Social Engagement, Limitations, and Mortality in Late Life

by

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor of Philosophy in the Department of
Sociology in the Graduate School
of Duke University

2010

ABSTRACT

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Abstract

This study uses social integration theory within a life course framework to examine the relationships among social engagement, physical limitations, cognitive limitations, and mortality. Data for this study come from the Americans' Changing Lives survey, a nationally representative panel study conducted in 1986, 1989, 1994, and 2002, with mortality information spanning from 1986 to 2005. First, structural equation modeling is used in cross-lagged panel models to examine gender differences in these relationships. Findings suggest that social engagement may have protective effects on health limitations for women but that physical and cognitive limitations can present barriers for social engagement among men. Second, growth mixture models were used to examine patterns of social engagement over time. This study then examined how these patterns of social engagement related to physical and cognitive limitations (using latent growth curve models) and mortality (using Cox proportional hazards models). Findings suggest the importance of maintaining high levels of social engagement and increasing social engagement over time for better physical and cognitive health and lower risk of mortality for older adults.

Dedication

I dedicate this dissertation to my grandmother, whose high levels of social engagement, physical activity, and cognitive sharpness inspired me to examine the relationships among these phenomena.

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1. Introduction

Dating back to Durkheim ([1897] 1979), researchers have been interested in the links between social relations and health. Much of this research in recent years deals with the effects of social relations on depression or well-being rather than physical health (e.g., Krause, Ellison, and Wulff 1998). Social relations are likely to promote both mental *and* physical health (Herzog, Ofstedal, and Wheeler 2002); however, the effects of social engagement on various physical and cognitive health outcomes and mortality have not been fully explored. This dissertation seeks to understand the relationships between social engagement and physical limitations, cognitive limitations, and mortality, using data from the American's Changing Lives survey, a nationally representative longitudinal panel study.

Most studies on social relations and health employ solely a variable-centered approach, common in studies using regression and structural equation modeling (Muthén and Muthén 2000). This approach typically assumes a relatively homogeneous population and answers questions about how well predictor variables explain differences in outcome variables (Laursen and Hoff 2006). A person-centered approach does not assume one homogeneous population but rather that the sample is heterogeneous with multiple unobserved groups within the sample (von Eye and Bogat 2006). This approach focuses on classifying individuals who share similar characteristics

or relations of characteristics into distinct groups (Jung and Wickrama 2008). This approach can answer questions concerning patterns of group or individual differences over time, shedding light on individuals' life trajectories. The person-centered and variable-centered approaches can be complementary rather than competing orientations. These approaches can enable the researcher to examine phenomena from the perspectives of differences in individuals and differences in relations among variables (Laursen and Hoff 2006).

The present study combines person-centered and variable-centered approaches. The person-centered approach is used when classifying individuals into distinct trajectory classes of social engagement over time. The variable-centered approach is used when examining the cross-lagged associations between social engagement, physical limitations, and cognitive limitations, and the association between social engagement trajectory class membership and physical limitations, cognitive limitations, and mortality.

1.1 Conceptual Definitions of Social Engagement

There is considerable conceptual heterogeneity concerning social engagement and the related constructs of "social participation" and "social integration." Berkman, Glass, Brissette, and Seeman (2000) argue that social engagement "results from the enactment of potential ties in real life activity" (p. 849) and suggest that participation in

social functions, social roles, group recreation, and church attendance are all examples of social engagement. Later, Glass and colleagues included both social and productive activities (activities that generate goods or services with economic value) in their conceptualization of social engagement (Glass, Mendes de Leon, Bassuk, and Berkman 2006). Zunzunegui, Alvarado, Del Ser, & Otero (2003) defined social engagement in terms of feelings of usefulness and feelings of playing an important role in the lives of their children, family, and friends. Herzog, Ofstedal, and Wheeler (2002), following a conceptual framework by Verbrugge, Gruber-Baldini, and Fozard (1996), define social engagement through three sets of activities: *Discretionary activities* (referring to activities during free time, such as socializing, public service, and sport activities), *committed activities* (those associated with major social and family role commitments, such as paid work, housework, and child care), and *obligatory activities* (those required for survival and self-sufficiency, such as personal care, sleep, and transportation). Several studies involving nursing home residents conceptualize social engagement in a particularly different way than those studying the non-institutionalized population. These studies define social engagement in terms of the ease with which people interact with others and are involved in activities within the facility (Achterberg, Pot, Kerkstra, Ooms, Muller, and Ribbe 2003; Kiely and Flacker 2003; Mor, Branco, Fleishman, Hawes, Phillips, Morris, and Fries 1995).

The concept of social integration has also been conceptualized in different ways in the literature. Zunzunegui et al. (2003) defined social integration as participation in formal social activities, such as membership in community associations, attendance of religious services, and visits to community-based senior centers. Moen, Dempster-McClain, and Williams (1989) define social integration as a count of social roles, such as relative, friend, neighbor, worker, church member, and club/organization member. Although they conceive of social integration in terms of social roles, respondents must be active in these roles to be counted. For example, they must attend religious services rather than merely identify with a religion to be considered as occupying the church member social role. Much of the research to date has defined the concept of social integration in terms of formal social roles (Hsu 2007; Moen, Dempster-McClain, and Williams 1989; Sieber 1974; Verbrugge, Gruber-Baldini, and Fozard 1996).

Ellaway & Macintyre (2007) define social participation in terms of whether or not respondents participated in several groups, such as political, civic, religious, educational, social, or fitness groups. Hsu (2007) included paid and unpaid work along with social group/club attendance. Nummella, Sulander, Rahkonen, and Uutela (2008) define social participation in terms of involvement in various social activities, such as hobbies, attendance of cultural or religious events, educational activities, and voluntary work. Others define social participation in a wide-ranging fashion as the involvement in

a plethora of activities (some involving direct interactions with other people and some not). These activities ranged from study circles, organization meetings, entertainment, gatherings of family or friends, and even letter-writing to the editor of a newspaper (Johnell, Mansson, Sundquist, Melander, Blennow, and Merlo 2006; Lindstrom 2006). Similar to Verbrugge et al. (1996), Van der Mei et al. (2007) defined social participation in terms of obligatory activities (such as employment, education, and household tasks) as well as leisure activities (such as volunteer work, both solitary hobbies and those spent with other people, entertainment, involvement in clubs/organizations, socializing with friends and family in person as well as through phone, mail, or e-mail).

Clearly there is much variation in the definitions of these concepts. In this dissertation, social engagement is conceptualized as participation in activities that involve interactions between or among people. Both informal activities, such as visiting with family and friends, as well as formal activities, such as volunteering, are included. Social engagement in this study will not include solitary activities as others have (e.g., Glass, Mendes de Leon, Bassuk, and Berkman 2006), and it will not be restricted to formal social roles (e.g., Verbrugge, Gruber-Baldini, and Fozard 1996). Although some social roles may be embedded within some of these social activities (e.g., frequency of visiting with family members implies familial roles), the frequency of interaction in these activities is what is important for the present study.

2. Gender, Social Engagement, and Limitations

Researchers have long been interested in the connections between social relations and health (House, Landis, and Umberson 1988). Although social interactions are likely to promote both mental and physical health (Herzog, Ofstedal, and Wheeler 2002; Krause, Ellison, and Wulff 1998), the effects of social engagement on physical and cognitive health outcomes have not been fully explored. Moreover, when investigating these relationships, the norm has been correlation and regression models that do not take into account unreliability of measures, possible correlated errors, and, most important, possible reciprocal relationships among these constructs. The purpose of this paper is to better understand the complex relationships among social engagement, physical limitations, and cognitive limitations and the differences in these relationships by gender. This study uses data from a nationally representative panel study to estimate structural equation models testing both selection processes and social benefit hypotheses informed by social integration theory.

2.1 Theory and Evidence

Social interaction is a prerequisite for the development of functioning members of society, with detrimental effects on health and well-being for those who are socially isolated (e.g., Grant, Hamer, and Steptoe 2009; Harlow, Dodsworth, and Harlow 1965). Social relations are important for health and successful aging (House, Landis, and Umberson 1988; Rowe and Kahn 1998), and in their various forms have been linked to

better self-rated health (Nummela et al. 2008), reduced risk of dementia (Fratiglioni, Paillard-Borg, and Winblad 2004), longer survival (Kiely and Flacker 2003), and a host of other health outcomes.

Social integration theory is one way in which scholars have thought about the importance of social relations for health. Social integration theory builds upon Durkheim's ([1897] 1979) classic study of suicide and argues that integration in the social structure can influence health. The defining characteristic of social integration at the individual level is attachments to the social structure. Social attachments can shape resources available, provide a sense of purpose, and increase motivation and social pressure to take better care of one's health (Berkman, Glass, Brissette, and Seeman 2000). Those who are more socially integrated often have a stronger connection to family and community generating a greater sense of purpose, which may, in turn, encourage health-promoting behaviors (Bassuk, Glass, and Berkman 1999). Social integration can enhance the flow of health-related information and encourage more effective utilization of health care services (Cohen 2004). Social attachments can serve as a buffer for adverse social conditions and stressful events (Schwerdtfeger and Friedrich-Mai 2009; Wortman 1984) as well as influence health through physiological pathways, such as through neuroendocrine reactivity and reduction of allostatic load (Seeman and McEwen 1996).

Much research to date has defined the concept of social integration in terms of formal social roles, such as "mother" and "worker," or counts of these roles (Hsu 2007;

Moen, Dempster-McClain, and Williams 1989; Sieber 1974; Verbrugge, Gruber-Baldini, and Fozard 1996). Much of this research does not take into account frequency of social interactions, which is relevant for understanding the degree to which individuals are socially integrated. Social engagement, as defined in this study, is one way to capture a broader array of social interactions and intensity of interaction that can contribute to greater attachment to the social structure. Social engagement is conceptualized as frequency of participation in activities that involve interactions between or among people. Although some social roles may be embedded within some of these social activities (e.g., frequency of visiting with family members implies familial roles), the frequency of interaction in these activities is what is important for the present study.

Social engagement among older adults may be especially important. Over the life course, individuals move into and out of multiple social roles, but as they age they are more likely to lose than to replace or add formal social roles (Evandrou and Glaser 2004; Lee and Powers 2002). For example, older adults are more likely to lose the worker role (Evandrou and Glaser 2004). Despite the potential loss of formal social roles, older adults may still participate frequently in important social activities that can contribute to greater integration into the social structure and likely benefit health, so it is especially important to examine these social interactions among the older population rather than solely a count of social roles.

There may be important differences in social integration for men and women. Women have a lower likelihood of dying than men of the same age (Case and Paxson 2005). As a larger proportion of women live to older ages, they may experience a greater loss of formal social roles. Examining formal social roles alone, however, neglects evidence that women are likely to be more socially engaged than men even in the face of role loss such as through widowhood (Bock and Webber 1972). Women often have more opportunities for social interactions than men due to their larger and more varied social networks (Antonucci 1994). Examining intensity of interaction may be especially important if women are more involved in social interactions than men. This greater interaction may contribute to greater attachment to the social structure for women than men, with possible implications for health.

2.1.1 Social Benefit Hypothesis

Longitudinal studies find some evidence for the social benefit hypothesis of social engagement's influence on cognitive limitations. Participation in social activities among older adults can reduce failure at cognitive tasks (Glei, Landau, Goldman, Chuang, Rodriguez, and Weinstein 2005) and promote cognitive functioning in general (Holtzman, Rebok, Saczynski, Kouzis, Wilcox Doyle, and Eaton 2004). Larger social networks among older adults correlated with higher initial levels of cognitive function and reduced cognitive decline over approximately five years of follow-up (Barnes, Mendes de Leon, Wilson, Bienias, and Evans 2004). A recent study over six years found

that high levels of social integration, in the form of familial and community roles, in late life slowed rates of memory decline (Ertal, Glymour, and Berkman 2008). Zunzunegui et al. (2003) found that risk of cognitive decline among older adults was predicted by low contact with social ties and low participation in social activities. Social activities can also reduce the risk of dementia (Fabrigoule, Letenneur, Dartigues, Zarrouk, Commenges, and Barbergergateau 1995; Wang, Karp, Winblad, and Fratiglioni 2002). Participation in social interactions may provide a cognitively challenging environment that protects against, delays, or minimizes cognitive decline (Barnes et al. 2004).

Longitudinal research also provides evidence for the social benefit hypothesis of the influence of social engagement on physical limitations. Having close personal contacts increases the odds of successful aging, defined as little or no difficulty on mobility and physical performance indicators (Strawbridge, Cohen, Shema, and Kaplan 1996). High social participation among older adults can enhance the maintenance of functional ability (Avlund, Lund, Holstein, and Due 2004) and is significantly associated with lower levels of disability measured by activities of daily living, gross mobility, and basic physical functions across gender and racial subgroups (Mendes de Leon, Glass, and Berkman 2003). Family networks may be especially protective of mobility disability (Giles, Metcalf, Glonek, Luszcz, and Andrews 2004); however, others find that social interaction with friends, but not with children or other relatives, is related to reduced risk of disability (Mendes de Leon, Gold, Glass, Kaplan, and George 2001).

Based on social integration theory and evidence from the literature, I test the following social benefit hypotheses:

Hypothesis 1: Social engagement is inversely related to subsequent cognitive limitations.

Hypothesis 2: Social engagement is inversely related to subsequent physical limitations.

2.1.2 Social Selection

While social engagement may influence health, health may also affect levels of social engagement (Li and Ferraro 2006; Verbrugge 1983). Li and Ferraro (2005) found evidence for both social benefits and social selection in their study of social integration and mental health. It is likely that those who are healthier are more socially engaged, as physical and cognitive limitations could impede older adults' abilities to participate in social activities.

Several studies have found evidence in favor of the flow from physical and cognitive limitations to lower levels of social engagement. Cognitive limitations can reduce social functioning (Washburn, Sands, and Walton 2003), and physical limitations can decrease the amount of face-to-face contact with others (Simonsick, Kasper, and Phillips 1998). Using path analysis, Brink and Stones (2007) found that hearing impairment affects linguistic communication, which, in turn, is related to lower social engagement. Women with physical limitations due to rheumatoid arthritis have lower

levels of social activity than women without these limitations (Zautra, Hamilton, and Yocum 2000). Structural equation models show that physical impairment reduces social activity in the general population in Norway (Eide and Roysamb 2002).

In accordance with this evidence, I also test hypotheses based on potential selection effects:

Hypothesis 3: Cognitive limitations are inversely related to subsequent social engagement.

Hypothesis 4: Physical limitations are inversely related to subsequent social engagement.

2.1.3 Reciprocal relationships between physical and cognitive limitations

Cognitive limitations and physical limitations may also influence each other. Evidence from longitudinal research shows that cognitive limitations can increase the risk of declines in functional status (Stuck, Walthert, Nikolaus, Bula, Hohmann, and Beck 1999). Tabbarah, Crimmins, and Seeman (2002) found that declines in cognitive functioning, in both routine tasks and novel/attention demanding tasks observed over seven years, were significantly associated with physical functioning declines in that period. Physical limitations may also influence cognitive limitations. Scherr and colleagues (1988) found that those who reported higher levels of functional limitations subsequently scored lower on cognitive tests. The ability to engage in physical activities

can also reduce the risk of cognitive decline (Yaffe, Barnes, Nevitt, Lui, and Covinsky 2001).

The main focus of this study is on the social benefit and selection processes involved in the relationships among social engagement and physical and cognitive limitations. Although I test the influence of cognitive limitations on subsequent physical limitations and vice versa, I do not make specific predictions for these tests.

2.1.4 Gender Differences

There are several ways in which gender differences could alter the relationships among social engagement and physical and cognitive limitations. First, women often have larger and more varied social networks (Antonucci 1994) and exchange support with a greater number of network members than men (Antonucci and Akiyama 1987). This suggests that women are likely to be more socially engaged than men. Men often depend solely on their spouse for support exchanges (Fuhrer and Stansfeld 2002), and they are less likely to participate in social activities in the community (Bock and Webber 1972). Thus, men may pursue fewer opportunities to be socially engaged.

Second, the effects of social engagement and limitations may also operate differently across gender. One study found that women who were more socially engaged with their friends had a lower probability of cognitive decline, but this pattern was not significant among men (Zunzunegui, Alvarado, Del Ser, and Otero 2003). Similarly, Gallant and Dorn (2001) found that social network variables were more

influential for women than for men in predicting better health behaviors. The physiological pathways through which social engagement influences health also may vary by gender, a pattern suggested by observed gender-specific differences in the associations between social relations and several biomarkers (Loucks, Berkman, Gruenwalk, and Seeman 2005). Seeman et al. (2002) found that men, but not women, who were more socially engaged had significantly lower allostatic load scores.

I make the following hypotheses regarding gender differences in the relationships among social engagement and physical and cognitive limitations:

Hypothesis 5: Women are more likely than men to benefit in their cognitive health from their social engagement.

Hypothesis 6: Women are more likely than men to benefit in their physical health from their social engagement.

2.2 Methods

2.2.1 Data

Data come from the Americans' Changing Lives (ACL) survey housed at the University of Michigan's Institute for Social Research and funded by the National Institute on Aging (House, 2007). This nationally representative longitudinal panel study collected data in 1986, 1989, 1994, and 2002. Wave 1 (N = 3,617) used a multistage stratified area probability sample of the continental United States' household population

aged 25 and older, with an oversampling of African Americans and adults aged 60 and older. The current analysis focuses on adults aged 60 and older (N=1,669 in Wave 1). Physical and cognitive limitations occur in greater proportions among older adults and are outcomes associated with aging (Fried and Guralnik 1997). As described previously, social engagement may be of particular importance for the older population as well. This chapter did not include Wave 4 of the ACL. The lag between Waves 3 and 4 was especially long (eight years), and only women had sufficient sample size for a Wave 3 to Wave 4 analysis, which yielded statistically significant results only for the Wave 3 latent constructs related to their subsequent manifestations. Inclusion of Wave 4 did not change the pattern of results presented below.

2.2.2 Measures

Social Engagement. The latent variable of social engagement is measured with five observed variables indicating frequency of involvement in several social activities: (1) "In a typical week, about how many times do you talk on the telephone with friends, neighbors, or relatives?" (2) "How often do you get together with friends, neighbors or relatives and do things like go out together or visit in each other's homes? (3) "How often do you attend meetings or programs of groups, clubs or organizations?" (4) "How often do you usually attend religious services?" and (5) about how many hours were spent on volunteer work during the last 12 months. Response categories for volunteering were: 0 = did not volunteer, 1 = less than 20 hours, 2 = 20-39 hours, 3 = 40-79

hours, 4 = 80-159 hours, 5 = 160 hours or more. Response categories for the other indicators were: 0 = never, 1 = less than once a month, 2 = about once a month, 3 = two or three times a month, 4 = once a week, and 5 = more than once a week. Some studies incorporate solitary activities (e.g., solitary hobbies) into their operationalization of social engagement (Glass, Mendes de Leon, Bassuk, and Berkman 2006; Nummela et al. 2008). The present study excludes these activities because they do not involve social interactions and thus do not fit within the conceptual framework.

Cognitive Limitations. The latent variable of cognitive limitations is measured with five items from the Short Portable Mental Status Questionnaire (SPMSQ): (1) "What is the date today—month, day, and year?" (2) "What day of the week is it?" (3) "What is the name of the president of the United States?" (4) "What is the name of the person who was president just before him?" (5) "Please subtract 3 from 20 and tell me the number you get. Then, keep subtracting 3 from this number and each new number you get, telling me the results as you go" (The interviewer stops the respondent when the answer is 2 or less).

Physical Limitations. The latent variable of physical limitations is measured with three observed variables largely related to items from the Rosow-Breslau disability scale. The items include: (1) "Do you currently have any difficulty climbing a few flights of stairs because of your health?" (2) "Do you currently have any difficulty walking several blocks because of your health?" (3) "Would you currently have any difficulty doing

heavy work around the house such as shoveling snow or washing walls, because of your health?"

Control Variables. Several exogenous variables (i.e., used solely as independent variables in SEM) are controlled in this analysis: *Age* (in years, ranging from 60 to 95 in Wave 1), *race* (1=white, 0=nonwhite [largely African American, along with small numbers of American Indian, Asian, and Hispanic respondents]), s*ex* (1=female, 0=male), *marital status* (1=currently married, 0=not currently married), *employment status* (1=currently employed, 0=not currently employed), *education* (continuous measure of highest grade completed), and *family income* from all sources (using the midpoint of each of the ten income categories, ranging from $2,500 to $110,000).

2.2.3 Analytic Plan

Structural equation models (SEM) were estimated using Mplus, Version 5 (Muthén and Muthén 2007) to test the lagged effects of social engagement, cognitive limitations, and physical limitations on all three latent variables at each subsequent wave, with separate models estimated for men and women. The cross-lagged panel model allows an analysis of each pathway between these variables while taking into account unreliability of measures, random errors, and potential correlated errors. Only effects between adjacent waves are estimated, as multiple lags would create severe multi-collinearity problems.

Missing data were handled with full information maximum likelihood (FIML) procedures. FIML incorporates all respondents in the data regardless of whether they participated in every wave of the survey or responded to every item, using information about the mean and variance of the variables' missing portions given other observed variables (Wothke 2000). FIML is less biased and more efficient than other ways of handling missing data, such as listwise deletion, pairwise deletion, or mean substitution (Schafer and Graham 2002; Schlomer, Bauman, and Card 2010; Wothke 2000). To help account for attrition due to death and dropout, models controlled for indicators of mortality selection (1 = died over the study period, 0 = survived) (Alley, Crimmins, Karlamangla, Hu, and Seeman 2008) and the number of waves respondents participated in (Brown working paper). Cao and Hill (2005) argue that it is important to take into account attrition both due to mortality (i.e., passive attrition) and attrition due to other causes (i.e., active attrition).

2.3 Results

Descriptive statistics of key variables and differences by gender appear in Table 1. The mean age of respondents was 69 years for men and 70 years for women. Men and women had an average of approximately 10 years of education, and a majority of respondents were white (69% of men and 68% of women). Men had significantly higher incomes than women ($21,500 compared to a mean income of $15,600 for women in

Wave 1). Men were significantly more likely than women to be married (66% to 44% respectively) and employed (31% to 18%). Women participated in slightly more waves on average and were significantly less likely to die over the course of the first three waves of the survey than men (22% of women died compared to 38% of men). Women were significantly more likely to be socially engaged than men with respect to visiting with family and friends, phoning family and friends, and attending religious services. Women had significantly higher scores on each of the physical limitations indictors, with sizable differences compared to men at each wave. Gender differences in the cognitive limitations indicators were less consistent across waves, but were typically in the direction of greater cognitive limitations among women.

Table 1. Descriptive Statistics and Differences by Gender

	Wave 1		Wave 2		Wave 3	
	Men	Women	Men	Women	Men	Women
Age (in years)	69.4	70.4*				
RACE						
White	69.1	68.3				
Nonwhite	30.9	31.7				
Currently Married (%)	65.6	43.8***				
Currently Employed (%)	30.6	18.3***				
Income	$21,500	15,600***				
Education (in years)	10.2	10.3				
Number of Waves					2.2	2.3***

Died					38.2	22.4***
SOCIAL ENGAGEMENT						
Visits with friends and relatives (0-5)	3.1	3.4***	3.2	3.7*	3.2	3.4
Talks on phone with friends/relatives (0-5)	3.0	3.8***	3.3	4.0***	3.3	3.8***
Attend meetings/event of organizations (0-5)	1.8	1.9	1.8	1.9	2.0	2.1
Attends religious services (0-5)	2.4	2.8***	2.3	2.9***	2.5	2.8*
Hourly categories of volunteer work (0-5)	0.9	0.9	1.0	1.1	1.0	1.0
COGNITIVE IMPAIRMENT (% incorrect)						
What is the date?	26.9	25.7	18.4	22.0	24.4	21.9
What day of week is it?	8.9	7.4	6.5	4.9	4.3	5.0
Who is the current U.S. President?	4.2	6.9*	8.3	9.6	6.1	6.7
Who is the previous U.S. President?	28.6	35.9**	5.3	7.2	18.0	24.9*
Subtract 3 from 20	28.6	36.4**	28.6	33.8	32.7	42.0**
PHYSICAL IMPAIRMENT (%)						
Difficulty climbing stairs	23.8	36.1***	21.1	35.4***	18.7	30.5***
Difficulty walking blocks	22.4	30.9**	17.5	30.0***	19.2	32.2***
Difficulty w/ heavy housework	33.3	46.6***	31.1	48.7***	29.8	45.4***
	N=550	N=1,119	N=402	N=877	N=261	N=628
	N=1,669		N = 1,279		N = 889	

Figures 1 and 2 display the significant pathways among social engagement, cognitive limitations and physical limitations for women and men, respectively, controlling for exogenous variables and attrition. The models both show good fit (women: comparative fit index = 0.93 and root mean square error of approximation =

0.04; men: comparative fit index = 0.90 and root mean square error of approximation = 0.05). A root mean square error of approximation of 0.06 and below (Hu and Bentler 1999) and a comparative fit index of 0.90 and above are generally considered good (Lance, Butts, and Michels 2006), though there is some debate about whether the bar should be raised or lowered, especially regarding the comparative fit index (Marsh, Hau, and Wen 2004).

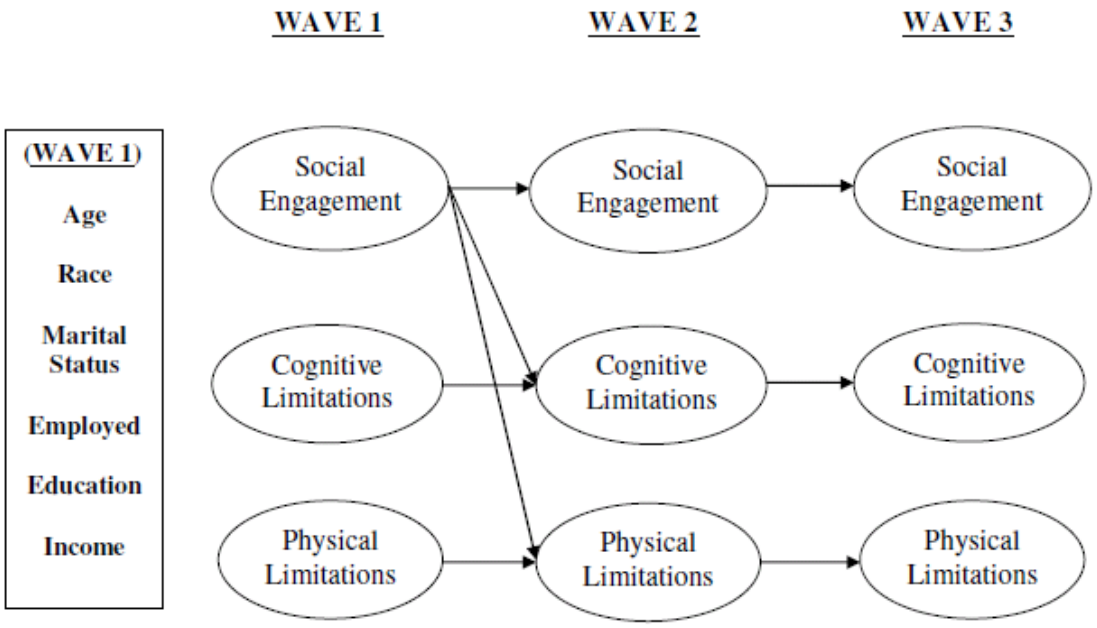


Figure 1. SEM for Women Age 60 and Older (N=1,119)

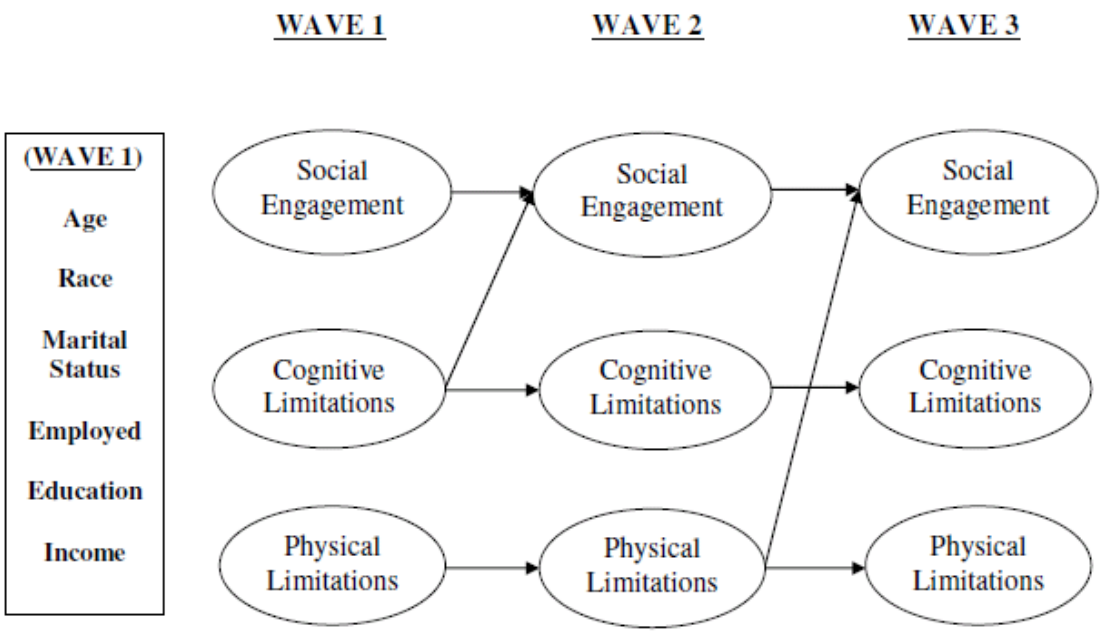


Figure 2. SEM for Men Age 60 and Older (N=550)

As one would expect, for both men and women social engagement at Wave 1 is strongly related to social engagement at Wave 2, cognitive limitations at Wave 1 is strongly associated with cognitive limitations at Wave 2, and physical limitations at Wave 1 is strongly related to physical limitations at Wave 2. Each of these Wave 2 variables is significantly related to its subsequent level at Wave 3 as well. For women, social engagement at Wave 1 is significantly associated with lower levels of cognitive limitations and physical limitations at Wave 2. For men, cognitive limitations at Wave 1

are significantly associated with lower levels of social engagement at Wave 2, and physical limitations at Wave 2 are significantly related to lower levels of social engagement at Wave 3. Table 2 shows the unstandardized estimates of these relationships. In analyses not shown, difference tests in the pathways among social engagement, cognitive limitations, and physical limitations established that the gender differences in these pathways are statistically significant.

Table 2. Unstandardized Estimates of the Relationships among Social Engagement, Cognitive Limitations, and Physical Limitations for Adults Age 60+ by Gender

	WOMEN			**MEN**		
		Wave 2			**Wave 2**	
	SE	**CL**	**PL**	**SE**	**CL**	**PL**
Wave 1 Measures						
Social Engagement (SE)	0.884*** (0.032)[a]	-0.260** (0.082)	-0.245** (0.098)	0.729*** (0.057)	-0.156 (0.129)	-0.024 (0.133)
Cognitive Limitations (CL)	-0.006 (0.039)	0.720*** (0.084)	-0.102 (0.095)	-0.139** (0.047)	0.613*** (0.109)	-0.174 (0.101)
Physical Limitations (PL)	-0.018 (0.024)	0.056 (0.058)	0.815*** (0.092)	0.025 (0.036)	0.073 (0.088)	0.666*** (0.074)
		Wave 3			**Wave 3**	
	SE	**CL**	**PL**	**SE**	**CL**	**PL**
Wave 2 Measures						
Social Engagement (SE)	0.835*** (0.046)	0.144 (0.105)	-0.129 (0.099)	0.926*** (0.085)	-0.153 (0.230)	0.037 (0.205)
Cognitive	0.065	0.500***	-0.027	0.020	0.582***	0.077

Limitations (CL)	(0.048)	(0.078)	(0.089)	(0.054)	(0.130)	(0.118)
Physical Limitations (PL)	-0.064 (0.036)	0.012 (0.068)	0.630*** (0.057)	-0.150** (0.053)	-0.019 (0.136)	0.861*** (0.096)

Note: Variables controlled are age, race, marital status, employment, education, income, death during survey, and the number of waves respondents interviewed.
[a] Standard errors in parentheses; *p< .05, **p< .01, ***p < .001
Model estimates: WOMEN: χ^2 = 751.1, df = 296; RMSEA = .04; comparative fit index = .93; MEN: χ^2 = 343.8; df = 155; RMSEA = .05; comparative fit index = .90

The relationships between the covariates and the endogenous variables of social engagement, cognitive limitations, and physical limitations at subsequent waves by gender appear in Tables 3 and 4 (the estimates displayed are from the same models as in Table 2). Controls for mortality during the survey and the number of waves in which respondents participated had some significant but inconsistent effects across the waves of social engagement and physical and cognitive limitations for women. For men, the only significant attrition measure was mortality related to Wave 3 cognitive limitations.

For women, those with more education at Wave 1 have higher levels of social engagement and lower levels of physical and cognitive limitations at Wave 2, with the pattern persisting for social engagement and cognitive limitations at Wave 3. White women have lower levels of cognitive limitations at Wave 2, and employed women and those with higher incomes have lower levels of physical limitations at Wave 2. Older women have higher levels of cognitive limitations at Wave 2 and higher levels of physical limitations at Waves 2 and 3.

For men, those with more education have higher levels of social engagement, lower levels of cognitive limitations, and lower levels of physical limitations (at Wave 2). Married men are more socially engaged in Wave 2 than unmarried men. White men experience lower levels of cognitive limitations at Wave 2, and older men have higher levels of cognitive limitations at Wave 3. Employed men experience lower levels of physical limitations at Wave 2.

Table 3. Unstandardized Estimates of the Relationships between Exogenous and Endogenous Variables Among Women

	WOMEN					
	Social Engagement		**Cognitive Limitations**		**Physical Limitations**	
	Wave 2	Wave 3	Wave 2	Wave 3	Wave 2	Wave 3
Age	0.000	-0.006	0.014**	0.004	0.021***	0.014*
	(0.003)	(0.003)	(0.005)	(0.007)	(0.005)	(0.006)
White	-0.056	0.022	-0.354***	-0.164	-0.017	0.058
	(0.042)	(0.050)	(0.073)	(0.090)	(0.070)	(0.090)
Married	0.001	0.011	-0.068	-0.042	-0.089	-0.006
	(0.038)	(0.039)	(0.069)	(0.074)	(0.064)	(0.070)
Employed	0.019	-0.018	0.000	-0.084	-0.158*	-0.015
	(0.043)	(0.044)	(0.079)	(0.080)	(0.076)	(0.080)
Education	0.047***	0.017*	-0.081***	-0.060***	-0.024*	0.001
	(0.007)	(0.008)	(0.011)	(0.013)	(0.010)	(0.012)
Income	0.002	0.000	0.000	0.002	-0.004*	0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
Number of	0.142**	-0.105	-0.352***	0.046	0.063	-0.293**

Waves	(0.050)	(0.096)	(0.084)	(0.148)	(0.086)	(0.106)
Died	-0.061	0.118*	-0.010	-0.092	0.289**	-0.405***
	(0.061)	(0.053)	(0.096)	(0.051)	(0.109)	(0.074)

Note: Exogenous variables were measured at Wave 1. Coefficients and standard errors were obtained from the same models as in Table 2.

[a] Standard errors in parentheses.

*p< .05, **p< .01, ***p < .001

Table 4. Unstandardized Estimates of the Relationships between Exogenous and Endogenous Variables Among Men

	MEN					
	Social Engagement		**Cognitive Limitations**		**Physical Limitations**	
	Wave 2	Wave 3	Wave 2	Wave 3	Wave 2	Wave 3
Age	0.000	0.002	0.014	0.032*	0.000	0.006
	(0. 004)	(0. 005)	(0.009)	(0.013)	(0.007)	(0.011)
White	-0.076	0.005	-0.338**	-0.048	-0.012	0.209
	(0. 052)	(0.065)	(0.127)	(0.161)	(0.107)	(0.144)
Married	0.150**	-0.056	-0.158	0.250	0.084	-0.037
	(0. 048)	(0.061)	(0.117)	(0.147)	(0.103)	(0.133)
Employed	-0.056	0.010	-0.125	0.156	-0.326**	-0.017
	(0.049)	(0.057)	(0.127)	(0.137)	(0.115)	(0.120)
Education	0.022**	-0.003	-0.088***	-0.030	-0.035**	0.025
	(0.006)	(0.008)	(0.018)	(0.021)	(0.013)	(0.018)
Income	0.000	0.001	0.015	-0.007	-0.005	-0.004
	(0.001)	(0.001)	(0.005)	(0.005)	(0.004)	(0.004)
Number of Waves	0.064	-0.040	-0.211	0.147	-0.163	0.177
	(0.064)	(0.135)	(0.158)	(0.646)	(0.089)	(0.199)
Died	-0.057	0.099	-0.051	0.401***	-0.051	0.004
	(0.070)	(0.071)	(0.180)	(0.112)	(0.124)	(0.136)

Note: Exogenous variables were measured at Wave 1. Coefficients and standard errors were obtained from the same models as in Table 2.
[a] Standard errors in parentheses.
*p< .05, **p< .01, ***p < .001

2.4 Discussion

This study examines the pathways among social engagement, physical limitations, and cognitive limitations and gender differences in these pathways, advancing the literature in several ways. First, this study incorporates a broader array of social interactions that can integrate individuals into the social structure than a focus solely on formal social roles (e.g., Moen, Dempster-McClain, and Williams 1992; Verbrugge 1983). As adults age and often lose formal social roles (Evandrou and Glaser 2004; Lee and Powers 2002), it becomes increasingly important to examine whether frequency of other social interactions have a positive impact on health. This study incorporates intensity of interaction by examining the frequency of participation in social activities rather than solely a count of formal social roles. Second, this study examines gender differences in the pathways among social engagement and physical and cognitive limitations. Women are often involved in greater amounts of social interaction than men (Antonucci 1994), suggesting that they may have greater attachment to the social structure. It is important to examine whether women are more socially integrated than men and if that integration leads to better health outcomes. Third, this study examines both social benefits and social selection, using structural

equation modeling with longitudinal data. This enables the development of cross-lagged panel models to better understand the associations of social engagement, physical limitations, and cognitive limitations for each of these subsequent latent variables. Structural equation modeling also removes random variance from latent variables and takes into account unreliability of measures and possible correlated errors. Further, this study controls for indicators of the number of waves respondents participated in and mortality during the survey period to help account for attrition (Alley et al. 2008; Brown working paper).

The social benefit hypotheses guided by social integration theory anticipate that greater social engagement is associated with lower levels of subsequent physical and cognitive limitations. Results lend support to the social benefit hypotheses among women, suggesting that social engagement has protective effects on subsequent physical and cognitive health. Greater social engagement is significantly associated with lower levels of subsequent physical and cognitive limitations among women, though these effects did not persist across all waves. It may be that the impact of social engagement appears only in the short-term.

Based on evidence suggesting the relevance of selection processes (Li and Ferraro 2005; Verbrugge 1983), this study also tested hypotheses that physical and cognitive limitations affect subsequent levels of social engagement. Evidence of selection appears among men with selection from cognitive limitations at baseline to lower levels of social

engagement in Wave 2 along with physical limitations in Wave 2 associated with lower levels of social engagement in Wave 3.

The gender differences in the pathways among social engagement and physical and cognitive limitations are striking. Women experience the benefits of social engagement for their health, while men experience selection processes with the flow from health limitations to lower levels of social engagement. Past literature suggests that women and men may differ substantially in their levels of social integration and the impact of that social integration on health (Antonucci and Akiyama 1987; Gallant and Dorn 2001). This may be a function of men's lower levels of social engagement overall, consistent with the literature regarding men's reliance on their spouse for social support and lower likelihood of participation in social activities in the community (Bock and Webber 1972; Fuhrer and Stansfeld 2002). Physical or cognitive limitations may provide further obstruction in the levels of social engagement for men who already may not engage in frequent social activities. Women who experience physical or cognitive limitations, however, may still make greater efforts than men to pursue social activities, maintaining their social attachments and potentially experiencing greater benefits for their health from their social engagement.

Some of the exogenous variables also influenced social engagement, physical limitations, and cognitive limitations. Men and women with more education had significantly higher levels of social engagement and lower levels of physical and

cognitive limitations. Age significantly related to both physical and cognitive limitations among women but only to increased cognitive limitations for men. Whites experienced lower levels of cognitive limitations among both men and women. Employed men had lower levels of physical limitations than men who were not employed. Married men had significantly higher levels of social engagement than unmarried men, but this relationship was not significant among women.

This study has several limitations. First, three observed variables for the latent construct of physical limitations are on the lower end of the acceptable range to measure a latent variable. Some other items measuring physical limitations were available in the Americans' Changing Lives survey, but they represented a much more severe level of disability (e.g. difficulty bathing oneself and staying in a bed or chair for most of the day for health reasons) that did not load well on the same factor in exploratory factor analysis. Second, indicators of social engagement did not take into account the quality of interactions in these social activities. It is possible that negative experiences with the social engagement activities impact health differently from positive experiences (August, Rook, and Newsom 2007). It is important for future research to explore this. Third, disaggregating by gender resulted in smaller sample sizes. Smaller sample size can reduce statistical power and thus obscure some underlying significant associations. Finally, as the survey progressed, the intervals between waves became longer, with

three years between Waves 1 and 2 and five years between Waves 2 and 3. Longer survey lags may have also made it more difficult to uncover significant relationships.

Despite these limitations, this study provides important information about social engagement and health. It provides support for the social benefit hypothesis among women that greater social engagement has protective effects on physical and cognitive limitations. These protective effects highlight the benefits of older adults' participation in social activities on health outcomes beyond counts of social roles, especially in the context of the role loss that often occurs as adults age (Evandrou and Glaser 2004). Evidence of selection processes appeared for men, as physical and cognitive limitations seemed to limit social engagement. The contrasts in directions of the pathways among social engagement and physical and cognitive limitations across gender highlight the importance of taking gender differences into account. Women may be more likely to obtain health benefits from social engagement while limitations in men's health can be detrimental to their levels of social engagement. The results of this study could encourage older adults, especially women, to become more socially engaged as one of several ways to maintain better physical and cognitive health.

3. Trajectories of Social Engagement and Limitations

Social relations are important for health and successful aging (House, Landis, and Umberson 1988; Rowe and Kahn 1998) and in their various forms, have been linked to better self-rated health (Nummela et al. 2008), lower blood pressure (Piferi and Lawler 2006), reduced risk of dementia (Fratiglioni, Paillard-Borg, and Winblad 2004), longer survival (Kiely and Flacker 2003), and a host of other positive health outcomes. Of particular interest for this study is whether patterns of social engagement over time are related to initial levels and changes in physical and cognitive limitations.

This study contributes to the literature on social relations and health in several ways. Although studies have established important links between social relations and health (House, Landis, and Umberson 1988), very little research takes into account the dynamic nature of both social relations and health over time. Social integration is not necessarily fixed across time but rather may fluctuate with the ebb and flow of social attachments across the life course. Similarly, health outcomes can vary substantially across time. Examining both trajectories of social relations and trajectories of heath outcomes can provide important leverage in understanding the relationships of these phenomena over time. Little attention has been paid to examining trajectories of social relations (Béland, Zunzunegui, Alvarado, Otero, and del Ser 2005), and even fewer studies examine the associations between patterns of change in social relations and trajectories of health. Of the few studies that do so, most examine social support or

other social exchanges that are related to, but distinct from, social engagement (Mavandadi, Rook, and Newsom 2007; Taylor and Lynch 2004). The present study uses social integration theory in a life course framework to examine latent class trajectories of social engagement and how membership in those trajectory classes is related to trajectories of physical and cognitive limitations, with data from a nationally representative panel study.

Another contribution of this study is the use of both variable-centered and person-centered approaches. Most studies on social relations and health employ solely a variable-centered approach, common in studies using regression and structural equation modeling, (Muthén and Muthén 2000). This approach typically assumes a relatively homogeneous population and answers questions about how well predictor variables explain differences in outcome variables (Laursen and Hoff 2006). A person-centered approach does not assume one homogeneous population but rather that the sample is heterogeneous with multiple unobserved groups within the sample (von Eye and Bogat 2006). This approach focuses on classifying individuals who share similar characteristics or relations of characteristics into distinct groups (Jung and Wickrama 2008). This approach can answer questions concerning patterns of group or individual differences over time, shedding light on individuals' life trajectories. The person-centered and variable-centered approaches can be complementary rather than competing orientations. These approaches can enable the researcher to examine phenomena from the

perspectives of differences in individuals and differences in relations among variables (Laursen and Hoff 2006). The present study combines these approaches, using the person-centered approach when classifying individuals into distinct trajectory classes of social engagement over time and using the variable-centered approach to examine the association between social engagement trajectory class membership and physical and cognitive limitations.

3.1 Theory and Evidence

Social integration theory is one way in which scholars have thought about the importance of social relations for health. Social integration theory builds upon Durkheim's ([1897] 1979) classic study of suicide and argues that integration in the social structure can influence health. The defining characteristic of social integration at the individual level is attachments to the social structure. Social attachments can shape resources available, provide a sense of purpose, and increase motivation and social pressure to take better care of one's health (Berkman, Glass, Brissette, and Seeman 2000). Those who are more socially integrated often have a stronger connection to family and community generating a greater sense of purpose, which may, in turn, encourage health-promoting behaviors (Bassuk, Glass, and Berkman 1999). Social integration can enhance the flow of health-related information and encourage more effective utilization of health care services (Cohen 2004). Social attachments can serve as a buffer for adverse social conditions and stressful events (Schwerdtfeger and Friedrich-Mai 2009; Wortman

1984) as well as influence health through physiological pathways, such as through neuroendocrine reactivity and reduction of allostatic load (Seeman and McEwen 1996).

Much research to date has defined the concept of social integration in terms of formal social roles, such as "mother" and "worker," or counts of these roles (Hsu 2007; Moen, Dempster-McClain, and Williams 1989; Sieber 1974; Verbrugge, Gruber-Baldini, and Fozard 1996). Much of this research does not take into account frequency of social interactions, which is relevant for understanding the degree to which individuals are socially integrated. Social engagement, as defined in this study, can capture a broader array of social interactions and intensity of interaction that can contribute to greater attachment to the social structure. Social engagement is conceptualized as frequency of participation in activities that involve interactions between or among people. Although some social roles may be embedded within some of these social activities (e.g., frequency of visiting with family members implies familial roles), the frequency of interaction in these activities is what is important for the present study.

Examining the relationship between patterns of social engagement over time and health outcomes is especially important in the context of the life course. The five main principles of the life course perspective include the following: the life-long process of human development and aging, individual agency within the constraints of social circumstance, individual embeddedness in historical time and place, the importance of timing of events and behavior, and the interdependence of lives in shared relationships

(Elder, Johnson, and Crosnoe 2003). Over the life course, individuals move into and out of multiple social roles but, as they age, they are more likely to lose than to replace or add formal social roles (Evandrou and Glaser 2004; Lee and Powers 2002). For example, older adults are likely to lose the worker role (Evandrou and Glaser 2004). Despite this potential loss of formal social roles, older adults may still participate frequently in social activities that can contribute to greater integration in the social structure and likely benefit health, so it is especially important to examine these social interactions among the older population.

Trajectories take into account patterns of stability and change of social phenomena over time, which is an integral feature of the life course perspective (George 2009). This view suggests that both social integration and health can change over time. It is important to examine whether patterns of change in social integration are associated with changes in health limitations. There is a dearth of research examining questions of this nature, however. Past literature suggests that social relations are important for health, but very few studies examine trajectories of social relations and whether they are associated with trajectories of physical or cognitive limitations.

Although based on between-person differences, longitudinal research to date suggests important links between social engagement and cognitive and physical limitations. Participating in social activities can reduce failure at cognitive tasks among older adults (Glei et al. 2005). Higher levels of interpersonal activity as well as

emotional support are associated with better cognitive functioning (Holtzman et al. 2004), whereas low contact with social ties and low participation in social activities are associated with greater risk of cognitive decline (Zunzunegui, Alvarado, Del Ser, and Otero 2003). Those who scored higher on an index of both social and solitary ("productive") activities experienced significantly lower levels of impairment in activities of daily living, gross mobility, and basic physical functions (Mendes de Leon, Glass, and Berkman 2003). Though important longitudinal links have been found, the bulk of research in this area does not take into account stability and change over time with the more dynamic approach that growth modeling offers.

A growing literature examines trajectories of disability (e.g., Li 2005; Nusselder, Looman, and Mackenbach 2006; Wolinsky, Miller, Malmstrom, Miller, Schoolman, Andresen, and Miller 2007), but few studies have examined how social relations may influence trajectories of physical or cognitive limitations. One of the few studies to approach this topic used growth models to examine the effects of social integration (a 0-4 scale of community association membership and at least monthly attendance in community center activities, public meetings, and religious attendance) on changes in cognitive function among a sample of older adults living in Spain (Béland et al. 2005). Results indicated that those who had high levels of social integration experienced stable cognitive functioning over time; however, those with low levels of social integration experienced accelerating cognitive decline (Béland et al. 2005). Another study

examining the impact of social relations on trajectories of health focused on religious service attendance, which is one aspect of social engagement. Those who frequently attended religious services experienced lower baseline levels and slower increases in difficulties with instrumental activities of daily living (IADLs); those who attended religious services less frequently experienced steeper increases in IADL limitations (Park, Klemmack, Roff, Parker, Koenig, Sawyer, and Allman 2008). These studies incorporate patterns of change in physical or cognitive limitations, but they do not take into account changes in social relations over time and how those patterns could influence health outcomes.

Very few studies examine the relationship between patterns of change in social relations over time and trajectories of physical and cognitive limitations, and most that do so examine social support or other social exchanges that are distinct from social engagement. Trajectories of perceived social support mediated the relationship between trajectories of disability and trajectories of depressive symptoms among older adults in North Carolina (Taylor and Lynch 2004). Another study used latent growth curve analysis to examine the effects of trajectories of positive exchanges (largely relating to emotional, instrumental, and informational support) and negative social exchanges (relating to critical behaviors by others, rejection/neglect, failure to provide support when needed, and unwanted advice from others) on trajectories of disability over two years. Those with stably high positive social exchanges were most likely to have little to

no disability over time. A majority of those who experienced increasing negative social exchanges exhibited increased disability with some later functional recovery (Mavandadi, Rook, and Newsom 2007).

These studies differ from the present study in several ways. Both of these studies focus on social exchanges and social support. Social support is one of several pathways through which social relationships can potentially influence health (Berkman, Glass, Brissette, and Seeman 2000). Social engagement represents broader social interactions than these social exchanges represent, so it is important to examine whether participation in these social activities influence health. Additionally, these studies use summed indices in their measures of social exchanges and limitations while the latent variable approach in the present study reduces measurement error for social engagement and physical and cognitive limitations. Further, the present study uses a nationally representative sample rather than a regional sample as in Taylor and Lynch (2004) and provides information on a longer span of time than the two-year time span examined in Mavandadi, Rook, and Newsom (2007). The existing literature, however, suggests that trajectories of social relations may have important consequences for health over time that should be further examined.

Based on social integration theory within a life course framework and empirical evidence of the relationships between social relations and physical and cognitive health, this study hypothesizes that patterns of stably high or increasing social engagement over

time will be associated with lower initial levels and less growth in physical and cognitive limitations over time.

3.2 Methods

3.2.1 Data

Data used in these analyses come from the Americans' Changing Lives (ACL) survey housed at the University of Michigan's Institute for Social Research and funded by the National Institute on Aging (House, 2007). This nationally representative panel study collected data in 1986, 1989, 1994, and 2002. Wave 1 (N = 3,617) used a multistage stratified area probability sample of the continental United States' household population aged 25 and older, with an oversampling of African Americans and adults aged 60 and older. Physical and cognitive limitations occur in greater proportions among older adults and are outcomes associated with aging (Fried and Guralnik 1997). As described previously, social engagement may be of particular importance for the older population as well. Only adults aged 60 and older were included in this analysis (N=1,669 in Wave 1).

3.2.2 Measures

Social Engagement. The latent variable of social engagement was measured with five observed variables indicating frequency of involvement in several social activities: (1) "In a typical week, about how many times do you talk on the telephone with friends,

neighbors, or relatives?" (2) "How often do you get together with friends, neighbors or relatives and do things like go out together or visit in each other's homes? (3) "How often do you attend meetings or programs of groups, clubs or organizations?" (4) "How often do you usually attend religious services?" and (5) about how many hours the respondent spent on volunteer work during the last 12 months. Response categories for volunteering included: 0 = did not volunteer, 1 = less than 20 hours, 2 = 20-39 hours, 3 = 40-79 hours, 4 = 80-159 hours, 5 = 160 hours or more. Response categories for the other indicators included: 0 = never, 1 = less than once a month, 2 = about once a month, 3 = two or three times a month, 4 = once a week, and 5 = more than once a week.

Cognitive Limitations. The latent variable of cognitive limitations was measured with five items from the Short Portable Mental Status Questionnaire (SPMSQ): (1) "What is the date today—month, day, and year?" (2) "What day of the week is it?" (3) "What is the name of the president of the United States?" (4) "What is the name of the person who was president just before him?" (5) "Please subtract 3 from 20 and tell me the number you get. Then, keep subtracting 3 from this number and each new number you get, telling me the results as you go" (The interviewer stopped the respondent when the answer was 2 or less).

Physical Limitations. The latent variable of physical limitations was measured with three items related to the Rosow-Breslau functional scale. The items included: (1) "Do you currently have any difficulty climbing a few flights of stairs because of your

health?" (2) "Do you currently have any difficulty walking several blocks because of your health?" (3) "Would you currently have any difficulty doing heavy work around the house such as shoveling snow or washing walls, because of your health?"

Control Variables. The analysis controlled for several variables: *Age* (in years, ranging from 60 to 95 in Wave 1), *race* (1=white, 0=nonwhite [largely African American, along with small numbers of American Indian, Asian, and Hispanic respondents]), s*ex* (1=female, 0=male), *marital status* (1=currently married, 0=not currently married), *employment status* (1=currently employed, 0=not currently employed), *education* (continuous measure of highest grade completed), and *family income* from all sources (using the midpoint of each of the ten income categories, ranging from $2,500 to $110,000).

3.2.3 Analytic Plan

This study uses growth mixture modeling (GMM) to estimate trajectory classes of social engagement over time. Class membership in social engagement trajectories derived from the GMM analysis are then used as a set of dummy variables to examine the association of membership in these social engagement trajectories with initial levels and changes (i.e., rate of growth) in physical and cognitive limitations, using standard latent growth curve models (LGM). Analyses were conducted using Mplus, Version 5 (Muthén and Muthén 2007).

Standard latent growth curve modeling examines differences between individuals in intra-individual change (Ram and Grimm 2009). LGM estimates a mean growth curve, describing an overall pattern of change in a single population (Muthén and Muthén 2000). The intercept (initial level) and slope (growth rate over time) are latent factors comprising LGM and are allowed to vary across individuals. The following are equations for a quadratic[1] latent growth curve model:

$$y_{it} = \eta_{0i} + \eta_{1i}x_t + \eta_{2i}x^2_t + \varepsilon_{it} \quad (1)$$

$$\eta_{0i} = \alpha_0 + \gamma_0 w_i + \zeta_{0i} \quad (2a)$$

$$\eta_{1i} = \alpha_1 + \gamma_1 w_i + \zeta_{1i} \quad (2b)$$

$$\eta_{2i} = \alpha_2 + \gamma_2 w_i + \zeta_{2i} \quad (2c)$$

Equation 1 represents within-individual change over time. Equations 2a, 2b, and 2c represent between-individual change over time, w_i. The outcome variable is y_{it} (i.e., physical limitations or cognitive limitations), η_0 is the intercept, η_1 is the linear slope, η_2 is the quadratic slope, t is the time point, x is the time score, and w is the covariate. The subscript *i* indicates that the parameter varies across individuals. Residuals are

[1] A quadratic growth model is presented because the quadratic models fit better than linear models for both physical and cognitive limitations.

represented by ε_{it}, ζ_{0i}, ζ_{1i}, and ζ_{2i}. Typically linear time scores are estimated with scores of 0, 1, 2, 3 for four waves (quadratic time scores are the linear time scores squared, i.e., 0, 1, 4, 9). Due to the unequal spacing between waves in the ACL, the time scores reflect the number of years since Wave 1 (with the Wave 1 time score equal to zero).

Growth mixture models are instances of finite mixture models useful for modeling data that are suspected or known to contain multiple subgroups or that have unknown distributional shapes (Everitt 1996; McLachlan and Peel 2000). These models began to be applied in the social sciences with Heckman and Singer's (1984) article on mixtures of hazard regressions, were developed and extended over the years (Nagin 2005; Nagin and Land 1993), and are now applied to study many types of trajectories (George 2009). Growth mixture models are similar to latent growth curve models with multiple groups, except that in GMM the subgroups are not known in advance and are instead unobserved and inferred from the data (Ram and Grimm 2009). GMM is also similar to latent class growth analysis (LCGA) in that both estimate mean growth curves for each class rather than one average trajectory for the entire sample as in LGM (Nagin 2005). In LCGA individuals within each class are treated as homogeneous, allowing zero variance and covariance in the growth factors. Growth mixture models, however, allow for individual variation around each of the growth curves, similar to the variation allowed in LGM (Muthén and Muthén 2000).

The main difference between the equations for GMM and LGM is the inclusion of the subscript *k* for the GMM equations. This inclusion reflects trajectory class membership. The following equations are for a linear growth mixture model[2] with K latent trajectory classes, where in Class k (k = 1, 2,…, K):

$$y_{it} = \eta_{0i} + \eta_{1i}\alpha_{kt} + \varepsilon_{it} \quad (3)$$

$$\eta_{0i} = \alpha_{0k} + \gamma_{0k} w_i + \zeta_{0i} \quad (4a)$$

$$\eta_{1i} = \alpha_{1k} + \gamma_{1k} w_i + \zeta_{1i} \quad (4b)$$

Here, y_{it} reflects social engagement trajectories. The α_k parameters vary across classes to capture different types of trajectories. The γ_k parameters allow the influence of the covariates on the growth factors to vary across class. Class-specific covariance matrices ψ_k allow for individual variation within each class (Muthén 2002).

Several fit indices were used to determine the number of trajectory classes in the growth mixture models. Models were iteratively tested with increasing numbers of classes, and models with linear and quadratic slopes were tested. Muthén (2004) argues that it is important to take covariates into account when determining the number of

[2] The equations presented reflect a linear GMM because it was the best-fitting model for trajectory classes of social engagement.

classes in growth mixture modeling. Thus, age, sex, race, marital status, employment status, income and education were included in the modeling process determining the number of trajectory classes (though unconditional models [without covariates] were estimated for comparison purposes). Preferred models had smaller Bayesian Information Criteria (BIC), sample-size adjusted BIC, and Akaike Information Criteria (AIC) values and a significant Lo, Mendell, Rubin (2001) likelihood ratio test (LMR-LRT) statistic (Jung and Wickrama 2008). A significant p-value for the LMR-LRT statistic indicates a solution with $C - 1$ classes is not sufficient and should be rejected in favor of C classes (Ram and Grimm 2009).

This study uses full information maximum likelihood (FIML) to handle missing data. FIML is a theory-based approach to missing data that incorporates all respondents in the data regardless of whether they participated in every wave of the survey or responded to every item. FIML uses all available data, including information about the mean and variance of the missing parts of a variable, given observed portions of other variables (Wothke 2000). FIML has been shown to be less biased and more efficient than other ways of handling missing data, such as listwise deletion, pairwise deletion, or mean substitution (Schafer and Graham 2002; Schlomer, Bauman, and Card 2010; Wothke 2000). In many cases, FIML produces equivalent results to multiple imputation methods (Collins, Schafer, and Kam 2001). To help account for attrition due to death and dropout, models controlled for indicators of mortality selection (1 = died over the

study period, 0 = survived) (Alley et al. 2008) and the number of waves in which respondents participated (Brown working paper). Cao and Hill (2005) argue that it is important to take into account both attrition due to mortality (i.e., passive attrition) and attrition due to other causes (i.e., active attrition).

3.3 Results

Table 5 shows the descriptive statistics of key variables. The mean age of respondents was 70 years; they had an average of 10.3 years of education and a mean income of $17,500 at baseline. Respondents were largely female (67.1%) and white (68.5%), a little over half were married, and around 22% were employed. Respondents participated in an average of 2.6 waves, and 58.8% died by Wave 4 of the survey, which is not uncommon due to the older ages of the respondents.

Table 5. Descriptive Statistics, Means and Percentages for Controls, Social Engagement, Cogntive Limitations, and Physical Limitations

	Wave 1	Wave 2	Wave 3	Wave 4
Age (in years)	70.1			
Female	67.1%			
RACE				
White	68.5%			

Nonwhite	31.5%			
Currently Married	51.1%			
Currently Employed	22.4%			
Income	$17,500			
Education (in years)	10.3			
Number of Waves				2.6
Died during study period				58.8%
SOCIAL ENGAGEMENT				
Visits with friends and relatives (0-5)	3.3	3.3	3.4	3.5
Talks on phone with friends and relatives (0-5)	3.5	3.8	3.7	3.8
Attend meetings/programs of organizations (0-5)	1.8	1.8	2.0	2.2
Attends religious services (0-5)	2.7	2.7	2.8	2.8
Hourly categories of volunteer work (0-5)	0.9	1.1	1.0	1.1
COGNITIVE LIMITATIONS (% incorrect)				
What is the date?	26.1%	20.9%	22.6%	25.7%
What day of week is it?	7.9%	5.4%	4.8%	4.6%

Who is the current U.S. President?	6.0%	9.2%	6.5%	5.6%
Who is the previous U.S. President?	33.5%	6.6%	22.9%	14.8%
Subtract 3 from 20 (continuing subtracting 3 from total)	33.8%	32.2%	39.3%	35.0%
PHYSICAL LIMITATIONS (% yes)				
Difficulty climbing stairs	32.6%	30.8%	27.0%	31.2%
Difficulty walking blocks	28.1%	26.1%	28.3%	39.3%
Difficulty w/ heavy housework	42.0%	43.0%	40.5%	49.4%
	N=1,669	N=1,279	N=889	N=436

A five-class linear solution for trajectories of social engagement fit the data best. This model had small information criteria values (AIC, BIC, sample-size adjusted BIC) relative to other class solutions. This solution also had a significant Lo, Mendell, Rubin (2001) likelihood ratio test statistic, indicating that a solution with four classes should be rejected in favor of a solution with five classes. The model had high entropy at 0.92, indicating a clear delineation of classes with little overlap (Celeux and Soromenho 1996). The social engagement trajectory classes are displayed in Figure 3. About 58% of the sample (N=996) comprised trajectory class 1, which was characterized by high levels of social engagement with a slight decrease over time. Trajectory class 2 (10.5% of the

sample, N=176) was also characterized by high initial levels of social engagement, but decreased more than class 1 over time. Approximately 13% of the sample (N=222) belonged to trajectory class 3, which was characterized by high levels of social engagement that increased slightly over time. The initial levels of social engagement in trajectory classes 1, 2, and 3 were nearly identical. About seven percent of the sample (N=112) comprised the class 4 trajectory, which had medium levels of social engagement that increased over time. Finally, trajectory class 5 was characterized by relatively low and decreasing levels of social engagement over time, with 11.5% belonging to this class (N=161).

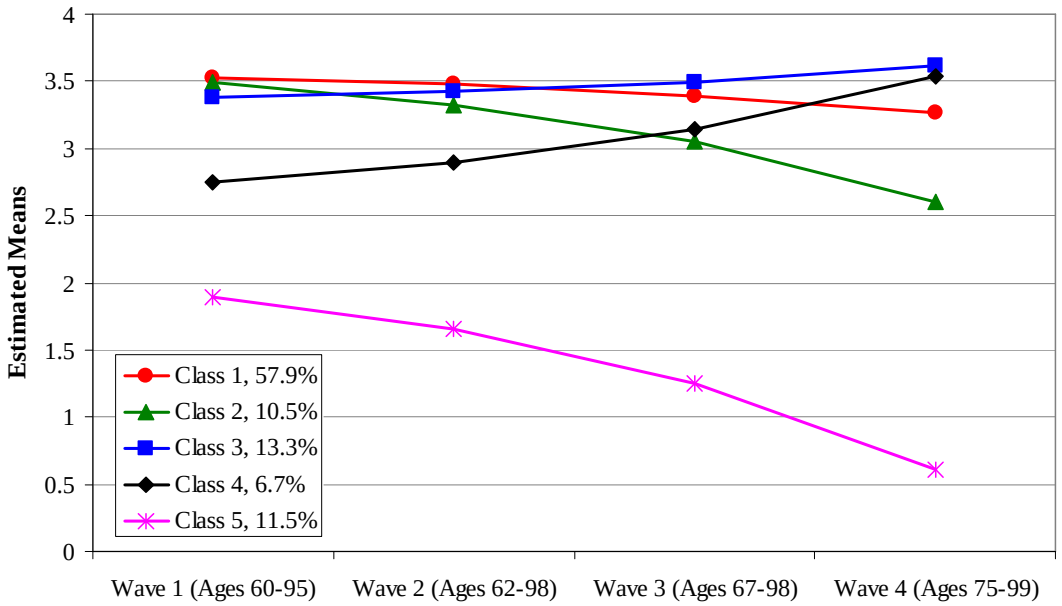


Figure 3. Estimated Means for Trajectory Classes of Social Engagement

The next step of the analysis coded social engagement trajectory class membership into a series of dummy variables, with trajectory class 5 (low-decreasing social engagement) as the reference category. The analysis proceeded with the dummy variables as covariates in standard latent growth curve models to examine whether membership in particular social engagement trajectory classes was associated with initial levels of and changes in cognitive and physical limitations over time. Unconditional (without covariates) and conditional (with covariates) models were run separately with linear and quadratic slopes. The smaller information criteria values, larger comparative fit index, and smaller root mean square error of approximation for both unconditional and conditional models indicated that a quadratic growth model fit best for both cognitive limitations and physical limitations.

Social engagement trajectory class membership was important for both cognitive and physical limitations. Tables 6 and 7 present the estimates for the association between social engagement trajectory class membership and cognitive and physical limitations, respectively. Figure 4 displays the trajectories of physical and cognitive limitations over time derived from the estimates in Tables 6 and 7.

Membership in trajectory class 1 (high-slightly decreasing social engagement) was associated with significantly lower initial levels of cognitive limitations compared with membership in class 5 (low-decreasing social engagement). Belonging to trajectory

class 3 (high-increasing social engagement), however, was significantly associated with higher initial levels of cognitive limitations. Older people, women, nonwhites, those who were not currently married, and those with less education had significantly higher initial levels of cognitive limitations. Age remained important for changes in cognitive limitations over time as well, and death during the study period was significantly and positively related to the quadratic slope of cognitive limitations. Membership in trajectory classes 1 through 4 were all significantly and negatively associated with the linear slope of cognitive limitations compared to membership in trajectory class 5, but they were all significantly and positively related to the quadratic slope of cognitive limitations. This suggests that belonging to any of the social engagement class trajectories compared with class 5 (low-decreasing social engagement) is protective for declines in cognitive limitations but those protective effects recede over time.

Table 6. Relationship between Social Engagement Trajectory Class Membership and Cognitive Limitations

	Intercept	Linear Slope	Quadratic Slope
Class 1	-0.044* (0.020)[a]	-0.284** (0.101)	0.316** (0.109)
Class 2	0.013 (0.028)	-0.313** (0.120)	0.309** (0.118)
Class 3	0.071* (0.029)	-0.378** (0.125)	0.353** (0.121)

Class 4	-0.014	-0.327*	0.300*
	(0.030)	(0.127)	(0.122)
Age	0.008***	-0.011**	0.009**
	(0.000)	(0.003)	(0.003)
Female	0.063***	-0.023	0.015
	(0.013)	(0.043)	(0.031)
White	-0.102***	-0.010	-0.025
	(0.014)	(0.047)	(0.034)
Married	-0.028*	-0.004	0.001
	(0.013)	(0.042)	(0.030)
Employed	-0.023	0.007	0.007
	(0.016)	(0.046)	(0.031)
Income	<0.001	0.001	-0.001
	(0.000)	(0.001)	(0.001)
Education	-0.024***	-0.010	0.005
	(0.002)	(0.007)	(0.005)
# Waves	-0.008	-0.068	0.026
	(0.007)	(0.034)	(0.031)
Died	0.023	-0.155	0.200*
	(0.017)	(0.088)	(0.099)

Note: Class 5 (low-decreasing social engagement) is the reference group for class membership.
[a] Standard errors in parentheses
* p<.05, **p<.01, ***p<.001

The social engagement trajectories were important for the slope, but not the initial levels, of physical limitations. Women, older people, those who were not working, and those with less education had significantly higher initial levels of physical

limitations. Those who died during the study period and who participated in fewer waves had higher initial levels of physical limitations as well. Class 1 (high-slightly decreasing social engagement), class 3 (high-slightly increasing), and class 4 (medium-increasing) were all significantly and negatively related to the linear slope of physical limitations compared with those in class 5 (low-decreasing social engagement). Membership in class 2 (high-moderately decreasing social engagement), however, was not significantly related to changes in physical limitations compared with the low-decreasing trajectory (class 5). Membership in classes 3 and 4 were significantly and positively associated with the quadratic slope of physical limitations, suggesting that these effects are reduced over time.

Table 7. Relationship between Social Engagement Trajectory Class Membership and Physical Limitations

	Intercept	Linear Slope	Quadratic Slope
Class 1	0.002	-0.445*	0.296
	(0.044)	(0.183)	(0.152)
Class 2	0.025	-0.393	0.268
	(0.059)	(0.222)	(0.172)
Class 3	0.081	-0.668**	0.413*
	(0.062)	(0.229)	(0.175)
Class 4	0.064	-0.745**	0.467*
	(0.062)	(0.236)	(0.179)
Age	0.009***	-0.006	0.004

	(0.001)	(0.007)	(0.004)
Female	0.178***	0.020	-0.028
	(0.027)	(0.080)	(0.048)
White	-0.019	0.153	-0.069
	(0.029)	(0.084)	(0.053)
Married	0.006	-0.107	0.064
	(0.028)	(0.079)	(0.049)
Employed	-0.158***	0.122	-0.035
	(0.033)	(0.084)	(0.050)
Income	-0.001	<0.001	<0.001
	(0.001)	(0.002)	(0.001)
Education	-0.017***	0.017	-0.008
	(0.004)	(0.012)	(0.008)
# Waves	-0.032*	-0.075	0.033
	(0.014)	(0.056)	(0.036)
Died	0.108**	0.068	0.031
	(0.034)	(0.141)	(0.159)

Note: Class 5 (low-decreasing social engagement) is the reference group for class membership.

[a] Standard errors in parentheses

* p<.05, **p<.01, ***p<.001

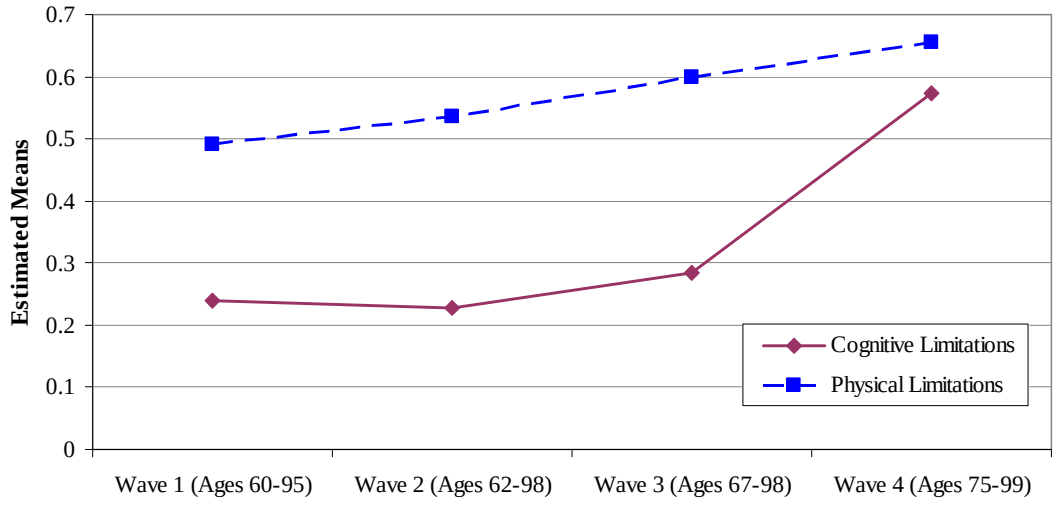


Figure 4. Trajectories of Physical and Cognitive Limitations

Note: Figure derived from estimates in Tables 6 and 7. Social engagement trajectory class membership, age, sex, race, marital status, employment status, income, education, number of waves in which respondents participated, and mortality during study period are included in these models.

Next, a multiple group analysis of social engagement trajectory classes further illustrates the relationship between patterns of social engagement and trajectories of physical and cognitive limitations. This analysis does not use a reference category as in the preceding analysis because here the sample is split into five subsamples, one for each social engagement trajectory class. A separate growth curve of limitations is estimated for those belonging to each class. This multiple group analysis uses only Waves 1 though 3 (Wave 4 is used in all other analyses in this chapter) because sample sizes for

some of the social engagement trajectory classes (N = 996, 176, 222, 112, and 161 for classes 1 to 5, respectively) became extremely small by Wave 4 with no variance for some variables, so Wave 4 could not be used. Model identification issues arise for quadratic models using only three waves of data, so linear models are estimated here. Marital status and employment status were not included in this portion of the analysis due to zero variance of these variables within some of the social engagement classes. All of the respondents belonging to social engagement trajectory class 3 were married, and none of the respondents in class 5 were employed. Models controlled for age, sex, race, income, education, number of waves in which respondents participated, and mortality during the study period. Figure 5 presents the trajectories of *cognitive* limitations within each social engagement class, and Figure 6 presents the trajectories of *physical* limitations within each social engagement class.

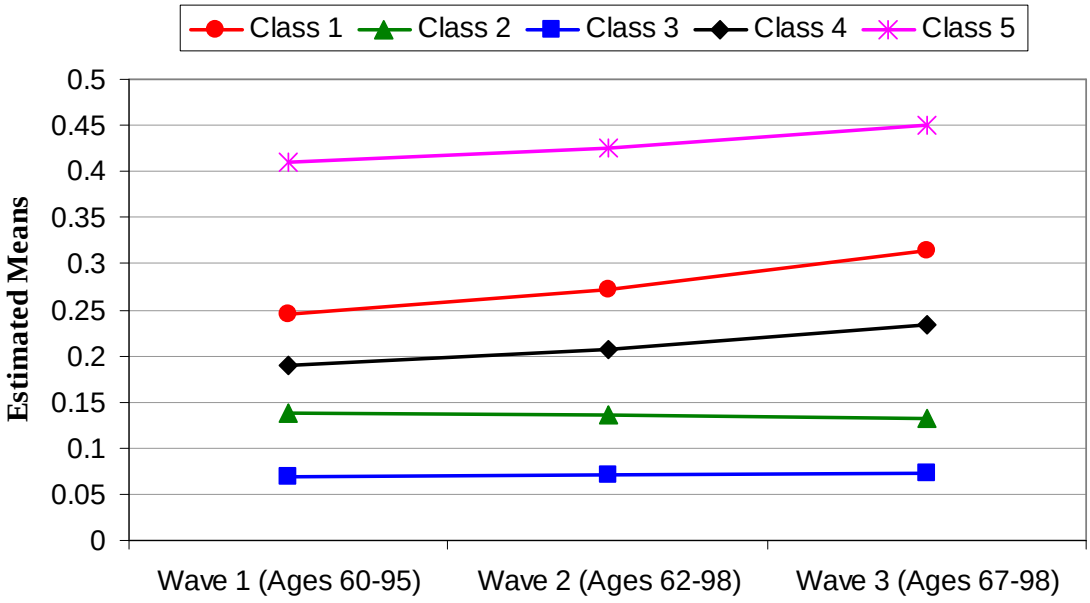


Figure 5. Multiple Group Analysis of Trajectories of Cognitive Limitations within each Social Engagement Class

Note: Wave 4 was not included due to very small sample sizes and zero variances within some of the social engagement classes. Age, sex, race, income, education, number of waves in which respondents participated, and mortality during study period are included in these models. Marital status and employment status could not be included in the models due to zero variance within some of the social engagement trajectory classes.

Most notable for the trajectories of cognitive limitations by social engagement trajectory class is that those belonging to the low-decreasing trajectory class of social engagement (class 5) have much higher levels of cognitive limitations over time than those in the other social engagement classes. Individuals belonging to class 3 (high-slightly increasing social engagement) experience the lowest levels of cognitive limitations over time.

A relatively similar stratified pattern is observed for trajectories of physical limitations by social engagement class. Those in class 5 again have higher levels of physical limitations, and that gap widens over time. Those belonging to class 3 (high-increasing social engagement) and class 4 (medium-increasing social engagement) experience the lowest levels of physical limitations, while those in class 1 (high-slightly decreasing social engagement) and class 2 (high-moderately decreasing social engagement) experience medium levels of physical limitations over time.

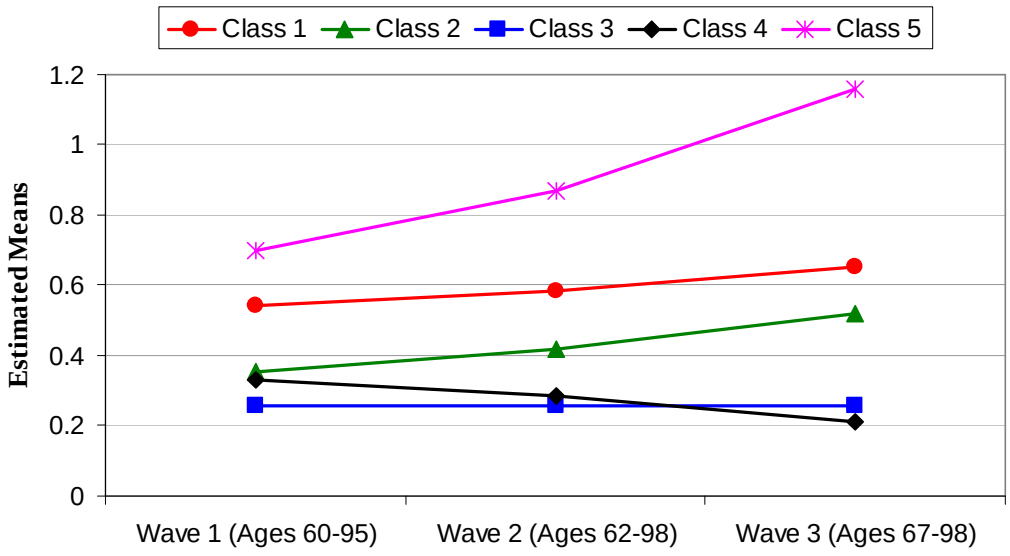


Figure 6. Multiple Group Analysis of Trajectories of Physical Limitations within each Social Engagement Class

Note: Wave 4 was not included due to very small sample sizes and zero variances within some of the social engagement classes. Age, sex, race, income, education, number of waves in which respondents participated, and mortality are included in these models. Marital status and employment status could not be

included in the models due to zero variance within some of the social engagement trajectory classes.

3.4 Discussion

The present study examines patterns of social engagement over time and how these patterns relate to initial levels and changes in physical and cognitive limitations over time, advancing the literature in several ways. The present study uses social integration theory within a life course framework, examining changes in both social engagement and health over time. The life course perspective highlights the importance of a long-range, dynamic view of social phenomena, incorporating patterns of change in people's lives and emphasizing the importance of linked lives (Elder and Shanahan 2005; George 1993). It is important to consider how patterns of older adults' engagement in social activities can change over time and influence health outcomes over time, especially in the context of formal social role loss that can occur as adults age (Evandrou and Glaser 2004; Lee and Powers 2002). The results of this study indicate the importance of the broad social interactions involved in social engagement. Focusing solely on formal social roles, as is common in much literature on social integration (e.g., Moen, Dempster-McClain, and Williams 1992; Verbrugge 1983) may neglect important sources of social interactions that can provide attachment to the social structure and relate to health. This study further advances the literature by incorporating frequency of

participation in social activities and patterns of change in this social engagement, rather than a static count of formal social roles occupied.

Related to this point, little attention has been paid to examining trajectories of social relations, with very few studies using patterns of change in social relations to predict trajectories of health (Mavandadi, Rook, and Newsom 2007). The present study does so and further advances this literature by combining person-centered and variable-centered approaches. Most research on social relations and health uses a variable-centered approach exclusively, focusing on between-person differences to predict outcomes (Laursen and Hoff 2006; Muthén and Muthén 2000). A person-centered approach identifies unobserved subgroups within the sample and classifies individuals who are similar to each other into distinct groups (Jung and Wickrama 2008; von Eye and Bogat 2006). This study uses the person-centered approach when classifying individuals into distinct trajectory classes of social engagement over time and the variable-centered approach to examine how social engagement trajectory class membership is associated with trajectories of physical and cognitive limitations. Further, the association between social engagement and physical and cognitive limitations is robust to the inclusion of indicators of passive attrition (mortality) and active attrition (the number of waves in which respondents participated), which were controlled in these analyses (Alley et al. 2008; Brown working paper; Cao and Hill 2005).

The results of this study provide support for hypotheses guided by social integration theory. They suggest that maintaining high or increasing levels of social attachments through high or increasing social engagement over time has protective effects on cognitive and physical limitations. Compared to those belonging to the low-decreasing social engagement trajectory class (class 5), all of the other social engagement trajectory classes were protective for changes in cognitive limitations, though these effects receded over time. Class 1 (high-slightly decreasing social engagement) also was associated with lower initial levels of cognitive limitations. Class 3 (high-slightly increasing social engagement), however, was associated with higher initial levels of cognitive limitations, which was not in the expected direction. This association was not significant when the number of waves in which respondents participated and mortality during the study period were *not* included in the analysis. This may indicate that attrition factors played a role in this unexpected association.

The social engagement trajectory classes were important for the growth rates, but not initial levels, of physical limitations. All of the classes, excluding class 2 (high-moderately decreasing social engagement), were protective for changes in physical limitations over time compared with those in class 5 (low-decreasing social engagement). This suggests that stably high and increasing social engagement may provide important protection from greater increases in physical limitations over time. Declining in social engagement over time may lead to a loss of social attachments

indicating less integration in the social structure and the loss of the protective effects that social integration may afford.

The multiple group analysis showed further support for the hypotheses based on social integration theory. This part of the analysis split the sample by social engagement class and estimated separate trajectories for physical and cognitive limitations for those belonging to each class. Those belonging to the class with low-decreasing social engagement over time (class 5) experienced the highest levels of both physical and cognitive limitations over time. Those belonging to the class with high and increasing social engagement (class 3) experienced the lowest levels of cognitive limitations. This suggests greater health benefits for those who are more attached to the social structure through high levels of social engagement across time and greater health problems for those who have fewer attachments to the social structure through low and decreasing levels of social engagement. Those who are more socially integrated likely experience more motivation, pressure, and information to take better care of their health than those who are less integrated.

Those who belonged to trajectory classes that increased in social engagement over time (class 3 and class 4), regardless of whether they started off with high levels of social engagement (as in class 3) or medium levels of social engagement (as in class 4), experienced the lowest levels of physical limitations over time. This suggests that becoming more socially integrated by increasing social engagement over time, even

when initial levels of social engagement are not particularly high, can be important for physical health. Those who belonged to classes in which the levels of social engagement decreased over time (classes 1, 2, and 5) experienced the highest levels of physical limitations, indicating the importance of maintaining high levels of social engagement over time.

Some of the control variables also influenced physical and cognitive limitations, largely influencing the initial levels but not the growth in these outcomes. Older people, women, and those with less education had significantly higher initial levels of both physical and cognitive limitations. Those who were not working also had higher initial levels of physical limitations, and whites and those who were currently married had significantly lower initial levels of cognitive limitations. Of all of the control variables, only age significantly affected growth rates in limitations, and this was only significant for the slope of cognitive limitations.

This study has several limitations. First, both social engagement and physical and cognitive limitations change over the same time period, so causal ordering is not clear. Although social integration theory suggests important pathways though which social engagement could influence health, physical and cognitive limitations could also hinder the ability of older adults to be socially engaged. Second, three observed variables for the latent construct of physical limitations are on the lower end of the acceptable range to measure a latent variable. Some other items measuring physical

limitations were available in the Americans' Changing Lives survey, but they represented a much more severe level of disability (e.g. difficulty bathing oneself and staying in a bed or chair for most of the day for health reasons) that did not load well on the same factor in exploratory factor analysis. Finally, indicators of social engagement did not take into account the quality of interactions in these social activities. It is possible that negative experiences with the social engagement activities impact health differently than positive experiences (August, Rook, and Newsom 2007). It is important for future research to explore this issue.

Despite these limitations, findings from this study provide important information about the relationship between social engagement and health. Results provide support for hypotheses guided by social integration theory within a life course framework taking into account patterns of stability and change in both social engagement and health outcomes. The use of trajectories and the life course perspective enrich this study by incorporating individual heterogeneity and a dynamic, longitudinal analysis. Trajectories of stably high social engagement and trajectories in which social engagement increases over time may be especially protective for physical and cognitive limitations. Moreover, those with declining social engagement had higher levels of physical limitations, indicating the importance of maintaining or increasing social engagement over time. The links between social engagement and better health

outcomes highlight the benefits of older adults' participation in broader social activities and the importance of maintaining high levels or increasing levels of social engagement.

4. Trajectories of Social Engagement and Mortality

Dating back to Durkheim ([1897] 1979), researchers have been interested in the relationship between social integration and health. Social isolation is detrimental to health and well-being (e.g., Grant, Hamer, and Steptoe 2009; Harlow, Dodsworth, and Harlow 1965) while social interactions can be beneficial for health and successful aging (House, Landis, and Umberson 1988; Rowe and Kahn 1998). Social relations in their various forms have been linked to better self-rated health (Nummela et al. 2008), reduced risk of dementia (Fratiglioni, Paillard-Borg, and Winblad 2004), longer survival (Kiely and Flacker 2003), and a host of other health outcomes.

This study contributes to the literature on social relations and health in several ways. Social integration theory guides this study, but much of the research on social integration does not take into account stability and change in social relations over time (Bennett 2002; Obisesan and Gillum 2009). Social integration is not necessarily fixed across time but rather may fluctuate with the ebb and flow of social attachments across the life course. These patterns of change in social integration may have important consequences for health whereas static conceptions of social relations can mask important variability in how social integration over time relates to health outcomes. Examining trajectories of social relations and how they affect heath can provide important leverage in more fully understanding these relationships within a longitudinal context.

Another contribution of this study is the use of both variable-centered and person-centered approaches. Most studies on social relations and health employ solely a variable-centered approach, common in correlation and regression studies (Muthén and Muthén 2000). This approach typically assumes a relatively homogeneous population and answers questions about how well predictor variables explain differences in outcome variables (Laursen and Hoff 2006). A person-centered approach does not assume one homogeneous population but rather that the sample is heterogeneous with multiple unobserved groups within the sample (von Eye and Bogat 2006). This approach focuses on classifying individuals who share similar characteristics or relations of characteristics into distinct groups (Jung and Wickrama 2008), and it can answer questions concerning patterns of group or individual differences over time, shedding light on individuals' life trajectories. The person-centered and variable-centered approaches can be complementary rather than competing orientations. These approaches can enable the researcher to examine phenomena from the perspectives of differences in individuals and differences in relations among variables (Laursen and Hoff 2006).

The present study combines person-centered and variable-centered approaches, using the person-centered approach to classify individuals into distinct trajectory classes of social engagement over time and the variable-centered approach to examine the

association between social engagement trajectory class membership and mortality (Laursen and Hoff 2006).

4.1 Theory and Evidence

Social integration theory is one way that scholars have thought about the importance of social relations for health. Social integration theory builds upon Durkheim's ([1897] 1979) classic study of suicide and argues that integration in the social structure can influence health. The defining characteristic of social integration at the individual level is attachments to the social structure. Social attachments can shape resources available, provide a sense of purpose, and increase motivation and social pressure to take better care of one's health (Berkman, Glass, Brissette, and Seeman 2000). Those who are more socially integrated often have a stronger connection to family and community generating a greater sense of purpose, which may, in turn, encourage health-promoting behaviors (Bassuk, Glass, and Berkman 1999). Social integration can enhance the flow of health-related information and encourage more effective utilization of health care services (Cohen 2004). Social attachments can serve as a buffer for adverse social conditions and stressful events (Schwerdtfeger and Friedrich-Mai 2009; Wortman 1984) as well as influence health through physiological pathways, such as through neuroendocrine reactivity and reduction of allostatic load (Seeman and McEwen 1996).

Much research to date has defined the concept of social integration in terms of formal social roles, such as "mother" and "worker" (Hsu 2007; Moen, Dempster-McClain, and Williams 1989; Sieber 1974; Verbrugge, Gruber-Baldini, and Fozard 1996). Much of this research does not take into account frequency of broader social interactions, which is relevant for understanding the degree to which individuals are socially integrated. Social engagement, as defined in this study, is one way to capture a broader array of social interactions and intensity of interaction that can contribute to greater attachment to the social structure. Social engagement is conceptualized as frequency of participation in activities that involve interactions between or among people. Although some social roles may be embedded within these social activities (e.g., frequency of visiting with family members implies familial roles), the frequency of interaction in these activities is what is important for the present study.

It is important to situate social integration theory and social engagement in the context of the life course. The life course perspective emphasizes the life-long process of aging, stability and change in individuals' lives, individual agency within the constraints of social circumstance, individual embeddedness in time and place, and the interdependence of lives in shared relationships (Elder, Johnson, and Crosnoe 2003). Social engagement among older adults may be especially important. Over the life course, individuals move into and out of multiple social roles, but as they age they are more likely to lose than to replace or add formal social roles, such as the loss of the

worker role at retirement (Evandrou and Glaser 2004; Lee and Powers 2002). Despite the potential loss of formal social roles, older adults often still have the ability and agency to participate frequently in social activities that can link their lives to others and help them form more social attachments. This participation can contribute to greater integration in the social structure and likely benefit health, indicating the particular importance of examining these social interactions among the older population.

The life course perspective's emphasis on stability and change in individuals' lives is encapsulated in research using trajectories. Trajectories are uniquely able to take into account patterns of stability and change of social phenomena over the life course. Within-person analysis of an individual's trajectory of social engagement, for example, focuses on the social engagement embedded in a person's past and whether that social engagement has changed over time. An individual's pattern of social engagement over time may have important consequences for his or her mortality, yet there is a dearth of empirical research examining the effects of trajectories of social relations on mortality.

4.1.1 Social Engagement and Mortality

Social engagement may have important protective effects on mortality. Social isolation, which can be considered a lack of social engagement, has been linked to higher rates of mortality, with socially isolated African American elderly women three times more likely to die than their non-socially isolated counterparts (LaVeist, Sellers, Brown, and Nickerson 1997). One aspect of social engagement, organizational attendance, was

associated with lower rates of mortality among Japanese elders (Sugisawa, Liange, and Liu 1994). Similarly, engaging in leisure activities with groups of people was associated with lower mortality among older adults in Israel (Walter-Ginzburg, Blumstein, Chetrit, and Modan 2002). Those who had more contact with friends and relatives, belonged to a church, and belonged to other formal and informal groups were less likely to die after nine years (Berkman and Syme 1979). Using a similar index to Berkman and Syme's (1979) Social Network Index, Obisesan and Gillum (2009) found that low scores on their index involving marital status, contact with friends and relatives, religious attendance, and voluntary association membership, were associated with a higher risk of dying. Participation in social and productive activities was found to have salutary effects on mortality after six years (Menec 2003). Occupying more social roles was associated with greater longevity among women (Moen, Dempster-McClain, and Williams 1989). Low social engagement in the form of an additive scale of 20 items (including both social and solitary activities) was a significant precursor of mortality after eight years (Bennett 2002). For nursing home residents, those with higher levels of social engagement (defined by ease of interaction in various group activities) had reduced odds of dying (Kiely and Flacker 2003; Kiely, Simon, Jones, and Morris 2000).

Less empirical research has examined the effects of patterns of change in social relations on mortality. One of the few studies to address this examined respondents' levels of social ties at two time points to predict mortality (Cerhan and Wallace 1997).

These authors found that among rural elders, those who had low levels of social ties at both time points had an increased risk of mortality while those who had an increase in levels of social ties from low to high had similar mortality risk to those who had stably high social tie levels. Among the Danish elderly, women with consistently low amounts of contact with family and friends or a decline in the frequency of contact over the two time points had higher odds of dying over four years than those with consistently high levels of contact (Lund, Modvig, Due, and Holstein 2000). Male health professionals who were socially isolated had higher mortality rates due to accidents, suicide, and non-cancer and non-cardiovascular causes, while an increase in social ties over the two time points of the study had protective effects on mortality (Eng, Rimm, Fitzmaurice, and Kawachi 2002).

Although these studies are an important initial step in studying changes in social relations over time and how these patterns affect mortality, these studies largely construct ad hoc categories reflecting changes in social relations based only on two time points. It is important to incorporate three or more times of measurement to better assess patterns of change (George 2009). Further, ad hoc classification has several disadvantages compared to empirically-derived trajectories because ad hoc classification cannot be statistically verified, may fail to identify rare but real patterns, and cannot measure the precision with which individuals are classified (Nagin and Tremblay 2005). Trajectories in the present study are empirically-derived via growth mixture modeling

using four waves of nationally representative panel data. These trajectories reflect intra-individual patterns of change in social engagement over time.

Previous studies illustrate the importance of examining patterns of change in social relations and their potential effects on mortality. Based on this evidence and social integration theory, this study hypothesizes that those who have high or increasing social engagement will have lower risk of mortality.

4.2 Methods

4.2.1 Data

Data come from the Americans' Changing Lives (ACL) survey housed at the University of Michigan's Institute for Social Research and funded by the National Institute on Aging (House, 2007). This nationally representative panel study collected data in 1986, 1989, 1994, and 2002. Wave 1 (N = 3,617) used a multistage stratified area probability sample of the continental United States' household population aged 25 and older, with an oversampling of African Americans and adults aged 60 and older. The current analysis focuses on adults aged 60 and older (N=1,669 in Wave 1). This decision was made due to the particular importance of social engagement and mortality for the older population. In general, mortality occurs in greater proportions among older adults and is an outcome often associated with aging (Horiuchi, Finch, Mesle, and Vallin 2003). As described previously, examining social engagement may be of particular

value for the older population due to the importance of participation in broader social activities that can help older adults maintain their integration in the social structure despite potential role losses as they age.

4.2.2 Measures

Mortality. The National Death Index provided information on the mortality of respondents in the Americans' Changing Lives survey from 1986 until 2005. In almost every case, deaths were verified with death certificates. There were 1,140 deaths (68% of the sample) among adults aged 60 and older during this time period. Table 8 displays the number of deaths for each year from 1986 to 2005.

Table 8. Mortality Information by Year for Older Adults (Ages 60-95 in 1986)

Year	Number of Deaths
1986	23
1987	49
1988	55
1989	67
1990	61
1991	54
1992	71
1993	63

1994	70
1995	59
1996	62
1997	62
1998	70
1999	71
2000	64
2001	58
2002	48
2003	36
2004	46
2005	51
	Total: 1,140

Social Engagement. The latent variable of social engagement is measured with five observed variables indicating frequency of involvement in several social activities: (1) "In a typical week, about how many times do you talk on the telephone with friends, neighbors, or relatives?" (2) "How often do you get together with friends, neighbors or relatives and do things like go out together or visit in each other's homes? (3) "How

often do you attend meetings or programs of groups, clubs or organizations?" (4) "How often do you usually attend religious services?" and (5) about how many hours were spent on volunteer work during the last 12 months. Response categories for volunteering were: 0 = did not volunteer, 1 = less than 20 hours, 2 = 20-39 hours, 3 = 40-79 hours, 4 = 80-159 hours, 5 = 160 hours or more. Response categories for the other indicators were: 0 = never, 1 = less than once a month, 2 = about once a month, 3 = two or three times a month, 4 = once a week, and 5 = more than once a week.

Control Variables. This study controls for sociodemographic characteristics, health conditions, and health behaviors at Wave 1. Sociodemographic characteristics include a*ge* (in years), *race* (1=white, 0=nonwhite [largely African American, along with small numbers of American Indian, Asian, and Hispanic respondents]), s*ex* (1=female, 0=male), *marital status* (1=currently married, 0=not currently married), *employment status* (1=currently employed, 0=not currently employed), *family income* (using the midpoint of each of the ten income categories, ranging from $2,500 to $110,000), and *education* (continuous measure of highest grade completed).

Several health behavior and health condition variables are included. *Cigarette smoking* contains three categories: never smoked, former smoker, and current smoker. *Alcohol Consumption* is a three-category variable based on the number of alcoholic drinks consumed per month: nondrinkers (zero drinks consumed in the past month), moderate drinkers (1 to 79 drinks in the past month), and heavy drinkers (80 or more drinks in the

past month). *Body mass index (BMI)* is weight in kilograms divided by height in meters squared (both self-reported). Established cut-points in the distribution of BMI generated the following categories: underweight (BMI less than or equal to 18.5), average weight (18.6 to 24.9), overweight (25 to 29.9), and obese (30 or higher). Three categories comprise *self-rated health*: excellent or very good, good, and fair or poor. The inclusion and coding of the preceding health behavior and health condition variables is consistent with Lantz, Golberstein, House, and Morenoff's (2010) study on mortality using ACL data. The inclusion of *number of chronic conditions* appears in several mortality studies (e.g., Hsu 2007; LaVeist, Sellers, Brown, and Nickerson 1997), and in this study can range from 0 to 9, and includes the following conditions: arthritis, lung disease, hypertension, heart attack, diabetes, cancer, stroke, broken bones, and urine beyond control. The *health limitations* variable comes from a question asking, "How much are your activities limited by health?" Response categories include: 0 = not at all, 1 = a little, 2 = some, 3 = quite a bit, and 4 = a great deal.

4.2.3 Analytic Plan

This study uses growth mixture modeling (GMM) to estimate trajectory classes of social engagement over time. Class membership in the social engagement trajectories derived from the GMM analysis are then used as a set of dummy variables in Cox proportional hazards models to examine the relationship between membership in these

social engagement trajectory classes and mortality. Analyses were conducted using Mplus version 5 (Muthén and Muthén 2007) and STATA version 10.

Growth mixture models are instances of finite mixture models useful for modeling data that are suspected or known to contain multiple subgroups or that have unknown distributional shapes (Everitt 1996; McLachlan and Peel 2000). These models began to be applied in the social sciences with Heckman and Singer's (1984) article on mixtures of hazard regressions, were developed and extended over the years (Nagin 2005; Nagin and Land 1993), and are now applied to study many types of trajectories (George 2009). Conventional latent growth curve models estimate a mean growth curve, describing an overall pattern of change in a single population (Muthén and Muthén 2000). The intercept (initial level) and slope (growth rate over time) are latent factors comprising the model and are allowed to vary across individuals. Growth mixture modeling relaxes the conventional growth modeling assumption of a single population and describes longitudinal change in unobserved subgroups using latent trajectory classes (Ram and Grimm 2009). Similar to latent class growth analysis (LCGA), growth mixture models estimate mean growth curves for each class rather than one average trajectory as in conventional growth curve modeling (Muthén 2004). However, in latent class growth analysis individuals within each class are treated as homogeneous, allowing zero variance and covariance in the growth factors, whereas growth mixture models allow for individual variation around each of the growth curves, similar to

conventional growth models (Muthén and Muthén 2000). The following equations are for a linear growth mixture model with K latent trajectory classes, where in Class k (k = 1, 2,…, K):

$$y_{it} = \eta_{0i} + \eta_{1i}\alpha_{kt} + \varepsilon_{it} \quad (1)$$

$$\eta_{0i} = \alpha_{0k} + \gamma_{0k} w_i + \zeta_{0i} \quad (2a)$$

$$\eta_{1i} = \alpha_{1k} + \gamma_{1k} w_i + \zeta_{1i} \quad (2b)$$

Equation 1 represents within-individual change over time. Equations 2a and 2b represent between-individual change over time. The outcome variable is y_{it} (i.e., social engagement), η_0 is the intercept, η_1 is the slope, t is the time point, and w is the covariate. The subscript *i* indicates that the parameter varies across individuals. The α_k parameters vary across classes to capture different types of trajectories. The γ_k parameters allow the influence of the covariates on the growth factors to vary across class (Muthén 2002). Residuals are represented by ε_{it}, ζ_{0i}, and ζ_{1i}. Typically linear time scores are estimated with scores of 0, 1, 2, 3 for four waves. Due to the unequal spacing between waves in the ACL, the time scores reflect the number of years since Wave 1 (with the Wave 1 time score equal to zero).

Several fit indices were used to determine the number of class trajectories in the growth mixture models. Models were iteratively tested with increasing numbers of classes, and models with linear and quadratic slopes were tested. Muthén (2004) argues that it is important to take covariates into account when determining the number of classes in growth mixture modeling. Thus, age, sex, race, marital status, employment status, income and education were included in the modeling process determining the number of trajectory classes (though unconditional baseline models [without covariates] were estimated for comparison purposes and had larger information criteria values). Preferred models had smaller Bayesian Information Criteria (BIC), sample-size adjusted BIC, and Akaike Information Criteria (AIC) values and a significant Lo, Mendell, Rubin (2001) likelihood ratio test (LMR-LRT) statistic (Jung and Wickrama 2008). A significant p-value for the LMR-LRT statistic indicates a solution with $C - 1$ classes is not sufficient and should be rejected in favor of C classes (Ram and Grimm 2009).

This study uses full information maximum likelihood (FIML) to handle missing data. FIML is a theory-based approach to missing data that incorporates all respondents in the data regardless of whether they participated in every wave of the survey or responded to every item. FIML uses all available data, including information about the mean and variance of the missing parts of a variable, given observed portions of other variables (Wothke 2000). FIML has been shown to be less biased and more efficient than other ways of handling missing data, such as listwise deletion, pairwise deletion, or

mean substitution (Schafer and Graham 2002; Schlomer, Bauman, and Card 2010; Wothke 2000). In many cases, FIML produces equivalent results to multiple imputation methods (Collins, Schafer, and Kam 2001).

Once the social engagement trajectory classes were derived from the growth mixture models, the classes were coded into a series of dummy variables to examine the relationship between the patterns of social engagement over time and mortality, with Cox proportional hazards models. The data were expanded into person-years, with an analytic sample of 22,532 person-years. There were 1,140 deaths from 1986 to 2005.

4.3 Results

Table 9 displays the descriptive statistics of key variables. The mean age of respondents was 70 years at baseline, and respondents averaged 10.3 years of education and had a mean income of $17,500 in Wave 1. A majority of respondents were women (67.1%) and white (68.5%), a little over half were married, and around 22% were employed. Forty-four percent of respondents rated their health as "excellent" or "very good," 25% as "good," and 31% as "fair" or "poor." Respondents had an average of 1.7 chronic conditions. On average, respondents experienced a little bit of limitation in their activities due to their health. About 3% of respondents were underweight, 41% were average weight, 37% were overweight, and 18% were obese. Approximately half of respondents had never smoked cigarettes, 30% were former smokers, and 20% were

current smokers. About 64% of respondents did not consume any alcoholic drinks in the past month, 34% were moderate drinkers, and 2% were heavy drinkers. Sixty-eight percent of the respondents died by 2005.

Table 9. Descriptive Statistics, Means and Percentages

	Wave 1	Wave 2	Wave 3	Wave 4
Age (in years)	70.1			
Female	67.1%			
Race				
White	68.5%			
Nonwhite (mostly African American)	31.5%			
Currently Married	51.1%			
Currently Employed	22.4%			
Income	$17,500			
Education (in years)	10.3			
# Chronic Conditions (0-9)	1.7			
Self-Rated Health				
Excellent or Very Good	44.2%			

Good	24.9%
Fair or Poor	30.9%
Activity Limitations Due to Health (0-4)	1.2
BMI	
Underweight	2.9%
Normal Weight (reference)	41.4%
Overweight	37.4%
Obese	18.3%
Smoking	
Never (reference)	49.5%
Former	30.2%
Current	20.3%
Alcohol Consumption (%)	
Nondrinker	63.5%
Moderate Drinker (reference)	34.2%
Heavy Drinker	2.3%

SOCIAL ENGAGEMENT				
Visits with friends and relatives (0-5)	3.3	3.3	3.4	3.5
Talks on phone with friends and relatives (0-5)	3.5	3.8	3.7	3.8
Attend meetings/programs of organizations (0-5)	1.8	1.8	2.0	2.2
Attends religious services (0-5)	2.7	2.7	2.8	2.8
Hourly categories of volunteer work (0-5)	0.9	1.1	1.0	1.1
	N=1,669	N=1,279	N=889	N=436

A five-class linear solution for trajectories of social engagement fit the data best in the growth mixture models. This model had small information criteria values (AIC, BIC, sample-size adjusted BIC) relative to other class solutions and a significant Lo, Mendell, Rubin (2001) likelihood ratio test statistic. The model had high entropy at 0.92, indicating a clear delineation of classes with little overlap (Celeux and Soromenho 1996). Several covariates, including age, sex, race, marital status, employment status, income and education, were controlled when determining the class trajectories.

Figure 7 displays the social engagement trajectory classes. About 58% of the sample (N=996) comprised trajectory class 1 of social engagement, which was

characterized by high levels of social engagement with a slight decrease over time. Trajectory class 2 (10.5% of the sample, N=176) was also characterized by high initial levels of social engagement, but decreased more than the class 1 trajectory over time. Approximately 13% of the sample (N=222) belonged to the class 3 trajectory, which was characterized by high levels of social engagement that increased slightly over time. About seven percent of the sample (N=112) comprised trajectory class 4, which had medium levels of social engagement that increased over time. Finally, trajectory class 5 was characterized by relatively low and decreasing levels of social engagement over time, with 11.5% belonging to this class (N=161).

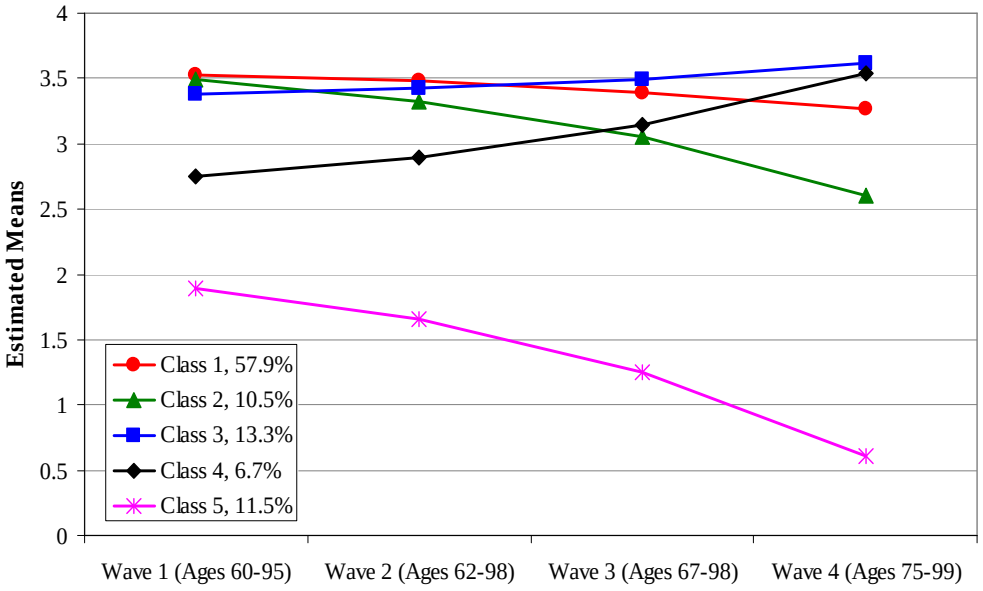


Figure 7. Social Engagement Trajectory Classes

Next, the social engagement trajectory classes were used as dummy variables in Cox proportional hazards models to examine the relationship between patterns of social engagement and mortality (shown in Table 10). Class 5 (low-decreasing social engagement) is the reference category. The social engagement trajectory classes are the only variables included in Model 1. Membership in each of the social engagement trajectory classes is significantly associated with lower risk of mortality than belonging to the low-decreasing social engagement trajectory class. Belonging to class 3 (high-slightly increasing social engagement) has the lowest hazard ratio of mortality out of all the social engagement trajectory classes.

Model 2 adds all of the sociodemographic, health condition, and health behavior variables. Women, younger people, and those with higher incomes have significantly lower hazard ratios for mortality. Those who have more chronic conditions, poor self-rated health (compared to excellent or very good health), and more health limitations reducing activities have significantly higher risk of mortality. Compared to those with average BMI, those who are underweight experience significantly higher hazard ratios for mortality while those who are overweight experience significantly lower hazard ratios. Compared to those who have never smoked cigarettes, both current smokers and former smokers have higher risk of dying, though the odds of dying are higher for current smokers. Both nondrinkers and heavy drinkers have higher risk of mortality

compared to those who moderately consume alcohol. Once these sociodemographic, health behavior, and health condition variables were added, those in class 2 (high-moderately decreasing social engagement) and those in class 4 (medium-increasing social engagement) were no longer significantly less likely to die than those in class 5. Class 1 (high-slightly decreasing social engagement) and class 3 (high-slightly increasing social engagement) remained significantly associated with lower risk of mortality than those in class 5.

Table 10. Hazard Ratios for the Relationship between Social Engagement Trajectory Class Membership and Mortality

	Model 1	Model 2
Class 1 (high - slight decrease)	0.446*** (0.041)[a]	0.804* (0.080)
Class 2 (high - moderate decrease)	0.297*** (0.038)	0.737 (0.120)
Class 3 (high - slight increase)	0.182*** (0.024)	0.517*** (0.094)
Class 4 (medium - increasing)	0.315*** (0.046)	0.765 (0.140)
Age		1.080*** (0.006)
Female		0.532*** (0.040)
White		0.917 (0.066)

Married	0.969 (0.069)
Employed	0.950 (0.091)
Income	0.994** (0.002)
Education	1.013 (0.010)
# Chronic Conditions	1.123*** (0.033)
Poor Self-Rated Health	1.204* (0.102)
Good Self-Rated Health	1.038 (0.082)
Health Limitations	1.078** (0.028)
Underweight	1.817*** (0.296)
Overweight	0.862* (0.059)
Obese	0.954 (0.085)
Current smoker	1.805*** (0.154)
Former smoker	1.233** (0.092)
Non-drinker	1.179* (0.084)

Heavy drinker		1.459*
		(0.272)
Observations	22532	22532

Note: Class 5 (low-decreasing social engagement) is the reference group for the class membership variables.
[a] Standard errors in parentheses
* p<.05, **p<.01, ***p<.001

4.4 Discussion

The present study uses social integration theory within a life course framework to examine the relationship between social engagement and mortality. This study contributes to the literature on social relations and health in several ways. Situating social integration theory within the life course framework can provide important insights into the relationship between social relations and health. The life course perspective emphasizes stability and change in individuals' lives as they age and the interdependence of lives in shared relationships (Elder and Shanahan 2005; George 1993). The linking of lives in social relations is important for health (House, Landis, and Umberson 1988), but these social relations are not fixed across time. Static conceptions of social integration can mask our understanding of the connections between social relations and health. Most studies on social integration and mortality, however, do not take into account the dynamic nature of social relations over time.

The few studies that do incorporate patterns of changes in social relations into mortality analyses typically only use two time points (Cerhan and Wallace 1997; Lund, Modvig, Due, and Holstein 2000), which can limit the ability to assess patterns of change (George 2009). Further, these studies typically construct ad hoc trajectories, which have several limitations such as the inability to statistically verify the trajectories, to identify rare but real patterns, or to measure the precision with which individuals are classified, all of which can be done with empirically-derived trajectories (Nagin and Tremblay 2005).

Another contribution of this study is the conceptualization and measurement of social engagement, which incorporates frequency of participation in a broader array of social interactions than often used in research employing social integration theory. Focusing solely on formal social roles, as is common in much literature on social integration (e.g., Moen, Dempster-McClain, and Williams 1992; Verbrugge 1983), may neglect important sources of social interactions that can provide attachment to the social structure and potentially benefit health. This may be especially important in the context of the loss of formal social roles that often occurs as adults age (Evandrou and Glaser 2004; Lee and Powers 2002). This study's measurement of social engagement further improves upon past research by using a latent variable approach that reduces measurement error rather than a summed index (e.g., Obisesan and Gillum 2009).

The incorporation of both variable-centered and person-centered approaches is another contribution of this study. Most research on social relations and health uses a variable-centered approach exclusively, focusing only on between-person differences to predict outcomes (Laursen and Hoff 2006; Muthén and Muthén 2000). A person-centered approach focuses on classifying individuals who are similar to each other into distinct groups (Jung and Wickrama 2008). The present study combines person-centered and variable-centered approaches, using the person-centered approach to classify individuals into distinct trajectory classes of social engagement over time and the variable-centered approach to examine the relationship between social engagement trajectory class membership and mortality (Laursen and Hoff 2006).

This study provides support for social integration theory. When only including the social engagement trajectories, membership in each of the social engagement trajectory classes was associated with reduced the risk of mortality compared to membership in the low-decreasing social engagement trajectory class. This suggests that greater attachment to the social structure through high or increasing social engagement may be protective for health. Once sociodemographic, health behavior, and health condition variables were controlled, membership in the social engagement trajectory class that started off high in social engagement and only decreased slightly (class 1) and in the trajectory class that was initially high in social engagement and increased slightly over time (class 3) both remained significantly associated with lower risk of mortality

compared to low-decreasing social engagement (class 5). Starting out high in social engagement but decreasing more than just a slight amount (as in class 2) was not significantly different from the low-decreasing trajectory in its association with mortality risk after controlling for the covariates, indicating the importance of maintaining high levels of social engagement over time. Starting out with medium levels of social engagement and increasing over time (as in class 4) also was not significantly different from the low-decreasing trajectory after including controls in the model, suggesting that starting out with lower levels of social engagement may prove to be less protective even if the levels of social engagement increase over time.

Many of the covariates were also significantly related to mortality. As expected, older people, men, and those with lower incomes had significantly higher risk of dying. Those who had more chronic conditions, poor self-rated health, and health limiting their activities also were at greater risk of dying. Underweight people, current and former smokers, and both nondrinkers and heavy drinkers were at higher risk of mortality, but those who were overweight had a lower risk of dying. These associations are in line with the results of previous research (e.g., Lantz, Golberstein, House, and Morenoff 2010). With mortality as the outcome, reverse causality for social engagement and mortality is not an issue in the traditional sense. Poor health, however, could have a causal effect on both patterns of social engagement and mortality. Consequently, the fact that patterns of social engagement are significant predictors of mortality even with

several measures of health controlled is especially important and provides strong evidence for the benefits of social integration for health.

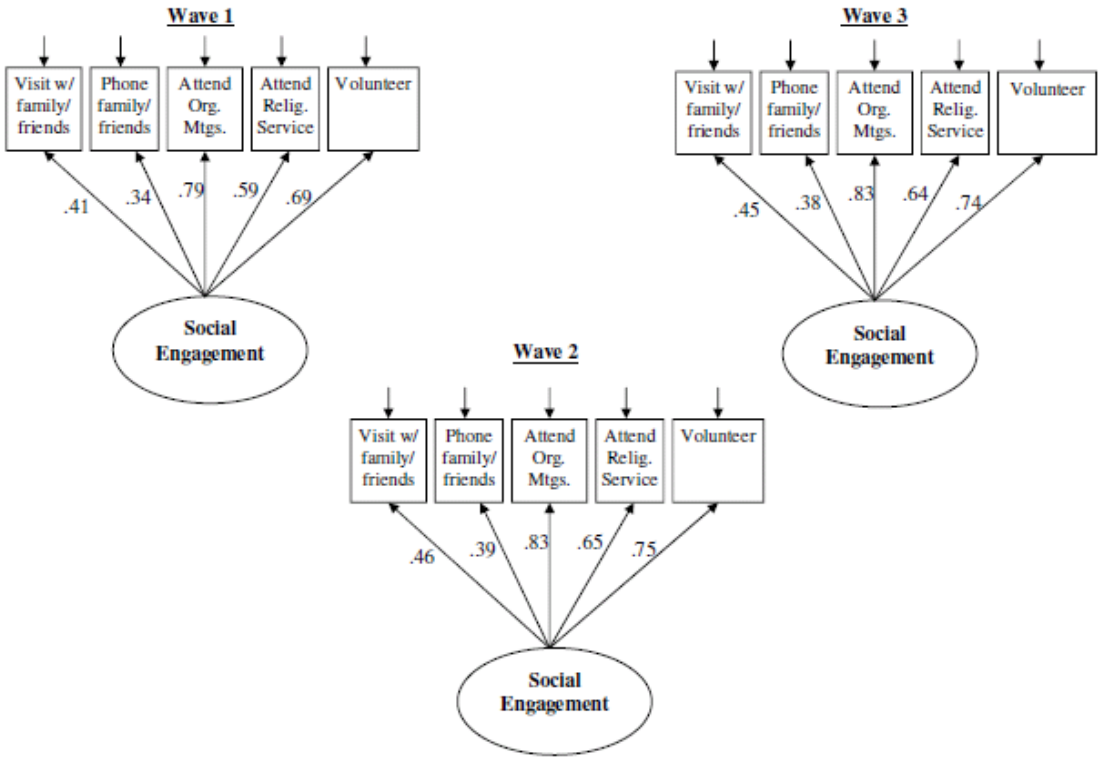
This study has several limitations. First, although the social engagement variable improved upon some previous measures of social engagement, the indicators of this variable did not take into account the quality of the social interactions involved. It is likely that negative experiences in the participation of social engagement activities affect health differently from positive experiences (August, Rook, and Newsom 2007). It is important for future research to explore this. Another limitation is that respondents self-reported their information for all of the variables except for mortality. Previous research shows that self-reported behaviors are generally valid when the behaviors in question are not illegal (Cohen and Vinson 1995). It is still possible, however, that respondents under-reported or over-reported some of their behaviors.

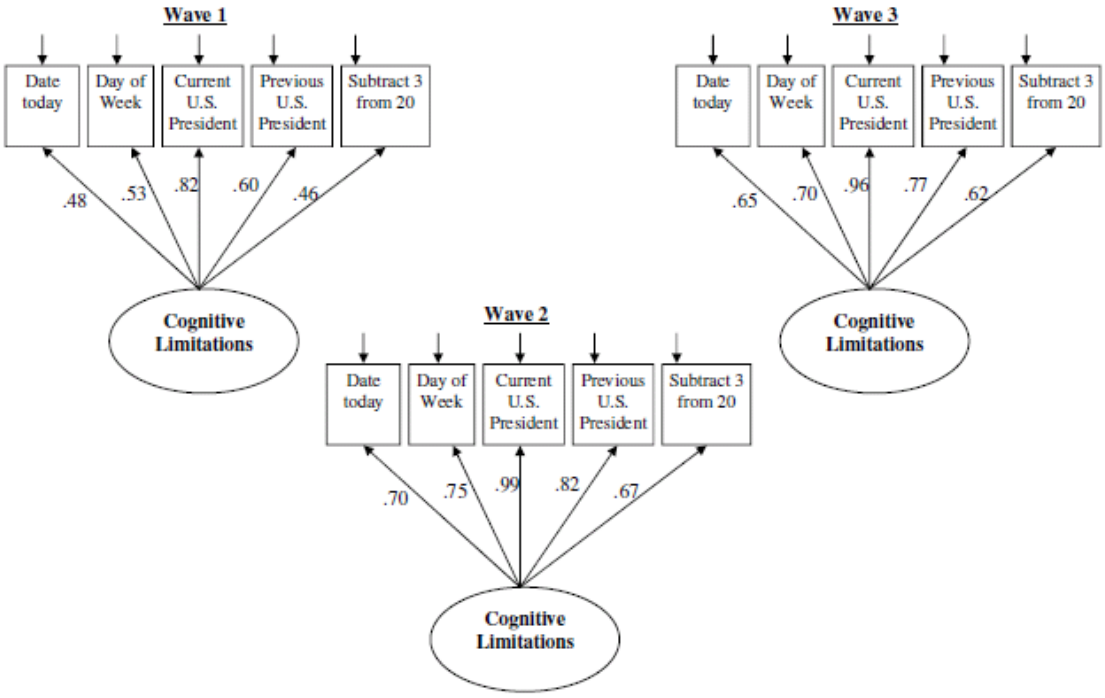
Despite these limitations, this study provides important information about the relationship between social engagement and mortality. This study provides support for social integration theory and does so within a life course framework taking into account patterns of stability and change in social engagement. The use of trajectories and the life course perspective enriches this study by incorporating individual heterogeneity and a dynamic, longitudinal analysis. Trajectories of social engagement that are initially high and either increase or only decrease slightly are related to lower risk of dying even after controlling for known predictors of mortality. These findings indicate the importance of

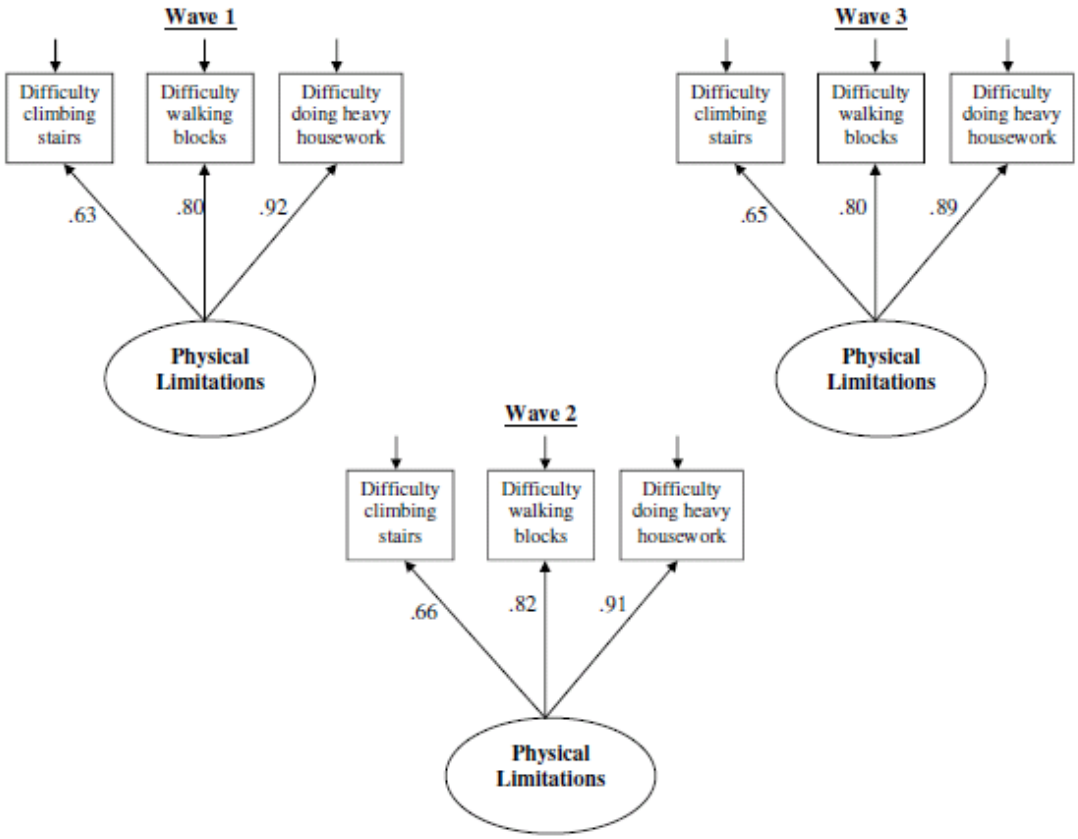
maintaining high levels of social engagement over time. The links between social engagement and better health outcomes highlight the benefits of older adults' participation in broader social activities. The results of this study, combined with the life course perspective's emphasis on individual agency within the constraints of social circumstance (Elder, Johnson, and Crosnoe 2003), could encourage older adults to maintain high levels of social engagement as one of several ways to reduce risk for mortality.

Appendix A

Below is the measurement model for social engagement, cognitive limitations, and physical limitations for women age 60 and older, related to Chapter 2.

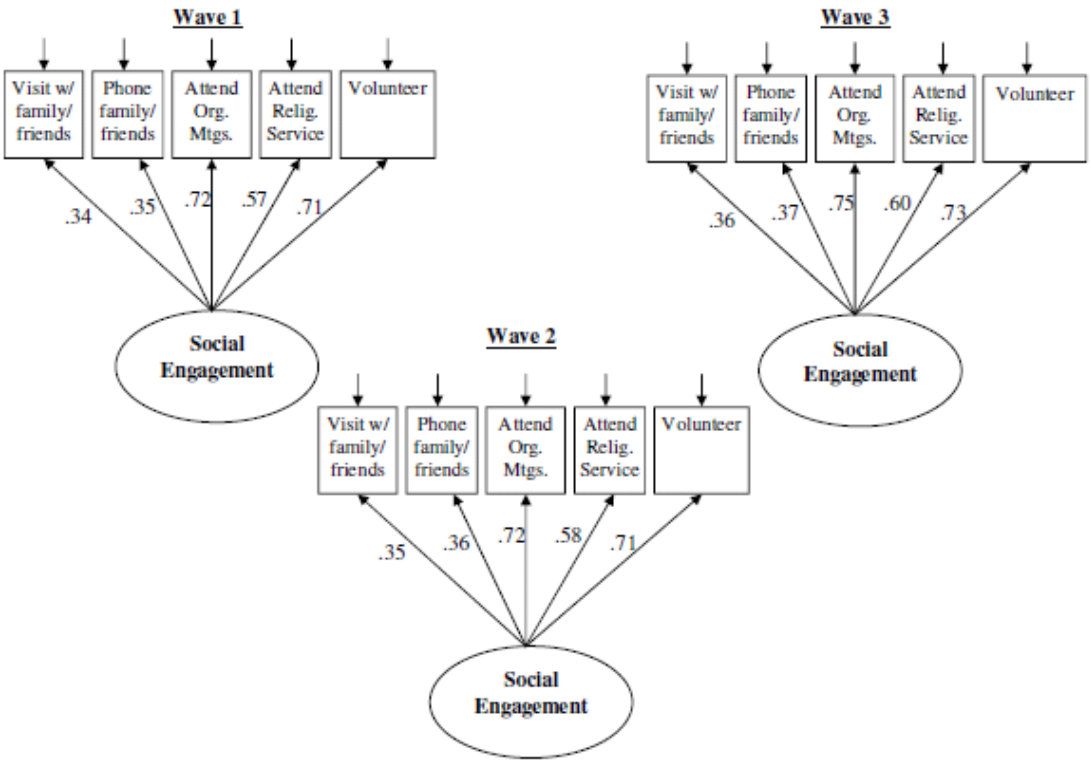


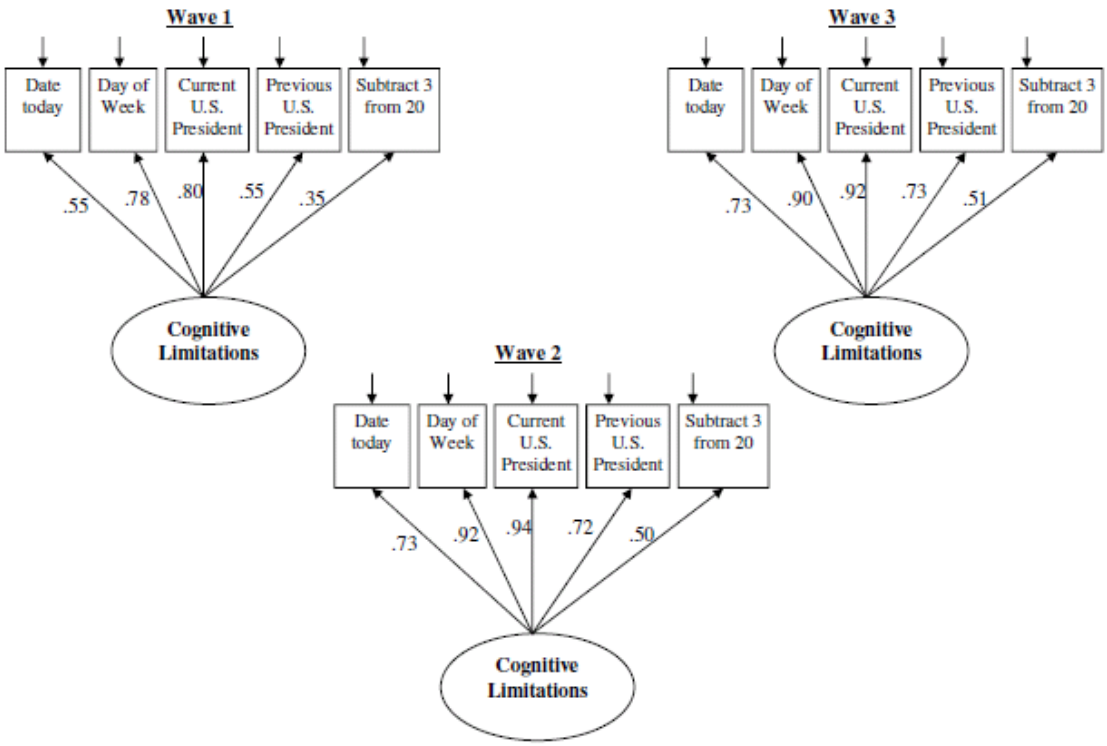

Wave 1
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.48
.53
.82
.60
.46
Cognitive Limitations
Wave 3
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.65
.70
.96
.77
.62
Cognitive Limitations
Wave 2
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.70
.75
.99
.82
.67
Cognitive Limitations

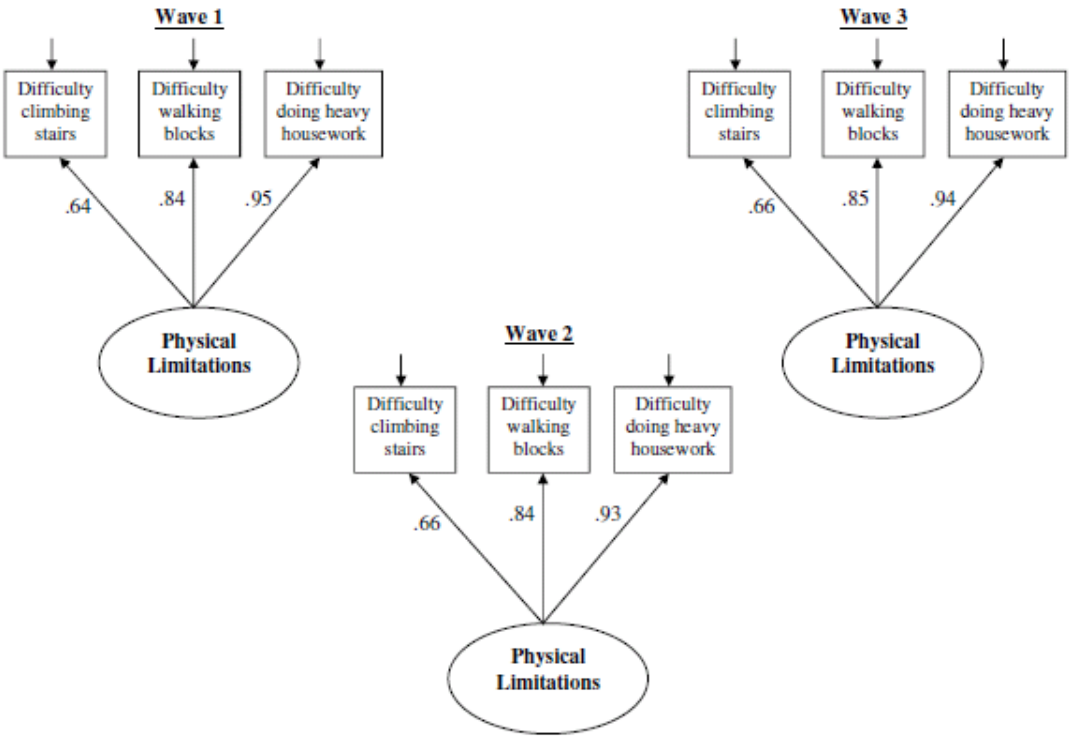

Wave 1
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.63
.80
.92
Physical Limitations
Wave 3
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.65
.80
.89
Physical Limitations
Wave 2
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.66
.82
.91
Physical Limitations

Appendix B

Below is the measurement model for social engagement, cognitive limitations, and physical limitations for men age 60 and older, related to Chapter 2.

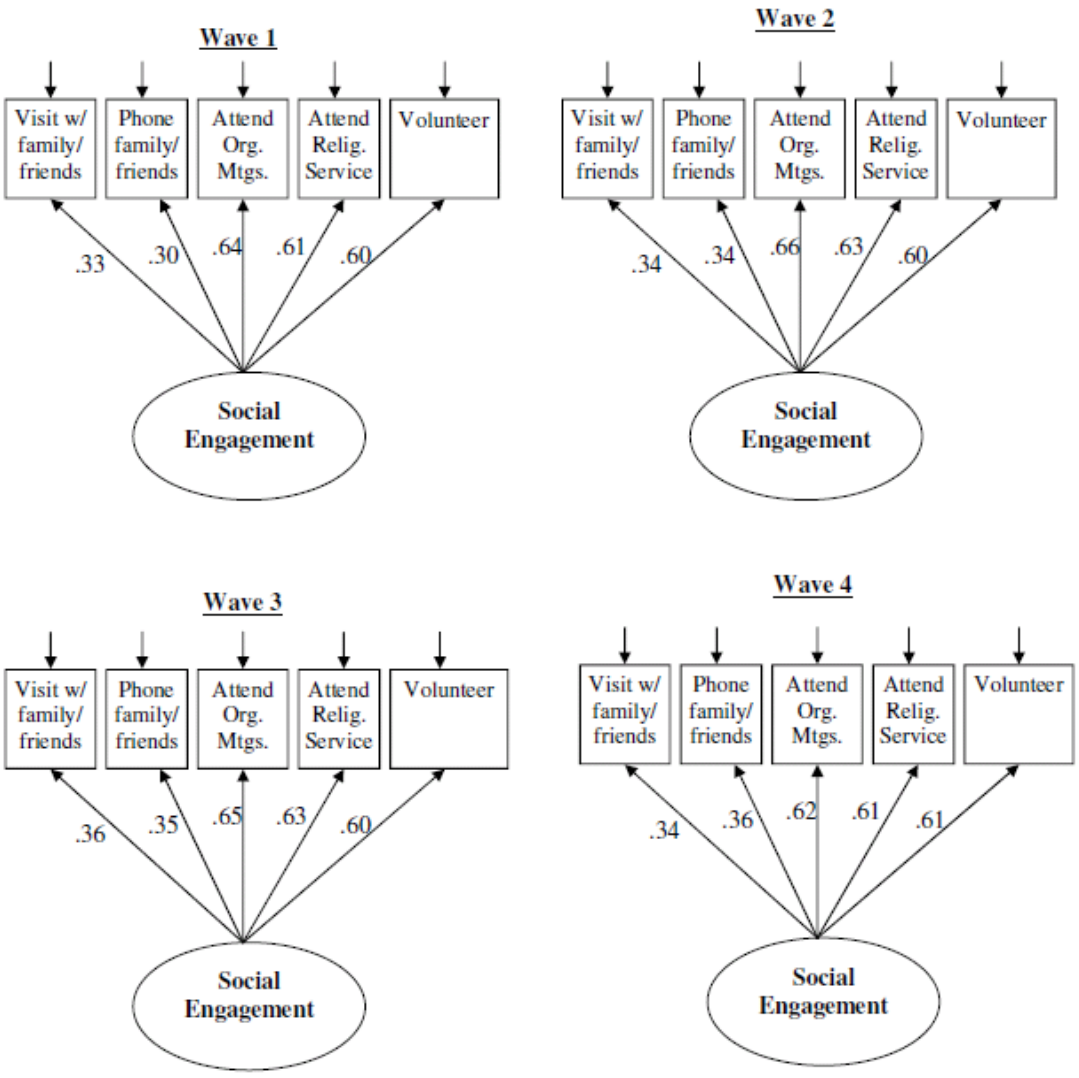


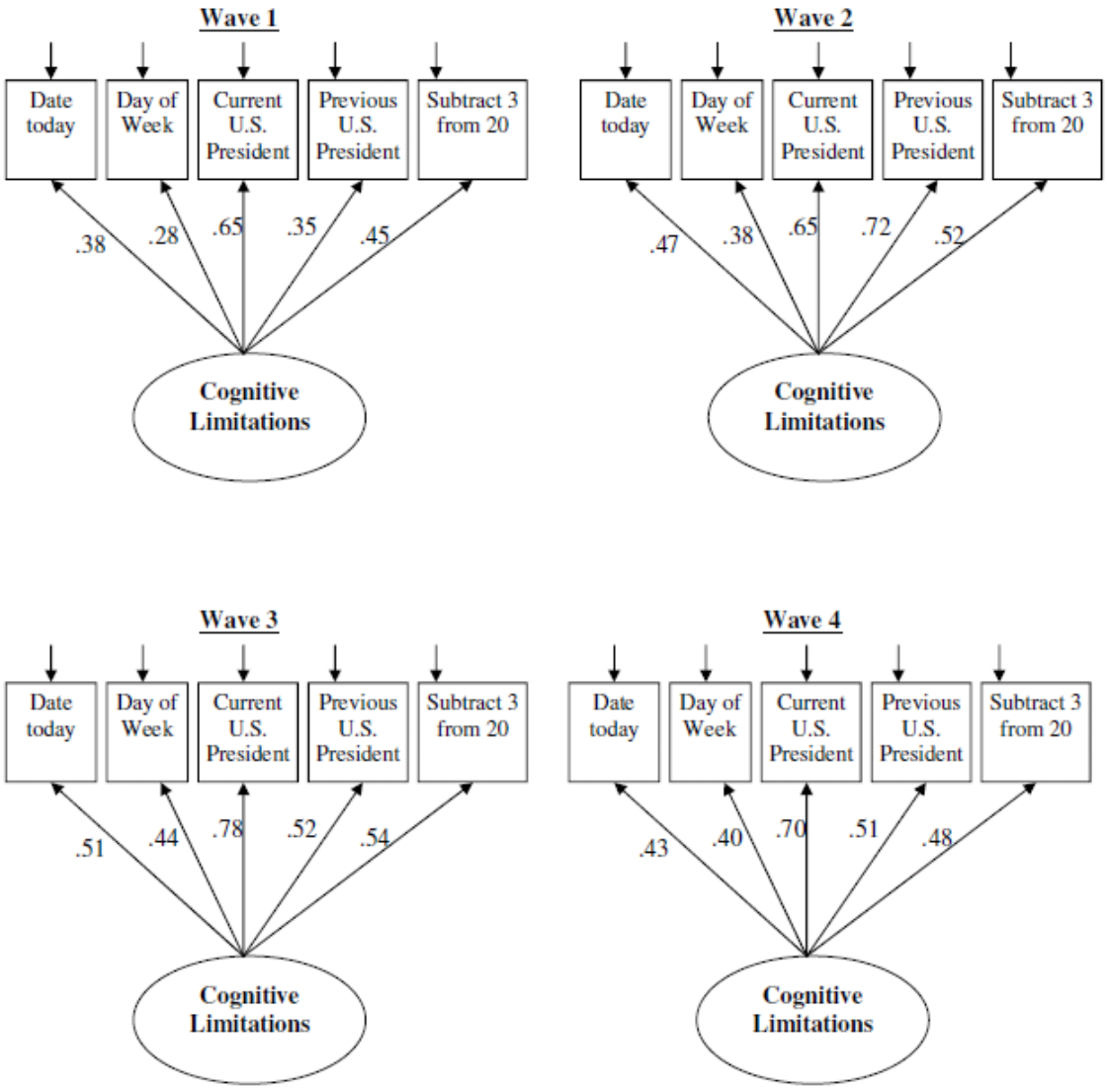

Wave 1
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.55
.78
.80
.55
.35
Cognitive Limitations
Wave 3
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.73
.90
.92
.73
.51
Cognitive Limitations
Wave 2
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.73
.92
.94
.72
.50
Cognitive Limitations

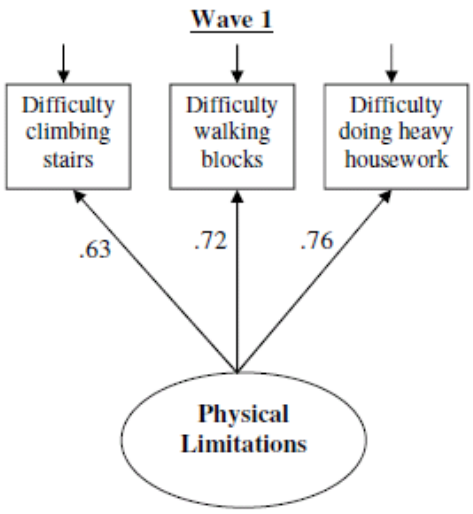

Wave 1
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.64
.84
.95
Physical Limitations
Wave 3
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.66
.85
.94
Physical Limitations
Wave 2
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.66
.84
.93
Physical Limitations

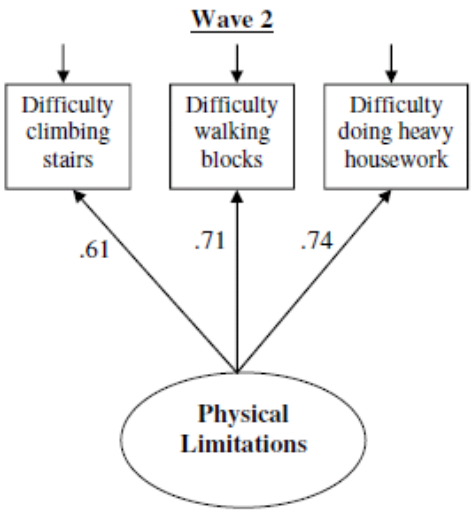
Appendix C

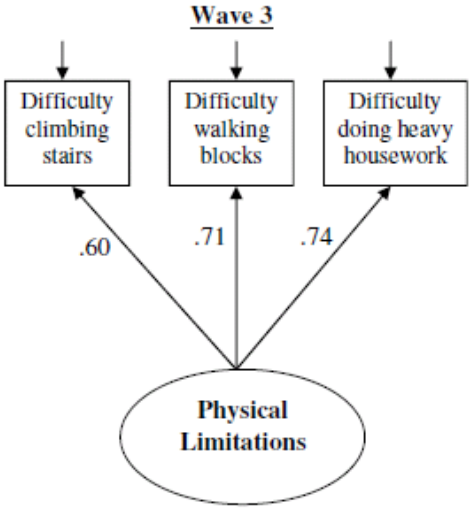
Below is the measurement model for social engagement, cognitive limitations, and physical limitations for the full sample of older adults, related to Chapter 3. The social engagement latent variables are the same for Chapter 4.

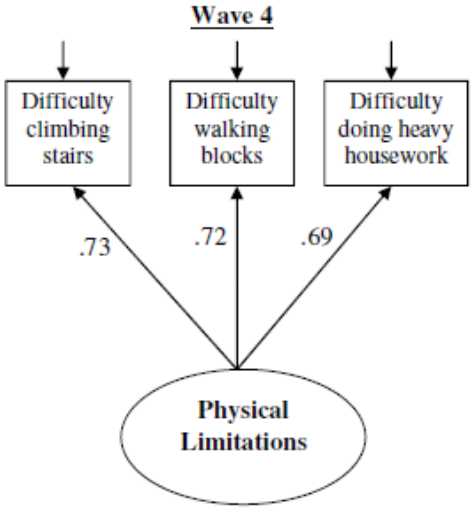



Wave 1
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.38
.28
.65
.35
.45
Cognitive Limitations
Wave 2
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.47
.38
.65
.72
.52
Cognitive Limitations
Wave 3
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.51
.44
.78
.52
.54
Cognitive Limitations
Wave 4
Date today
Day of Week
Current U.S. President
Previous U.S. President
Subtract 3 from 20
.43
.40
.70
.51
.48
Cognitive Limitations


Wave 1
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.63
.72
.76
Physical Limitations


Wave 2
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.61
.71
.74
Physical Limitations


Wave 3
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.60
.71
.74
Physical Limitations


Wave 4
Difficulty climbing stairs
Difficulty walking blocks
Difficulty doing heavy housework
.73
.72
.69
Physical Limitations

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Biography

Patricia Thomas was born in California on October 23, 1983. She received her B.A. in Sociology and American Studies from California State University, Fullerton in 2005, and her Master's degree in Sociology from Duke in December 2007. She has published, "Is It Better to Give or to Receive? Social Support and the Well-Being of Older Adults" in *Journal of Gerontology: Social Sciences* in May 2010. Her first publication, with Edythe M. Krampe and Rae R. Newton, "Father Presence, Family Structure, and Feelings of Closeness to the Father among Adult African American Children," was published in the *Journal of Black Studies* in 2008. She also published, "The Shifting Roles of Fathers and the Consequences of Father Absence and Presence," in *Battleground: The Family, vol. 1*, edited by Kimberly P. Brackett in 2008. She is currently supported by the Philip Jackson Baugh fellowship for research on aging.