Determinants of maintenance and recovery of function in a representative older community-resident biracial sample

Gerda G. Fillenbaum, PhD[a,b], **Richard Sloane, MPH**[a,b], **Bruce M. Burchett, PhD**[a], **Katherine Hall, PhD**[a,b,c], **Carl F. Pieper, DrPH**[a,b,c,d], **Heather E. Whitson, MD, MHS**[a,b,c], **Cathleen S. Colón-Emeric, MD, MHS**[a,b,c]

[a]Duke University Medical Center, Durham, North Carolina, United States.

[b]Claude D. Pepper Center, Center for Aging and Human Development, Duke University Medical Center, Durham, North Carolina, United States.

[c]Geriatric Research Education Clinical Center, Durham Veteran Affairs Medical Center, Durham, North Carolina, United States.

[d]Department of Biostatistics and Bioinformatics, Duke University Medical Center, Durham, North Carolina, United States.

Abstract

OBJECTIVES: Focus on decline in performance of activities of daily living (ADL) has not been matched by studies of recovery of function. Advised by a broad conceptual model of physical resilience, we ascertain characteristics that identify (1) maintenance, (2) decline, and (3) recovery of personal self-maintenance activities over six years in an older, community representative, African American and White sample.

DESIGN: Longitudinal study, analyses included descriptive statistics and repeated measures proportional hazards.

SETTING/PARTICIPANTS: Community-representative participants of the Duke Established Populations for Epidemiologic Studies of the Elderly (EPESE), unimpaired at baseline (n = 3187; 46% White, 54% African American; 64% female, 36% male), followed annually for up to 6 years.

MEASURES: Data included information on basic activities of daily living (BADL), demographic characteristics, health status, social services provided and received, household size, neighborhood safety, and survival status.

RESULTS: Over six years, ~75% remained unimpaired, of whom 30% were unimpaired when they dropped out or died. Of ~25% who became impaired, just under half recovered. Controlled

Corresponding author Gerda G. Fillenbaum, PhD, Center for the Study of Aging and Human Development, Box 3003, Duke University Medical Center, Durham, NC 27710, Gerda.Fillenbaum@duke.edu, tel: 919-660-7530/5.

analyses indicated that those who became impaired were in poorer health, younger, and more likely to be African American. Characteristics of recovery included younger age, not hospitalized in the previous year, and larger household size.

CONCLUSIONS/IMPLICATIONS: Maintenance of health status facilitated continued unimpaired BADL. While decline was associated with poorer health, younger age, and being African American, recovery was also associated with younger age, together with larger household size, and no further deterioration in health as measured here. Maintenance of good health is preferred, but following decline in functioning, increased effort to improve health and avoid further decline, which takes into account not only physical but also personal social conditions, is needed.

Brief Summary

Over six years, 74% of an older community-based sample remained unimpaired in basic activities of daily living; of the remaining 26%, 56% recovered. Decline is neither inevitable nor immutable, recovery requires social support.

Keywords

Older adults; activities of daily living; longitudinal design; recovery; functional status

Introduction

The desire to be able to function independently is probably universal. It is therefore not surprising that studies of functional status have largely focused on identifying characteristics associated with decline in function,[1] the prevalence of problems in that area,[2-4] population changes in disability over time,[5,6] and differences in the rate and type of decline experienced with increase in age.[7-10] With the exception of medical disciplines specifically concerned with facilitating function (e.g., occupational therapy, physical therapy), less attention has been paid to issues associated with recovery, particularly at a population level, with some exceptions.[8,9,11-17]

This is now changing with the burgeoning interest in physical resilience, a concept the definition of which remains in flux.[18] Uniquely, the proposed Whitson/Colón-Emeric conceptual model of physical resilience, which guides the present study, takes a whole person point of view, that encourages close examination of personal and environmental factors related to maintenance and recovery of functioning and physical well-being.[18]

Using this model, we examine decline and recovery in basic activities of daily living (BADL) (bathing, dressing, transfer from bed to chair, toileting, feeding oneself), i.e., personal self-maintenance activities required for survival,[19] and impairment in any two of which indicates eligibility for nursing home care.

To examine change in BADL, we focus on demographic, social, physical health and cognitive characteristics, health service use and environment characteristics associated with: 1) decline, 2) maintenance of functioning, and 3) recovery following impairment. In the process, we are also able to ascertain the proportion of older adults who retain unimpaired

functioning as age increases, and the proportion able to return to unimpaired functioning after impairment.

We anticipate that maintenance of performance in BADL will be associated primarily with maintenance of good physical health, while recovery from BADL impairment will be facilitated by an improved physical health status which includes absence of further health decline, possibly bolstered by social support.

Methods

Our data come from the first six annual waves of the Duke site of the multisite Established Populations for Epidemiologic Studies of the Elderly (Duke EPESE; 1986/87-1992/1993).[20] Duke EPESE is a longitudinal epidemiologic investigation of change in health status and health service use of community residents in a five county area (one urban county, four rural), in the north-central Piedmont of North Carolina. A four-stage sampling design yielded a probability sample of household residents aged 65 years or older. Only one person 65 years of age or older was selected from a chosen household.[21] By design, African Americans were oversampled to increase statistical precision for this group.[20]

Of the 5,221 persons selected, 4,162 (80%; 54% African American, 45% White, <1% other race/ethnicity; 35% male) were successfully interviewed by individuals who had undergone training on Duke EPESE questionnaire administration and enrollment procedures. After reviewing completed questionnaires, a sample of participants was re-interviewed as an additional check. The telephone interview used computer-assisted telephone interviewing.

The first, fourth, and seventh waves were conducted in-person in the home, and included an expansion of the core information gathered by telephone in the annual intermediate waves. Annual response rates ranged from 93.7%-98.7% through the first seven waves.

The study was approved by the Duke University Health System IRB, all participants or their proxies gave written consent.

Sample for current study

The sample for the current study included only self-designated African American and White sample members ("other race" was excluded because of small numbers, N=26), able at baseline to perform each BADL activity (described below) independently (N=3,468). To permit minimum time in which to develop an impairment and to recover, sample members had to be present at the first two waves, and at a minimum of one wave after impairment (N=3,331; prior analyses indicated that 79% of those who improved did so at the next wave, and 14% at the wave after that). Participants for whom identification of future recovery was unavailable due to drop out, death before the next wave, missing two consecutive waves, or first impairment at the final study wave, were dropped from the study (N=144), resulting in an analysis sample of 3,187 members. No statistically significant differences were found between the group of 144 and the analysis sample for any of the study variables. The analysis sample included 45 proxy respondents, who were asked only for objective information. They were distinguished by older age, lower education and income, and poorer

mobility, nearly all were cognitively impaired, but their rate of BADL impairment was comparable to that of the self-responders.

Data selected

Non-changing demographic information was obtained only at baseline. Otherwise, the main data for the current study were sought at each wave, supplemented by information gathered triennially at the in-person waves.

Dependent variable

The dependent variable, self- (or proxy-) report of ability to perform ADL, was assessed using the Katz ADL items: bathing, dressing, transfer, toileting, feeding self.[19] Each item was scored as able to perform independently (0) or not (1). Scores were summed (scoring range 0-5), and dichotomized to indicate independence in all activities (0) vs problem with one or more items (1). The sample was divided into three BADL categories – those who remained unimpaired throughout the study, those who became impaired during the study and did not recover, and those who recovered after becoming impaired.

Independent variables

The independent variables selected were those found in previous studies to be associated with functional status and change in functional status.[12,13,15,17,22-26]

Demographic characteristics—Demographic characteristics included sex, race, age (continuous, and categorized as 65-74/75-84/ 85 years), education (collapsed to 0-17 years, categorized as 0-8/9-12/13-17 years); and income (continuous, reported in $1,000s, obtained triennially).

Social condition—Annual report of social contacts was assessed by marital status (married vs not married), number of others in the household (categorized as 0/1/ 2), and triennial reports of help received from family/friends (possible range 0-12 activities, categorized at baseline median 0-8 vs 9), help given to family/friends (range 0-13, categorized at baseline median 0-7 vs 8), presence of someone he/she could count on (yes vs maybe or no), presence of a confidante (yes vs maybe or no).

Cognitive status—was assessed by the Short Portable Mental Status Questionnaire (scoring range 0-10 errors, scored as 0-3 vs 4 errors).[27]

Health status—Included self- (or proxy-) reported information on physician-ascertained chronic health conditions: heart attack and hip fracture within the previous five years at study entry (annually thereafter), diabetes, and stroke (annually), each recoded as "Yes or suspected" vs "No". Information was summed to indicate presence of any of these conditions; once reported, the condition was assumed to be present for the remainder of the subject's stay in the study. For each wave, hospitalization within the past year was also included as an additional measure of health. Mobility was determined triennially by dichotomized self-report of ability to walk indoors, go up/down stairs, and walk half a mile.[28]

Environment—Measured at baseline in terms of self-reported neighborhood safety from crime (safe vs little or no safety).

Survival status—Survival status through December 2015 was determined by search of National Death Index records, which provides accurate information on date and cause of death.[29]

Statistical analysis

Missing information was either imputed using the predictive mean matching method,[30] or, in the absence of available imputation, the last wave of data was carried forward. Missing BADL data was minimal.

Descriptive statistics (Ns, percent, χ^2, t-tests) were used to characterize the sample, the three BADL categories, and for initial bivariate comparisons at baseline.

Repeated measures proportional hazards analyses, to evaluate the hazards of reporting any incident BADL impairment as attributable to having any of the health conditions in the previous year, were performed using the dichotomized BADL scale as the dependent variable. Employed in this way, the estimates derived from the proportional hazards can be interpreted as a conditional likelihood function for these discrete event times. While the three BADL categories were fixed, independent variables that could change (e.g., chronic conditions, hospitalization, help given and received), were included as time-varying covariates. Because cohort members entered the observation period at different ages, data were left-truncated, and on a year-by-year basis age served as the time-to-event scale. However, baseline age (the age at which the subject entered the cohort), was utilized as a covariate in adjusted analyses. To summarize, the repeated measures proportional hazards was selected over other methods because: 1) the nature of the data was in discrete event times (i.e., 1 year follow-up surveys), the number of which varied by person; 2) it accommodated time-varying covariates; 3) within-person correlated error was accounted for; and 4) because cohort members entered at different ages, this method allowed us to compare subjects who were at similar ages during the risk period.

To identify significant variables, separate chunk analyses of demographic characteristics, health status (handled in sections, see Appendix Table A1), social factors, and environmental safety were run using repeated measures proportional hazards analyses. Presence of any chronic condition was included in each chunk since prior analysis indicated this to be a prime associate of decline, i.e., we determined within each chunk, which variables significantly predicted outcome after the presence of a chronic condition had been taken into account. The presence/absence of chronic conditions, and the significant variables identified in each chunk, were then entered into a final model to predict development of BADL impairment, and among those who developed BADL impairment, to predict recovery. Analyses were run using SAS v9.4.

Results

At baseline, mean age was 73 years; two thirds were women, over half were African American, and half had only an elementary school education (Table 1). Approximately one third had one or more of heart attack, diabetes, stroke, or hip fracture, and 13% had been hospitalized in the previous year. Similar proportions (~40%), were married, lived alone, or with one other person. The vast majority reported that they had someone who could help them in case of need, but fewer had someone they could confide in. Of services provided within families and among friends (e.g., companionship, gifts and financial help and advice, transportation, meals, help when sick, babysitting), half of the respondents reported providing eight or more of 13 services, while half received nine or more of 12 services. Approximately 20% were unable to walk half a mile or to climb stairs. Just over 11% had cognitive impairment. Nearly one in seven lived in an area they considered unsafe.

Over six years of follow-up (Table 2), approximately three quarters remained unimpaired throughout their time in the study, of whom 30% were still unimpaired when they dropped out or died. The BADL functions, from most to least frequently impaired, were: bathe/ shower, dress, transfer, use toilet, feed self. For approximately half, incident impairment involved a single activity, but two activities for roughly 25%. Of the roughly 25% who became BADL impaired, nearly half recovered, of whom the majority, 55.6%, remained recovered throughout the course of their stay in the study (20% who dropped out or died before the end of the study, 35.6% present when the study ended), 35.7% became impaired again and stayed so, while 8.7% also became impaired again but then recovered.

Bivariate analyses of baseline data indicated that five characteristics distinguished those who would become impaired from those who would not (Table 1). Statistically significant differences included presence of a proxy (not explored further because of small Ns), African American race/ethnicity, lack of a reliable helper, hip fracture, and previous year hospitalization. Unadjusted baseline data provided little indication of the characteristics that were associated with recovery once impaired (Table 3, findings associated with recovery: younger age, larger household). There was increased incidence of heart disease (1.8%-2.4%), stroke (1.5%-2.7%) and hip fracture (0.5%-1.0%) over time, with marked incidence of diabetes noted at the in-person waves, possibly due to correction of report based on medications. Among the four specific health conditions considered, none individually predicted impairment, neither did absence predict recovery.

The individual chunk analysis results are given online (Appendix Table A1). A summary analysis including only the statistically significant variables present in each chunk (Table 4), indicated that all variables entered (presence of any health condition, baseline age, race/ ethnicity, hospitalization in the past year), predicted impairment. Only younger age, absence of hospitalization in the previous year, and larger household size predicted recovery; ability to walk half a mile did not.

Discussion

This study examined maintenance of personal self-care tasks and recovery after impairment in such functions. Our findings indicate that, of an initially unimpaired sample of African American and White community residents age 65 and over, approximately 75% remained unimpaired over a period of six years, while nearly half of those who became impaired recovered. Among over half of the latter, recovery remained stable for the remainder of their stay in the study. Controlled analyses indicated that determinants of impairment and recovery differed. African Americans were more likely to become impaired, but race was not associated with recovery; younger persons were more likely to both become impaired and to recover; poor health was associated with decline, while maintenance of health and larger household size were associated with recovery.

Comparison of our findings with that of other studies is difficult because of differences in the time frames covered, the measures of functional status, the definitions of impairment, the covariates examined, and the analytic techniques used.[11,12,22,31] Overall, however, in agreement with others, among community-representative older African American and White adults, functional decline does not necessarily occur as age increases, and when it does occur may not be permanent.

The statistically controlled characteristics associated with continued unimpaired BADL functioning were few: older age; White race/ethnicity; better health, as assessed by absence of recent hospitalization and reduced likelihood of a chronic health condition. Continued good health is expected to be associated with continued unimpaired functioning, and is less likely to be present among older persons who are African American.[2,32] However, older age goes counter to expectation. It may indicate a hardy survivor effect, i.e., that the people who are older are either less susceptible to health problems, or that they have them under better control.

Recovery was not associated with the presence of any of the four specific health conditions (possibly because these were chronic conditions, involved in precipitating impairment), and neither was race/ethnicity, indicating that while impairment may be race-associated, recovery may not. Recovery was associated with a lower likelihood of being hospitalized (since hospitalization reflects a serious need, lower likelihood of hospitalization probably indicates a lower likelihood of having a serious health condition). This finding is in agreement with previous report that hospitalization was a robust predictor of functional decline (here, of non-recovery).[32] Also in agreement with previous report, maintenance and recovery were found to be associated with younger age at baseline,[11,15,33] having someone that could be counted on (found in unadjusted analysis),[17] and living in a larger household. While we might assume that larger households may provide more support that aids recovery (social contacts, help with meals, keeping medical appointments), we have no direct evidence of that occurring here. Characteristics of the residential environment, here measured as perceived safety, did not influence outcomes -- the broader environment may be less relevant when focus is on personal self-maintenance.

In agreement with previous work, socioeconomic status (education, income) was not a significant indicator of BADL status or change.[1,34] Other explanations may also be relevant. Above age 65, there is greater equalization of access to medical care (Medicare, Veterans Administration medical services). Further, the current model included information on social and environmental factors, considerations not typically included. Where recovery is concerned, we have seen here that social characteristics appear to be relevant.

Our final model confirmed prediction that determinants of impairment in BADL were not necessarily the obverse of determinants of recovery. Specifically, younger age was associated with both increased odds of impairment and of recovery; presence of health conditions increased odds of impairment, but was not associated with recovery; larger household size did not reduce odds of impairment, but did increase odds of recovery.

Limitations

While we used the Whitson/Colón-Emeric conceptual model of resilience as a guide, only aspects of this model could be considerd, and it was applied only to BADL activities. Different aspects of the model may have greater relevance for more complex concerns (e.g., household ADL, advanced ADL).

The ideal time interval for examining change in ADL status remains to be determined. Shorter time intervals capture more changes, more of which may be inconsequential. Longer time intervals may miss true changes, with increased likelihood of participant drop out and death. The current one-year interval was determined by data availability, but may nevertheless represent a reasonable compromise, and is clinically relevant.

We did not focus on the number or specific BADL tasks impaired (predominantly one impairment, most often bathing), or the order of recovery, but encourage this in a larger sample.

Health conditions and hospitalization were self-reported, but self-report has been found to have adequate accuracy.[35,36] Duration and reason for hospital use have changed over time, nevertheless, hospitalization captures severity of health condition, which was the issue of concern. We did not experience inconsistent recall,[37] since once mentioned, the chronic conditions reported were carried forward. Absent adequate information, some relevant health conditions (e.g., musculoskeletal and sensorial disorders), were not considered.[38,39] However, the health conditions included were those found to be important in previous studies.[1,26]

Future studies

Future studies should be larger, include instrumental ADL, focus on specific ADL activities, and take a broader array of relevant characteristics into account (e.g., depression; exercise; health behaviors; nutritional status; wealth, income and health insurance during middle age; racial/ethnicity and income residential integration).[15,22,23,40] Attention is also needed on alternative ways of maintaining personal independence,[12] and assessing the value of early identification of problems through noninvasive electronic monitoring.

Conclusions and implications

Our findings indicate that to maintain unimpaired BADL, and improve likelihood of recovery when impaired, health status should be maintained. Of other associated characteristics, age *per se* is not amenable to modification. Race/ethnicity is, in large measure, a social construct; for disadvantaged populations, greater attention needs to be paid to facilitating access in the earlier years to resources that are associated with improved health in later years – better education, employment and income opportunities, and access to health care. Current data reflect the experience of segregation and inequitable access to resources associated with better health. It is notable that when there is residential integration, no differences in functional status have been found.[23]

Acknowledgements

Appendix material.

Determinants of maintenance and recovery of function in a representative older community-resident biracial sample

Table A1.

With chronic conditions controlled, chunk tests to identify specific demographic, social, health status, and environmental conditions significantly associated with development of impairment in BADL and of recovery following impairment. The specific statistical procedure used is described in the text under Methods, Statistical analysis.

Separate chunk test predictors of new BADL[1] impairment and of consequent recovery						
	Predictors of impairment in BADL			Predictors of recovery from BADL impairment		
	Hazard ratio	95% CI	P-value	Hazard ratio	95% CI	P-value
Health status: Chronic conditions only						
Presence of any chronic condition[2]	2.57	2.22, 2.97	**<.001**	0.91	0.80, 1.03	0.13
Chronic conditions + demographics						
Presence of any chronic condition	2.40	2.08, 2.78	**<.001**	0.87	0.77, 0.98	**0.026**
Baseline age (continuous)	0.80	0.78, 0.82	**<.001**	0.93	0.91, 0.95	**<.001**
African American	1.22	1.05, 1.42	**0.01**	1.06	0.92, 1.22	0.44
Female	0.995	0.84, 1.18	0.95	0.96	0.82, 1.11	0.56

Separate chunk test predictors of new BADL[1] impairment and of consequent recovery					
	Predictors of impairment in BADL			Predictors of recovery from BADL impairment		
	Hazard ratio	95% CI	P-value	Hazard ratio	95% CI	P-value
Education	1.002	0.98, 1.02	0.88	0.99	0.97, 1.01	0.47
Median income/1000	1.002	0.99, 1.01	0.54	0.999	0.99, 1.01	0.77
Chronic conditions + Social factors						
Presence of any chronic condition	2.57	2.22, 2.97	**<.001**	0.90	0.80, 1.02	0.09
Married	0.99	0.84, 1.20	0.91	0.94	0.80, 1.11	0.46
Household, 2 in household	1.002	0.86, 1.25	0.98	1.14	0.97, 1.33	0.11
Household, 3+ in household	0.96	0.79, 1.16	0.67	1.28	1.09, 1.50	**0.002**
Give help (8-12 vs 0-7) [high=more]	1.11	0.97, 1.27	0.13	1.01	0.91, 1.12	0.88
Get help (9-13 vs 0-8) [high=more]	1.07	0.94, 1.23	0.30	1.01	0.90, 1.13	0.89
Has someone to confide in	1.04	0.86, 1.24	0.70	0.91	0.78, 1.19	0.27
Has someone to count on	0.81	0.65, 1.02	0.07	1.09	0.88, 1.35	0.42
Cognitive impairment (4+ errors)	0.95	0.76, 1.20	0.66	0.96	0.77, 1.19	0.69
Chronic conditions + hospitalization						
Presence of any chronic condition	2.02	1.75, 2.33	**<.0001**	0.94	0.83, 0.94	0.31
Hospitalization in past 12 months	3.17	2.85, 3.53	**<.0001**	0.85	0.78, 0.85	**<.001**
Chronic conditions + impaired mobility						
Presence of any chronic condition	2.59	2.23, 3.01	**<.0001**	0.90	0.79, 1.02	0.10
Walk across small room -- impaired	1.12	0.91, 1.38	0.28	1.05	0.91, 1.22	0.50
Climb stairs -- impaired	1.04	0.87, 1.23	0.69	0.95	0.84, 1.07	0.38
Unable to walk 0.5 miles	1.02	0.88, 1.19	0.77	1.15	1.03, 1.28	**0.015**
Chronic conditions + environment						
Presence of any chronic condition	2.58	2.22, 2.99	**<.001**	0.90	0.79, 1.02	0.09
Area safety	0.94	0.75, 1.16	0.44	0.93	0.77, 1.12	0.44

CI = confidence interval

[1] BADL impairment (bathing, dressing, eating, transfering, using toilet), developing since baseline over up to 6 annual waves

[2] Chronic condition: any of heart, diabetes, stroke, hip fracture at baseline and accruing over next 6 annual waves; once reported, chronic condition is present for the rest of the subject's stay

References

1. Stuck AE, Walthert JM, Nikolaus T, et al. Risk factors for functional status decline in community-living elderly people: A systematic literature review. Soc Sci Med 1999;48:445–469. [PubMed: 10075171]

2. Jacob ME, Marron MM, Boudreau RM, et al. Age, race, and gender factors in incident disability. J Gerontol A Biol Sci Med Sci 2018;73:194–197. [PubMed: 29045556]

3. Progressive Latham K. and accelerated disability onset by race/ethnicity and education among late midlife and older. J Aging Health 2012;24:1320–1345. [PubMed: 22982972]

4. Rodrigues MAP, Facchini LA, Thumé E, Maia F. Gender and incidence of functional disability in the elderly: A systematic review. Cad Saúde Pública 2009;25 Suppl 3:S464–S476. [PubMed: 20027393]

5. Freedman VA, Martin LG, Schoeni RF. Recent trends in disability and functioning among older adults in the United States: A systematic review. JAMA 2002;288:3137–3146. [PubMed: 12495394]

6. Freedman VA, Wolf AD, Spillman BC. Disability-free life expectancy over 30 years: A growing female disadvantage in the US population. Am J Public Health 2016;106:1079–1085. [PubMed: 26985619]

7. Deeg DJH. Longitudinal characterization of course types of functional limitations. Disabil Rehab 2005;27:253–261.

8. Gill TM, Gahbauer EA, Lin H, et al. Comparisons between older men and women in the trajectory and burden of disability over the course of nearly 14 years. J Am Med Dir Assoc 2013;14:280–286. [PubMed: 23294968]

9. Hardy SE, Allore HG, Guo Z, Gill TM. Explaining the effect of gender on functional transitions in older persons. Gerontology 2008;54:79–86. [PubMed: 18230952]

10. Nusselder WJ, Looman CWN, Mackenbach JP. Nondisease factors affected trajectories of disability in a prospective study. J Clin Epidemiol 2005;58:484–494. [PubMed: 15845335]

11. Casasnovas GL, Nicodemo C. Transition and duration in disability: New evidence from administrative data. Disabil Health J 2016;9:26–36. [PubMed: 26440555]

12. Dong L, Freedman VA, Sanchez BN, Mendes de Leon CF. Racial and ethnic differences in disability transitions among older adults in the United States. J Gerontol A Biol Sci Med Sci 2019;74:406–411. [PubMed: 29562316]

13. Hardy SE, Gill TM. Recovery from disability among community-dwelling older persons. JAMA 2004;291:1596–1602. [PubMed: 15069047]

14. Hardy SE, Gill TM. Factors associated with recovery of independence among newly disabled older persons. Arch Intern Med 2005;165:106e112

15. Gill TM, Robison JT, Tinetti ME. Predictors of recovery in activities of daily living among disabled older persons living in the community. J Gen Intern Med 1997;12:757–762. [PubMed: 9436895]

16. Gill TM, Hardy SE, Williams CS. Underestimation of disability in community-living older persons. J Am Geriatr Soc 2002;50:1492–1497. [PubMed: 12383145]

17. Zunzunegui MV, Rodriguez-Laso A, Otero A, et al. Disability and social ties: Comparative findings of the CLESA study. Eur J Ageing 2005;2:40–47. [PubMed: 28794715]

18. Whitson HE, Duan-Porter W, Schmader KE, et al. Physical resilience in older adults: Systematic review and development of an emerging construct. J Gerontol A Biol Sci Med Sci 2016;71:489–495. [PubMed: 26718984]

19. Katz S, Akpom CA. A measure of primary sociobiological functions. Int J Health Services 1976;6:493–507.

20. Cornoni-Huntley J, Blazer D, Lafferty M, et al. Established Populations for Epidemiologic Studies of the Elderly: Resource Data Book. Vol. II Washington DC: PHS, NIH (NIH Publication No.: 90-495), 1990.

21. Kish L Survey Sampling. New York: John Wiley & Sons, 1965.

22. Wolinsky FD, Bentler SE, Hockenberry J, et al. Long-term declines in ADLs, IADLs, and mobility among older Medicare beneficiaries. BMC Geriatrics 2011,11:43 http://www.biomedcentral.com/1471-2318/11/43 [PubMed: 21846400]

23. Thorpe RJ Jr., R McCleary, JR Smolen, et al. Racial disparities in disability among older adults: Finding from the exploring health disparities in integrated communities study. J Aging Health 2014;26:1261–1279. [PubMed: 25502241]

24. Huisman M, Kunst A, Deeg D, et al. Educational inequalities in the prevalence and incidence of disability in Italy and The Netherlands were observed. J Clin Epidemiol 2005;58:1058–1065. [PubMed: 16168352]

25. Tsai Y Education and disability trends of older Americans, 2000-2014. J Public Health 2016;39:447–454.

26. Fried LP, Ettinger WH, Lind B, et al. Physical disability in older adults: A physiological approach. J Clin Epidemiol 1994;47:747–760. [PubMed: 7722588]

27. Pfeiffer E A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc 1975;23:433–441. [PubMed: 1159263]

28. Rosow I, Breslau N. A Guttman health scale for the aged. J Gerontol 1966;21:556–559. [PubMed: 5918309]

29. Doody MM, Hayes HM, Bilgrad R. Comparability of National Death Index Plus and standard procedures for determining cause of death in epidemiologic studies. Annals of Epidemiol 2001;11:46–50.

30. Landerman LR, Land K, Pieper C. An empirical evaluation of the predictive mean matching method for imputing missing values. Sociol Method Res 1997;26:3–33.

31. Freedman VA, Martin LG, Schoeni RF, Cornman JC. Declines in late-life disability: The role of early- and mid-life factors. Soc Sci Med 2008;66:1588–1602. [PubMed: 18222580]

32. Oates GR, Jackson BE, Partridge EE, et al. Sociodemographic patterns of chronic disease: How the mid-south region compares to the rest of the country. Am J Prev Med 2017;52(1S1):S31–S39. [PubMed: 27989290]

33. Fried LP, Guralnik JM. Disability in older adults: Evidence regarding significance, etiology, and risk. J Am Geriatr Soc 1997;45:92–100. [PubMed: 8994496]

34. Landerman LR, Fillenbaum GG. Differential relationships of risk factors to alternative measures of disability. J Aging Health 1997;9:266–279. [PubMed: 10182407]

35. Baumeister H, Kriston L, Bengel J, Harter M. High agreement of self-report and physician-diagnosed somatic conditions yields limited bias in examining mental–physical comorbidity. J Clin Epidemiol 2010;63:558–565. [PubMed: 19959329]

36. Roberts RO, Bergstralh EJ, Schmidt L, Jacobsen SJ. Comparison of self-reported and medical record health care utilization measures. J Clin Epidemiol 1996;49:989–995. [PubMed: 8780606]

37. Cigolle CT, Nagel CL, Blaum CS, et al. Inconsistency in the self-report of chronic diseases in panel surveys: developing an adjudication method for the Health and Retirement Study. J Gerontol B Psychol Sci Soc Sci 2018;73:901–912. [PubMed: 27260670]

38. Griffith L, Raina P, Wu H, et al. Population attributable risk for functional disability associated with chronic conditions in Canadian older adults. Age Ageing 2010;39:738–745. [PubMed: 20810673]

39. Palazzo C, Ravaud J-F, Trinquart L, et al. Respective contribution of chronic conditions to disability in France: Results from the National Disability-Health Survey. PLoS ONE 2012;7(9): e44994. doi:10.1371/journal.pone.0044994 [PubMed: 23024781]

40. Marmot M. Fair society, healthy lives: the Marmot review; strategic review of health inequalities in England post-2010 (S. l) The Marmot Review, UCL Institute of Health Equity, London, 2010 ISBN 978–0-9564870–0-1 www.ucl.ac.uk/marmotreview accessed October 2, 2019.

Table 1.

Baseline data only. Total sample, and comparison of those who remained unimpaired in basic activities of daily living[1] throughout with those who became impaired.

	Total sample at baseline (N = 3187) N (%) or Mean (sd)	Baseline comparison of those who remained unimpaired with those who became impaired			
		Remained unimpaired (N = 2361) N (%) or Mean (sd)	Became impaired (N = 826) N (%) or Mean (sd)	χ² or t-test[2]	P-*value*
Proxy respondent used	45 (1.4)	34 (1.1)	11 (0.3)	30.87	**<.001**
Demographic characteristics					
Age	73.0 (6.3)	73.0 (6.3)	73.0 (6.5)	0.00	0.99
65-74 years	2038 (64.0)	1502 (63.6)	536 (64.9)	0.43	0.51
75-84 years	960 (30.1)	723 (30.6)	237 (28.7)	1.08	0.30
85 years	189 (5.9)	136 (5.8)	53 (6.4)	0.47	0.49
Sex				0.06	0.81
Male	1154 (36.2)	852 (36.1)	302 (36.6)		
Female	2033 (63.8)	1509 (63.9)	524 (63.4)		
Race				18.85	**<.001**
African American	1711 (53.7)	1214 (51.4)	497 (60.2)		
White	1476 (46.3)	1147 (48.6)	329 (39.8)		
Education	8.7 (4.1)	8.7 (4.1)	8.5 (4.2)	0.00	0.99
0-8 years	1622 (50.9)	1190 (50.4)	432 (52.3)		
9-12 years	1083 (34.0)	820 (34.7)	263 (31.8)		
13 years	482 (15.1)	351 (14.9)	131 (15.9)		
Income, imputed	$10,728 ($10,246)	$10,794 ($10,283)	$10,541 ($10,146)	0.38	0.54
Social factors					
Married	1269 (39.8)	952 (40.3)	317 (38.4)	0.97	0.33
Total in household	2.0 (1.2)	2.0 (1.2)	2.0 (1.3)	0.60	0.55
Others in household					
Lives alone	1251 (39.3)	908 (38.5)	343 (41.5)	2.41	0.12
One other person	1320 (41.4)	996 (42.2)	324 (39.2)	2.21	0.14
2 other people	616 (19.3)	457 (19.4)	159 (19.3)	0.01	0.95
Has someone can count on	2718 (85.3)	2031 (86.0)	687 (83.2)	3.96	**0.047**
Has someone can confide in	2275 (71.3)	1693 (71.7)	582 (70.5)	0.47	0.50
Give help (cut at median:7/8)				0.08	0.78
Below median	1358 (44.6)	1006 (44.7)	352 (44.2)		
Above median	688 (55.4)	1243 (55.3)	445 (55.8)		
Get help (cut at median: 8/9)				1.27	0.26
Below median (0-8)	1301 (42.3)	952 (41.6)	349 (44.0)		
Above median (9+)	1778 (57.7)	1333 (58.3)	445 (56.0)		

	Total sample at baseline (N = 3187) N (%) or Mean (sd)	Baseline comparison of those who remained unimpaired with those who became impaired			
		Remained unimpaired (N = 2361) N (%) or Mean (sd)	Became impaired (N = 826) N (%) or Mean (sd)	χ^2 or t-test[2]	P-*value*
Cognitive status					
SPMSQ impaired: score 4	353 (11.1)	249 (10.6	104 (12.6)	2.65	0.10
Health status					
Chronic conditions					
Heart attack (suspect+yes)	249 (7.8)	181 (7.7)	68 (8.2)	0.27	0.60
Diabetes (suspect+yes)	595 (18.7)	431 (18.3)	164 (19.9)	1.03	0.31
Stroke (suspect+yes)	178 (5.6)	133 (5.6)	45 (5.5)	0.04	0.84
Hip fracture (suspect+yes)	39 (1.2)	19 (0.8)	20 (2.4)	13.23	**0.003**
Number of health conditions	0.33 (0.58)	0.32(0.54)	0.34 (0.58)	0.83	0.40
0	2298 (72.1)	1707 (72.3)	591 (71.6)	1.98	0.58
1	732 (23.0)	543 (23.0)	189 (22.9)		
2	142 (4.5)	102 (4.3)	40 (4.8)		
3	15 (0.5)	9 (0.4)	6 (0.7)		
Hospitalization					
Hospitalization previous year	416 (13.1)	270 (11.4)	146 (17.7)	21.0	**<.001**
Impaired mobility					
Walk indoors	115 (3.6)	85 (3.6)	30 (3.6)	0.00	0.97
Climb stairs	430 (13.6)	305 (13.0)	125 (15.3)	2.62	0.11
Walk half mile	637 (20.6)	480 (21.0)	157 (19.6)	0.76	0.38
Environmental factor					
Neighborhood: little safety	436 (14.3)	322 (14.2)	114 (14.5)	0.02	0.88

[1]Basic activities of daily living = bathing, dressing, transfering, using toilet, feeding self

[2]χ^2 used for categorized variables, t-test used for continuous variables

Missing data: Provide help (N = 141), receive help (N = 108), SPMSQ (N = 7), climb stairs (N = 28), walk half a mile (N = 98), neighborhood safety (N = 136)

Statistically significant values have been bolded

(sd) = standard deviation

Table 2.

Pattern of impairment and recovery status over six years among sample members with no basic ADL impairment at baseline

BADL[1] impairment status	N (%)[2]	N (%)	N (%)
No impairment during study	2361 (74.1)		
No impairment, sample member present throughout		1639 (51.4)	
No impairment, left study by death/dropout		722 (22.7)	
Became impaired during study	826 (26.0)		
Remained impaired		445 (14.0)	
Recovered		381 (12.0)	
Stayed recovered			212 (55.6)
Became impaired again, then stayed impaired			136 (35.7)
Became impaired again, recovered again			33 (8.7)

[1] BADL = Basic activities of daily living (bathing, dressing, transfering, using toilet, feeding self)

[2] Percentages in first data column do not sum to 100 because of rounding.

Table 3.

Baseline data only. Comparison of those who recovered basic activities of daily living after becoming impaired with those who did not.

	Comparison of those who recovered BADL[1] after becoming impaired with those who did not			
	No recovery (N = 445) N (%) or Mean (sd)	Recovered (N = 381) N (%) or Mean (sd)	χ^2 or t-test[2]	P-value
Demographic characteristics				
Age	73.3 (6.6)	72.7 (6.3)	1.36	0.17
65-74 years	275 (61.8)	261 (68.5)	4.95	**0.044**
75-84 years	142 (31.9)	95 (24.9)	4.88	**0.027**
85 years	28 (6.3)	25 (6.6)	0.02	0.88
Sex			0.15	0.70
Male	160 (36.0)	142 (37.3)		
Female	285 (64.0)	239 (62.7)		
Race			0.06	0.80
African American	266 (59.8)	231 (60.6)		
White	179 (40.2)	150 (39.4)		
Education	8.6 (4.2)	8.4 (4.1)	0.43	0.81
0-8 years	231 (51.9)	201 (52.8)		
9-12 years	140 (31.5)	123 (32.3)		
13 years	16.6 (74)	57 (15.0)		
Income, imputed	$10,591 ($10,138)	$10,482 ($10,168)	0.02	0.88
Social factors				
Married	166 (37.3)	151 (39.6)	0.47	0.49
Total in household	1.9 (1.3)	2.0 (1.2)	1.07	0.28
Others in household				
Lives alone	198 (44.5)	145 (38.1)	3.50	0.06
One other person	173 (38.9)	151 (39.6)	0.05	0.82
2 other people	74 (16.6)	85 (22.3)	4.26	**0.039**
Has someone can count on	369 (82.9)	318 (83.5)	0.04	0.84
Has someone can confide in	318 (71.5)	264 (69.3)	0.46	0.50
Give help (cut at median: 7/8)			0.21	0.65
Below median	194 (44.9)	158 (43.3)		
Above median	238 (55.1)	207 (56.7)		
Get help (cut at median: 8/9)			0.14	0.71
Below median (0-8)	186 (43.4)	163 (44.7)		
Above median (9+)	243 (56.6)	202 (55.3)		
Cognitive status				

	Comparison of those who recovered BADL[1] after becoming impaired with those who did not			
	No recovery (N = 445) N (%) or Mean (sd)	Recovered (N = 381) N (%) or Mean (sd)	χ^2 or t-test[2]	P-value
SPMSQ impaired: score 4	59 (13.3)	45 (11.9)	0.34	0.56
Health status				
Chronic conditions				
Heart attack (suspect + yes)	37 (8.3)	31 (8.1)	0.09	0.93
Diabetes (suspect + yes)	88 (19.8)	76 (20.0)	0.0038	0.95
Stroke (suspect + yes)	22 (4.9)	23 (6.0)	0.48	0.49
Hip fracture (suspect + yes)	11 (2.5)	9 (2.4)	0.01	0.92
Number of health conditions[3]	0.37 (0.56)	0.37 (0.60)	0.19	0.85
0	319 (71.7)	272 (71.4)	0.02	0.99
1	101 (22.7)	88 (23.1)		
2	21 (5.2)	17 (4.5)		
3	4 (0.5)	4 (1.1)		
Hospitalization				
Hospitalization previous year	84 (18.9)	62 (16.3)	0.34	0.56
Impaired mobility				
Walk indoors	16 (3.6)	14 (3.7)	0.00	0.95
Climb stairs	71 (16.2)	54 (14.2)	0.58	0.45
Walk half mile	86 (20.0)	71 (19.0)	0.12	0.73
Environmental factor				
Neighborhood: little safety	56 (13.2)	305 (84.0)	1.27	0.26

[1] BADL = Basic activities of daily living (bathing, dressing, transfering, using toilet, feeding self)

[2] χ^2 used for categorized variables, t-test used for continuous variables

[3] Number of health conditions – because of small numbers, persons with three health conditions have been combined with persons with two health conditions in calculating χ^2

(sd) = standard deviation

Statistically significant values have been bolded

Table 4.

Predictors of development of impairment in BADL[1] and of recovery from impairment

	Significant predictors of impairment in BADL			Significant predictors of recovery following initial BADL impairment		
	HR	**95% CI**	*P* value	**HR**	**95% CI**	*P* value
Baseline age	0.81	0.79, 0.83	**<.001**	0.93	0.92, 0.95	**<.001**
African American race/ethnicity	1.28	1.11, 1.48	**0.001**	------	-------	-------
Presence of any health condition	1.89	1.64, 2.18	**<.001**	------	-------	-------
Hospitalization previous year	3.07	2.76, 3.42	**<.001**	0.81	0.74, 0.88	**<.001**
Household size 3 members	-------	-------	-------	1.16	1.02, 1.32	**0.026**
Unable to walk 0.5 miles	-------	-------	-------	1.10	0.98, 1.23	0.10

HR = Hazard ration; CI = confidence interval; bolded values are statistically significant; ------- = variable not relevant for this analysis

Predictors are based on variables significant in chunk tests of demographic characteristics, social factors, cognitive status, number of chronic conditions (heart disease, diabetes, stroke, hip fracture), hospitalization, mobility, and environmental variables.

[1]BADL impairment developing since baseline over up to 6 annual waves. BADL items include bathing, dressing, eating, transfering, using toilet