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Associations among pain, depression, and functional limitation in low-income, home-dwelling older adults: An analysis of baseline data from CAPABLE

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Introduction

In 2010, adults 65 and older were 13% of the US population¹ yet accounted for 33.9% of total health care costs.² At present, this population totals 40.3 million people and is growing at a faster rate than any other age group in the nation.¹ The detrimental effects of the diseases and functional limitations faced by this population are well documented and have significant implications for both quality of life (QOL) and healthcare costs.³ Functional limitations are associated with a plethora of negative health and social consequences, including increased health service utilization, increased frailty, fear of falling, and poor quality of life.^{4,5,6}

Unfortunately, assessment, impact, or control strategies for functional limitations are rarely addressed systematically in health care delivery, despite the significant role of functional limitations in driving health care costs.⁷ Often, services delivered by healthcare teams fail to adequately support patients in their efforts to achieve functional goals.⁸ In the United States, despite the recent emphasis on teams, delivery of care is often focused on disease management and provided in silos, with providers failing to address function through interdisciplinary collaboration. Primary care providers (PCP) usually focus on management of chronic diseases; specialists on their specialty (cardiovascular, respiratory); and nurses on medication reconciliation, patient education, and symptom management. Physical and/or occupational therapists, who have the greatest expertise in assessment of function, are typically engaged in care only after a catastrophic event.

Collectively, activities of the health care team are directed toward maximizing quality of life and function. However, with each provider viewing the patient through a distinct professional lens, the health care team often overlooks targeted interventions that focus on maximizing functional ability amongst medically complex community dwelling elders. These missed opportunities are unfortunate, as functional limitations, defined as having difficulty with activities such as bathing, preparing meals, or walking, are often modifiable.

Prior research has identified complex interactions between chronic pain, deconditioning and loss of function, isolation, and depression,¹¹¹² indicating that better interdisciplinary management of pain and depression may influence functional limitations and improve health-related quality of life. Associations between chronic pain and depression are particularly strong among African American and Hispanics due to race-related disparities in identification of and treatment for pain-related depression.¹³ Still, despite some evidence that depression is more strongly related to a decline in functional status than pain is,¹⁴ few have examined the extent to which depression may mediate the relationship between pain and functional limitations among minority and low-income populations.

Understanding whether depression mediates the relationship between pain and functional limitations may lead to more impactful targeted interventions. Efforts should particularly investigate relationships between functional limitations, depression, and pain among low-income and minority groups, as these groups have higher rates of pain,¹³ psychosocial and physical disability,¹⁵¹⁶¹⁷ depression¹⁸¹⁹ and under-treatment of chronic conditions compared to higher-income and non-Hispanic whites. Given that well-documented positive associations exist between depression and functional limitations among older adults, we suspect that depression may serve as a mediator in the relationship between pain and functional limitation amongst this largely low-income and minority sample.⁸²⁰²¹

This paper aims to advance understanding of associations between pain, depression, and functional limitations among a population of low-income, functionally-challenged, community-dwelling older adults living in Baltimore, MD. Linear regressions will be used to assess associations between self-reported functional limitations, depression, and self-reported pain; and mediation models will be tested using multiple regression analyses, as proposed by Baron and Kenny (1986).²² Unadjusted regressions and regression models adjusted for variations in age, sex, race, number of comorbidities, and living arrangement will be considered, as functional limitations have been positively associated with higher age,²³ higher levels of comorbidity,²⁰²⁴²⁵ greater social isolation,²⁵ female sex,²⁴ and African-American race²⁴ in prior studies. Based on previous research, we hypothesize that greater functional limitation will be positively associated with increased self-reported pain and positively associated with greater depressive symptomology. Moreover, we hypothesize that depression will mediate the relationship between functional limitations and pain.

Methods

Sample

This study represents a secondary analysis of baseline process data gathered within CAPABLE, an ongoing study funded through grants from the Robert Wood Johnson Foundation, National Institutes of Health, and Centers for Medicare and Medicaid Services.¹⁰ Formally entitled “Community Aging in Place: Advancing Better Living for Elders,” CAPABLE is testing an intervention which may help low-income, community-dwelling older adults with functional limitations age safely within their homes. This study focuses primarily on low-income and African-American older adults, as these populations have higher rates of disability,¹⁵¹⁶²⁰ pain¹³ and depression¹⁸ than higher-income and white

populations. In particular, this analysis attempts to examine the associations of pain, depression, and age with functional limitations among older adults living in Baltimore City.

Participants in CAPABLE have been recruited using targeted direct mailing and by referral from numerous community partners. As of this analysis, a total of 788 individuals have been initially assessed for eligibility, with 507 excluded based on eligibility criteria or an inability to schedule baseline assessment visits. Consent was obtained in a home visit prior to baseline assessment. The present sample includes all 285 eligible, consenting participants who have undergone a baseline assessment with a trained data collector. At initial assessment, participants were cognitively intact, were aged 65 years or older, reported income less than or equal to 200% of the poverty level, and reported difficulty with at least 1 activity of daily living (ADL) or at least 2 instrumental activities of daily living (IADL).¹⁰ Participants were excluded if hospitalized more than 3 times in the previous 12 months; if already receiving in-home physical therapy, nursing services, or occupational therapy; if diagnosed with a terminal condition or receiving active cancer treatment; or if dwelling in an apartment or planning to move within 1 year. The majority of participants were African American and female. Data for this study were gathered by the CAPABLE team using a standardized baseline questionnaire, recorded electronically using REDCap, and abstracted for this analysis by the study's data manager.

This secondary analysis has received ethical approval under the aegis of the larger CAPABLE study, which was granted approval by the Johns Hopkins Medical Institutions Internal Review Board.

Measures

The primary dependent variable of this review was functional limitations. Functional limitations were measured using an assessment tool developed by Katz et al (1963),²⁵ which reflects an individual's perceived difficulty and need for assistance in performing 8 ADLs. Items are rated on a 3-point scale (0="No difficulty and don't need help", 1="Difficulty but don't need help", 2="Needs help regardless of difficulty"), and a total baseline score ranging from 0 to 16 is generated from the sum of a participant's responses to the 8 prompts, with a higher total score indicating a decreased level of function.

The primary independent variables included pain and presence of depressive symptomology. We used the British Pain Society's Pain Rating Scale²⁶ to gather data on pain by asking each participant to rate the intensity, distress, interference of normal activities, and relief from pain, each on a continuous scale from 0–10. Pain interference is a measure of how much pain interferes with the ability to do activities, and pain intensity is how intense the pain is perceived to be. Presence of depressive symptoms was evaluated using the Patient Health Questionnaire-9 (PHQ-9), a validated nine-item module used to assess the severity of depressive symptoms in a patient. Participants rated answers on a scale of 0 ("not at all") to 3 ("nearly every day"), with total scores equaling the sum of individual responses. For purposes of this analysis, PHQ-9 score was treated as a continuous variable, with higher scores indicating a higher level of depressive symptomology.

Covariates included in this analysis were race, sex, age, number of common comorbidities, and whether a participant lived alone. Since nearly all participants in the study were African-American, race was grouped into the categories “African-American” and “non-African-American.” A count of comorbidities was created using the number of the following conditions for which participants reported receiving treatment from a doctor: high blood pressure, arthritis, high cholesterol, diabetes, depression, cancer, and heart disease. Age was treated as a continuous variable. Means and frequencies were generated for sex, race, living arrangement, age, comorbidities, PHQ-9 total scores, pain intensity, pain interference and treatment for depression.

Data Analysis

Linear regression analyses were used to examine the cross-sectional associations between degrees of functional limitation, pain, and PHQ-9 total score. Model 1, represented in table 2, examines unadjusted associations between functional limitations and each pain measure, as well as the unadjusted association between functional limitation and PHQ-9 total score. Model 2, also represented in table 2, reflects the results of multiple regression used to assess these associations with the inclusion of listed covariates: age, sex, race, number of common comorbidities, and living arrangement.

Mediation models were tested using a four-step method proposed by Baron and Kenny (1986), outlined below: (1) regress the outcome variable (OV) on the independent variable (IV); (2) regress the mediator on the IV; (3) regress the OV on the mediator; (4) conduct a multiple regression analysis of the OV on both the IV and the mediator. To establish a mediator effect, the first, second, and third equations must show a significant association in the hypothesized direction. In the fourth equation, 2 conditions must be met: (1) the mediator significantly predicts the OV and (2) the direct relationship of the IV to the OV is less in the fourth (multiple) regression than in the first. If the IV is no longer a significant predictor when the mediator is controlled, the findings support full mediation; if both the mediator and the IV predict the OV, findings support partial mediation.²² Mediation was assessed in the relationships between functional limitations and two pain measures (pain intensity and pain interference). Mediation models were tested with and without the inclusion of age, sex, race, and living arrangement.

To reduce the influence of collinearity among different measures of pain, separate regressions were performed for each measurement of pain. Beta coefficients and p-values for adjusted and unadjusted regression models are recorded in Table 2; and mediation models are presented graphically.

For all tests, p-values less than or equal to 0.05 were considered statistically significant. All statistical procedures were performed using STATA/SE statistical software, Version 13.1 (StataCorp LP, College Station, TX).

Results

Baseline data for 285 participants were included in this secondary analysis. Demographic and medical characteristics of these participants have been recorded in Table 1. The mean

age of all participants was 75.6 years. Within the sample population, a majority of participants were female (87.0%), African-American (85.6%), and high school graduates (52.1%). At time of data collection, 50.2% of participants lived alone and 23.2% of participants were being treated for depression. Participants had a mean pain intensity score of 3.9 out of 10 and a mean pain interference score of 4.8 out of 10. On average, patients had a total of 3.8 common comorbidities and were mildly depressed with an average PHQ-9 score of 6.9.

Simple linear regression revealed a positive association between functional limitations and all metrics of pain intensity, distress, and interference, with the exception of current pain intensity. Pain relief was not significantly associated with ADL total score ($\beta = -0.01$, $p = 0.09$). Lastly, PHQ-9 total score was positively associated with ADL total score ($\beta = 0.15$, $p = 0.00$), indicating that a higher level of depressive symptomology is, as hypothesized, associated with increased functional limitations. Among all independent variables studied, self-rated pain interference explained the greatest amount of variation in ADL total score among participants ($adj R^2 = 0.07$). Results of these tests are included in Table 2.

Simple linear regressions also revealed significant associations between PHQ-9 total score and various measures of pain intensity, distress, and interference (see Table 3). Pain relief was negatively associated with intensity of depression ($\beta = -0.02$, $p = 0.01$). Adjusting for variations in age, sex, race, living arrangement, and comorbidities had no significant impact on the magnitude or significance of the association between PHQ-9 total score and current pain intensity, pain intensity last week, pain distress, pain distress last week, or pain interference. Controlling for these factors did, however, render the relationship between PHQ-9 total score and pain relief statistically insignificant ($p = 0.06$). Results of these tests are documented in Table 3.

Figure 1 and Figure 2 summarize the results of adjusted mediational models derived using the analysis proposed by Baron and Kenny.²² The following initial conditions were met for PHQ-9 total score to function as a mediator in the relationship between current pain intensity and ADL total score: (1) the main effect of current pain intensity (IV) on ADL total score (OV) was statistically significant ($\beta = 0.12$, $p = 0.05$); (2) the relationship between current pain intensity (IV) and PHQ-9 total score (mediator) was statistically significant ($\beta = 0.37$, $p = 0.00$); and the association between PHQ-9 total score (mediator) and ADL total score (OV) was significant ($\beta = 0.14$, $p = 0.00$). As is shown in figure 1, PHQ-9 score fully mediated the relationship between ADL total score and current pain intensity.

Likewise, the following conditions were met for PHQ-9 total score to function as a mediator in the relationship between pain interference and ADL total score: (1) pain interference (IV) was significantly associated with ADL total score (OV) ($\beta = 0.26$, $p = 0.00$); (2) pain interference (IV) was significantly associated with PHQ-9 total score (mediator) ($\beta = 0.47$, $p = 0.00$); and PHQ-9 total score (mediator) was significantly associated with ADL total score (OV) ($\beta = 0.14$, $p = 0.00$). As shown in figure 2, PHQ-9 score partially mediated the relationship between ADL total score and pain interference.

These mediation effects remained present after adjustment for variations in age, sex, race, living arrangement, and number of common comorbidities.

Discussion

Functional limitations and disabilities among older adults significantly impact quality of life and personal healthcare expenditures. Results of this study indicate that low-income, functionally challenged older adults living in Baltimore City have a relatively high incidence of severe pain and depression. Depression and pain are closely associated with functional limitations, and multiple regression indicates that depression seems to mediate the relationship between pain and functional limitation. Ultimately, variations in pain interference and PHQ-9 total score account for roughly 14% of the variation in functional limitations among this sample (*adj. R*² = 0.14).

Prior research indicates that issues of pain and depression are often under-treated and under-explored among minority individuals.¹³ As such, little is known about the association between functional limitations and pain and depression among the specific population studied in this analysis. Still, a number of researchers have examined the associations among pain, depression, and functional limitations among older adults as a general population. Other authors, including Kaupilla, Pesonen, Tarkkila, and Rosenberg (2007) have found that pain is less strongly associated with functional limitations than are other factors, including depression, social isolation, and poor cognition.¹⁴ Numerous others have found that depression is associated with a higher risk for onset of disability in activities of daily living.²⁸²⁹ Still others, including Green et al (2003) and Iliffe et al (2009) have found that depression is associated with factors such as pain, social isolation, poverty, and race.¹²¹³³⁰ Walker and colleagues found that pain severity was associated with functional limitations and disability and that depressive symptoms were associated with disability among middle aged and older African American women with OA.³¹ Though no studies have shared the exact design of the current analysis, several have identified similar associations between pain and depression as well as between depression and functional limitations.

Given the findings of preceding studies, it is relatively unsurprising that a link exists between depression and functional limitations. As others have noted, it is probable that depression and pain exist as components of a larger model, in which risk factors such as age, comorbidities, racial discrimination, social isolation, educational status, pain, and depression may contribute to an individual's risk for disability. As there are diverse pathways that contribute to a cycle of pain, depression, and functional limitations, it is essential that care providers partner to improve the functional ability of aging minorities.

This study does have strengths that warrant mentioning. It attempts to elucidate the relationship between three highly inter-related variables: pain experience, depression, and functional limitations. This analysis used a sample distinct from those used in prior studies, with over 80% of participants being African-American and all participants living at less than 200% of the poverty line. This unique sample has facilitated a better understanding of how associations among pain, depression, and functional limitations may vary based on race, income, and location. Further, data was gathered by trained professionals using validated

measures. Nonetheless, generalizability of the study's findings may be limited by the fact that the sample was predominantly African-American, female, and living within the same city. Another limitation is the cross-sectional nature of the data, which limits causal inference.

This analysis adds to a growing body of work documenting linkages between pain, depression, and functional limitations. Results show that depression mediates the relationship between pain and functional limitations in controlling for a number of other relevant factors. Addressing the range of conditions that promote disability among older adults necessitates viewing a patient's needs holistically, accounting for the numerous factors—environmental, medical, personal, and social—that could influence an individual's capacity to perform necessary tasks. In order to reduce risk, healthcare providers and researchers should consider regularly screening for depression and pain, as low-income populations and racial and ethnic minorities are at increased risk for under-treatment of these conditions.³²³³ By addressing pain and depression, two modifiable conditions which are associated with functional limitation, healthcare workers may improve older adults' quality of life while simultaneously advancing cost-effective, patient-centered care.

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Figure 1.
Depression as mediator in the relationship between pain intensity and functional limitations

Figure 2.
Depression as mediator in the relationship between pain interference and functional limitations

Table 1

Baseline Demographic and Medical Characteristics of CAPABLE Study Participants (n=285)

Characteristic	Summary Statistic
Age (mean $\pm$ SD)	75.6 $\pm$ 7.6
Female (%)	248 (87.0)
Black (%)	244 (85.6)
Education (%)	
Less than High School/GED	92 (32.4)
High School/GED	148 (52.1)
Bachelor's Degree+	44 (15.5)
Living alone (%)	140 (50.2)
Treated for depression (%)	66 (23.2)
Comorbidities (mean $\pm$ SD)	3.8 $\pm$ 1.5
Pain (mean $\pm$ SD)	
Current pain intensity	3.9 $\pm$ 3.0
Pain intensity last week	5.4 $\pm$ 2.9
Current pain distress	3.4 $\pm$ 3.0
Pain distress last week	5.1 $\pm$ 3.0
Pain interference	4.8 $\pm$ 3.1
Pain relief	5.5 $\pm$ 2.6
PHQ-9 Total (mean $\pm$ SD)	6.9 $\pm$ 5.1
ADL Total Score (mean $\pm$ SD)	4.0 $\pm$ 3.1

Table 2

Association between ADL total score and pain or depression

Independent Variables	Model 1				Model 2			
	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p-value</i>	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p-value</i>
Pain now	0.13	0.06	2.11	0.04	0.12	0.06	1.93	0.05
Pain last week	0.16	0.06	2.59	0.01	0.16	0.06	2.44	0.02
Distressing pain	0.19	0.06	3.14	0.00	0.18	0.06	3.07	0.00
Distressing last week	0.16	0.06	2.78	0.01	0.17	0.06	2.70	0.01
Pain interference	0.27	0.06	4.69	0.00	0.26	0.06	4.39	0.00
Pain relief	-0.01	0.01	-1.71	0.09	-0.01	0.01	-1.71	0.09
PHQ-9 Total	0.15	0.03	4.17	0.00	0.14	0.04	4.01	0.00

Model 1: Univariate linear regression of ADL total score (OV) on various IV's

Model 2: Adjusted for variations in age, sex, race, living arrangement, and comorbidities

Table 3

Association between PHQ-9 total score and pain

Independent Variables	Model 1				Model 2			
	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p-value</i>	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p-value</i>
Pain now	0.45	0.10	4.65	0.00	0.37	0.10	3.69	0.00
Pain last week	0.50	0.10	4.96	0.00	0.44	0.10	4.29	0.00
Distressing pain	0.55	0.09	5.84	0.00	0.49	0.10	5.12	0.00
Distressing last week	0.49	0.09	5.13	0.00	0.45	0.10	4.52	0.00
Pain interference	0.53	0.09	5.63	0.00	0.47	0.10	4.78	0.00
Pain relief	-0.02	0.01	-2.62	0.01	-0.02	0.01	-1.91	0.06

Model 1: Univariate linear regression of PHQ-9 total score (OV) on various IVs

Model 2: Adjusted for variations in age, sex, race, living arrangement, and comorbidities