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Disaggregating Activities of Daily Living Limitations for Predicting Nursing Home Admission

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RESEARCH ARTICLE

Disaggregating Activities of Daily Living Limitations for Predicting Nursing Home Admission

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Objective. To examine whether disaggregated activities of daily living (ADL) limitations better predict the risk of nursing home admission compared to conventionally used ADL disability counts.

Data Sources. We used panel data from the Health and Retirement Study (HRS) for years 1998–2010. The HRS is a nationally representative survey of adults older than 50 years (n = 18,801).

Study Design. We fitted Cox regressions in a continuous time survival model with age at first nursing home admission as the outcome. Time-varying ADL disability types were the key explanatory variables.

Principal Findings. Of the six ADL limitations, bathing difficulty emerged as the strongest predictor of subsequent nursing home placement across cohorts. Eating and dressing limitations were also influential in driving admissions among more recent cohorts. Using simple ADL counts for analysis yielded similar adjusted R^2s; however, the amount of explained variance doubled when we allowed the ADL disability measures to time-vary rather than remain static.

Conclusions. Looking beyond simple ADL counts can provide health professionals insights into which specific disability types trigger long-term nursing home use. Functional disabilities measured closer in time carry more prognostic power than static measures.

Key Words. Long-term care, disability, aging, hazard rates, ADLs

Institutionalization is common among individuals at advanced ages because of older persons' greater frailty and also because they are less likely to have spouses to care for them even if they live in the community. About one in eight people age 85 years or older resided in institutions in the United States in 2010 (Congressional Budget Office 2013). In the same year, federal and state governments spent $404 billion on Medicaid, of which $113 billion was expended for nursing home services, home health care, intermediate care facility services, and home and community-based services, and this sum is

projected to reach $871 billion by 2020 (Office of the Actuary 2012). The high costs associated with institutionalization have generated much interest in understanding the factors related to nursing home admission, to identify ways to improve the preadmission assessment of older adults.

One of the main criteria used in nursing home preadmission assessments in many countries is limitations in activities of daily living (ADL), measuring the older individual's ability to perform basic functions such as bathing, dressing, or eating. ADL measures are also employed by public and private long-term care insurers to evaluate care needs and benefit eligibility. Numerous studies have demonstrated that knowing a person's total number of ADL limitations can help predict the chances of community-dwelling adults subsequently entering nursing homes (c.f., Salive et al. 1993; Liu, McBride, and Coughlin 1994; Mor et al. 1994; Miller and Weissert 2000; Akamigbo and Wolinsky 2006; Gaugler et al. 2007).

Several of these studies further highlighted a "threshold effect": for example, Salive et al. (1993) found that the risk of institutionalization increased fivefold for elderly persons with 3+ ADL limitations, but only twofold for those with 1–2 limitations. In a meta-analysis of over 70 empirical studies, Gaugler et al. (2007) confirmed that the risk of subsequent nursing home admission increased substantially for older adults having 3+ ADL dependencies; they also concluded that the threshold indicator of functional impairment was one of the strongest predictors of nursing home placement compared to other commonly used socioeconomic control factors. This corresponds with how long-term care insurers determine care and benefit eligibility in practice; for example, state-administered Medicaid programs generally utilize a 3+ ADL limits trigger (Stone 2002).

Although there is consensus regarding how the total count of ADL disabilities and the threshold influences subsequent nursing home placement, little is known about whether *different types* of ADL disability are especially predictive of the outcome of interest. Researchers who have examined aspects of late-life ADL disability solely without relation to institutionalization risk suggest that certain functional limitations, such as bathing, dressing, and walking, tend to be more prevalent among the U.S. elderly than other limitations

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(Wiener et al. 1990; Crimmins 2004; Martin et al. 2010). Bathing, dressing, walking, and transferring also tend to be more difficult for older adults to perform than eating or toileting (Dunlop, Hughes, and Manheim 1997; Spector and Fleishman 1998; Finlayson, Mallinson, and Barbosa 2005). Thus, one might logically expect the somewhat distinct ADL limitations to have different effects on nursing home admission risk.

We used data from the Health and Retirement Study (HRS) from 1998 to 2010 to examine the relative importance of each of the six ADL disabilities—and separately, ADL counts (none; mild: 1–2 disabilities; severe: 3+ disabilities)—in predicting future nursing home admission among older adults. This expands on prior literature thus far emphasizing only the use of the latter configuration, and it also allows us to assess which of the two ADL configurations is more informative. Most prior analyses also focused on ADL factors that antedate nursing home entry by several years. Nonetheless, ADL disabilities are not necessarily chronic in nature; for example, research on the patterns of change in disability suggests that adults of age 65+ tend to exhibit a pattern of functional 'decline and recovery' up to about age 85 (Fonda, Clipp, and Maddox 2002; Fauth et al. 2007). Thus, a second contribution of this study is that we better elucidate the impact of the mutability of ADL disabilities over the life course on the risk of institutionalization. To do so, we compared results from multivariate models when ADL measures are introduced as time-varying covariates, in lieu of static covariates alone. Finally, we also assessed the robustness of the ADL disability predictors to birth cohort controls.

METHODS

Data

Our analyses were based on responses from initially community-dwelling older adults reinterviewed every 2 years (if living) between 1998 and 2010 in the HRS. The HRS, a nationally representative panel survey of adults older than 50, provides a rich source of information on older Americans' physical and mental health, insurance coverage, financial situations, family support systems, work status, and retirement planning. To facilitate temporal analysis, we relied on the HRS data file compiled by RAND, which features variables with consistent coding across survey waves (RAND 2011). Our final sample consisted of 18,801 individuals (10,739 women and 8,062 men) living in the community when interviewed in 1998, and where applicable, followed into

nursing homes and other residential settings thereafter. This sample pooled together subjects from four birth cohorts, including the Asset and Health Dynamics of the Oldest Old (AHEAD) and Children of the Depression (CODA) cohorts, as well as the HRS and War Baby (WB) cohorts. At the start of our observation period in 1998, AHEAD and CODA respondents were 67 years old and above, HRS respondents were age 56–68, and WB respondents were age 51–56.

The HRS is based on a stratified multistage area probability sample of U.S. households. The complex sample design, which includes oversamples of Hispanics, blacks, and households in the state of Florida, requires the use of sampling weights. The base year 1998 individual-level weights, in particular, are appropriate for our purposes as we are performing a prospective analysis, that is, taking a sample of individuals "at risk," and following them through time until either the event of interest occurs or observation ceases. We also adjust standard errors to account for the clustering across observations for the same subject.

Dependent Variables

Since 1995, HRS has collected information about whether a respondent resided in a nursing home at the time of the interview. This residence status is mainly recorded by the interviewer, but where necessary, a respondent is asked: "Are you living in a nursing home or other health care facility?" Notably, this measure excludes overnight nursing home stays which are short term in nature. Consistent with prior studies (e.g., Freedman 1996), we used the first instance of a positive response as an indicator of long-term nursing home entry and focused on first nursing home admissions. To determine admission date, we relied primarily on the self-reported move-in date provided it is consistent with the interviewers' record of whether the respondent was observed living in a nursing home at interview wave. For about 16 percent of those eventually institutionalized, we imputed the missing admission date using the midpoint of the survey dates where the individual was last known to be in the community and first observed living in a nursing home.

Combining the respondent's admission date and date of birth yielded the age at first nursing home admission, which was the main outcome variable for our analyses. The observed mean is age 82.9 (range: 52.8–102.8; median: 84.9) for the 1,437 individuals who subsequently entered nursing home over the 12-year observation period. For censored cases, we coded the outcome variable based on the respondent's age at censoring using the date of death,

attrition date, or observation cutoff. An additional variable indicating whether the observation was censored was also used in estimation.

Independent Variables

Our main variables drew on responses to the following question on ADL limitations in the survey: "Because of a health or memory problem do you have any difficulty with [ADL]?, where [ADL] refers to six distinct activities, namely dressing, including putting on socks and shoes; walking across a room; bathing or showering; eating, such as cutting up your food; getting in and out of bed; and using the toilet, including getting up and down." The wording of this question was standardized only from the 1998 HRS survey onward, as were the types and number of limitations assessed and the response coding (Health and Retirement Study [HRS] 2004). Consequently, we drew data from 1998 (which here we term the "baseline") onward and excluded earlier survey waves. Subjects who responded "yes", "can't do", or "don't do" to a particular task were coded as having that particular ADL disability. Note that the six ADL disabilities examined are by-and-large consistent with those referenced by the Medicaid program except that the latter considers "getting around inside the home" in lieu of walking, and specifies transferring as "transferring from a bed to a chair" (Stone 2002). As in prior studies (e.g., Salive et al. 1993; Gaugler et al. 2007), we constructed three categories for aggregate ADL counts (none; mild: 1–2 disabilities; severe: 3+ disabilities).

We also included a parsimonious set of control variables widely used by researchers to study the risks associated with nursing home placement. Determinants were classified into three components: predisposing, enabling, and need/illness characteristics as elucidated in the Andersen's (1968) behavioral model of health services use and later studies (see e.g., Bradley et al. 2002; Taylor et al. 2005). Predisposing controls included sex, race (white or nonwhite), education, marital status, social supports, and census region (West, Northeast, Midwest, South, and Other). We used separate binary markers to indicate whether the person was a high school graduate, married, had two or more living children, lived with others in household, used formal home health care, received help from spouse in ADL tasks, and received help from other family members (e.g., child, grandchild, or other relatives) in ADL tasks. Enabling control variables—which measure access to resources that may be instrumental in accessing nursing home services—included six binary variables (each coded as 0 = *no*, 1 = *yes*) to reflect having Medicare, Medicaid, private health insurance, private long-term care insurance, low household

income, and low household assets. Illness control variables comprised self-rated health (excellent, very good, good, and fair/poor); eight binary markers to indicate preexisting chronic conditions such as stroke, cancer, and diabetes; and cognitive score (treated as a continuous variable). Aside from this set of controls, we also included a proxy flag as many interviews with respondents living in nursing homes required questions to be answered by a proxy respondent (HRS 2011). Cohort controls were included successively to assess the robustness of the individual ADL disability predictors.

Statistical Analyses

One of the most frequently used models applied to study time to first nursing home admission is the semiparametric Cox proportional hazards model. Prior studies have modeled the outcome in the regression model using either chronological age (e.g., Freedman 1996) or time-on-study adjusting for age as a covariate (e.g., Liu, McBride, and Coughlin 1994; Bauer 1996). In this study, we opted for the former approach as we expect the hazard to change more with age rather than as a function of follow-up time. In other words, we expected a greater change in nursing home risk between a 60- and an 80-year old followed over the same period time, rather than between two same-aged individuals with different follow-up times.

Formally, let α_0 be the age at which a subject enters the study, α be the age of the individual at the point of nursing home admission or censoring, and x_j be the set of predisposing, enabling, and illness characteristics controlled on. The admission hazard for an individual age α is expressed as:

$$h(\alpha|\alpha_0, \boldsymbol{x_j}) = h_0(\alpha|\alpha_0) \exp(\boldsymbol{x_j \beta})$$

Our model posits that subjects entered the risk set on their first interview (the earliest observed age in the sample is 50) and exited at their event or censoring age. We also accommodated left-truncated data (or delayed entry) which arose because for certain values of α, there were individuals who already entered a nursing home, while others had not yet entered the study. Our model employs the typical assumptions that the time-varying ADL variables measured at the start of each interview interval endures throughout the interval, and that both static (baseline) and time-varying covariates have a proportional effect on the hazard of nursing home entry.

To compare between static and time-varying ADL measures, we fitted two Cox regressions using aggregate ADL counts and the full set of controls described earlier. Next we regressed the six individual ADL limitations on age

at first nursing home admission, controlling on the same set of factors. We calculated the adjusted R^2 values for each regression to evaluate whether the aggregate or disaggregate ADL configuration (per time-varying measures) is more informative. Finally, we repeated the preceding regression but added birth cohort controls (with and without interacting them with the ADL covariates) to assess the robustness of the ADL disability predictors to possible cohort effects.

Before proceeding with the estimations, we checked for collinearity among the ADL variables and the set of covariates. Moderate levels of bivariate correlations were detected among the six ADL variables (0.30–0.48). Most prominently, bathing is positively correlated with almost all of the other ADL factors, especially dressing (ρ = .48) and walking (ρ = .46). This indicates that individuals who report difficulty bathing also tend to report dressing and walking difficulties, which is not surprising as older adults who are frail could be limited in multiple activities of daily living. Subsequently, we explored the use of ADL interactive terms (e.g., bathe–dress–walk interaction) to see if such terms offer extra explanatory power.

An examination of the broader correlation matrix revealed that the correlation between the ADL factors and the rest of the covariates was fairly low (−0.15 to 0.26). Pairwise correlations among the control variables were mostly well below 0.50. We noted a relatively strong correlation between married and living with others in household (ρ = .71). This is not surprising as married persons are more likely to live with others (particularly spouse or children) in the same dwelling.

RESULTS

Table 1 presents descriptive statistics for the ADL disabilities and control variables measured at baseline (column 1), and averaged over all years in which respondents remained exposed to nursing home admission risk. In 1998, 85.8 percent of the sample had no ADL limitations, 9.9 percent had 1–2 limitations, and 4.3 percent had three or more limitations. Across the six limitations, dressing problems were most widespread (7.7 percent), followed by transferring (5.5 percent) and bathing problems (5.3 percent). Eating difficulty was the least prevalent (2.1 percent). On average across years, however, more respondents reported suffering from dressing, walking, and bathing difficulties (means 6.5–9.2 percent), rather than transferring, toileting, or eating difficulties (means 2.9–5.7 percent).

Table 1: Descriptive Statistics of Explanatory Variables: Health and Retirement Study, 1998–2010

Variable	*1998 (%)*	*All Years* (%)*
ADL disabilities by count		
No ADL limitations	85.8	82.9
Mild disability (1–2 ADL limitations)	9.9	12.0
Severe disability (3+ ADL limitations)	4.3	5.1
Disaggregated ADL disability types		
Walking	4.9	6.6
Dressing	7.7	9.2
Bathing	5.3	6.5
Eating	2.1	2.9
Transferring from/to bed	5.5	5.7
Toileting	4.4	5.4
Other need characteristics		
Cognition score (scale 0–7)	4.54 (0.84)	4.36 (0.80)
Self-rated health		
Excellent	15	12
Very good	27	30
Good	31	32
Fair/poor	27	27
Ever-have chronic diseases		
High blood pressure	40	53
Diabetes	11	17
Cancer	9	14
Chronic lung disease	6	9
Heart disease/attack	18	24
Stroke	6	8
Major psychiatric	10	14
Arthritis	46	59
Predisposing characteristics		
Female	56	56
Nonwhite	13	13
High school graduate	76	78
Age	64.9 (10.2)	69.3 (9.3)
Married	64	62
Two or more living children	81	82
Lives with others in household	78	75
Use formal home health care	6	8
Informal care (spouse)	2	3
Informal care (others)	2	3
Census region		
West	19	19
Northeast	18	18
Midwest	26	26
South	37	38
Other	0.03	0.17

continued

Table 1 *Continued*

Variable	*1998 (%)*	*All Years* (%)*
Enabling characteristics		
Have Medicare	47	64
Have Medicaid	6	7
Have private health insurance	72	62
Have private long-term care insurance	9	12
Low household wealth	23	21
Low household annual income	23	23

Note. $N = 18{,}801$ (unweighted). Percentages shown for dichotomous variables and means with standard deviations in parentheses for continuous variables. All variables are weighted by individual 1998 weights. We use the 25th percentile as cutoff for household wealth ($6,300 in 1998 dollars) and household income ($16,000 in 1998 dollars). These translate to approximately $9,000 and $23,000 (in 2012 dollars), respectively.
*Mean values averaged over all years in which respondents are at risk for nursing home admission (i.e., alive and not institutionalized).

Table 2 reports the hazard ratios from Cox proportional hazard regressions examining the effects of ADL limitation counts on the risk of nursing home admission (confidence intervals are given in brackets). We see that the hazard ratios and adjusted R^2s are higher when ADL counts measured closer in time are used: the adjusted R^2 increases from 22.8 to 30.6 percent when time-varying ADL variables are used in place of their baseline counterparts. Consequently, treating ADL measures as static covariates would underestimate the true effect of functional disability by over 67 percent (hazard ratio 2.25 vs. 1.58). This highlights the relative importance of recognizing the mutability of ADL disabilities over the life course. Note that we are not concerned by endogeneity because the time-varying ADL covariates are measured at the last available interview *prior* to the event or censoring age. The last column in the table allows for all covariates to time-vary, which yields a substantially higher adjusted R^2 of 51.6 percent. Consistent with prior studies, the results in Table 2 also reveal that nursing home admission risk increases with greater disability. Mildly disabled individuals have 1.7 times the admission risk of individuals with no ADL disabilities, whereas severely disabled individuals have 2.1 times the admission risk of the reference group. A related reason why the severely disabled are more prone to entering nursing homes is because they are also more likely to be eligible for long-term care-related benefit payouts under public or private insurance programs.

Figure 1 presents evidence of age-specific differences in the prevalence of the six ADL limitations by sex. Of interest is that from age 80 onward, a

Table 2: Results of Cox Regression Models, Hazard Ratios of Nursing Home Admission Risk Using Aggregated ADL Counts

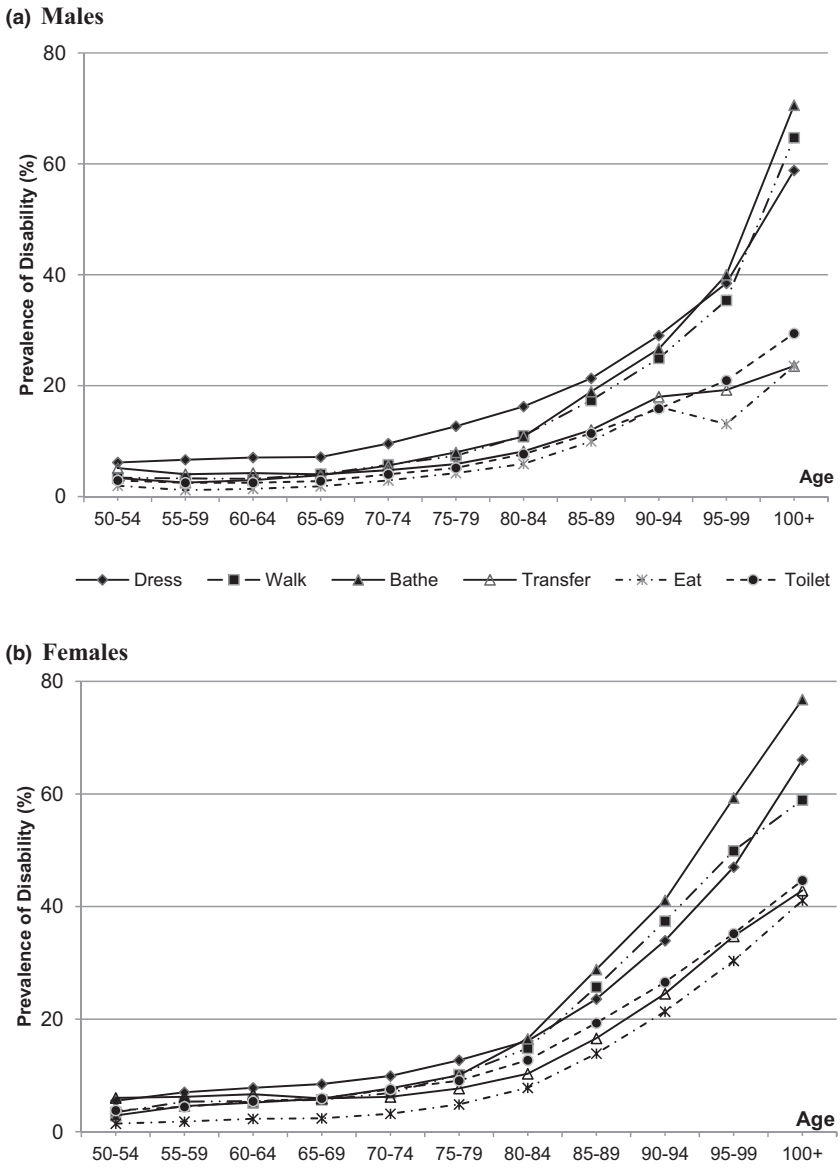
	Static ADL Measures		*Time-Varying ADL Measures*		*Time-Varying ADL and Covariates*	
	HR	*95% CI*	*HR*	*95% CI*	*HR*	*95% CI*
No ADL limitations (ref.)	–		–		–	
Mild (1–2 ADL limitations)	1.58***	[1.34, 1.86]	2.25***	[1.93, 2.62]	1.74***	[1.48, 2.04]
Severe (3+ ADL limitations)	1.97***	[1.55, 2.51]	3.63***	[2.98, 4.41]	2.14***	[1.71, 2.67]
Adjusted R^2	22.8%		30.6%		51.6%	
Chi-squared	20,418.7		754.5		15,893.9	
df	54		48		54	

Note. N = 18,801; individual 1998 weights applied. In the first two regressions, all other controls are measured at baseline.
CI, confidence interval; HR, hazard ratio.
***$p < .01$.

clear separation appears in the six prevalence rates. Among older men, bathing, dressing, and walking are the three most prevalent disabilities, while transferring and toileting ADLs fall in the middle, and inability to eat without help is the least prevalent. For older women, the order is similar: bathing, walking, and dressing are most widespread, followed by toileting, transferring, and eating. In addition, the differences in prevalence rates at later ages are fairly significant. For instance, the gap between bathing and eating prevalence is 27 percentage points [=40–13 percent] for males age 95–99, but only 5 percentage points [=11–6 percent] for men age 80–84. Overall, these observations lend support to our preliminary conjecture that certain ADL disabilities could be more influential in driving nursing home admission than others. In particular, bathing, dressing, and walking disabilities—which are most prevalent among both older men and women—may possibly emerge as stronger predictors of future nursing home admission compared to the others.

Disaggregating time-varying ADL covariates in Table 3 demonstrates the relative importance of the six disability types. Column 1 shows that of the six limitations considered, only bathing ($p < .01$) has a strong and significant impact on nursing home admission: all else equal, a person currently having difficulty in bathing faces 1.74 times the admission risk of a person with no

Figure 1: Proportions of Males and Females with Each of the Six ADL Disability Types by Age Group (a) Males; (b) Females



Note: N =18,801.

Table 3: Results of Cox Regression Models, Hazard Ratios of Nursing Home Admission Risk Using Disaggregated ADL Limitation Types

			(3) With Cohort Controls and Interaction Terms			
	(1) Pooled	*(2) With Cohort Controls*	*AHEAD*	*CODA*	*HRS*	*WB*
ADL limitation types						
Bathing	1.74***	1.74***	1.70***	ns	ns	ns
Dressing	0.93	0.93	0.79*	ns	1.67††	ns
Eating	1.18	1.18	1.11	ns	ns	ns
Walking	1.16	1.17	1.08	ns	ns	ns
Transferring	1.05	1.06	1.16	ns	ns	ns
Toileting	1.06	1.06	1.05	ns	ns	ns
Cohort controls						
AHEAD (ref.)		–	–			
CODA		1.22*	1.16			
HRS		1.62***	1.19			
WB		2.23**	1.52			
Adjusted R^2	51.4%	51.6%	52.4%			
Chi-squared	20,946.4	1,514.6	17,519.3			
df	58	57	79			

Note. N = 18,801; individual 1998 weights applied. ADL variables and all other controls are time-varying.
For test of difference in ADL effects across cohorts: $^{\dagger}p < .10$, $^{\dagger\dagger}p < .05$, ns = not significantly different from the reference group (i.e., the AHEAD cohort).
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

such difficulty. The adjusted R^2 achieved (51.4 percent) is similar to that in Table 2 (51.6 percent). In an attempt to further increase explanatory power, we added ADL interaction terms in the regression. Nevertheless, the overall improvement in adjusted R^2 is very small; for example, adding the bathe–dress–walk interaction term increased the amount of explained variance from 51.4 percent to just 52.2 percent. Consequently, all ADL variables were maintained in the final adjusted model without interaction terms; an examination of the postregression covariance matrix also reveals weak correlations between the estimated coefficients (i.e., no evidence of multicollinearity). Thus, while separating the ADL disability types for analysis is not necessarily more informative than using aggregate ADL counts, a disaggregated ADL analysis has the unique advantage that it could allow physicians and caregivers insight regarding the specific disability types likely to trigger long-term nursing home entry.

Adding cohort controls to the regressions yields further insight into the relative importance of ADL disability types by birth cohort. When cohort

controls are added without interaction terms in column 2 of Table 3, the effect of the bathing limitation remains robust ($p < .01$). In addition, we find that more recent cohorts appear to face higher risks of nursing home admission; for example, CODA respondents (born 1924–1930) on average face a 22 percent higher risk of nursing home admission, compared to the oldest AHEAD cohort (born 1890–1923), while HRS respondents (born 1931–1941) face 62 percent higher risk compared to the AHEAD cohort. Nevertheless, column 3 of Table 3 shows that this proved to be attributable to certain ADL limitations; when cohort controls are interacted with the ADL covariates, the direct effects of cohort dummies are no longer significant. This holds for the aggregated ADL configuration discussed earlier as well. We thus conclude from these results that ADL disability predictors are overall robust to cohort effects in our sample. The bathing limitation is singularly the most important ADL limitation predicting nursing home placement across *all* birth cohorts. Current difficulty with dressing is also significant in explaining nursing home admission, especially so for the more recent HRS cohort.

One might expect that the effect of ADL factors on the risk of nursing home admission could vary depending on the social support network, especially the individual's access to formal and informal care at home and in the community. Thus, for intimate tasks such as bathing or dressing, older persons might prefer to receive help from spouses rather than professional helpers (in the community or nursing homes) or other kin. To formally test this hypothesis, we introduce interaction terms into the base model just discussed. Accordingly, Table 4 shows the hazard ratio estimates for ADL effects stratified first by marital status, and then spouse care status (conditional on being married). Clearly spouse care has the greatest influence on the risk of nursing home admission for married older adults with walking difficulties in our sample; for them, the effect of receiving spousal help significantly reduces the risk of admission ($p < .05$). At the same time, we note that the walking limitation is in fact significant in explaining nursing home admission for the unmarried group, alongside the bathing limitation. This is consistent with the higher prevalence of walking disability observed among the unmarried respondents (7.9 percent) as compared to their married counterparts (3.3 percent at baseline).

Contrary to expectations, the effect of the bathing or dressing limitation on nursing home admission does not significantly differ by marital and/or spouse care status. The bathing limitation increases the risk of admission by about the same amount across groups (hazard ratios 1.71 and 1.73). The fact that the bathing difficulty has such an important impact suggests that

Table 4: ADL Effects on Nursing Home Admission Risk, with Marital Status and Spouse Care Status Interactions

	Marital Status Only		*Marital and Spouse Care Statuses*		
	Single	*Married Difference*	*Single*	*Married, No Spouse Care*	*Married, Spouse Care*
Bathing	1.72***	ns	1.73***	1.71†	ns
Dressing	0.89	ns	0.90	ns	ns
Eating	1.10	ns	1.10	ns	ns
Walking	1.25*	ns	1.25**	ns	1.04††
Transferring	1.00	ns	1.01	ns	ns
Toileting	1.06	ns	1.06	ns	ns

Note. N = 18,801; individual 1998 weights applied. ADL variables and all other controls are time-varying. In the second regression, a three-category dummy variable is used whereby the availability of spouse care is conditional on being married (i.e., single, married without spouse care, and married with spouse care). For test of difference in ADL effects across marital status and spouse care status: $^{\dagger}p < .10$, $^{\dagger\dagger}p < .05$, ns = not significantly different from the reference group (i.e., not married).
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

providing training to home health aides and/or better equipment at home could mitigate older persons' risk of entering the nursing home. Nonetheless, additional analysis is required to more precisely evaluate which elderly might be most helped by which adaptation, and how long each of these measures might be effective.

DISCUSSION

In this study, we modeled the effect of time-varying disaggregated ADL limitations on the risk of nursing home admission. Our multivariate analysis revealed that difficulty with bathing is a strong and independent predictor of subsequent nursing home placement across all birth cohorts examined after controlling for other important confounders. The dressing limitation was also salient for more recent cohorts' nursing home entry. Walking, eating, transferring, and toileting disabilities were not significant in any of the regressions. The insignificance of the walking limitation was perhaps surprising as it was a rather common affliction in our sample, but the result can be explained by the fact that aids including walkers, canes, wheelchairs, and electric carts can help ease mobility problems quite effectively.

The relative importance of the bathing disability in nursing home admission could be attributable to the fact that it requires more human assistance

than the other basic activities of everyday life. For instance, it may be hard to bathe independently even with aids like grab bars. Specifically, Wiener et al. (1990) showed that more adults age 65+ (whether institutionalized or not) required personal help in bathing than other activities. Medical studies have also suggested that adults needing assistance with bathing find this activity to be both physically and emotionally demanding due to pain, anxiety resulting from being naked in front of strangers, being afraid of falling, and discomfort from drafty bathing areas or harsh water spray (Rader et al. 2006).

Our analyses were also informative on whether disaggregating the ADL factors provided greater prognostic power than the aggregate ADL measures used in prior studies. We believe that the disaggregated limitation measures can provide health professionals and policy makers with insights regarding the specific disability types likely to trigger long-term institutionalization in the older population. As an example, this knowledge could be useful in the design of interventions to improve community care programs for older people to help them remain in their own homes for as long as possible. Thus, resources devoted to educating home care workers and informal carers about the importance of helping older persons bathe more easily could help delay institutionalization among the elderly. Similarly, the retrofitting of dwelling units and the introduction of safety equipment or assistive devices targeted at aiding the bathing process could help offset deficits in independent functioning in the home environment. Inasmuch as the relative importance of the bathing disability in nursing home admission stems from this ADL requiring more human assistance than other types of limitations, care assessors may wish to refine the current eligibility criteria for residential care services to take into account the differential needs associated with particular ADL factors.

Finally, our results showed that ADL disabilities measured closer in time were more informative than static baseline measures for predicting nursing home entry, which is not surprising as ADL limitations are mutable over time. We also found some suggestion that more recent cohorts faced higher risk of nursing home admission, mainly attributable to the dressing ADL limitation. A plausible explanation for the cohort differentials observed in our data is that the AHEAD cohort was a relatively select group of elderly adults with above-average health: to be included in the sample, they had to be living in the community at relatively advanced ages (74–105) at the 1998 baseline. Consequently, they were less likely to suffer from multiple limitations prior to being institutionalized as compared to the HRS cohort, which was a more representative group of individuals age 56–68 at baseline.

We also rule out that the possibility that cohort differentials are due to differences in age and other health-related factors, including ever-have chronic illnesses and cognitive ability, as these were controlled in our models. Interestingly, it has been postulated that dressing is particularly difficult for dementia patients: such individuals may feel overwhelmed by choices in dressing and may not remember how to tie a shoe lace or buckle a belt. The dataset we use is limited in its ability to provide a clear diagnosis of this relationship because the HRS started collecting information on dementia and Alzheimer's only from the 2010 wave. Future research on nursing home admissions covering longer follow-up periods and with measures on memory-related diseases will be required to investigate further how admission risk and the relative importance of the ADL factors change by cohort.

By simultaneously allowing for both time-varying ADL factors and control variables, it was possible to achieve adjusted R^2 values of around 50 percent. These values are quite comparable to, and in fact slightly surpass, those of prior studies which have also examined nursing home placement risk using standard Anderson model predictors. For example, Foley et al. (1992) reported Cox-Snell R^2 values of 43–45 percent per their logistic regressions analyses. Consequently, we believe that the issue of substantial unexplained variance is not peculiar to our sample. In a recent meta-analysis of the determinants of nursing home admission among older adults in the United States, Gaugler et al. (2007) opined that "a considerable amount of unexplained variance in the prediction of nursing home admission still remains in many studies."

Our study has some limitations that future research can remedy. First, the HRS measures of ADL disabilities are self-reported, yet normative perceptions of "having difficulty" with a particular task may vary across respondent groups. For example, it has been argued that women tend to assess their own health less positively than men (c.f., Hall and Channing 1990; Arber and Ginn 1993). There is mixed evidence of this in our sample: *t*-test statistics reveal that mean responses to ADL items were significantly higher for women than for men in some instances, but this was not consistent across waves or items. Second, the nursing home admission trigger we examined is limited to physical health measured by ADLs, although a nontrivial proportion of nursing home users are probably institutionalized due to cognitive impairment and severe mental health issues. Others have documented improvements in cognitive functioning among older persons in their 80s (Freedman, Aykan, and Martin 2001, 2002), so future research should evaluate the relative importance of ADL versus cognitive impairment triggers in practice. A final limitation is that nursing home admissions can be dynamic over time. In our

analysis, we have minimized the exposure to churning effects by carefully distinguishing between overnight nursing home stays and long-term nursing home use; 92 percent of the sampled respondents observed to enter nursing homes remained in such facilities until their final interview wave.

In sum, our results presented an intriguing counterpoint to the current practice of according all six ADLs equal weighting in research and practice. Recognizing that some ADL disabilities may be relatively more important for nursing home admissions could contribute to more effective targeting of health and community-based care provision and aid in the forecasting of future demand for residential aged care services. The identification of elders at elevated risk for nursing home placement would enable policy makers at the state level to better plan for resource allocation, which in turn has implications for future program spending on long-term care services.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.