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Abstract

Objectives: This study examines whether perceived neighborhood characteristics relate to pain outcomes among middle-aged and older adults. **Methods:** Data were from the Health and Retirement Study (2006–2014; *n* = 18,814). Perceived neighborhood characteristics were physical disorder, social cohesion, safety, and social ties. We fitted adjusted generalized estimating equation models to evaluate prevalence, incidence, and recovery of moderate-to-severe limiting pain 2 years later. **Results:** The mean age of our sample was 65.3 years; 54.6% were female and 24.2% reported moderate-to-severe limiting pain at baseline. Positive neighborhood characteristics were associated with low prevalence (e.g., prevalence ratio [PR]: .71 for *disorder*) and reduced incidence (e.g., PR: .63 for *disorder*) of moderate-to-severe limiting pain. Positive neighborhood characteristics were associated with a high recovery rate from moderate-to-severe limiting pain (e.g., PR = 1.15 for *safety*), though the 95% CIs for disorder and cohesion crossed the null. **Discussion:** Neighborhood characteristics may be important determinants in predicting pain in later life.

Keywords
chronic pain, neighborhoods, disability

Introduction

Chronic pain is a highly prevalent and extremely costly public health problem in the United States (Case et al., 2020; Dahlhamer et al., 2018; Gaskin & Richard, 2012; Zajacova et al., 2021). Pain has been used to justify both the approval and prescription of opioids, making it an underlying driver in the opioid epidemic (Case et al., 2020; McGreal, 2018). The prevalence of pain is disproportionately high in older adults (Dahlhamer et al., 2018), as age is a leading risk factor for many painful conditions (Patel et al., 2013). Pain can also be very problematic in older adults and is often associated with disability, social isolation, reduced quality of life, and greater costs and burden to health care systems (Covinsky et al., 2009; Domenichiello & Ramsden, 2019; Patel et al., 2013). Despite emerging research on social determinants in pain, most existing studies focusing on socioeconomic status (SES); those with less education and wealth have a higher risk of experiencing more pain, more severe pain, and pain interferences (Case et al., 2020; H. Grol-Prokopczyk, 2017; Zajacova et al., 2020). However, research examining associations between neighborhood factors and pain outcomes is still limited.

Neighborhood is vital to individuals' health and well-being (Diez Roux & Mair, 2010; Duncan & Kawachi, 2018; Ross & Mirowsky, 2001). Neighborhood characteristics, including neighborhood socioeconomic status (nSES) and those related to social and built environmental characteristics, have been identified as key determinants of mortality (Bosma et al., 2001; Meijer et al., 2012; Osypuk et al., 2017) and a wide range of health outcomes (Clarke & George, 2005; Freedman et al., 2008; Glymour et al., 2010; Gomez et al., 2015; Shariff-Marco et al., 2021). Neighborhoods may have a greater impact on the health and well-being of older adults compared to younger adults, due to factors such as increased vulnerability to environmental exposures, reliance on

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community resources, and limited mobility (Glass & Balfour, 2003; Yen et al., 2009).

A handful of studies have investigated the association between neighborhood characteristics and pain outcomes in older adults (Brooks Holliday et al., 2019; Davies et al., 2009; Fuentes et al., 2007; Green & Hart-Johnson, 2012; Jordan et al., 2008; Kim et al., 2020; Morris et al., 2022; Ulirsch et al., 2014). Although some studies suggest that living in a disadvantaged neighborhood may be associated with worse pain outcomes in younger populations, research on older adults has produced inconsistent findings (Fuentes et al., 2007; Jordan et al., 2008; Kim et al., 2020). For example, one study that used clinical data from a pain center found that higher neighborhood socioeconomic status (nSES) was associated with better pain outcomes among patients aged 50 and over (Fuentes et al., 2007). The study also showed that nSES mediated the differences in pain outcomes between White and Black participants. Another study conducted in the United Kingdom (UK) assessed neighborhood characteristics using the UK Index of Multiple Deprivation and found that it was linked to a higher risk of developing disabling pain (Jordan et al., 2008). In contrast, an US-based study found that perceived neighborhood social cohesion was not associated with pain onset among older adults (Kim et al., 2020). These mixed findings can be attributed to differences in measures of neighborhood characteristics and pain outcomes, study populations, and research designs. As a recent review has pointed out, more research is needed to explore the social and geographical factors that influence pain outcomes among older adults (Patel et al., 2021).

The relationship between neighborhood characteristics and pain outcomes in older adults, though not directly tested, can be explained through multiple potential pathways. Living in a disadvantaged neighborhood, characterized by factors such as physical disorder and higher crime rates, can increase the risk of chronic distress, depression, and anxiety (Choi & Matz-Costa, 2018; Hill et al., 2009; Yen et al., 2009), which are known to influence pain outcome (Brooks Holliday et al., 2019; Fancourt & Steptoe, 2018). Negative psychosocial factors like stereotyping, prejudice, and discrimination can also exacerbate pain experiences and affect the quality of pain care in disadvantaged neighborhoods (Brown et al., 2018; Craig et al., 2020). Maly and Vallerand (2018) has suggested that it is important to assess neighborhood-level barriers on pain outcomes, with a particular emphasis on understanding how environmental stressors may limit support networks and physical activity which may influence pain outcomes.

Second, behavioral factors, such as disordered sleep, smoking, obesity, and physical inactivity, are another potential pathway linking neighborhood characteristics to pain outcomes (Brooks Holliday et al., 2019; Duchowny et al., 2020; Okifuji & Hare, 2015; Ray et al., 2011; Stokes et al., 2020; Tucker-Seeley et al., 2009). For example, older adults living in neighborhoods with lower levels of walkability or social cohesion are less likely to meet physical activity recommendations (Gebauer et al., 2020), which could contribute to worse pain outcomes. Lastly, living in neighborhoods with high levels of physical disorder and low levels of social cohesion can hinder the development of supportive social networks, such as friendships, kinships, and acquaintanceships (Browning & Cagney, 2002; Sampson, 2012), which have been associated with higher pain prevalence both directly and indirectly through psychosocial factors like social isolation, or loneliness (Karayannis et al., 2019; Yu et al., 2021).

The existing research on neighborhood and pain in older adults is incomplete in several ways. First, the current findings are mixed, with some studies suggesting a link between neighborhood characteristics and pain outcomes while others do not. Second, most of the research relied on clinical or regional data rather than national population-based data, which limits the generalizability of the findings. Finally, while many studies have focused on nSES or neighborhood disadvantage, few have examined modifiable neighborhood factors that may play a significant role in shaping pain outcomes in older adults. Indeed, perceived neighborhood characteristics can precisely capture how neighborhood residents are exposed to, experience, or interact with their neighborhoods in ways that shape pain outcomes, especially on perceived modifiable neighborhood characteristics, such as social and built environment. Taken together, to inform interventions designed to improve the burden of chronic pain in older adults, researchers need to assess neighborhood comprehensively use nationally representative data and adopt a longitudinal research design to assess the relationship between neighborhood and pain.

The present study aims to fill the current research gap by examining neighborhood effects on chronic pain using population-based data from a nationally representative sample of middle-aged and older adults in the US. Specifically, we evaluated the influence of perceived neighborhood physical disorder, social cohesion, safety, and social ties on the prevalence, incidence, and recovery rate of moderate-to-severe limiting pain (abbreviated below as *pain* for parsimony) in older adults. We hypothesized that low physical disorder, high cohesion, high safety, and more social ties would be associated with low prevalence, low incidence, and high recovery of self-reported moderate-to-severe limiting pain.

Methods

Sample

Data were from the 2006 to 2014 biennial waves of the Health and Retirement Study (HRS), a nationally representative longitudinal survey of adults aged 51 and older in the United States. The HRS survey is longitudinal survey that is conducted by the University of Michigan. Study details have been documented elsewhere (Karp, 2007). We used the HRS core data, the Leave-Behind Questionnaires (LBQ), and

RAND HRS Longitudinal File. The LBQ is a self-administered questionnaire that was left with respondents upon the completion of an in-person Core Interview (Smith et al., 2013). It has been used to obtain information about participants' evaluations of their life circumstances, subjective wellbeing, and lifestyle. One random half of the HRS sample received the LBQ in 2006 then followed up 4 years later in 2010, and the other half received it in 2008 then followed up in 2012.

Figure 1 shows the exclusion flow chart. Among 29,542 respondents who were eligible and participated in 2006–2014 biennial core HRS survey, we excluded 4962 individuals who were not eligible for LBQs and 1161 aged 50 or younger. Because our research focused on neighborhood factors and pain, we excluded 2849 respondents who were either in nursing homes or not cohort eligible. Then, we excluded 43 respondents who had missing information on pain measures, 1713 respondents who had missing information for four neighborhood variables (n = 39) and socio-demographic characteristics (n = 1674). The respondents who were excluded from the analytic sample were more likely to be older, male, currently married, have a high school degree or above, be in higher wealth quartiles, be from urban areas, and be currently working for pay, compared to those who were included in the analytic sample.

These exclusion criteria yielded three sets of analytic samples. To estimate the prevalence of moderate-to-severe limiting pain, the first analytic sample consists of 18,814 respondents (29,857 person-wave observations) regardless of their pain status at baseline. To estimate the incidence of pain, we used 15,163 participants (22,411 person-wave observations) who reported no pain or mild pain without limitations at baseline. To estimate the recovery rate of pain, we used 5892 respondents (7446 person-wave observations) who reported experiencing moderate-to-severe limiting pain at baseline. We used 2006–2012 neighborhood data because the neighborhood social cohesion and physical disorder were only asked in LBQs. Although neighborhood safety and social ties were asked of all the core participants in every wave, we used safety and social ties information from the same wave in which social cohesion and physical disorder were assessed to be consistent with measurement timing.

Measures

Moderate-to-Severe Limiting Pain. The primary outcomes of this study are whether respondents experienced, reported onset, or reported recovered from moderate-to-severe limiting pain. Respondents were asked three questions related to pain in HRS core survey. The initial question is "are you often troubled with pain? (yes/no)." We considered the respondents who answered "yes" were experiencing chronic pain for two reasons, though no duration was asked about pain in this question. First, the wording has the advantage of not requiring respondents to be experiencing pain at moment of the interview. Second, the question does not specify whether pain

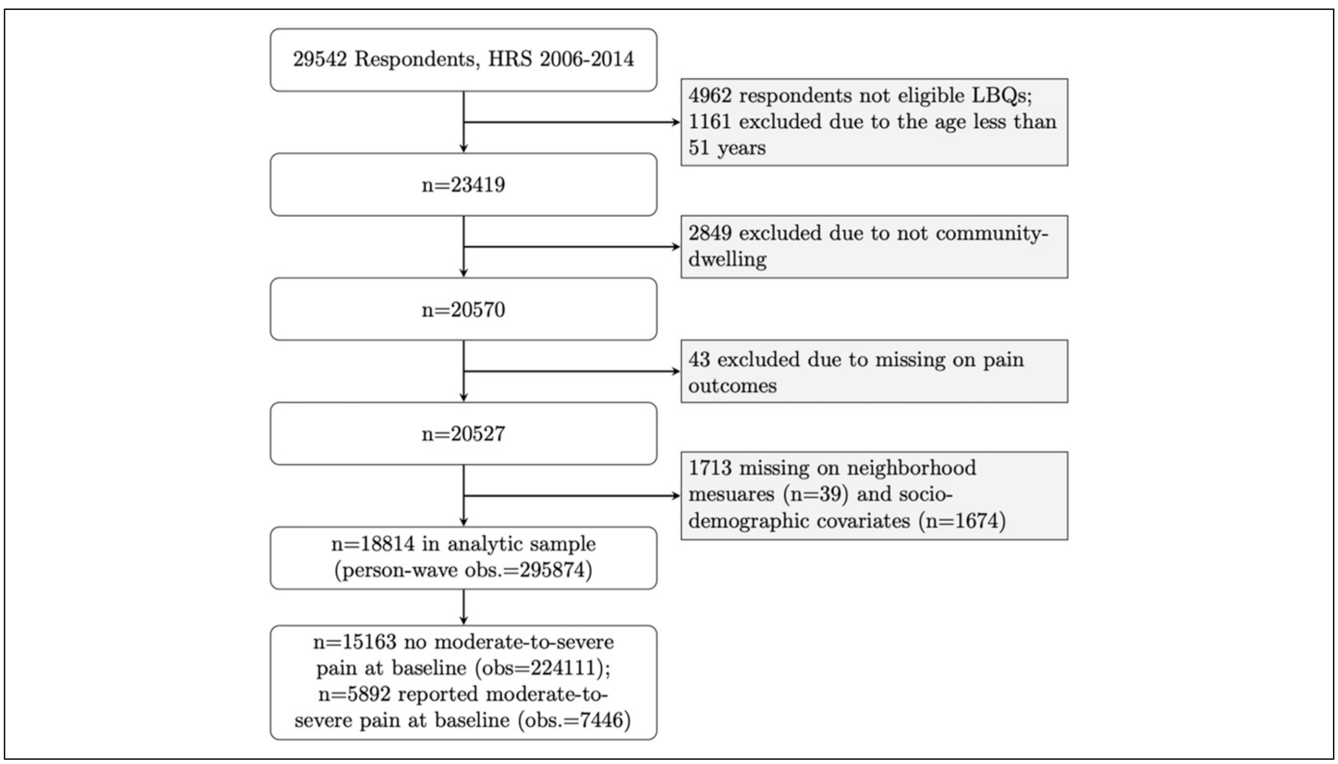

Figure 1. Derivation of the analytic sample.

has to be continuous or episodic, however "often troubled" indicates that it is unlikely to capture trivial or fleeting experience of pain. Lastly, prior study also validates that chronic pain prevalence estimates from the HRS align closely with those from other studies specifying duration (Hanna Grol-Prokopczyk, 2017). Among respondents who confirmed that often troubled with pain, HRS asks two follow up questions regarding the severity and interference of the pain: "How bad is the pain most of the time: mild, moderate, or severe?", and "Does the pain make it difficult for you to do your usual activities such as household chores or work? (yes/no)." Following previous studies (Covinsky et al., 2009; Li et al., 2021), we used all three questions and classified respondents who answered yes to the first question, then rated their pain as moderate or severe, or reported having difficulty with usual activities (moderate-to-severe limiting pain = 1) versus those who answered no pain, or mild pain without limitations (moderate-to-severe limiting pain = 0; or also refer to as "pain free" or "no pain" for parsimony).

Exposure: Self-Reported Neighborhood Characteristics. We used four subjective neighborhood characteristics as our primary exposures of interest: social cohesion, physical disorder, safety, and social ties, consistent with prior study (Nguyen et al., 2016). Respondents were asked to evaluate the areas "within a 20-minute walk or 10-block radius of respondents' home." First, neighborhood social cohesion were assessed with four questions assessing whether they felt part of the area, trusted people, people were friendly, and people would help if respondent were in trouble (Cagney et al., 2009).

The neighborhood physical disorder scale measured with four questions that asked about the presence of vandalism or graffiti, vacant or deserted houses, cleanliness of the area, and whether respondents would be afraid walking home at night (Cagney et al., 2009).

All four items in the social cohesion and physical disorder scales used a seven-point Likert scale. The social cohesion and physical disorder scales have good internal consistency reliability with Cronbach's αs of .86 for social cohesion and .83 for physical disorder. We first reverse coded items, so higher scores represent more cohesive or less disorder in their neighborhoods. Two indices were created by averaging of the items and were set to missing if more than two items were missing. Following a prior study (Nguyen et al., 2016), the disorder and social cohesion indices were then linearly transformed to be consistent with the 0–1 range of the other neighborhood variables (see below) by subtracting 1 from the original scores and dividing by 6.

Neighborhood safety was assessed with a single question asking respondents how they rated the safety of their neighborhoods with response categories on a 5-point Likert scale (i.e., excellent, very good, good, fair, or poor). Also, following Nguyen et al. (2016), we dichotomize the variable where "1" defined as good, very good, or excellent and "0" defined as fair or poor.

Neighborhood social ties were assessed with four questions. Respondents were asked if they had friends or relatives in the neighborhood and how often they get together with neighbors for a social visit. Following a prior study (Osypuk et al., 2017), we summed up all three items (i.e., having friends in the neighborhood, having relatives in the neighborhood, and getting together at least once per month) and divided by 3 to create an index from 0 to 1. Higher scores represent more social ties in their neighborhoods. Scores were set to missing if values for more than one item were missing.

Demographic, Geographic, and Socioeconomic Covariates. Covariates were all assessed at baseline, which ranged from 2006 to 2012, depending on when the sample received LBQs. The following hypothesized confounders were included in the analyses based on their potential contribution to both neighborhood selection and pain outcomes: age in years (continuous), self-reported sex/gender (female vs. male; male as the reference group), self-reported race/ethnicity (recoded based on self-reported race including White/Caucasian, Black or African American, and other, and self-reported ethnicity including Mexican, other, type unknown, and non-Hispanic; non-Hispanic White as the reference group, non-Hispanic Black, Latino/a, and non-Hispanic other), census divisions (Northeast, Midwest, South as the reference group, and West), urbanicity (urban as the reference group, suburban, and rural), self-reported whether moving out of the area between waves, self-reported marital status (married/partnered as the reference group, widowed, separate/divorced, or never married), self-reported highest educational attainment (less than high school as the reference group, high school/GED, some college, four-year college or above), household wealth quartiles (recoded from the net wealth data imputed by RAND; highest quartile as the reference group), self-reported employment status (currently working for pay vs. not working as the reference group).

Health Covariates. We included four baseline health covariates. The variable representing the number of chronic conditions was assessed by summing multiple self-reported diagnosed chronic conditions, including hypertension, diabetes, arthritis, cancer, lung disease, heart disease, stroke, and psychiatric problems. Depression in the past 2 weeks based on the modified 8-item Centers for Epidemiologic Studies-Depression [CES-D] (Radloff, 1977). We recoded depression as a dichotomous variable with "yes" indicating three or more depressive symptoms versus "no" indicating none or less than three depressive symptoms. We also included 5-item activities of daily living (ADLs) assessed based on self-reported whether a respondent has difficulty to perform the tasks such as bathing, eating, dressing, walking across a room, and getting in or out of bed, and 5-item instrumental activities of daily living (IADLs) based on self-reported whether a respondent has difficulty to perform the tasks such as using a phone, taking medication, handling money, shopping, and preparing meals (Katz, 1983). Both

ADL and IADL scores were calculated by summing the five items from each scale and provided by the RAND HRS Longitudinal File.

Analytic Strategy

The weighted descriptive statistics of the neighborhood characteristics and other covariates were presented in Table 1. We formally tested the differences between two groups (with vs. without moderate-to-severe limiting pain at baseline) via *t* test or chi-square test depending on level of measurement of variables. We then estimated prevalence, incidence, and recovery rate of moderate-to-severe limiting pain 2 years later as a function of neighborhood characteristics at baseline via Generalized Estimating Equations (GEE) modeling with a Poisson distribution, log link function, and wave fixed effects. In the models estimating prevalence (Table 2, Panel A), we used the full sample of respondents regardless of the pain status at baseline. Then we estimated the two-year incidence (Table 2, Panel B) by using the sub-sample of the respondents who reported no moderate-to-severe limiting pain at baseline and estimated the two-year recovery rate (Table 2, Panel C) using the sub-sample of the respondents who reported moderate-to-severe limiting pain at baseline. Baseline refers to the waves of 2006, 2008, 2010, and 2012; 2 years later refers to the time of assessing pain at the waves of 2008, 2010, 2012, and 2014. All the exposures and covariates were assessed at baseline. For example, neighborhood measures (and covariates) in 2006 were used to predict pain outcomes 2 years later in 2008. Because baseline pain could be potentially a confounder of the neighborhood relation with later pain, we also conducted a sensitivity analysis to estimate concurrent associations between the prevalence of moderate-to-severe limiting pain and neighborhood characteristics. The results of sensitivity analysis were in supplementary materials (see eTable 2).

Because several covariates could plausibly be conceptualized as confounders or as mechanisms/mediators, we built three nested models in estimating prevalence ratios by adjusting different sets of covariates. In the first set of models, we controlled for demographic and geographic covariates, including age in years, female gender, race/ethnicity, census divisions, urbanicity and whether move out of area between waves. In the second set of models, we further adjusted for additional socioeconomic variables, including marital status, education, household wealth quartiles, and employment status. In the third set of models, we included four health measures—self-reported number of chronic conditions, depression, ADL, and IADL because neighborhood context has been found to linked with the onset of chronic conditions (Freedman et al., 2011), mental health (Echeverría et al., 2008), and disability (Nguyen et al., 2016).

Because health covariates were potentially affected by past neighborhood context, we consider the second set of models as the primary results and the third set of models as mediating analyses. To adjust for HRS's complex survey design and household-level clustering, we applied average weights calculated from the weights specific to the Leave-Behind Questionnaires.

Results

The average age of our sample was 65 years old and about 55% respondents were women. Descriptive statistics by baseline pain status were presented in Table 1. Among those who reported moderate-to-severe limiting pain at baseline, 63% respondents reported experiencing moderate-to-severe limiting pain and 37% reported recovery from it 2 years later. Among respondents who reported no pain or mild pain without limitations at baseline, 12% respondents reported experience new-onset moderate-to-severe limiting pain 2 years later (see Table 1). The mean values (+/− standard deviation) on standardized social cohesion, physical disorder, and social ties indices were .71 (+/− .22 SD), .71 (+/−.23 SD), and .52 (+/− .37 SD) for respondents reported moderate-to-severe limiting pain at baseline, and .76 (+/− .21 SD), .77 (+/−.22 SD), and .53 (+/− .31 SD) for respondents were pain-free or reported mild pain without limitation at baseline, respectively. About 90% of respondents rated their neighborhood safety as excellent, very good, or good.

Prevalence Ratios: Moderate-to-Severe Limiting Pain

Table 2, Panel A presents results from GEE models that estimated the prevalence of moderate-to-severe limiting pain. After adjusting for demographic and geographic characteristics (model 1), perceiving more favorable neighborhoods across all dimensions was associated with a lower prevalence of moderate-to-severe limiting pain 2 years later (prevalence ratio [PR] for social cohesion: .56, 95% confidence interval [CI]: .50, .62; PR for physical disorder: .55, 95% CI: .50, .61; PR for good to excellent vs. fair/poor safety: .72, 95% CI: .67, .78; and PR for social ties: .86, 95% CI: .79, .94; Table 2). After additionally adjusting for socioeconomic covariates (model 2) associations remained statistically significant. In model 3, we additionally adjusting for health covariates, the coefficients for safety and social ties were not statistically significant.

Incidence Risk Ratio: Moderate-to-Severe Limiting Pain

After adjusting for demographic and geographic, perceiving more favorable neighborhoods across all domains was associated with lower incidence of moderate-to-severe limiting pain 2 years later (Table 2, Panel B). Each unit increase in perceived neighborhood social cohesion was associated in 50% lower risk of incident pain (PR: .50, 95% CI: .41, .60); similarly each unit increase in physical disorder was associated in 47% lower risk (PR .53, 95% CI: .44, .63); perceived neighborhood safety as

Table 1. Weighted Descriptive Statistics of Adults Aged 51 and Older by Pain Status (With or Without Moderate-to-Severe Limiting Pain) at Baseline.

	With moderate-to-severe limiting pain at baseline (n = 7446)		Without moderate-to-severe limiting pain at baseline (n = 22411)		p-value
Moderate-to-severe limiting pain at 2 years later, n (prop.)	4781	(63.32)	2992	(12.38)	NA
No moderate-to-severe limiting pain at 2 years later, n (prop.)	2665	(36.68)	19,419	(87.62)	NA
Neighborhood characteristics					
Social cohesion 0–1, mean (SD)	.71	(.22)	.76	(.21)	<.000
Physical disorder 0–1, mean (SD)	.71	(.23)	.77	(.22)	<.000
Safety (ref. not safe), n (prop.)	6211	(86.78)	20,045	(92.53)	<.000
Social ties 0–1, mean (SD)	.52	(.37)	.53	(.31)	<.000
Age, mean (SD)	65.57	(9.92)	65.20	(9.84)	.559
Female (ref.: male), n (prop.)	4962	(62.36)	12,481	(52.11)	<.000
Race/ethnicity, n (prop.)					<.000
White, non-Hispanic (ref.)	5036	(77.17)	15,646	(80.27)	
Black, non-Hispanic	1262	(10.30)	3732	(9.35)	
Latino/a	944	(9.42)	2411	(7.64)	
Other, non-Hispanic	204	(3.10)	622	(2.74)	
Marital status, n (prop.)					<.000
Married/partnered (ref.)	3986	(56.02)	13,900	(64.41)	
Divorced/separated	1425	(19.34)	3310	(15.17)	
Widowed	1695	(19.18)	4312	(15.32)	
Never married	340	(5.46)	889	(5.10)	
Education, n (prop.)					<.000
Less than high school (ref.)	1735	(18.83)	3882	(12.85)	
High school or GED	4270	(59.41)	11,660	(51.04)	
Some college	377	(5.85)	1153	(5.83)	
College and above	1064	(15.91)	5716	(30.28)	
Wealth quantile[a], n (prop.)					<.000
Quantile 1 (least wealthy)	2340	(29.25)	4477	(17.04)	
Quantile 2	2023	(27.66)	5310	(22.19)	
Quantile 3	1671	(22.37)	5998	(27.36)	
Quantile 4 (wealthiest; ref.)	1412	(20.72)	6626	(33.41)	
Current working for pay, n (prop.)	2003	(31.55)	9729	(50.59)	<.000
Census divisions, n (prop.)					.004
Northeast	1113	(15.69)	3412	(16.39)	
Midwest	1706	(25.73)	5552	(27.19)	
South (ref.)	3115	(37.62)	8966	(35.45)	
West	1512	(20.97)	4481	(20.97)	
Urbanicity, n (prop.)					<.000
Urban (ref.)	3527	(44.52)	11,445	(49.62)	
Suburban	1841	(24.90)	5117	(22.57)	
Rural	2078	(30.58)	5849	(27.81)	
Move out of area between waves, n (prop.)	544	(6.98)	1289	(5.57)	<.000
Number of chronic conditions (0–9), mean (SD)	2.83	(1.53)	1.76	(1.36)	<.000
Depressive symptoms ≥3 (ref.: <3), n (prop.)	2862	(38.65)	3191	(13.52)	<.000
Difficulty with ADLs[b] (0–5), mean (SD)	.69	(1.17)	.11	(.50)	<.000
Difficulty with IADLs[c] (0–5) mean (SD)	.47	(.97)	.11	(.49)	<.000

Underlying data are pooled observations (obs. = 29,875) of the respondents (n = 18,814) in the 2006–2014 waves of the Health and Retirement Study (HRS). Sample weights are set equal to the respondents' average leave-behind specific weight in the sample. Numbers of person-wave observations are not weighted and reflect thus the sample size, while percentages are weighted and reflect the population characteristics for categorical variables (e.g., neighborhood safety, age, female gender, race/ethnicity, marital status, and education). Baseline refers to the waves of 2006, 2008, 2010, and 2012; 2 years later refers to the time of assessing pain at the waves of 2008, 2010, 2012, and 2014. All the exposure and covariates were assessed at baseline. For example, neighborhood measures in 2006 were used to predict pain outcomes in 2008. p-value was calculated based on unweighted characteristics.

[a]The wealth quantiles are created using the whole HRS sample. The reported percentages in the table reflect the wealth distribution in the analytic sample.

[b]ADLs, activities of daily living, include five tasks: bathing, eating, dressing, walking across a room, and getting in or out of bed.

[c]IADLs, instrumental activities of daily living, include five tasks: using a phone, taking medication, handling money, shopping, and preparing meals.

Table 2. Weighted Generalized Estimating Equation Models of Prevalence, Incidence, and the Recovery Rate of Moderate-to-Severe Limiting Pain 2 years Later Predicted by Neighborhood Characteristics at Baseline.

	Model 1	Model 2	Model 3
	PR [95% CI]	PR [95% CI]	PR [95% CI]
Panel A: Prevalence of moderate-to-severe limiting pain			
Social cohesion (*n* = 24144)	.56 [.50, .62]	.71 [.64, .78]	.86 [.78, .96]
Physical disorder (*n* = 24116)	.55 [.50, .61]	.72 [.65, .80]	.83 [.75, .92]
Safety (*n* = 26097)	.72 [.67, .78]	.84 [.78, .90]	.96 [.89, 1.03]
Social ties (*n* = 25654)	.86 [.79, .94]	.88 [.81, .95]	.95 [.87, 1.03]
Panel B: Incidence of moderate-to-severe limiting pain			
Social cohesion (*n* = 18258)	.50 [.41, .60]	.63 [.52, .75]	.74 [.61, .89]
Physical disorder (*n* = 18233)	.53 [.44, .63]	.70 [.58, .84]	.78 [.64, .94]
Safety (*n* = 19701)	.70 [.61, .81]	.82 [.72, .95]	.95 [.82, 1.10]
Social ties (*n* = 19398)	.84 [.73, .98]	.86 [.75, 1.00]	.91 [.79, 1.06]
Panel C: Recovery rate of moderate-to-severe limiting pain			
Social cohesion (*n* = 5886)	1.27 [1.07, 1.52]	1.10 [.92, 1.31]	.98 [.82, 1.16]
Physical disorder (*n* = 5883)	1.31 [1.11, 1.56]	1.13 [.95, 1.35]	1.05 [.89, 1.25]
Safety (*n* = 6396)	1.25 [1.09, 1.42]	1.15 [1.01, 1.32]	1.07 [.94, 1.22]
Social ties (*n* = 6256)	1.15 [1.02, 1.30]	1.14 [1.01, 1.28]	1.09 [.96, 1.23]

Notes. Underlying data are pooled observations of respondents in the 2006–2014 waves of the Health and Retirement Study. Baseline refers to the waves of 2006, 2008, 2010, and 2012; 2 years later refers to the time of assessing pain at the waves of 2008, 2010, 2012, and 2014. All the exposure and covariates were assessed at baseline. For example, neighborhood measures in 2006 were used to predict pain outcomes in 2008. All models were weighted using average leave-behind specific survey weight. All coefficients are risk ratios and their 95% confidence intervals from a generalized estimating equation ("xtgee") configured to the Poisson distribution, log link function, and unstructured within-group correlation. All neighborhood measures have a range of 0–1, so the coefficients are directly comparable across variables, and coefficients for social cohesion, physical disorder, and social ties represent the contrast between worst possible and best possible value (0 vs. 1). For safety, the comparison is between those who rated their neighborhood as excellent, very good, or good versus those who rated their neighborhood as fair or poor.

Model 1 adjusted for age, female gender, race/ethnicity, census division, urbanicity, and whether moving out of area between waves.

Model 2 additionally adjusted for marital status, education, household wealth quartiles, whether currently working for pay.

Model 3 additionally adjusted for number of chronic conditions, depression (whether depressive symptoms ≥3 modified based on 8-item CES-D scale in the past 2-weeks), difficulty with activities of daily living (ADL), and difficulty instrumental activities of daily living (IADL).

excellent, very good, and good (vs. fair or poor) predicted 30% lower risk (PR: .70, 95% CI: .61, .81); and higher level of social ties in the neighborhood also predicted 16% lower risk (PR: .84, 95% CI: .73, .98). After adjusting for socioeconomic status (model 2), the associations were attenuated but remained statistically significant (with the exception of the marginally significant association with perceived safety). In model 3, we additionally adjusting for health covariates, the coefficients for safety and social ties were not statistically significant.

Recovery Rate: Moderate-to-Severe Limiting Pain

Table 2, Panel C presents the estimated recovery rate of moderate-to-severe limiting pain. After adjusted for demographic and geographic characteristics (model 1), perceiving more favorable neighborhoods across all domains was associated with higher recovery rate of moderate-to-severe limiting pain 2 years later. For example, each unit increase in perceived neighborhood social cohesion predicted a 27% higher ratio of recovery from pain (PR: 1.27, 95% CI: 1.07, 1.52); similarly each unit increase in physical disorder predicted 31% higher ratio (PR: 1.31, 95% CI: 1.11, 1.56); perceived neighborhood safety as excellent, very good, and good (vs. fair or poor) predicted 25% higher ratio (PR: 1.25, 95% CI: 1.09, 1.42); and higher level of social ties in the neighborhood also predicted 15% higher ratio (PR: 1.15, 95% CI: 1.02, 1.30). Model 2 further adjusted for socioeconomic status, and the associations were attenuated while CIs for social cohesion and physical disorder crossed the null. In model 3, after additionally adjusting for health covariates, none of the associations were statistically significant and the 95% CIs crossed the null.

We also conducted sensitivity check that estimates concurrent associations between neighborhood characteristics and prevalence of moderate-to-severe limiting pain (see eTable 2). The results were very similar to the results that estimate prevalence of moderate-to-severe limiting pain 2 years later in Table 2.

Discussion

This study examined associations between perceived neighborhood characteristics and chronic pain among middle-aged and older adults in the US. Although an emerging trend of research has examined neighborhood effects on pain, we extended this topic by using nationally representative data, relatively comprehensive assessments of neighborhoods, and longitudinal research designs. We focused not only the prevalence and incidence of pain, but also the rate of recovery from pain. To our knowledge, this is the first population-based study to investigate how perceived neighborhood characteristics shape prevalence, incidence, and recovery rate of moderate-to-severe limiting pain. We found that lower levels of physical disorder, higher levels of social cohesion, higher levels of perceived safety, and more social ties, were associated with lower levels of prevalent and incident pain and higher rate of recovery from pain. Our findings suggest that both perceived built environment (i.e., physical disorder and safety) and perceived social factors (i.e., social cohesion and social ties) on neighborhoods play an important role in shaping pain outcomes.

Consistent with evidence from regional or clinical studies, we detected neighborhood effects on pain outcomes. All four perceived neighborhood measures were associated with pain outcomes adjusting for demographic and geographic factors (e.g., age, gender, race/ethnicity, census division, and urbanicity). The associations held after additionally adjusting for individual SES such as education, household wealth quartiles, suggesting that perceived neighborhood characteristics had independent associations with pain outcomes. Among people *with pain* at baseline, perceived safety and social ties, but not social cohesion and physical disorder, were associated with better recovery outcomes after adjustment for individual SES. This finding indicates that individual SES factors may explain away the effects of social cohesion and physical disorder on pain recovery outcomes. We hypothesized that health covariates were potentially mediators between neighborhood context and pain outcomes. Our findings show that the effects of neighborhood safety and social ties on all three pain outcomes were all explained away by baseline health covariates; and the effect sizes of neighborhood social cohesion and disorder on pain prevalence and incidence were attenuated but remain statistically significant.

Our findings are contrast to one study that found no association between perceived social cohesion and pain using similar data (Kim et al., 2020). We measured pain slightly different from approach used in Kim et al. (2020). We considered both severity and pain-related disability when assessing pain, while Kim et al. (2020) assessed pain using a binary measure of whether troubled with pain. It is possible that neighborhood factors may be more likely to provide findings with important clinical implications; our study focused on moderate-to-severe disabling pain (also referred as "significant pain" in some studies) because those types of pain can greatly impact everyday life, and may lead to functional limitation or disability (Covinsky et al., 2009).

While most prior research emphasizes the importance of built environment or objective assessment of neighborhoods on pain outcomes in older adults (Fuentes et al., 2007; Jordan et al., 2008), our findings highlighted that perceived neighborhood social and physical environment characteristics also matter to later-life pain outcomes. Indeed, prior study comparing objective and subjective neighborhood characteristics, though not in older population, and found perceived build environment and safety, but not the objective measure of total crime and walk scores, were associated with pain (Brooks Holliday et al., 2019). It is important to notice that perceived neighborhood characteristics might be more relevant to individual's health.

We also tested whether and how mental and physical health may act as mediators in the relationship between perceived neighborhood characteristics and moderate-to-severe disabling pain outcomes in older adults. Our findings show that after including chronic conditions, depression, ADL-, and IADL-disability in the models, the coefficients for social cohesion and physical disorder for prevalence and incidence were attenuated and were not statistically significant for recovery from pain; and none of the associations between safety and social ties between three pain outcomes were statistically significant. These findings suggest that adverse neighborhood characteristics can lead to worse health, disability, and psychological distress that can further contribute to worse pain outcomes.

Limitations

This paper has several limitations. First, HRS does not ask for detailed information about pain, such as duration and location of pain. Second, given that the reference group is no pain or mild non-limiting pain, we might underestimate the associations between neighborhood and pain outcomes. Third, although we applied a longitudinal design, we only observed prevalence, incidence, and recovery rate of pain over 2 years. It is possible that neighborhood might influence pain outcomes after 2 years or more. We encourage future research to examine neighborhood effects on pain trajectory over a longer period. Although pain measures in HRS were updated in later waves from 2016 to 2020, we cannot incorporate more recent waves mainly because of the unavailability of neighborhood measures on safety and social ties after 2012. Fourth, we focused on the subjective neighborhood environment based on self-reported information. Some factors, such as psychological disposition, could influence respondents' reporting on their neighborhood factors and health outcomes. Thus, we cannot rule out that the possibility of the same source bias. We encourage future research use both subjective and objective neighborhood measures to examine the associations between neighborhood characteristics and pain outcomes. Lastly, although we have included the disability measures (i.e., ADLs and IADLs) at baseline to our models as mediators, disability could also be conceptualized as the consequence of pain. Future research could further examine how neighborhood characteristics shape disablement process among older adults with or without pain.

Despite these limitations, this study has two major strengths. First, we used a large and national survey of older adults and a longitudinal design. Second, we established the correct temporal order with our exposure and outcome measures and controlled for a comprehensive list of socio-demographic characteristics to reduce confounding.

Conclusion

We found that both perceived built and social environment at the neighborhood level predicted the prevalence, incidence, and recovery rate of pain among middle-aged and older adults in the United States. Our results suggest that good neighborhoods are associated not only with lower prevalence and incidence of pain, but also with a higher recovery rate. These findings have important implications for policy makers and health care providers as they consider the role of neighborhood characteristics in offering assessments and interventions to target physical activity and relieve pain symptoms. Our research also provides valuable information for policy decisions on community resource allocation and development plans to promote population health among older adults, which is particularly important within the framework of healthy aging and aging in place.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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