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Individual and neighborhood characteristics as predictors of depression symptom response

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ABSTRACT

Objective: Assess whether neighborhood characteristics predict patient-reported outcomes for depression.

Data sources: VA electronic medical record data and U.S. census data.

Study design: Retrospective longitudinal cohort.

Data extraction methods: Neighborhood and individual characteristics of patients (N=4,269) with a unipolar depressive disorder diagnosis and an initial Patient Health Questionnaire (PHQ-9) score ≥10 were used to predict 50% improvement in 4-8-month PHQ-9 scores.

Principal findings: The proportion of a patient's neighborhood living in poverty (OR=.98; 95% CI:.97-1.00; *p*=.03) was associated with lower likelihood of depression symptom improvement in addition to whether the patient was Black (OR=.76; 95% CI:.61-.96; *p*=.02) had PTSD (OR=.59; 95% CI:.50-.69; *p*<.001) or had any service-connected disability (OR=.73; 95% CI:.61-.87; *p*<.001).

Conclusions: Neighborhood poverty should be considered along with patient characteristics when determining likelihood of depression improvement.

Key words: depression; improvement; Veterans; neighborhood; administrative.

INTRODUCTION

The extent to which effective treatments for depression achieve their intended symptom improvement outcomes (i.e., the quality of care) can vary substantially across treatment settings.[1] However, in order to accurately assess treatment quality based on outcomes, it is important to identify and account for non-treatment-related factors that might also impact symptom response. [2] Both an individual's sociodemographic characteristics and characteristics of the lived environment may play important roles in determining depression symptom response.[3]

Individual patient demographic characteristics such as age, gender, race, and poor socioeconomic status have been inconsistently associated with depression treatment response; across studies, these characteristics have been shown to have no association, associations with greater response, and associations with worse response.[4-6] Characteristics of patients' neighborhoods such as elevated poverty rates, low educational attainment, or unstable housing may reflect psychosocial stressors and reduced access to resources (e.g., transportation, childcare) which can undermine treatment participation or moderate treatment response. Systematic reviews of epidemiologic studies have reported mixed findings regarding whether individuals who live in more socioeconomically disadvantaged neighborhoods are at increased risk for depression.[7,8] However, neighborhood income levels have been associated with antidepressant adherence,[9] which could result in improved treatment outcomes among patients from neighborhoods with higher incomes. Other neighborhood characteristics may have similar effects but have not been extensively studied within health system populations.

Understanding the potential effects of neighborhood characteristics on treatment outcomes could enable comparisons of outcomes across treatments and settings serving diverse populations. Such comparisons could be used to identify effective care practices, accounting for differences in patient populations, in order to replicate highly effective care and improve less effective practices. Understanding the effects of neighborhood characteristics on treatment outcomes could also assist with the identification of patients less likely to respond to depression treatment and lead to the development of personalized approaches for these patients.

In the current study, we used patient characteristics obtained from electronic medical records (EMRs) and patient neighborhood characteristics obtained from US census data to assess the interplay between patient and environmental factors on depression care response among a cohort of U.S. Veteran Health Administration (VA) patients diagnosed with depressive disorders. We hypothesized that patient residing within disadvantaged neighborhoods (characterized by higher rates of poverty, lower rates of employment, and less stable housing) would have poorer depression symptom response, after controlling for individual demographic and clinical characteristics extracted from the EMR.

METHODS

Data source and cohort selection

We obtained data from the VA Corporate Data Warehouse (CDW), an administrative data source which contains treatment information for all patients who receive care through the VA. The patient cohort included all patients with 1) a diagnosis of a unipolar depressive disorder (ICD-10-CM codes F32.0-F32.5, F32.9-F33.3, F33.40-F33.42, F33.9, F34.1) recorded during an outpatient encounter in calendar year (CY) 2016, 2) a PHQ-9 score ≥10 (which indicates probable major depression) recorded within 2 months of the first depression diagnosis in CY16, and 3) neighborhood characteristics available from US Census data based on patient residence census tract information within CDW. Our primary analyses included a sub-cohort of patients who also had at least one additional available PHQ-9 score during the 4-8 months after their initial PHQ-9, which is the measurement period proposed by the National Committee on Quality Assurance for their Healthcare Effectiveness Data and Information Set (HEDIS) measure of depression symptom response.[10] We excluded patients with bipolar, personality, psychotic, and pervasive developmental disorder diagnoses to be consistent with the HEDIS measure, and

because the presence of these disorders may result in divergent treatment practices compared to unipolar depression. Sensitivity analyses were performed on a separate cohort of patients with an available PHQ-9 score 1-8-months following the initial PHQ-9 score.

Measures

Medical record data. Patient demographic data extracted from CDW included age, gender, race, Hispanic ethnicity, census tract of home residence, and marital status. Comorbid PTSD and substance use disorder diagnoses (ICD-10 codes), inpatient psychiatric treatment, and service-connected disability status during the year prior to first depression diagnosis in CY16 were obtained. We also included an indicator of medical comorbidity, the Elixhauser medical comorbidity measure, with higher scores indicating higher levels of medical morbidity.[11]

We defined depression symptom improvement as a ≥50% reduction between the initial PHQ-9 score and the score of the first PHQ-9 occurring during the 4-8-month follow-up period based on the HEDIS measure of depression symptom response.[10] For the cohort with a PHQ-9 collected in the 1-8-month follow-up window we used the last PHQ-9 up until 4 months if a PHQ-9 was not available in the 4-8-month window. We also conducted sensitivity analyses using an exploratory continuous measure of improvement defined as the percentage improvement from baseline to follow-up (range 0 to 100%), and score improvement as a continuous measure of change in the follow-up PHQ-9 score relative to the baseline PHQ-9 score.

Census data. We obtained characteristics of each US census tract from the U.S. Census Bureau 2011-2015 American Community Survey 5-year estimates. The census tract characteristics included the percent of each Census tract that was: male, Veteran, Black or African American, age 65 years or older, residing in same residence for 5 years or more, age 25 years and over with less than a high school education, unemployed, receiving supplemental nutrition assistance (i.e., food stamps), below the federal poverty level, in a female-headed household with no husband and with any children less than 18 years old, in an owner-occupied housing unit, and in housing units lacking complete plumbing facilities.

Data Analysis

First, we conducted a multivariable logistic regression model predicting receipt of a follow-up PHQ-9 during the 4-8-month period following first PHQ-9 administration to identify potential sources of assessment bias. Next, we explored correlations and variance inflation

factors (VIF). We excluded two neighborhood variables, % of households occupied by the resident for 5 or more years and % of households on food stamps, from the final models due to high correlations (> .65) with other variables and large VIFs (≥ 4) indicating potential multicollinearity. We then conducted multivariable logistic regression analyses predicting depression symptom improvement including all remaining individual and neighborhood characteristics as independent variables. We included census tracts as random intercepts to control for within-neighborhood clustering of patients. Next, we conducted a series of sensitivity analyses. First, we evaluated predictor reliability using parallel multivariable linear regression models predicting two additional outcome measures: absolute PHQ-9 change and percent PHQ-9 change. We also included facilities as fixed effects in these models to control for potentially unmeasured facility level differences in the care provided. Finally, we repeated all three outcome models in the expanded cohort that included patients with a PHQ-9 follow-up assessment during 1-8 months. We conducted all analyses using SAS Enterprise Guide version 7.1.[12]

RESULTS

Patient characteristics

Our sample with baseline PHQ-9 score of 10 or higher (N=27,114) was on average 50 years old (SD=15.1), 82.2% male, 63.5% White, 26.1% Black, 9.7% Hispanic, and 49.3% married. In this sample, 46.0% of patients had a comorbid PTSD diagnosis, 23.1% had a substance use disorder diagnosis, 3.0% had an inpatient psychiatric stay during the prior year, and 72.9% had a VA service-connected disability. Baseline PHQ-9 scores were in the moderately severe range with a mean of 16.7 (SD=4.4) out of a maximum score of 27.

Neighborhood characteristics

Taking the neighborhood characteristics of each cohort member (each represented as a percentage), the averages across all members were: 48% male (SD=4.6), 10% Veteran (SD=5.4), 17% Black (SD=23.2), 18% over 65 years old (SD=8.0), 66% (SD=14.0) residing in the same residence for 5 or more years, 14% (SD=9.3) over 25 years old with less than a high school education, 9% (SD=5.5) unemployed, 15% (SD=11.4) receiving food stamps, 15% (SD=10.4) below the poverty line, 8% (SD=5.3) single female-headed with children, 64% (SD=20.6) with owner-occupied housing units, and less than .5% (SD=1.1) lacking complete plumbing facilities.

Patient and neighborhood characteristics associated with follow-up depression assessment

Among the 27,114 patients with at least one positive PHQ-9 score, 4,269 (15.7%) had a subsequent PHQ-9 assessment within 4-8 months. Characteristics significantly associated with completing a follow-up depression assessment included older age (OR=1.01 [95% CI 1.01-1.01]), Hispanic ethnicity (1.19 [1.05-1.34]), the presence of a service-connected disability (1.33 [1.23-1.45]), and the presence of a PTSD diagnosis (1.25 [1.17-1.34]). Characteristics associated with decreased odds of completing a follow-up assessment were male gender (0.83 [0.76-0.91]) and residence in a neighborhood with an elevated proportion of Veterans (0.98 [0.97-0.99]).

Predictors of depression symptom response

Of the 4,269 patients that completed a follow-up depression assessment within 4 to 8 months, 924 (21.6%) experienced a 50% or more improvement in their depression severity. In multivariable models, we found lower odds of 50% improvement in depression symptoms for individuals who were Black (OR 0.76 [95% CI .61-.96]), had PTSD (.59 [.50-.69]), or had a service-connected disability (.73 [.61-.87]). The percentage of neighborhood residents below the poverty line (0.98 [.97-1.00]) or who owned their residence (.99 [.99-1.00]) were also associated with decreased likelihood of 50% improvement in depression symptoms (see Table 1).

Sensitivity analyses to investigate stability of these predictors performed on absolute change in PHQ-9 scores and percent change in PHQ-9 scores as measures of depression improvement resulted in similar findings with regard to neighborhood characteristics. Baseline depression severity surfaced as an additional reliable predictor of absolute change (B = .50, SE = .02, t = 23.60, p< .001) and percent change (B = .01, SE = .001, t = 5.77, p< .001) in PHQ-9 scores at 4-8-month follow-up. Sensitivity analyses of patients with a 1-8-month follow-up PHQ-9 (N=8,154) differed in that age (OR 1.01 [95% CI 1.00-1.01]) and Hispanic ethnicity (0.81 [0.66-0.98]) were also associated with 50% improvement in multivariable analyses. Analyses utilizing continuous measures of response (absolute change and percentage improvement in PHQ-9 scores) with a 1-8-month follow-up period resulted in similar findings to sensitivity analyses of those with a 4-8-month PHQ-9 follow-up.

DISCUSSION

We found two neighborhood socioeconomic characteristics – percent poverty and percent home ownership – to be modest but statistically significant predictors of depression symptom

improvement after accounting for individual demographic and clinical factors available in patient electronic medical records. Our finding that greater neighborhood poverty was associated with a lower likelihood of symptom response is consistent with our initial hypothesis and with prior epidemiological studies that have shown cross-sectional correlations between poverty and rates of depression.[13] Neighborhood poverty may impact depression treatment response through various mechanisms including fewer health-promoting community resources (e.g., access to healthy foods, recreational spaces), increased exposure to stressors such as crime or discrimination, and less social capital within networks to address needs like employment, housing, or transportation (e.g., report by WHO on social determinants of mental health).[3,14] Neighborhood poverty may also serve as an approximation for individual financial status, which we were not able to control for given the available medical record data; a lack of individual financial resources likely contributes to poor depression symptom response separate and in addition to neighborhood factors.

Although neighborhood poverty had a statistically significant association with depression symptom response, the strength of the effect was modest in terms of the predicted impact on PHQ-9 scores. Based on an estimated coefficient of -.04, an absolute difference of 25% in the poverty rate would confer a 1-point difference in PHQ-9 scores assuming all other factors are held constant. Thus, the effect of poverty will be most useful to consider when considering populations that experience wide variations in neighborhood poverty.

Our finding that greater neighborhood home ownership was associated with decreased likelihood of depression symptom response is in contrast to prior studies which have generally demonstrated home ownership to be associated with less stress and depression compared to renting.[15,16] Our study included a number of covariates not included in prior studies and measured symptom change rather than cross-sectional associations, which may explain the discrepancy in findings. We note neighborhood home ownership was not statistically significant in sensitivity analyses, suggesting the association with depression is weak and variable depending on measure of response used.

Our finding that Black race was associated with worse depression outcomes is consistent with prior general population studies of antidepressant treatment response and surveys reporting low rates of treatment engagement among Black patients.[17] Within the VA, Black patients are equally likely to receive adequate psychotherapy but are less likely to receive adequate

antidepressant treatment when compared to White individuals.[18] These disparities may contribute to our findings of worse symptom improvement among Black VA patients. Also, consistent with our findings, comorbid PTSD and anxiety has previously been associated with worse treatment outcomes in clinical trials of antidepressant medications and psychotherapy.[5,19] Worse outcomes among patients with PTSD or anxiety could partially be due to a treatment focus on symptoms related to these conditions rather than depression symptoms. Exposure treatments have also been noted to briefly exacerbate depression symptoms in the course of treatment before improvements were noted with the completion of treatment.[20,21] Finally, worse depression outcomes among patients with service-connected disabilities are to be expected considering the chronic symptom burden and impairments to social role functioning associated with increased disability relative to those that may not meet criteria for service connection. Overall, treatment adjustments should be considered to accommodate for differences in the clinical needs of patients with characteristics that predict worse outcomes. For example, Ell et al. describe several sociocultural adaptations to collaborative care management for depression for ethnic minorities including psychoeducation to target culturally-specific misconceptions regarding depression, greater opportunities for family involvement, and specific content focused on coping with socioeconomic stress and limited access to social resources.[22]

Interpretation of study findings should incorporate some limitations. The cohort included in our primary analyses represented a subset of the overall population of VA patients with depression diagnoses due to limited availability of follow-up PHQ-9 scores within patient EMRs. While reasons for missing PHQ-9 scores are not available in the data, multiple factors likely contribute, including difficulty entering PHQ-9 scores into VA's EMR system, limited adoption of measurement-based care, use of the PHQ-9 for initial screening and assessment rather than symptom monitoring, and early patient treatment drop-out. Treatment factors were not included in our analyses in order to focus on baseline predictors, but differences in treatment may have impacted symptom response and should be considered as potential mediators of neighborhood effects in future studies. Although the demographic and clinical characteristics of our study cohort is similar to previously studied cohorts of VA patients with depression,[23] our cohort differs substantially from patients with depression in the general population (e.g., depressed VA patients are predominantly male, of older age, and more likely to have PTSD).[24] Thus, our findings may not be generalizable to non-VA patients or other health systems. Finally, we did

not have access to individual census data for VA patients and could not assess the extent to which VA patients are similar to the other individuals in their neighborhoods.

Our findings have implications for quality measurement and for predicting patient treatment outcomes. Incorporating neighborhood poverty as an indicator of socioeconomic adversity, particularly when individual measures of financial resources are not available, is likely to modestly improve models of depression symptom outcomes. Racial composition and the prevalence of comorbid PTSD and disability may be particularly useful for risk-adjustment when comparing outcomes between different populations of patients with depression. Finally, health systems such as the VA may wish to consider more robust and systematic efforts to obtain follow-up depression severity assessments to reduce the bias in outcome measurement, improve the validity of outcome-based quality measures, and ultimately improve care.

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Contributors

VP, NB, PP designed the study and drafted the manuscript. DG extracted the data, conducted the data analysis, and helped with data interpretation. KZ and HMK helped with interpretation of findings and provided critical revisions. All authors contributed to and have approved the final manuscript.

Disclosures

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TABLES

Table 1. Multivariable logistic regression predicting ≥ 50% improvement in PHQ-9 scores at 4-8-month follow-up and multivariable linear regression analyses of percent improvement in PHQ-9 and absolute improvement in PHQ-9 among VA patients diagnosed with depression (N=4,269).

	50% improvement	% improvement	absolute improvement
Variables	OR (95% CI)	B (SE)	B (SE)
Intercept	.24 (.07, .81)*	.24 (.11)*	-3.56 (2.35)
Demographics			
Age (years)	1.00 (1.00, 1.01)	.001 (<.001)	.01 (.01)*
Gender (male)	1.10 (.89, 1.36)	.004 (.01)	.08 (.25)
Race (Black)	.76 (.61, .96)*	-.02 (.01)	-.75 (.27)**
Race (other/unknown)	.97 (.75, 1.26)	-.01 (.01)	-.33 (.33)
Hispanic ethnicity	.86 (.65,1.14)	-.02 (.02)	-.60 (.36)
Married	1.06 (.90, 1.24)	.01 (.01)	.03 (.20)
Clinical			
Baseline PHQ-9	1.01 (.99, 1.03)	.01 (.001)***	.50 (.02)***
PTSD diagnosis	.59 (.50, .69)***	-.05 (.01)***	-.99 (.20)***
SUD diagnosis	.93 (.77, 1.13)	-.01 (.01)	-.15 (.23)
Inpatient psychiatry	1.15 (.76, 1.74)	.02 (.02)	.23 (.51)
Disability rating	.73 (.61, .87)***	-.04 (.01)***	-.59 (.24)*
Elixhauser score	1.00 (.99,1.02)	<.001 (.001)	.02 (.02)
Neighborhood			
% Veteran	1.00 (.98, 1.02)	-<.001 (.001)	-.02 (.02)
% Male	1.01 (.99, 1.03)	.001 (.001)	.03 (.02)

% Black	1.00 (.99, 1.01)	-<.001 (<.001)	.001(.01)
% > 65	1.01 (.99, 1.02)	.001 (.001)	.02 (.01)
% 25yo w/less than high school education	1.01 (.99, 1.02)	.001 (.001)	.02 (.01)
% Unemployed	1.00 (.98, 1.02)	<.001 (.001)	.01 (.03)
% Below poverty line	.98 (.97, 1.00)*	-.003 (.001)**	-.04 (.02)**
% Female-headed household	1.00 (.98, 1.02)	<.001 (.001)	-.01 (.03)
% Owner occupied	.99 (.99, 1.00)*	-.001 (<.001)	-.01 (.01)
% Housing w/o plumbing facilities	.99 (.92, 1.06)	.01 (.004)	.07 (.09)

Note: PHQ-9 = Patient Health Questionnaire 9; OR = odds ratio; CI = confidence interval; B = regression unstandardized estimate; SE = standard error; PTSD = Post Traumatic Stress Disorder; SUD = Substance Use Disorder.

* p<.05, **p<.01, ***p<.001