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Research Article

Racial and Ethnic Differences in Disability Transitions Among Older Adults in the United States

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Abstract

Background: Racial and ethnic differences in disability persist and are possibly widening in recent years, but evidence is limited for racial and ethnic differences in disability progression through the entire disablement process and potential influential factors. The objective of this study is to examine racial and ethnic differences in patterns of late-life disability transitions, using a new disability spectrum that incorporates successful accommodation with assistive devices in response to capacity limitations to prolong independence.

Methods: The study cohort consisted of a nationally representative sample of Medicare beneficiaries aged 65 and older in the United States who were enrolled in the 2011 National Health and Aging Trends Study and followed up annually until 2015 ($n = 6{,}198$). First-order Markov transition models were used to determine racial/ethnic differences in transitions among three stages of self-care and mobility limitations (fully able, successful accommodation, difficulty/assistance) and death.

Results: After adjustment for age and sex, non-Hispanic Black and Hispanic respondents had higher probabilities of unfavorable transitions and lower probabilities of remaining in the successful accommodation stage than non-Hispanic White respondents. The racial and ethnic differences in probabilities of maintaining successful accommodation remained statistically significant after adjustment for socioeconomic and health factors (Black: 0.56, 95% CI = 0.52–0.60; Hispanic: 0.53, 95% CI = 0.44–0.61; White: 0.63, 95% CI = 0.61–0.65).

Conclusions: Successful accommodation with assistive devices may provide possibilities for implementing interventions to enhance older adults' capacities and reducing racial/ethnic differences in late-life disability.

Keywords: Health disparities, Disablement process, Epidemiology, Psychosocial, Successful accommodation.

In the context of population aging, achieving health equity is of particular importance for the racially and ethnically diversifying older adult population in the United State. Despite the increase in longevity over the past decades, racial and ethnic gaps in late-life health persist (1,2). Inequalities arising from social factors and health care over the life course manifest as disparities in a variety of medical conditions and functional limitations in late life (3–5). As a result, racial/ethnic minorities tend to be at increased risk of disability at older ages compared with non-Hispanic White adults (6).

Racial/ethnic differences in late-life disability warrant continued research. Overall levels of late-life disability have declined since the 1980s (7). Nevertheless, racial/ethnic differences in years lived without disability appear to have widened since the early 1980s, in part because older minorities continue to experience onset of disability at younger ages than Whites (1). Other evidence suggests important racial/ethnic differences in the rate of progression of disability after onset. Findings from the Health and Retirement Study indicate that compared with older White adults, Blacks and Hispanics have higher risks of progressing from mild to severe disability (8) and experience more adverse disability trajectories (9).

Previous studies of racial/ethnic differences in disability have focused primarily on measures of difficulties or dependence in activities of daily living (6,8,9). However, it is increasingly recognized that these measures do not adequately capture the variety of approaches

individuals may adopt in response to changes in capacity, such as ability modification (10–12). Recent developments in the conceptualization and measurement of the disablement process allow a more nuanced examination of behavioral adaptations to disability progression, particularly accommodation with assistive devices (10,13). Use of devices to accommodate declines in physical capacity may not only substitute for personal assistance to prolong independence (14–16), but also affect the recognition and reporting of disability (11,17). There may be important racial/ethnic differences in access to or use of advanced assistive devices, as they depend on factors like breadth of insurance coverage, availability of financial resources, and personal preferences (18,19). However, there is very little systematic information on how the use of assistive devices in early stages of disability affects racial/ethnic differences in progression to more severe stages of disability (20–22).

Our overall objective is to examine racial/ethnic differences in disability transitions across the entire spectrum of the disablement process in a nationally representative sample of older adults from the National Health and Aging Trends Study (NHATS), with a specific focus on the role of successful accommodation with assistive devices in this process. We also investigate potential determinants that may account for observed racial/ethnic differences in disability transitions.

Methods

Study Population

Data were obtained from the NHATS, a national panel survey designed to study trends and trajectories in late-life disability in the United States (23). Annual in-person interviews were conducted in a nationally representative sample of Medicare beneficiaries aged 65 and older, with oversamples at older ages and of Black enrollees. Proxy interviews were conducted in approximately 6%–7% of cases when sample persons were unable to respond for themselves. A last month of life interview was conducted with an informant following a sample person's death. Details of the study design have been described elsewhere (23).

The present study is based on the 2011–2015 rounds of the NHATS. The study sample consisted of 6,198 non-nursing home respondents who (1) were enrolled at the 2011 NHATS (baseline) (2); reported their primary race/ethnicity to be non-Hispanic White, non-Hispanic Black, or Hispanic (hereafter White, Black, or Hispanic); and (3) had completed at least two consecutive core interviews.

Measures

Disability stages

Disability measures were derived from questions about help received, use of assistive devices and difficulties in performing self-care activities (eating, bathing, toileting, and dressing) and mobility (going outside, getting around inside, and getting out of bed) in the last month prior to the interview (Supplementary Table S1). Four mutually exclusive categories were generated for each activity: (a) fully able: a respondent had no difficulties in performing activities without device use or personal assistance; (b) successful accommodation: a respondent had no difficulties in performing certain activity with device use but without personal assistance; (c) difficulty: a respondent had difficulties in performing certain activity (with devices, if used, but without personal assistance); and (d) assistance: a respondent received personal assistance to perform activities, or reported the

activity was not done. Difficulty and assistance were combined due to the small numbers in these two groups. A summary measure for disability stages was then created based on the lowest level across the seven activities (10,24).

We defined the interview round from which a transition occurred as the previous round, and the interview round to which a transition was made as the current round. For respondents with multiple disability transitions during the 4 year study period, the current round of one transition is the previous round of the next transition. Disability stages at current round included fully able, successful accommodation, difficulty/assistance, and death. Because death is an absorbing state, the disability stages at previous round were fully able, successful accommodation and difficulty/assistance.

Race and ethnicity

Race and ethnicity were ascertained from respondents or proxy informants using the following questions: "What race do you (does the sample person) consider yourself (himself/herself) to be: White, Black or African American, American Indian, Alaska Native, Asian, Native Hawaiian, Pacific Islander, or something else?" and "Do you (does the sample person) consider yourself (himself/herself) Hispanic or Latino?" Respondents who chose multiple races were further asked to identify their primary race. In the present study, the derived primary race/ethnicity variable was used. Respondents with races other than White and Black were excluded due to the small numbers. The race/ethnicity categories therefore included White, Black, and Hispanic.

Covariates

Sociodemographic characteristics include age at baseline (65–69, 70–74, 75–79, 80–84, 85 and above), sex (male, female), educational attainment (below high school, high school, above high school but below bachelor, bachelor and above), annual total income at the previous round, and living arrangement at the previous round. For 17 respondents who either refused to report educational attainment or did not know, high school, the most common category, was assigned. Total income at the previous round was based on self-report and the NHATS imputation from the 2011, 2013 and 2015 rounds of the NHATS (25–27). Because data were not collected at the 2012 and 2014 rounds, values of the 2011 and 2013 rounds were used for the 2012 and 2014 rounds, respectively. A respondent's income category at a certain round was classified by weighted quartiles of total income at baseline (below or equal to the 25th percentile, above the 25th percentile but below or equal to the 50th percentile, above the 50th percentile but below or equal to the 75th percentile, above the 75th percentile). Living arrangement at the previous round was derived from a series of questions about whom the respondent lived with and their relationships. Respondents were classified into four groups, including living alone, living with spouse or partner only, living with spouse/partner and others, and living with others only. For 25 respondents who had missing values for living arrangement at baseline, information on living arrangements from the next round was used instead.

Health factors at the previous round included number of medical conditions (none or one, two, three, four and above) and cognitive impairment (no dementia, possible dementia, probable dementia). Medical conditions included heart disease, hypertension, arthritis, osteoporosis, diabetes, lung disease, stroke, and cancer. Respondents self-reported whether a doctor ever told that he or she had any of the conditions. Cognitive function was assessed using a battery of

cognitive tests for nonproxy respondents (memory, orientation, and executive function), and the AD8 Dementia Screening Interview for proxy informants (28). The three-category dementia classification was generated using a previously described approach (29). The percentage of missing data ranged between 1.7% and 2.6% across the five rounds, and the last observations were carried forward to replace missing values.

Statistical Analysis

We compared baseline sample characteristics across racial and ethnic groups using chi-squared tests. We pooled disability transitions during the 4 year study period in the study sample, and calculated the frequencies and weighted percentages of disability transitions.

To examine racial/ethnic differences in disability transitions, we modeled disability transition probabilities as a function of previous round disability stage, race/ethnicity, and covariates. We used first-order Markov transition models, which assume that the conditional distribution of disability stage at the current round depends on disability stage at the previous round (30). A general model is written as

$$logit \Pr\left(Y_{ij} = y_{ij}|Y_{ij-1} = y_{ij-1}\right) = x'_{ij}\,\beta + \alpha y_{ij-1}\ ,$$

where j–1 denotes the previous round, j denotes the current round, Y_{ij} is a four-category variable (fully able, successful accommodation, difficulty/assistance, death) for respondent i at the current round, Y_{ij-1} is a three-category variable (fully able, successful accommodation, difficulty/assistance) for respondent i at the previous round, and $\Pr\left(Y_{ij}|Y_{ij-1}\right)$ is the probability of being in a particular disability stage at the current round given the disability stage at the previous round. We fitted the transition models using PROC SURVEYLOGISTIC for multinomial logistic regression with the analytic weights for the current round Y_{ij} provided by the NHATS in order to incorporate sampling design of the study. Correlation of repeated measures was accounted for by the CLUSTER statement.

We estimated three sequential models: a base model adjusting for age and sex; an intermediate model adjusting for age, sex, and socioeconomic factors (educational attainment, total income, and living arrangement); and a fully adjusted model with additional control for health factors (number of medical conditions and cognitive impairment). To test for racial/ethnic differences in disability transition probabilities, we added interactions between race/ethnicity and previous disability stage to the models, and generated conditional predicted probabilities and 95% confidence intervals by specifying each combination of race/ethnicity and disability stages at the previous round and setting each covariate to its weighted mean value. In the absence of a formal statistical test of estimated individual transition probabilities, we used the nonoverlap of confidence intervals of these probabilities as a conservative evaluation of significant group differences in transitions (31).

All analyses were conducted using statistical software SAS Version 9.4 (SAS Institute, Cary, NC) and Stata Version 14.2 (Stata Corp, College Station, TX). All significance tests were evaluated at the level of $p < .05$.

Results

Sample Characteristics at Baseline

Table 1 presents sample sizes and weighted baseline characteristics for the analytic sample. Of the 6,198 respondents included in the present study, 4,441 were White, 1,381 were Black, and 376 were Hispanic. Approximately half (52.2%) were aged between 65 and 75, 56.5 per cent were female, and 51.7 per cent had educational attainment above high school, and 31.2 per cent lived alone at baseline. In terms of baseline health, approximately half (44.9%) had more than two medical conditions, and one-fifth were classified as having probable dementia (9.6%) or possible dementia (10.2%). With respect to capacities for self-care activities and mobility at baseline, 33.5 per cent were fully able, 28.8 per cent successfully accommodated with devices, and 37.7 per cent had difficulties or needed personal assistance.

Compared with White respondents, Black and Hispanic respondents had lower educational attainment; were less likely to live with a spouse or partner only; and were more likely to have possible or probable dementia, and to report difficulties or need personal assistance in self-care activities and mobility at baseline (all $p \le .001$) (Table 1).

Annual Disability Transitions

There were a total of 19,177 transitions from the 6,198 respondents during the 4 year study period. The weighted, unadjusted frequencies for transitions between each of the three stages of disability and death for each of the three groups are shown in Supplementary Table S2. The overall pattern suggests that Black and Hispanic respondents tend to progress more rapidly from being fully able to developing difficulty in or needing assistance with self-care activities and mobility compared with Whites, and are less likely to use successful accommodation in the progression.

Results from the age- and sex-adjusted and fully-adjusted multinomial logistic regression models are presented in Supplementary Table S3. Based on these models, we generated predicted transition probabilities for each racial/ethnic group. After adjustment for age and sex, Blacks and Hispanics tended to have higher predicted probabilities of unfavorable transitions from each of disability stage at the previous round (Table 2). Specifically, Black and Hispanic respondents were as follows: (a) more likely to transition directly from being fully able to having difficulties or needing personal assistance [Black: 0.20, 95% Confidence Interval (CI) = 0.17–0.23; Hispanic: 0.21, 95% CI = 0.15–0.27; White: 0.14, 95% CI = 0.12–0.15], (b) less likely to maintain successful accommodation (Black: 0.53, 95% CI = 0.50–0.57; Hispanic: 0.50, 95% CI = 0.41–0.58; White: 0.64, 95% CI = 0.63–0.66), and (c) less likely to transition back to successful accommodation once having difficulties or needing personal assistance (Black: 0.14, 95% CI = 0.12–0.16; Hispanic: 0.13, 95% CI = 0.10–0.17; White: 0.18, 95% CI = 0.17–0.19). These predicted transition probabilities are in line with the crude transition frequencies, confirming a pattern that older minorities tend to transition more rapidly from a fully able state to difficulty/assistance in self-care activities and mobility, and are less likely to transition to or remain in a state of successful accommodation. In absolute probabilities, this pattern also appeared somewhat stronger in Hispanic than Black respondents.

The racial/ethnic differences in transitions to or from the state of difficulty/assistance were mostly reduced to nonsignificant levels after adjustment for socioeconomic factors (Supplementary Table S4) and further attenuated after additional adjustment for health factors (Table 3). However, older minorities remained less likely to maintain successful accommodation even after adjustment for socioeconomic and health factors (Black: 0.56, 95% CI = 0.52–0.60; Hispanic: 0.53, 95% CI = 0.44–0.61; White: 0.63, 95% CI = 0.61–0.65) (Table 3).

Discussion

This study examined racial/ethnic differences in disability transitions across a spectrum of disability stages that incorporates

Table 1. Weighted Baseline Sample Characteristics by Race/Ethnicity, the National Health and Aging Trends Study, 2011–2015

	Total (*n* = 6,198)	Race/ethnicity, weighted %			*p* value
		White (*n* = 4,441)	Black (*n* = 1,381)	Hispanic (*n* = 376)	
Age					.052
65–69	27.8	27.6	29.1	28.0	
70–74	24.4	23.8	27.9	26.8	
75–79	19.0	19.0	18.2	19.5	
80–84	15.0	15.2	13.9	13.7	
85 and above	13.9	14.3	11.0	12.0	
Sex					.218
Male	43.5	43.8	39.3	45.2	
Female	56.5	56.2	60.7	54.8	
Education					<.001
Below high school	20.8	15.8	40.5	59.1	
High school	27.5	28.5	24.7	18.0	
High school no bachelor	26.4	28.0	20.9	13.6	
Bachelor and above	25.3	27.7	13.9	9.3	
Total income					<.001
≤25th percentile	24.9	20.7	45.7	51.2	
≤50th percentile	25.6	25.8	24.9	24.1	
≤75th percentile	25.6	27.0	19.8	16.2	
>75th percentile	23.9	26.5	9.6	8.4	
Living arrangement					<.001
Alone	31.2	31.7	34.0	22.1	
With spouse/partner only	46.5	49.7	24.9	33.2	
With spouse and others	8.9	7.9	11.7	18.0	
With others only	13.4	10.7	29.4	26.7	
Number of medical conditions					.025
None or one	28.8	29.4	21.9	30.2	
Two	26.3	26.1	27.9	27.0	
Three	22.8	22.7	25.8	21.1	
Four and above	22.1	21.9	24.4	21.8	
Cognitive impairment					<.001
No dementia	80.2	82.5	69.8	63.5	
Possible dementia	10.2	9.2	14.9	17.9	
Probable dementia	9.6	8.3	15.3	18.6	
Disability stage					<.001
Fully able	33.5	34.1	29.7	31.0	
Successful accommodation	28.8	30.2	23.5	17.3	
Difficulty/assistance	37.7	35.7	46.8	51.7	

Table 2. Annual Disability Transition Probabilities Adjusted for Age and Sex, the National Health and Aging Trends Study, 2011–2015

Disability stage at round *j*-1	Race/ethnicity	Disability stage at round *j*, probability (95% CI)			
		Fully able	Successful accommodation	Difficulty/assistance	Death
Fully able	White	0.64 (0.63, 0.66)	0.20 (0.19, 0.22)	0.14 (0.12, 0.15)	0.01 (0.01, 0.02)
	Black	**0.56 (0.52, 0.60)**	0.22 (0.19, 0.25)	**0.20 (0.17, 0.23)**	0.02 (0.01, 0.03)
	Hispanic	0.60 (0.53, 0.67)	0.17 (0.11, 0.22)	**0.21 (0.15, 0.27)**	0.02 (0.00, 0.04)
Successful accommodation	White	0.12 (0.11, 0.13)	0.64 (0.63, 0.66)	0.22 (0.20, 0.23)	0.02 (0.02, 0.02)
	Black	0.14 (0.12, 0.17)	**0.53 (0.50, 0.57)**	**0.29 (0.26, 0.32)**	0.03 (0.02, 0.04)
	Hispanic	0.14 (0.09, 0.20)	**0.50 (0.41, 0.58)**	**0.34 (0.27, 0.42)**	0.02 (0.00, 0.04)
Difficulty/assistance	White	0.08 (0.07, 0.09)	0.18 (0.17, 0.19)	0.67 (0.66, 0.69)	0.06 (0.06, 0.07)
	Black	0.07 (0.06, 0.08)	**0.14 (0.12, 0.16)**	**0.72 (0.70, 0.75)**	0.07 (0.06, 0.08)
	Hispanic	0.09 (0.06, 0.12)	**0.13 (0.10, 0.17)**	0.71 (0.66, 0.76)	0.06 (0.04, 0.08)

Notes: CI = Confidence interval.

Number of respondents is 6,198; reference is White, and bold values indicate significant group differences in transitions.

accommodation with assistive devices, using data from a nationally representative sample of Medicare beneficiaries. We found that minority respondents had higher probabilities of unfavorable transitions and lower probabilities of remaining in the stage of successful accommodation than White respondents. The racial/ethnic differences were partially explained by socioeconomic and health factors.

Our finding that minorities were more likely to transition to and remain in unfavorable disability stages than White adults is consistent

Table 3. Annual Disability Transition Probabilities Adjusted for Age and Sex, Education, Income, Living Arrangement, Number of Medical Conditions, and Cognitive Impairment, the National Health and Aging Trends Study, 2011–2015

Disability stage at round *j*-1	Race/ethnicity	Disability stage at round *j*, probability (95% CI)			
		Fully able	Successful accommodation	Difficulty/assistance	Death
Fully able	White	0.62 (0.60, 0.64)	0.21 (0.19, 0.22)	0.16 (0.15, 0.17)	0.02 (0.01, 0.02)
	Black	**0.56 (0.52, 0.60)**	0.23 (0.19, 0.26)	0.20 (0.16, 0.23)	0.02 (0.01, 0.03)
	Hispanic	0.59 (0.51, 0.67)	0.19 (0.13, 0.25)	0.21 (0.14, 0.27)	0.02 (0.00, 0.03)
Successful accommodation	White	0.11 (0.10, 0.13)	0.63 (0.61, 0.65)	0.23 (0.22, 0.25)	0.02 (0.02, 0.02)
	Black	0.15 (0.12, 0.18)	**0.56 (0.52, 0.60)**	0.27 (0.24, 0.30)	0.02 (0.01, 0.03)
	Hispanic	0.14 (0.09, 0.20)	**0.53 (0.44, 0.61)**	0.31 (0.24, 0.39)	0.01 (0.00, 0.03)
Difficulty/assistance	White	0.09 (0.08, 0.10)	0.19 (0.18, 0.21)	0.67 (0.65, 0.69)	0.05 (0.04, 0.06)
	Black	0.09 (0.08, 0.11)	0.18 (0.15, 0.20)	0.69 (0.66, 0.72)	0.04 (0.03, 0.05)
	Hispanic	0.13 (0.09, 0.17)	0.19 (0.14, 0.24)	0.65 (0.59, 0.71)	0.03 (0.02, 0.04)

Notes: CI = Confidence interval.

Number of respondents is 6,198; reference is White, and bold values indicate significant group differences in transitions.

with previous work. Cross-sectional findings from the NHATS indicate that higher percentages of Black and Hispanic respondents receive personal assistance rather than accommodate with assistive devices, compared with White respondents (10). Data from the first two rounds of the NHATS also suggest racial and ethnic differences in incident and persistent successful accommodation, although the differences in short-term transitions were largely accounted for by health, demographic, socioeconomic, and environment-related factors (13). Analysis of the Women's Health and Aging Study also shows that older Black women had higher risks of progressing from high-functioning or preclinically disability to having difficulties in walking (32). Preclinical disability was defined as having behavioral or task modification but no disability (32), which is in parallel with the stage of successful accommodation in our study.

We also found significant racial/ethnic differences in successful accommodation with assistive devices after adjustment for socioeconomic and health factors. Device use is a type of ability modification that reflects older adults' behavioral response to functional decline. The relationship between race/ethnicity and use of assistive devices is complex and is often intertwined with decisions about personal assistance (18). Prior cross-sectional studies have suggested that minorities are more likely to use devices for mobility disabilities, particularly canes which are more affordable and accessible than advanced assistive technologies, and more likely to combine device use with informal care (18,19). One longitudinal study of racial/ethnic variation in discontinuation of mobility device use found no differences (20). Our approach differs conceptually from past literature in that we consider changes in use of devices but also whether there is residual difficulty given device use. The latter may depend on not only the type of device but the nature of the underlying impairment. We did not explore in this analysis whether minority groups had different underlying impairments, used assistive devices disproportionate to their underlying needs, or experienced less effective device use relative to more advantaged groups. Distinctions along these lines may be a fruitful area for further research.

Our results showed that the observed racial/ethnic patterns of disability transitions were partially explained by socioeconomic and health characteristics, which may reflect that minority groups have more substantial health needs in late life but insufficient resources to address their health needs. Minorities in the United States are over-represented in lower socioeconomic strata (33). Low socioeconomic status substantially influences health outcomes over the life course

through health behaviors, physical/social environments, and health care (34). Initial evidence suggests that use of assistive devices may be facilitated by better insurance coverage and greater economic resources (19), which may favor Whites older adults who, on average, tend to have considerably more of these resources than do minority elders. Although all respondents were Medicare beneficiaries, variations may still exist. Take mobility devices as an example. More complex and expensive devices such as wheelchairs and scooters require face-to-face examinations and written prescriptions from doctor visits. Lack of contact with medical system or poor quality of contact may decrease the probability of device use (19). Moreover, assistive devices may not be sufficient to meet health needs when diseases progress rapidly or conditions are not well under control, which are more common among minority elderly than White older adults. Although the racial/ethnic differences in transitions from being fully able or successful accommodation were partially attenuated in terms of statistical significance, the overall patterns remained. There may be residual factors that affect these transitions. For instance, given the cultural construct of race/ethnicity, differences in social or cultural norms may influence the acceptability and preference of assistive devices versus personal assistance (35), for which information is not available in the present study.

Our study has several limitations. First, we are limited to examining changes in disability status on an annual basis; although this time frame is more frequent than other national studies, our analysis is unable to take into account any additional intrainterval transitions that may have occurred. Second, the sample size for the Hispanic group is relatively small, which may have limited the power to detect statistically significant differences in disability transitions for this group. Moreover, it has also limited our ability to investigate the heterogeneity within the Hispanic group. Third, the four-year follow-up period may not be long enough to capture the natural history of the disablement process from being fully able to death. Fourth, our modeling approach assumes that transitions are not dependent on prior experience or on the duration in the current state. Fifth, there may be residual confounding, such as respondents' unobserved preferences for device use versus personal assistance. Other accommodating approaches used to maintain independence may also exist and differ across racial/ethnic groups.

Our study provides evidence for racial/ethnic differences in disability progression and use of assistive devices, and identifies minorities as disadvantaged populations in terms of maintaining

independence. It also highlights an early stage in the disablement process where accommodation with assistive devices may play a role in postponing disability. Effective interventions are needed to target minority elderly groups in order to enhance their capacities and close the gap in disability between racial/ethnic groups.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of interest

None declared.

References

1. Freedman VA, Spillman BC. Active life expectancy in the older US population, 1982–2011: differences between blacks and whites persisted. *Health Affairs*. 2016;35:1351–1358. doi:10.1377/hlthaff.2015.1247

2. Harper S, MacLehose RF, Kaufman JS. Trends in the black-white life expectancy gap among US states, 1990–2009. *Health affairs*. 2014;33: 1375–1382. doi:10.1377/hlthaff.2013.1273

3. Williams DR, Jackson PB. Social sources of racial disparities in health. *Health Aff (Millwood)*. 2005;24:325–334. doi:10.1377/hlthaff.24.2.325

4. Nelson AR, Stith AY, Smedley BD. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care (full printed version)*. Washington (DC): National Academies Press. 2002.

5. Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med*. 1994;38:1–14.

6. Mendes de Leon CF, Barnes LL, Bienias JL, Skarupski KA, Evans DA. Racial disparities in disability: recent evidence from self-reported and performance-based disability measures in a population-based study of older adults. *J Gerontol B Psychol Sci Soc Sci*. 2005;60:S263–S271. doi:10.1093/geronb/60.5.S263

7. Freedman VA, Spillman BC, Andreski PM, et al. Trends in late-life activity limitations in the United States: an update from five national surveys. *Demography*. 2013;50:661–671. doi:10.1007/s13524-012-0167-z

8. Latham K. Progressive and accelerated disability onset by race/ethnicity and education among late midlife and older adults. *J Aging Health*. 2012;24:1320–1345. doi:10.1177/0898264312459345

9. Liang J, Xu X, Bennett JM, Ye W, Quiñones AR. Ethnicity and changing functional health in middle and late life: a person-centered approach. *J Gerontol B Psychol Sci Soc Sci*. 2010;65:470–481. doi:10.1093/geronb/gbp114

10. Freedman VA, Kasper JD, Spillman BC, et al. Behavioral adaptation and late-life disability: a new spectrum for assessing public health impacts. *Am J Public Health*. 2014;104:e88–e94. doi:10.2105/AJPH.2013.301687

11. Agree EM. The influence of personal care and assistive devices on the measurement of disability. *Soc Sci Med*. 1999;48:427–443. doi:10.1016/S0277-9536(98)00369-4

12. Jette AM. Toward a common language of disablement. *J Gerontol A Biol Sci Med Sci*. 2009;64:1165–1168. doi:10.1093/gerona/glp093

13. Freedman VA, Kasper JD, Spillman BC. Successful aging through successful accommodation with assistive devices. *J Gerontol B Psychol Sci Soc Sci*. 2016;72:300–309. doi:10.1093/geronb/gbw102

14. Hoenig H, Taylor DH Jr, Sloan FA. Does assistive technology substitute for personal assistance among the disabled elderly? *Am J Public Health*. 2003;93:330–337. doi:10.2105/AJPH.93.2.330

15. Freedman VA, Agree EM, Martin LG, Cornman JC. Trends in the use of assistive technology and personal care for late-life disability, 1992–2001. *The Gerontologist*. 2006;46:124–127. doi:10.1093/geront/46.1.124

16. Agree EM, Freedman VA. Incorporating assistive devices into community-based long-term care: an analysis of the potential for substitution and supplementation. *J Aging Health*. 2000;12:426–450. doi:10.1177/089826430001200307

17. Jette AM. How measurement techniques influence estimates of disability in older populations. *Soc Sci Med*. 1994;38:937–942. doi:10.1016/0277-9536(94)90426-X

18. Freedman VA, Martin LG, Cornman J, Agree EM, Schoeni RF. Trends in assistance with daily activities: racial/ethnic and socioeconomic disparities persist in the US older population. In: Cutler DM, Wise DA, eds. *Health at Older Ages: The Causes and Consequences of Declining Disability Among the Elderly*. Chicago, IL: University of Chicago Press; 2009:411–438.

19. Agree EM, Freedman VA, Sengupta M. Factors influencing the use of mobility technology in community-based long-term care. *J Aging Health*. 2004;16:267–307. doi:10.1177/0898264303262623

20. Cornman JC, Freedman VA. Racial and ethnic disparities in mobility device use in late life. *J Gerontol B Psychol Sci Soc Sci*. 2008;63:S34–S41. doi:10.1093/geronb/63.1.S34

21. Resnik L, Allen S. Racial and ethnic differences in use of assistive devices for mobility: effect modification by age. *J Aging Health*. 2006;18:106–124. doi:10.1177/0898264305280981

22. Ilunga Tshiswaka D, Loggins Clay S, Chiu C-Y, Alston R, Lewis A. Assistive technology use by disability type and race: exploration of a population-based health survey. *Disabil Rehabil Assist Technol*. 2016;11:124–132. doi:10.3109/17483107.2015.1090487

23. Montaquila J, Freedman V, Edwards B, Kasper J. *National Health and Aging Trends Study Round 1 Sample Design and Selection*. NHATS Technical Paper# 1. Baltimore, MD: Johns Hopkins University School of Public Health. 2012.

24. Freedman VA, Kasper JD, Cornman JC, et al. Validation of new measures of disability and functioning in the National Health and Aging Trends Study. *J Gerontol A Biol Sci Med Sci*. 2011;66:1013–1021. doi:10.1093/gerona/glr087

25. Montaquila J, Freedman VA, Kasper J. *National Health and Aging Trends Study Round 1 Income Imputation*. Baltimore, MD: Johns Hopkins University School of Public Health. 2012.

26. Montaquila J, Freedman VA, Kasper JD. *National Health and Aging Trends Study Round 3 Income Imputation*. NHATS Technical Paper #10. Baltimore, MD: Johns Hopkins University School of Public Health. 2015.

27. Montaquila J, Freedman VA, Kasper JD. *National Health and Aging Trends Study Round 5 Income Imputation*. NHATS Technical Paper #15. Baltimore, MD: Johns Hopkins University School of Public Health. 2016.

28. Galvin JE, Roe CM, Powlishta KK, et al. The AD8: a brief informant interview to detect dementia. *Neurology*. 2005;65:559–564. doi:10.1212/01.wnl.0000172958.95282.2a

29. Kasper JD, Freedman VA, Spillman BC. *Classification of persons by dementia status in the National Health and Aging Trends Study*. Technical Paper #5. Baltimore, MD: Johns Hopkins University School of Public Health. 2013.

30. Diggle P. *Analysis of Longitudinal Data*. Oxford, UK: Oxford University Press. 2013.

31. Austin PC, Hux JE. A brief note on overlapping confidence intervals. *J Vasc Surg*. 2002;36:194–195. doi:10.1067/mva.2002.125015

32. Thorpe RJ Jr, Weiss C, Xue QL, Fried L. Transitions among disability levels or death in African American and white older women. *J Gerontol A Biol Sci Med Sci*. 2009;64:670–674. doi:10.1093/gerona/glp010

33. Semega JL, Fontenot KR, Kollar MA. *Income and Poverty in the United States: 2016. U.S. Census Bureau, Current Population Reports*. Washington, DC: U.S. Government Printing Office. 2017.

34. Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. *Health Aff (Millwood)*. 2002;21:60–76. doi:10.1377/hlthaff.21.2.60

35. Ripat J, Woodgate R. The intersection of culture, disability and assistive technology. *Disabil Rehabil Assist Technol*. 2011;6:87–96. doi:10.3109/17483107.2010.507859