best available estimate is appropriate when evaluating a heterogeneous patient sample.

Percentage of Patients With Challenging Social Determinants of Health

One of the major issues with area-based measures of social deprivation or lower socioeconomic status is that they group all people from a similar geographic region as the same when differences exist. These differences can drive targeted solutions. The 4% of patients in our sample who reported transportation issues related to receiving healthcare is similar to that previously reported and not only in orthopaedic surgery [31]. Thus, transportation is a known issue across healthcare, and broad interventions across health systems or from a public policy standpoint may be beneficial, including need-based taxi or ride-share credits. Further, in our patient sample, only 4% of patients reported being unable to afford prescribed medications, which is well below the 7% across the United States reported in June 2021 [37]. We think this difference may be a function of the many over-the-counter medications used in orthopaedic surgery, such as NSAIDs, which are available as generics at a low cost when a prescription is provided. Financial support from a hospital, clinic, or insurer may help patients in need receive the medications they need; this may not only lead to improved clinical outcomes for such patients but also improved financial outcomes for hospitals who may avoid unnecessary emergency room visits or readmissions. Also, we found 2% of our patient sample had no current housing, whereas the estimated proportion of people in the United States who are unhoused is approximately 0.2% [33]. One possible reason for this discrepancy is because our patients faced housing instability more than prolonged homelessness. Another possible reason is because the cost of living in and around Boston tends to be quite high, which may mean that a great proportion of the patients in our cohort experienced homelessness; however, in 2019, Massachusetts experienced a 0.3% (18,471 of 6,892,503) rate of homelessness [23, 32]. Thus, further investigation is warranted, as it is not clear what is causing the discrepancy between the national and state-level homelessness rates and our patient sample. Lastly, 8% of patients in our sample were unemployed but actively looking for work, which is well above the current 3.6% unemployment rate in the United States [7]. Patients with housing and/or employment concerns would benefit from being connected with social work and other services early on; therefore, identifying these individuals at the onset of care is critical. Overall, these findings emphasize the importance of understanding in detail the community being served at a local level as policy is being developed because the percentages of people with certain issues varies from those of the entire population. Ultimately, focused interventions at the local level should build on the broader policy being implemented on a larger scale. Although the proposed interventions do not necessarily lead to patients seeking care earlier, studies are needed to assess whether such initiatives may be able to improve clinical outcomes for those with certain SDoH characteristics.

Factors Associated With Poorer Scores for Physical and Mental Health

The factors associated with worse presenting patient physical and mental health were not entirely unexpected. The association of transportation difficulties with worse presenting symptoms likely represent the combined impact of poor physical function (inability to drive) and psychosocial (less robust social or family support) factors, whereas the inability to pay for medications may highlight that some patients are simply trying to make ends meet and not seeking care unless symptoms become severe. Although we accounted for these patient-specific factors, insurance type continued to be a clinically relevant variable. The finding that patients covered by Medicaid have worse presenting symptoms was unsurprising, given prior research [3, 11]. This finding suggests that unrecognized driving factors among patients covered by Medicaid are not captured by patients' sociodemographic data or our included SDoH questionnaire. One potential explanation for this finding is the known association between Medicaid insurance and decreased access to musculoskeletal care [19, 26]. Patients with Medicaid might not be able to afford the time off from work or other responsibilities to seek musculoskeletal care until symptoms are quite severe and debilitating. A prior investigation has also demonstrated that patients with public insurance and those with a lower education level visited the emergency department for musculoskeletal complaints that generally only need outpatient care [27]. Additionally, patients with adequate health literacy seek outpatient care more than those with limited health literacy, and Medicaid insurance may be a proxy for limited health literacy [29]. Thus, patients with Medicaid insurance might delay orthopaedic care until symptoms and disease processes are more advanced. Similarly, patients with workers compensation insurance also had clinically worse symptoms at presentation to an orthopaedic surgery clinic. Prior research has demonstrated worse symptoms and clinical outcomes in patients with workers compensation insurance who have lumbar disc herniation [2] or who are undergoing upper extremity surgery [10]. Workplace injuries might be more severe,

leading to worse physical function at presentation. Additionally, the known psychosocial relationship between workers compensation and outcomes may account for this finding in this study. Because insurance type remains associated with worse symptoms, and even though we accounted for detailed, patient-specific data, more work is needed to highlight the modifiable factors that can be addressed with interventions to improve health equity. Patients on Medicaid may benefit from proactive care teams who reach out before clinic visits to assess what support services may be needed to try to ensure any barriers to timely, high-quality care are alleviated as best as possible.

Conclusion

By using novel patient-specific data, we demonstrated that transportation issues and financial hardship were associated with worse patient-reported physical and mental health. Additionally, certain traditional demographic variables (such as insurance type) remained relevant, whereas others (age, gender, race, and marital status) were not found to be associated with clinically important effect sizes. The patient-level SDoH findings provide data to support the development and implementation of targeted policy and interventions to help address disparities. For example, taxi vouchers or ride-sharing credits to attend clinic visits might be beneficial for patients demonstrating such a need. Telemedicine may also contribute to ensuring improved access to orthopaedic care [39], especially among those with financial hardship and an inability to travel to clinic visits easily. Additionally, support services that provide medication-related financial assistance may allow patients to obtain necessary medications and not only benefit patient-reported physical and mental health but also decrease avoidable complications and readmissions. Lastly, patients on Medicaid, who have housing instability, or who report employment concerns may benefit from proactive outreach from clinic or institutional support staff, such as social work, to help connect them to local, state, and/or federal programs that may alleviate barriers to care. As programs and initiatives are implemented, frequent evaluations of their successes (or failures) will be needed to ensure progress is being made in reducing healthcare disparities in orthopaedic surgery; this can begin by evaluating whether providing taxi vouchers or ride-share credits decrease the "no show" frequency in clinics or assessing whether connecting patients to local, state, and/or federal programs makes a positive change on patient health, as measured by PROMs. Studies can also examine how these detailed, patient-level SDoH factors are associated with clinical outcomes after treatment.

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