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Linking Neighborhood Context and Health in Community-Dwelling Older Adults in the Medicare Advantage Program

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Abstract

OBJECTIVES—To examine whether neighborhood context moderates the relationship between multiple chronic conditions (MCC) and function among Medicare Advantage (MA) beneficiaries.

DESIGN—Cross-sectional study.

SETTING—2013 Medicare Health Outcome Survey Cohort 16 baseline data.

PARTICIPANTS—A sample of 187,434 MA beneficiaries aged 65 and older.

MEASUREMENTS—We defined disadvantaged neighborhoods as those with an Area Deprivation Index above the 85th percentile. MCC is defined as two or more chronic conditions. The primary outcome was any self-reported functional limitations with a basic activity of daily living (ADLs) or instrumental ADL. We used survey-weighted multivariate linear probability

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Author Contributions:

Daniel Jung: Contributed to the design of study and analyzed the data. Drafted the article and approved the final version to be published.

Amy Kind: Contributed to the design of study and interpretation of the results. Revised the article critically for important intellectual content and approved the final version to be published.

Stephanie Robert: Contributed to the design of study and interpretation of the results. Revised the article critically for important intellectual content and approved the final version to be published.

William Buckingham: Contributed to data analysis. Revised the article critically for important intellectual content and approved the final version to be published.

Eva DuGoff: Designed and directed the project including contributions to the study design, data analysis, and interpretation of the data. Drafted and supervised the article, and approved the final version to be published.

regression to examine whether the neighborhood disadvantage moderates the relationship between MCC and report of a functional limitation.

RESULTS—35.6% of the sample reported a functional limitation. Compared to those with 0-1 chronic conditions, beneficiaries with MCC were more likely to report a functional limitation (Odds Ratio [OR], 2.63; 95% Confidence Interval [CI], 2.50-2.77). Beneficiaries in the most disadvantaged neighborhoods were more likely to report a functional limitation than those in less disadvantaged neighborhoods (OR, 1.14; 95% CI, 1.08-1.21). Among older adults with MCCs, the probability of reporting a functional limitation was 12 percentage points greater among those living in the most disadvantaged neighborhoods compared to those living in less disadvantaged neighborhoods.

CONCLUSION—We find that neighborhood context is a significant predictor of a functional limitation and moderates the association between chronic conditions and functional limitations. Publicly available indicators like the ADI could be used by health plans and public health officials to target interventions to reduce functional impairment.

Keywords

Neighborhood disadvantage; Functional Limitation; Multiple chronic conditions; Medicare Advantage

INTRODUCTION

Preventing and managing functional limitations are important for older adults to maintain independence at home.^{1,2} Understanding the risk factors for functional limitations is crucial to develop initiatives to prevent and manage function limitations. Previous studies have found that worse health such as multiple chronic conditions (MCC) increased the risk of functional limitations^{3,4} and older adults with both MCC and functional limitations are more likely to experience worse health outcomes including lower quality of life and higher mortality.⁵ Also, individuals living in socioeconomically disadvantaged neighborhoods are more likely to experience functional limitations.^{6,7} While it is well established that individual- and neighborhood-level factors are independently associated with functional limitations, studies have not examined the joint contribution of MCC and neighborhood disadvantage on functional limitations. Clarifying the role of neighborhood disadvantage in the association of health and function could help policymakers and health plans target individuals to better support independence and quality of life for older adults.

Where one lives is an important influence on health and function. Living in socioeconomically disadvantaged neighborhoods is associated with lower self-reported health,⁶ functional limitations,^{6,7} multimorbidity,⁸ and higher mortality among older adults.^{6,9,10} It is known that disadvantaged neighborhoods are associated with lower level of social support and availability for caregivers support,^{11,12} lack of resources including health care, retail stores, and recreational facilities,^{13,14} and financial support resources to pay for equipment or assistance,¹¹ which are suboptimal for older adults to manage their health and function. Considering the importance of social and structural resources for older adults with MCC,¹⁵⁻¹⁸ living in a disadvantaged neighborhood may pose additional challenges to

maintaining health and function. Also, with increasing age and declining health, people are likely to spend greater amounts of time within their neighborhood of residence.¹⁹ Considering the importance of neighborhood context for health and functional limitation among older adults, examining whether neighborhood characteristics moderates the relationship between individual health and functional limitations will improve our understanding of the risk factors for functional limitations.

Previous studies of functional limitations in the US have largely focused on the Medicare fee for service (FFS) population or general older adult population. These studies have not examined a growing subgroup: older adults enrolled in the MA health plans. MA accounts for 17.6 million Medicare beneficiaries, 31% of the Medicare population, and enrollment in MA is expected to grow to more than 22 million by 2020.²⁰ MA plans provide Medicare-covered inpatient and outpatient services, and many also provide prescription drug coverage. While MA beneficiaries have reported a significant difference in mortality, healthcare utilization, quality of care, and access to healthcare compared to FFS Medicare beneficiaries,^{21,22} our understanding of functional limitations among Medicare recipients has been limited to FFS Medicare beneficiaries. Expanding our understanding of risk factors for functional limitations in MA population could support Medicare and MA plans to design interventions to efficiently improve beneficiaries' functional ability and health.

We examine the effect of neighborhood disadvantage on the association between health measured by MCC and self-reported functional limitation in a nationally representative sample of community dwelling individuals 65 and older enrolled in MA in 2013. We use a robust measure of neighborhood socioeconomic contextual disadvantage, Area Deprivation Index (ADI),²³ to test the association of neighborhood disadvantage and MCC with functional limitation and to test the potential moderating effect of neighborhood disadvantage on this association.

METHOD

Data Source

We used the 2013 Medicare Health Outcome Survey (HOS) cohort 16 baseline survey, a telephone and mail survey of beneficiaries enrolled in MA health plans. These data were collected by Centers for Medicare & Medicaid Services (CMS) to monitor the quality of care provided by Medicare Advantage Organizations (MAOs).²⁴ A randomly selected sample was drawn from each participating MAO:²⁵ 1,200 beneficiaries were selected from MAOs with more than 1,200 beneficiaries, while all beneficiaries in MAOs with 500 to 1200 were included.

Study Sample

A total of 585,956 beneficiaries were eligible for the 2013 HOS cohort 16 baseline survey of which 304,213 beneficiaries responded (51.9 percent response rate). We excluded survey respondents who were younger than 65 (n=49,552), those who did not answer all functional limitations survey items (n=24,619), survey respondents who could not be matched to an Area Deprivation Index (ADI) (n=39,565), and those in hospice or an institution (n=2,371).

Respondents in Puerto Rico and U.S. Virgin Islands were excluded from the sample as their reported care experiences have been shown to be substantially different from those in the continental United States.²⁶ The final analytic sample included 187,434 respondents.

Dependent Variable

Functional limitation—Respondents with one or more difficulty in self-reported ADL or IADL measures were classified as having a functional limitation. Functional limitation was determined using 6 self-reported activities of daily living (ADL) and 4 instrumental activities of daily living (IADL) measures. Supplementary Text S1 provides ADL and IADL survey questions and response categories.

Independent Variables

Most Disadvantaged Neighborhoods—We used the 2013 ADI, a composite index of 17 measures of poverty, education, housing and employment indicators at the census block group level, to classify the most disadvantaged neighborhoods. Consistent with previous studies, we defined the most disadvantaged neighborhoods as those with an ADI score above the 85th percentile (ADI = 114.6).²⁷ We identified an individual's neighborhood using their 9-digit zip code linked to the Census block group.

Multiple Chronic Conditions—We defined individuals as MCC if they reported having two or more chronic conditions out of 18 chronic conditions.²⁸ The full list is provided in Supplementary Table S2.

Other Covariates—Based on the Aday-Andersen health behavior model, we selected covariates representing predisposing, enabling, or health need factors.²⁹ Predisposing factors included age, gender, race, marital status, education, region, and living arrangements. Enabling factors were measured using income and Medicaid status. Respondents' health needs were captured by MCC (see above) and self-reported memory problems. Because issues with memory are known to be associated with lower functional ability, we include an indicator of self-reported memory problems based on how often memory problems interfered with activities in the past month.^{30,31} We also include an indicator of whether survey responses were provided by the beneficiary or a proxy respondent to account for potential reporting differences.³² We also include health plan characteristics including plan type, tax status, and performance based on the 2015 Medicare 5 Star Rating which uses plan performance measures collected in the study period. A list of the covariate categories is provided in Supplementary Table S2.

Statistical Analysis

To provide representative estimates of the MA population and to account for nonresponse bias, we calculated survey weights as the inverse of the probability of selection multiplied by probability of non-response. Our survey weight calculation procedure is described in Supplementary Text S3. Analyses accounted for the survey weight as well as the complex survey design using the survey package in R.³³ All analyses were conducted in Rstudio, version 1.0.143.³⁴

We first examined the characteristics of MA beneficiaries by neighborhood disadvantage. To determine the independent association between MCC and functional limitations and neighborhood disadvantage and functional limitations, we used survey-weighted multivariate logistic regression models controlling for individual predisposing characteristics, enabling factors, other health conditions, proxy respondents, and health plan characteristics. To test whether neighborhood disadvantage moderated the relationship between MCC and functional limitation, we added an interaction term between neighborhood disadvantage and MCC to the baseline model. We used the Wald test to assess whether the combination of the interaction term and main effects was statistically significant at $p = 0.05$.³⁵ To facilitate interpretation, we calculated the mean predicted probabilities by neighborhood disadvantage and MCC.

We performed several sensitivity tests to assess the robustness of our results. We examined alternative specifications of the number of chronic conditions (0-1, 2-3, 4-5, and 6 or more)^{36,37} and alternative thresholds of neighborhood disadvantage (80th and 90th percentile). We also examined models where functional limitation was defined as two or more difficulties with an ADL or IADL and excluded proxy respondents.

RESULTS

The sociodemographic and health plan characteristics of MA beneficiaries are described in Table 1. Older adults in MA living in the most disadvantaged neighborhoods were more likely to be non-White (40.2%), have more chronic conditions, have less education (36.5%) and income (47.3%), and live alone (39.7%). Nearly half of MA beneficiaries who live in the most disadvantaged neighborhoods reported having a functional limitation compared to one out of three beneficiaries from less disadvantaged neighborhoods.

Table 2 reports the odds ratio (OR) of reporting a functional limitation using multivariate logistic regression models. In Model 1, we find that the odds of reporting a functional limitation in beneficiaries living with MCC were 2.63 times higher than beneficiaries with 0-1 chronic condition (OR, 2.63; 95% CI, 2.50-2.77; $P < 0.001$). Beneficiaries living in the most disadvantaged neighborhoods were more likely to report a functional limitation than those in less disadvantaged neighborhoods (OR, 1.14; 95% CI, 1.08-1.21; $P < 0.001$). In Model 2, which includes an interaction term between neighborhood disadvantage and MCC, we find that the relationship between MCC and functional limitations is moderated by neighborhood disadvantage ($p < 0.001$).

Figure 1 illustrates the predicted probability of reporting a functional limitation by neighborhood disadvantage and MCC. Among MA beneficiaries with 0-1 chronic conditions, the difference in the probability of reporting a functional limitation was small and not significant: 17 percent in less disadvantaged neighborhoods and 20 percent in the most disadvantaged neighborhoods. Among MA beneficiaries with MCCs, there was a 12 percentage point difference in the predicted probability of reporting a functional limitation by neighborhood disadvantage: 40 percent in less disadvantaged neighborhoods and 52 percent in the most disadvantaged neighborhoods. This difference was statistically significant (Wald test, $p < 0.001$).

Results of sensitivity analyses were qualitatively similar to the main analysis (Supplementary Table S4-S8).

DISCUSSION

We find that MA beneficiaries living in the most disadvantaged neighborhoods compared to those in less disadvantaged neighborhoods with MCCs are 12 percentage points more likely to report a functional limitation. MA beneficiaries living in the most disadvantaged neighborhoods were also significantly more likely to report living with MCCs (79.9% vs 72.7%). Among older adults who were not living with MCCs, there was no statistically significant difference in the probability of reporting a functional limitation by neighborhood disadvantage. These results suggest that older adults in MA with MCC or who live in the most disadvantaged neighborhoods face more challenges to maintaining their independence and the challenge is significantly greater for those who are also living with MCCs.

Our findings are consistent with previous studies reporting that people in disadvantaged neighborhoods have worse health outcomes. Freedman and colleagues have found that living in less economically advantaged areas was associated with higher chances of functional limitations among adults age 55 or older.³⁸ Kind and colleagues have reported that living in a disadvantaged neighborhood was associated with higher rehospitalization risk among older adults in Medicare FFS and Singh et al. have found that cancer patients in high poverty areas had substantially higher rates of late-stage cancer diagnosis and lower rates of cancer survival than those in low poverty areas.^{27,39} Our findings extend this literature by focusing on the MA beneficiaries, and also by examining how the association between chronic condition burden and functional limitations differs by neighborhood context. We find that among older adults enrolled in MA plans, those living in the most disadvantaged neighborhoods had higher probability of reporting a functional limitation overall. Also, the probability of reporting a functional limitation was significantly greater among those with MCC.

Among older adults with 0 or 1 chronic condition, we did not find a significant difference in the probability of reporting a functional limitation by neighborhood disadvantage. One possible explanation of this result is that healthy people may be less affected by neighborhood context. Disadvantaged neighborhoods are known to be associated with fewer of healthcare resources^{40,41} and lower levels of social support^{11,12} which are important components of health care for people and maintain functional ability.^{15–17} These factors may be less important for healthier people as they may have less need and greater resilience.^{42,43}

Considering MA beneficiaries in disadvantaged neighborhoods are more likely to have MCC, MA health plan administrators should consider developing area-based target interventions to address functional limitations. For example, increasing resources in disadvantaged neighborhoods to support self-management programs in community settings could be helpful to prevent and manage functional limitations and improve health outcomes. Successful programs have been designed in the context of chronic condition management.^{44–46} Functional limitations can prevent optimal chronic condition management by complicating access to health care, interfering with self-management, and necessitating

reliance on caregivers.⁴⁷ As maintaining function for older adults with MCC is important to maintain independence and quality of life, using neighborhood-level measures to target interventions designed to improve function and health among older adults, especially those with MCC, should be considered to help vulnerable populations.

It is important to note several study limitations. First, we used self-reported data to measure functional limitation and chronic conditions, which are subject to recall and respondent bias. Second, our measure of chronic conditions did not account for level of disease severity. Lastly, because this study is based on a cross-sectional study design, we cannot infer that neighborhood context causes functional limitations. Further studies examining the long-term neighborhood effect on healthier older adults would be needed to better understand the mechanism of neighborhood context effects on functional limitation.

This study presents evidence on the relationship between neighborhood socioeconomic context, health, and function among MA beneficiaries. We find that neighborhood context is an important predictor of functional limitation and publicly available indicators like the ADI could improve health plan targeting and intervention design. Additional studies on neighborhood disadvantage using longitudinal data will be helpful to improve our understanding of the effect of neighborhood disadvantage on functional impairment and health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Impact Statement

We certify that this work is novel. Previous studies have documented that individual- and neighborhood-level factors are independently associated with functional limitations. However, we are not aware of any studies examining the joint contribution of individuals' health and neighborhood context on functional limitations. This is important to clarify the role of neighborhood context in the association between health and function to inform targeting strategies that can support independence and quality of life for older adults.

Figure 1. Probability of Reporting a Functional Limitation by Multiple Chronic Conditions and Level of Area Deprivation Index
A=Less Disadvantaged Neighborhood
B=Most Disadvantaged Neighborhood

Table 1

Survey-Weighted Characteristics of Respondents by Area Deprivation Index, Health Outcome Survey, 2013

	Overall	Neighborhood Context		P-value
		Less Disadvantaged ^a	Most Disadvantaged ^b	
N	8,413,979	7,166,352	1,247,628	
Age (%)				0.001
65-69	30.0	29.8	31.1	
70-74	26.9	26.9	27.1	
75-79	19.2	19.2	19.6	
80-84	13.4	13.6	12.2	
85 or older	10.5	10.5	10.1	
Female (%)	58.7	58.0	62.8	<0.001
Race (%)				<0.001
White	78.4	81.7	59.8	
Black	10.3	7.6	26.3	
Other	11.2	10.8	13.9	
Education (%)				<0.001
Did not graduate from high school	21.6	19.0	36.5	
High school or general equivalency diploma	31.7	31.4	32.4	
More than high school	42.1	45.0	25.7	
Missing	3.5	3.3	4.2	
Income (%)				<0.001
<\$10,000	11.3	9.5	21.4	
\$10,000-\$19,999	17.5	16.1	25.9	
\$20,000-\$29,999	15.0	15.0	14.8	
\$30,000-\$49,999	18.0	19.1	11.6	
\$50,000+	17.0	19.0	5.0	
Missing	10.1	10.3	8.9	
Don't know	11.2	10.9	12.4	
Medicaid (%)	19.1	16.4	35.1	<0.001
Living Arrangement (%)				<0.001
Living with Family/Spouse	63.9	65.8	53.2	
Living Alone	29.8	28.1	39.7	
Living with Paid Caregiver	3.1	3.0	3.5	
Missing	3.1	3.0	3.7	
Number of Chronic Condition (%)				<0.001
0-1	26.3	27.3	20.0	
2+	73.7	72.7	79.9	
One or more Functional Limitations (%)	35.6	34.0	45.4	<0.001

	Overall	Neighborhood Context		P-value
		Less Disadvantaged ^a	Most Disadvantaged ^b	
Memory Problems (%)				
Two days or more	14.8	13.8	20.5	<0.001
Less than two days	81.9	83.0	75.4	
Missing	3.4	3.2	4.1	
Proxy Respondent (%)	10.9	10.3	14.8	<0.001
Plan Type (%)				<0.001
Health maintenance organization	66.5	65.8	70.2	
Preferred provider organization	29.0	29.4	26.7	
Other	4.5	4.8	3.1	
For Profit (%)	73.8	72.5	81.4	<0.001

^a Areas with an ADI score below or equal to the 85th percentile

^b Areas with an ADI score above the 85th percentile

Table 2

Association between Neighborhood Disadvantage and Multiple Chronic Conditions and Reported Functional Limitation, Health Outcome Survey, 2013

	Model 1 ^a		Model 2 ^b	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Chronic Conditions				
0-1	Ref		Ref	
2+	2.63 (2.50-2.77)	<.001	2.54 (2.41-2.69)	<.001
Neighborhood Disadvantage				
Less Disadvantaged Neighborhood	Ref		Ref	
Most Disadvantaged Neighborhood	1.14 (1.08-1.21)	<.001	0.92 (0.81-1.06)	0.250
Most Disadvantaged Neighborhood*CC 2+			1.29 (1.11-1.49)	<.001

^a Covariates include number of chronic conditions, neighborhood disadvantage, age, gender, race, marital status, education, living arrangements, region, income, Medicaid status, self-reported memory problems, proxy, plan type, plan tax status, health plan performance.

^b Covariates include number of chronic conditions, neighborhood disadvantage, interaction term between number of chronic conditions and neighborhood disadvantage, age, gender, race, marital status, education, living arrangements, region, income, Medicaid status, self-reported memory problems, proxy, plan type, plan tax status, health plan performance.

OR=Odds Ratio

CC=Chronic Conditions