The Effect of Parent and Adult-Child Contact on Elderly Cognitive Functioning

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Abstract

Previous research on social engagement and elderly cognitive functioning (dementia) provides evidence that social contact is associated with higher levels of cognitive functioning in older adults; however, no causal direction has been determined. This article tests whether the frequency of social contact between elderly parents and their adult, nonresident children has an effect on elderly cognitive functioning using the Health and Retirement Study.

Least squares results support previous studies suggesting that higher levels of parent-child contact are associated with higher cognitive functioning of elderly parents. Quantile regressions illustrate the association is strongest for those individuals in the upper half of cognition distribution. Controlling for endogeneity of contact frequency and parent's cognitive functioning through two-stage least squares fails to reject the hypothesis that contact with nonresident, adult children has no causal impact on cognitive functioning. The association between contact and cognition is therefore a result of selection bias.

Keywords: Cognitive Functioning; Dementia; Elderly; Parent-Child Contact; Health Production; Health and Retirement Study

JEL classification: I12; J10

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This research was conducted as part of my dissertation in the Department of Policy Analysis and Management at Cornell University. The paper has benefited from advice provided by my dissertation committee members, Donald Kenkel, Elizabeth Peters, and John Cawley. The paper benefited from comments provided by participants at the 2010 American Society of Health Economists Conference; the 2010 Western Economic Association International Conference; and the 2010 Southern Economic Association Conference, especially my discussants Laura Argys and Dhaval Dave. Special thanks also to the faculty and graduate students in the Department of Policy Analysis and Management during presentations in the department seminar series and the graduate Research in Progress seminars. All errors are my own.

Introduction

There are currently an estimated 5.4 million Americans with Alzheimer's disease (Alzheimer's Association, 2011), with predicted estimates for 2050 ranging between eleven and sixteen million, unless methods to effectively prevent and treat the disease are found. Currently, one in eight individuals age 65 and over has Alzheimer's disease (Alzheimer's Association, 2011). Seschadri et al (2006) estimate that one in five women and one in six men, who reach the age of 65, will develop some form of dementia in their lifetime.[1]

There is no effective cure for dementia, but the costs of care are not trivial. In addition to foregone earnings, unpaid caregivers incur out-of-pocket costs averaging $218 per month and experience higher levels of stress as well as negative impacts on their own health, employment, income and financial security (Alzheimer's Association and National Alliance for Caregiving, 2004). Furthermore, the increasing incidence of dementia and high utilization of medical services by patients results in high costs for Medicare. In 2011, the total cost of health and long-term care for all dementia beneficiaries was expected to be $183 billion, with 70 percent paid for by Medicare and Medicaid (Alzhiemer's Association, 2011).

One vein of literature examines social interaction and elderly cognition, finding more social contact is associated with higher levels of cognitive functioning in older adults (Ertal, et al, 2008, Fratiglioni et al, 2000 & 2004, Barnes, et al, 2004, Bassuk, et al, 1999); however, no causal direction has been established and this research generally combines all forms of social interaction into one aggregate measure. Further, this literature does not account for frequency of contact. A recent panel of researchers, at the request of the National Institutes of Health, was charged with the task of assessing "whether previous research on purported risk or protective factors for Alzheimer's disease (AD) and cognitive decline is of sufficient strength to warrant specific recommendations for behavioral, lifestyle, or

[1] The greatest risk factor for development of dementia is advanced age. Women are more likely to develop due to longer life expectancies (Plassman et al, 2007). Studies on age-specific incidence of dementia have found no significant difference by gender (Bachman et al., 1993; Fillenbaum et al., 1998; Fitzpatrick et al., 2004; Kukull et al, 2002; and Rocca et al, 1998); however, the incidence of dementia increases with age (Plassman et al, 2007).

pharmaceutical interventions/modifications targeted to these endpoints (Williams, 2010)." The panel found little evidence that low social support increases the risk for AD and little evidence of an association between social support and cognitive decline.[2] Furthermore, of the five studies the panel focused on, only one included contact with children as a form of social engagement (Fratiglioni et al, 2000). However, the panel stated that further research was required to clarify and confirm the findings on social engagement and AD.

This paper uses the Health and Retirement Study to test the effect of frequency of social contact between the elderly and their adult, nonresident children on elderly cognitive functioning. Because the presence of children is demonstrated to reduce the risk of dementia (Fratiglioni et al., 2000), the first objective of this paper is to examine the correlation between contact frequency and cognitive functioning. The second objective is to determine whether there is a causal relationship between contact and cognitive functioning. The study applies various econometric methods in an effort to determine the nature of the relationship between contact and cognition and explores how contact context is associated with cognition. Results support previous research finding an association between parent-child contact and cognition, especially for those in the upper half of the cognitive functioning distribution; however, controlling for the endogenity of contact, the evidence fails to reject the null hypothesis that the relationship is not causal.

This is not the first article to estimate a causal relationship between a lifestyle and cognition. Rohwedder and Willis (2010) use retirement policies from twelve different countries to predict the endogenous choice of retirement for men and its effect on cognitive functioning. Their results indicate that earlier retirement causes lower cognitive scores due to less mental stimulation. Glymour et al (2008) use state compulsory schooling laws to instrument for educational investment and find that, decades after their completion of school, individuals who obtained more education have higher cognitive scores.

[2] The panel reviewed a total of 43 potential factors. Moderate evidence was found of increased risk of AD for carriers of the apolipoprotein E-ε4 (APOE ε4) genotype and use of conjugated equine estrogen with methyl progesterone. Cognitive training showed a high level of evidence of decreasing the risk of cognitive decline.

Cognitive functioning, Social Contact and What We Know

Investigating the social determinants of cognitive change is valuable because even small changes in cognitive functioning can be signs of loss ranging from mild cognitive impairment to dementia, the most common form of which is AD.[3] Mild cognitive impairment (MCI) is defined by problems with memory, language or other essential cognitive functions that are severe enough to be noticeable to others and show up on tests, but not severe enough to interfere with daily life. Dementia on the other hand is a clinical syndrome associated with a loss or decline in memory and other cognitive abilities that impact daily life.[4]

The literature that examines social integration of the elderly and its relationship to cognitive functioning and dementia has generally grouped all forms of social interaction into one index as the sum of various types of interaction; i.e. whether there is a spouse present, whether the person has children and/or living parents, whether they have any contact with their neighbors and/or participate in volunteer activity. A recent paper by Ertal et al (2008) created such an index and examined how the most socially integrated (highest quartile) compared to the less integrated individuals (lower 3 quartiles). Using flexible growth curve models, their results find that high social integration predicts slower cognitive decline. Barnes et al (2004), using the Chicago Health and Aging Project, found the same results with a slightly different index.[5] Saczynski et al (2006) found that mid-life social engagement was not associated

[3] AD comprises of 60 to 80 percent of all dementia cases (Alzheimer's Association, 2011; Plassman et al, 2007).

[4] In particular a diagnosis of dementia must meet the following criteria, as defined by the *2011 Alzheimer's Disease Facts and Figures* released by the Alzheimer's Assocation:

1. It must include decline in memory and in at least one of the following cognitive abilities:
    a. The ability to generate coherent speech or understand spoken or written language;
    b. The ability to recognize or identify objects, assuming intact sensory function;
    c. The ability to execute motor activities, assuming intact motor abilities, sensory function and comprehension of the required task; and
    d. The ability to think abstractly, make sound judgments and plan and carry out complex tasks.
2. The decline in cognitive abilities must be severe enough to interfere with daily life.

Vascular dementia, mixed dementia, dementia with Lewy bodies, Parkinson's disease, Frontotemporal dementia, Creutzfeldt-Jakob disease and normal pressure hydrocephalus are all types of dementia with the most common being AD. For specific definitions of these types of dementia refer to Alzheimer's Association, 2011 available at: http://www.alz.org/downloads/Facts_Figures_2011.pdf - accessed 12/28/11.

[5] Social networks were based on the number of children, relatives, and friends seen at least once a month. Social engagement was measured with four items related to social and productive activity.

with an increased risk of dementia, but those with the lowest levels of social engagement in late life have a risk 2.3 times higher than those with the highest level of social interaction. Fratiglioni et al (2000) used Swedish data and found that those without social ties were 1.5 times more likely to develop dementia and single people had a 1.9 times higher risk of dementia than married people. Finally, Bassuk et al (1999) compared those with very high levels of social ties to those with no social ties and found that the three year odds of developing dementia were 2.2, six year odds were 1.9, and 12 year odds were 2.4, for those with no social ties.

Related literature examining social integration through alternate definitions and/or the examination of other cognitive outcomes also finds evidence to support that more engagement is better for cognitive outcomes. Glei et al (2005) examined both social contact, through networks, and social activities on the performance of various cognitive tasks in a nationally representative sample of elderly Tiawanese and found the number of people in various social networks was not associated with cognitive performance.[6] Wilson et al, (2007) followed up the research of Barnes et al (2004) with a study on emotional loneliness, perceived social isolation, and AD risk and observed a risk for AD twice as large for lonely individuals, 3.2 versus 1.4 for those not lonely.[7] Glymour et al (2008) examined stroke patients to determine whether social ties (an index defined as intimate ties, personal ties, and organizational ties) had an effect on cognitive recovery after stroke.[8] They found that those with more social ties and emotional support have better cognitive scores at the 6-month follow up.

These studies all consistently find a positive association between social engagement and a reduced risk for cognitive decline; however, the limitation of this literature is that they do not account for people selecting different forms of contact; i.e. whether they marry, have children, associate with their

[6] The cognitive tasks examined were the ability to state their own address; give the age in years; identify the date (month, day, year), identify the weekday, and subtract the number three from twenty a total of four consecutive times. This test is the Chinese equivalent to the Mini Mental State Exam.
[7] The study included covariates for social network size and average frequency of social participation.
[8] Intimate ties were defined as having a spouse or live-in partner, personal ties were defined as having weekly contact with one or more children, two or more friends, and two or more relatives, and organizational ties are defined as unpaid volunteer or community work, paid work, religious attendance and attendance at civic organizations.

neighbors or volunteer. This is important because cognitively healthier people are able to interact with more social groups; therefore, those with the most contacts have better scores and slower decline than those with the fewest. Such selection represents reverse causality. The decision to limit social engagement to parent-child contact is supported by Hughes and Waite (2004), who find that relationships with adult children are inherently different from relationships with friends and more distant kin and thus are likely to have a stronger impact on health.

Grouping all forms of social engagement together into an aggregate measure masks the variation between specific types of social contact and cognitive decline. Further, choosing to participate in any one of the activities included in these studies is endogenous to varying degrees (i.e. "going to the museum" versus "having kids", the vast majority of the elderly population have at least one child regardless of economic status, while museum attendance could be highly correlated with socioeconomic status, education, etc.). The primary contribution of this paper is that it looks at a specific form of social engagement, contact with adult-children, and tests its relationship with cognitive functioning to determine whether a causal relationship exists. This paper goes beyond simply using indicators of the existence of specific social ties by examining a finer measure, the frequency contact, which is expected to capture the impact of social engagement better than simply controlling for the presence for contact.

Previous research identifies three hypotheses regarding the link between lifestyle and the risk of cognitive decline and dementia: the cognitive reserve, the vascular, and the stress hypotheses (Fratiglioni et al, 2004; Stern, 2002). The cognitive reserve hypothesis suggests that mental activity, learning, and social interaction prevent or reduce cognitive deficits by activating brain plasticity. Evidence supporting this hypothesis is that those with higher levels of education have a lower risk for Alzheimer's disease.[9] The vascular hypothesis suggests that social, mental, and physical activity prevents or reduces the risk for dementia or AD through reduction of cardiovascular disease and stroke. Finally, the stress hypothesis

[9] Stern, et al, 1994; Evans et al., 1997; Kukull et al., 2002.

suggests that active individuals have more positive emotional states and reduced stress, leading to lower susceptibility to AD.

Increased social contact, particularly contact with adult children can influence cognitive functioning in several ways. Specifically, contact with children may induce cognitive stimulation though conversation which promotes learning and the formation of new ideas which would support the cognitive reserve hypothesis. Contact can also induce physical activity which helps vascular health and supports the vascular hypothesis. Another possible mechanism is a greater sense of purpose or emotional validation which could have direct neurohormonal benefits and support the stress hypothesis (Fratiglioni et al, 2004). Contact with children also serves as a possible reminder to take care of one's own health. These reminders may results from children, directly, noticing health declines and helping parents seek help before conditions develop into chronic disease or, indirectly, through pressure to take care of oneself for the sake of their children.

Data and Econometric Model

Data: Health and Retirement Study

The data are from the Health and Retirement Study (HRS) which is a longitudinal study administered biannually sponsored by the National Institute of Aging (grant number NIA U01AG009740) and conducted by the University of Michigan's Institute of Social Research.[10] Created to collect detailed information about the economic circumstances of older Americans, the HRS is a rich source of data on respondent assets, income, benefit use, pensions, earning, savings and spending. It also collects a vast array of demographic and health information including health conditions, health care utilization and direct

[10] Specifically, I use the RAND HRS, Version J with select variables merged in from the RAND-enhanced Fat Files. Contact with children variables come from the original HRS data files. Both are available at http://hrsonline.isr.umich.edu/.

measures of cognition required of this analysis (National Institute on Aging (NIA) and National Institutes of Health, 2007).[11]

Sample

By the last wave, in 2008, the HRS interviewed 30,548 primary respondents and spouses. The HRS administered cognitive functioning questions to both primary respondents and spouses; all surveyed respondents are included in the analysis.[12] Of this total the data are further restricted in several ways, implemented list-wise. The administration of the cognitive recall scores, described below, changed in 1998; therefore, interviews before 1998 are not used in the sample so that all respondents' cognitive scores are administered in the same manner. Pooling 1998 to 2008 the remaining respondents resulted in 154,944 person-year observations. For this remaining sample, the entire 2006 wave is dropped because the HRS did not ask respondents about the contact they had with their children, leaving 129,120 person-year observations. Next 43,829 observations are dropped due to attrition.[13] Non-parents and those with missing child contact information (13,960 observations) are also excluded.[14] Next, 1,253 observations are dropped due to missing race data.[15] Observations in the top 1.28 percent of the contact distribution are

[11] Currently the HRS is made up of five nationally representative cohorts. The original study cohort, known as the HRS cohort, interviewed a sample of over 12,000 individuals between the ages of 51 and 61 (strictly born from 1931 to 1941) and their spouses in 1992. Spouses in all subsequent cohorts were interviewed regardless of age. The next cohort in the survey referred to as the Study of Assets and Health Dynamics among the Oldest Old, or AHEAD, was interview in 1993. This sample includes over 8,000 individuals who were age 70 or older (born in 1923 or earlier) at time of interview and their spouses. In 1998 the two cohorts were integrated into one large survey and two additional cohorts were added to the survey to fill in the gap between the HRS and AHEAD cohorts and to "refresh" the sample, adding a sample of individuals in their early fifties. The former cohort is known as the Children of the Depression Age, or CODA, with individuals born between 1924 and 1930 and raised during the Great Depression. The latter cohort is known as the War Baby cohort with respondents born between 1942 and 1947, around the time of World War II. In 2004, the Early Boomer cohort, born 1948-1953, was added to the study and in 2010 the Mid-Boomer cohort, born 1954-1959, will enter the study. These "refresher" cohorts were added to account for aging and attrition in the survey (NIA, 2007). For further information see the National Institute of Aging data book *"Growing Older in America: The Health and Retirement Study"* or visit the HRS website http://hrsonline.isr.umich.edu/.

[12] The analysis excludes the Early Boomer cohort, which was not interviewed until 2004 to keep the sample period consistent.

[13] Of the 43,829 observations dropped for attrition, 23.25 percent was due to survey non-response; 65.63 percent was due to death; 8.57 percent due to respondents asking to withdraw from survey participation; and 2.55 percent was spouses who had not yet entered the survey through marriage.

[14] The contact questions were asked only for respondents who had nonresident children. Therefore, this number includes many the younger respondents who still had any of their children living at home.

[15] This group is omitted because it is a heterogeneous group and the RAND HRS files do not allow for the identification of finer race categories.

dropped eliminating 896 observations.[16] 7,227 observations are dropped due to missing cognitive scores. This does not mean respondents were not interviewed. Those respondents who are not found capable of taking the cognitive recall test are assigned proxy respondents to evaluate their cognition.[17] 273 respondent observations are dropped because their contact information was provided by proxy respondents. Proxy respondents, especially nonfamily members, are less likely to have an accurate idea of the contact frequency between parents and their adult-children; thus observations for those individuals who were not able to respond for themselves were dropped. 5,565 observations are dropped for new spouses, of existing respondents, that entered the survey after 1998.

Two more restrictions are made to create the final analysis sample. 7,308 person-year observations are dropped because respondents reside with their children. There are two situations in which older parents would live with their adult children. In the first scenario, parents move in with one of their children because they themselves need help due to deteriorating health or a change in financial status after retirement. In the second case, one or more children move in with the parents due to some health or financial problem of the children. This exclusion is made because the reason for parents and children residing together is unclear in the data, making determining the effect of contact between resident parents and children very difficult; thus resident parents are not included in the analysis.[18]

Finally, 18,189 person-year observations were dropped for men. This exclusion is made because the measure of contact is a household level measure which is primarily answered by women, 83 percent

[16] The distribution is highly skewed to the right; therefore, it is also possible that there is greater reporting error at tail given the maximum contact value reported is 5110 contact days, equivalent to daily contact with 14 children. The cut off at the top 1.28 percent of the sample is 1460 total child contact days, representing daily contact with four children. 84.5% of the sample at this step has 4 children.

[17] Descriptive statistics of the sample of respondents with missing cognitive scores are available upon request from the author. The main difference between respondents without reported cognitive scores is in contact. Respondents report more days of contact with their children in the previous year. However, the sample is also older, less educated, exhibits more adverse health conditions at baseline and is overall more disadvantaged along most demographic characteristics.

[18] The final nonresident sample is overall quite similar to the initial nonresident sample; results available upon request from author. The only notable difference is that the mean cognitive recall score is about one point lower for the initial sample.

versus 17 percent for men.[19] That being the case, the variable appears to not be an adequate measure of contact between men and their nonresident children as none of the results indicate a significant association between contact and cognitive functioning. Alternately, contact with nonresident children may truly have no relationship with men's cognition; however, given the crude nature of the variable this paper is unable to make any conclusions about men's contact with their children and its effect on cognition.[20] The remaining final analysis sample is 27,699 person-year observations (7,374 unique women) spanning 1998 to 2008.

Variables

Table 1 shows cognitive recall scores, contact, and descriptive statistics of all covariates for the initial and final full sample, by gender, residence status, and for those with no children. The definition and derivation of the dependent variable and other key variables are discussed below.

Cognitive measure. The HRS employs a set of questions to measure several aspects of cognitive function.[21] As the survey has evolved these measures have changed slightly with some being eliminated and others added.[22] The measures that have remained relatively consistent throughout include the immediate and delayed free-recall tests used in this analysis.

The immediate free-recall test is a series of 10 short, concrete, high-frequency nouns that are read to the respondents at two-second intervals. Immediately following the list respondents are asked to recall

[19] The HRS assigns respondents the role of family or financial respondent to be responsible for answering questions on behalf of the household in that domain. In the case of married or partnering households the responsibility is divided among the couple while in households with uncoupled individuals the respondent is responsible for both sets of questions. In the case that neither member of a married/coupled household or the respondent in the uncoupled household is found fit to participate in the study a proxy respondent is assigned. Married men are even less likely to be family respondents, only 11.5 percent.

[20] Results for men are available upon request from the author.

[21] The goal is to provide descriptive information on a comprehensive range of cognitive functions, span all difficulty levels from competent cognitive functioning to cognitive impairment, be sensitive to change over time, be administrable in a survey environment with lay interviewers, over the phone, in a short time, and be valid and reliable (Herzog and Wallace, 1997).

[22] For a complete description of cognitive measures in the HRS refer to Ofstedal, Fisher and Herzog (2005) and/or McArdle, Fisher and Kadlec (2007).

as many of the words as possible.[23] The delayed free-recall test asks the respondents to recall the words previously listed after a five minute interval during which other cognitive measure questions are administered. The scores of the two tests are added together, as is common in the literature, for a total score, which is used as the dependent variable and is a representative measure of episodic memory (Small and Hultsch, 1993; Glymour et al, 2005; Adam et al, 2006; and Ertal et al, 2008, define cognitive recall similarly).[24]

This test is similar to the Hopkins Verbal Learning Test – Revised (HVLT-R) (Brandt, 1991; Benedict et al, 1998; Aretouli and Brandt, 2010) which has been validated for healthy adults and several neurological diseases; Alzheimer's, Parkinson's, and Huntington's diseases. Benedict et al (1998) provide normative data on the HVLT-R for adults ages eighteen to eighty-eight. For adults fifty-five to sixty-nine years old the mean total recall was 76 percent for words and the delayed recall was 82 percent; while adults seventy to eighty-eight year old adults average total recall and delayed recall were 70 and 73 percent, respectively.[25] Aretouli and Brandt (2010) find that those diagnosed with AD recall an average of 42 percent of words in total recall and six percent in delayed recall.[26] In the sample for this paper the average scores for immediate and delayed recall are 61 and 53 percent for women ages 55-69 and 52 and 40 percent for women ages 70-88, respectively. The immediate recall averages are closer to those found in Benedict et al (1998) after the first trial recall (see footnote 24) and the delayed recall scores are lower because respondents did not have word lists read to them three times.

[23] In the 1992 and 1994 waves of the HRS the word lists were of 20 words, which were later shortened due to the greater level of complexity and for comparability when the HRS and AHEAD were merged. The greater degree of complexity for these two waves resulted in scores for the immediate and delayed recall test being on average lower than those scores for the 10 words tests. In 1998, the HRS also changed their lists to a set of four that are randomly assigned to respondents and made sure that spouses were not asked the same list. For these reasons the analysis period starts with the 1998 wave.

[24] A subcategory of declarative memory, episodic memory is the type of long term, declarative memory in which we store memories of personal experiences that are tied to particular times and places (Tulving, 1993).

[25] The HVLT-R reads a list twelve words to respondents three times and has them recall words after every round. The numbers above represent percent of Total Recall, which is the sum of the words recalled after all three rounds. After the first round (comparable to immediate recall in the HRS) adults 55-69 recalled 62 percent and adults 70-88 recalled 56 percent of the words read.

[26] Percentages are age adjusted.

The drawback in using this measure, in the HRS, is that the recall tests are only administered to those respondents who agree to take the test and who have the mental capacity to answer the questions.[27] The most cognitively impaired are selected out of the sample; therefore, it is important to note that the results in the paper should be interpreted as determinants of MCI and not necessarily dementia/AD.[28]

Examining the cognitive recall scores within the sample described above, Figure 1 shows the scores, over the period of 1998 to 2008, which appear normally distributed with a mean score of 10.5 words recalled. Figure 2 illustrates a trajectory of cognition by age for women score.[29] The trajectories show a slower rate of decline at younger ages and faster rate of decline for the oldest respondents. Additional patterns of cognitive functioning can be examined upon request from the author.

Contact measure. Ideally, data on parent and adult-child contact would be obtained through a randomized control trial, where varying levels of contact frequency or intensity could be imposed on the treatment group. In addition, ideal data would include detailed information about the activities parents and adult-children engage in or the degree of engagement between the two groups (contact intensity), the length of time they are engaged in these activities, and the nature of the relationship between parents and children. Unfortunately, such data is not available; however, the HRS asks respondents about the frequency of contact that they have with their nonresident biological children. This information comes from respondents answering how many times they have had contact with each child in the form of an in person meeting, telephone conversation, or by written communication in the last year. Specifically the respondent is asked to provide a number and qualify it in terms of days, weeks, months or years. These responses are used to calculate the days of contact for each child then contact days are added for all

[27] Non-response averages between 8 and 12.5 percent per wave, decreasing over time. In each wave, less than one percent of non-response was due to refusal, which should not bias results.

[28] The summary statistics for those who have cognitive recall scores and those who do not are available upon request from the author. They support the idea that the cognitive recall scores are indicative of MCI as those with missing data are older, have more contact with their children, have higher levels of health problems, have higher frequencies of living with their children, and have higher frequencies of children living within ten miles of their residence.

[29] The fitted model, based on a fully interacted quadratic ordinary least squares model, is $C_i = \alpha_0 + \alpha_1 age_i + \alpha_2 age_i^2 + \alpha_3 X_i + \alpha_4 X_i * age_i + \alpha_5 X_i * age_i^2 + \varepsilon_i$, where X_i is the characteristic of interest.

nonresident children.[30] Alternately, it is a measure of total child-contact days a respondent had with their children.

Returning to Table 1, women engage in contact with their children an average of 397 child-days. Figure 3 shows the distribution of the contact measure. It is evident that mothers tend to report contact with children with a relatively large amount of heaping that appears to occur in about 50 day, or 2.5 month, intervals. This is a result of most parents reporting contact in weeks and may bias results due to reporting error.[31] In 1998, the respondents from the original HRS cohort were not asked about contact with their nonresident children, only the new respondents for the CODA and War Babies cohorts. In this case the contact with children for the HRS respondents was calculated by taking the mean reported contact in the 1996 and 2000 waves.[32] The HRS did not ask any respondents about contact with their children in 2006, this wave is completely omitted from the analysis, as mentioned above. A limitation of this measure is that it does not provide any information about the nature of the interaction between parents and adult children, most importantly whether their interaction is active and cognitive stimulating in some manner, or passive.[33] There is also no ability to identify the duration of any child contact spell which can be very heterogeneous across individuals.

Health variables. Aging is associated with a higher prevalence of adverse health changes; thus, it is important to control for any health conditions that may potentially impact cognitive functioning (Bynum et al, 2004). The vast array of health information available in the HRS allows for various conditions can be controlled in the analysis. Specifically, models include a baseline measure of The

[30] Respondents who said they saw one child multiple times in a day were coded as having only one contact per day with a maximum for 365 days for any child.

[31] This bias, if any, will result from estimation and not inability to recall contact as respondents with proxy respondents and those who are not able do not qualify to take the Immediate and Delayed Recall questions are not included in the sample.

[32] Analyses were done omitting the 1998 wave (with variations using both the 1998 and 2000 baseline characteristics, separately); there were no statistical differences in the results across all the models therefore the observations for 1998 are kept in all analyses in this paper. An indicator variable is included in all models to control for the interpolated data or for observations where contact was not reported for all nonresident adult children, 17 percent.

[33] The 2004 and 2008 waves asked a random subsample of respondents about contact frequency by mode of contact (in person, telephone, or written) and about their overall perception about their relationship with all of their children through a battery of questions. Analysis for these measures is measures are included in Tables 6 and 8.

Center for Epidemiologic Studies Depression Scale (CES-D), number of chronic illnesses, any limitations in activities of daily living (ADLs) and any limitations of instrumental activities of daily living (IADLs).[34] These controls are similar those used in Ertal (2008). The models also control for other functional limitations, and fine motor index at baseline.[35] Table 1 shows descriptive statistics for these conditions.

Methods: How Contact Predicts Cognitive Functioning

The Grossman (1972) health production model, in which an individual receives utility from health, is used to examine whether more contact between parents and their adult children results in higher levels of cognitive functioning in old age. While parent-child contact is not assumed in the original model to be an investment in health production, this paper treats the frequency of contact with adult children is a time investment in one's health through the direct and indirect mechanisms mentioned above. The goal of this study is to examine the marginal product of contact with their children in producing cognitive functioning. In the Grossman model, an individual receives utility from health and the consumption of other goods. Health can be produced by combining various inputs, such as medical care and time. The level of health investment is set where the marginal benefit from investment in health equals the marginal cost of investing. The specific investment in this case is contact between an older parent and their nonresident adult children. However, the parent is not the only one who determines the level of contact that is received. A child has his or her own utility function, which may be maximized at a different level

[34] The CES-D is the sum of five "negative" indicators and two "positive" indicators (reversed in definition to be negative resulting in a scale of 0 to 7). The negative indicators measure whether the respondent experienced the following sentiments all or most of the time: depression, everything is an effort, sleep is restless, felt alone, felt sad, and could not get going. The positive indicators measure whether the respondent felt happy and enjoyed life, all or most of the time. The number of chronic illnesses is the sum of the following conditions: high blood pressure, diabetes, cancer, lung disease, heart problems, stroke, arthritis, and/or back pain. Problems with ADLs is the report of having problems with any of five tasks of bathing, eating, dressing, walking across a room, and getting in or out of bed. Problems with IADLs is the report of having problems with any of the five tasks of using the telephone, taking medication, handling money, shopping, preparing meals.

[35] Other function limitations include having difficulty with one for the following tasks: walking several blocks, walking one block, sitting for about 2 hours, getting up from a chair after sitting for long periods, climbing several flights of stairs without resting, climbing one flight of stairs without resting, lifting or carrying weights over 10 lbs, stooping kneeling, or crouching, reaching arms above shoulder level, pushing or pulling large objects, and picking up a dime from the table. The fine motor index uses the picking up a dime, eating, and dressing activities.

of contact than their parents may desire, given the other activities they may want to participate in; therefore, the observed level of interaction is one that jointly maximizes utility. Put another way, observed contact is the equilibrium between parental demand for contact and children's supply of contact.

Supply of contact is not exogenous. Problems of endogeneity arise because children's contact is a function of parental cognitive functioning. This would lead to a non-monotonic relationship between child contact and parent cognition, i.e. as cognitive functioning begins to decline adult children are less likely to enjoy interaction with their parents and contact will decrease; however, as cognitive functioning continues to decline the supply of contact will increase again in order to provide parents with help and supervision. Identification requires an exogenous source of variation in the supply of contact to independently predict the effect of contact. The source of variation used in this analysis is the number of female children, given the number of children an individual has; see *Instrumental Variables (IV)* below.

Ordinary Least Squares (OLS)

The first step is to determine whether contact between parents and their adult, nonresident children exhibit the same patterns as those found in previous research on overall contact and cognitive functioning. The OLS model is

$$C_{ij} = \beta_0 + \beta_1' X_{i0} + \beta_2 contact_{ij} + \varepsilon_{ij} \qquad (1)$$

where C_{ij} is the cognitive recall score, as accessed by the Immediate and Delayed Recall Scores, for person i in round j; X_{i0} is the matrix of baseline covariates and $contact_{ij}$ is the measure of contact. There is no previous work examining the relationship between the frequency of contact with children and cognitive functioning; therefore, several functional forms of contact are examined in the OLS specification to determine the most appropriate way to model contact. The functional forms examined here are a linear and squared term and a log-normal transformation.[36] The data are pooled; therefore, the standard errors are clustered on the individual level. The variables in vector X_{i0} include race, years of

[36] A set of dichotomous variables for quintile in the contact distribution as a nonlinear specification and linear and log transformed models controlling for whether a parent had daily contact with their children was also implemented. Results are available upon request from the author.

education, number of children, age, and age-squared, as well as, work status, log income, log wealth, marital status and health conditions measured at baseline.[37] Clustered standard errors account for the correlation of errors on the individual level due to the pooled nature of the data.

Quantile Regression

OLS provides coefficient estimates that are based on the conditional mean of the conditional-on-covariates distribution of cognitive functioning. If the distribution of cognitive functioning is symmetric then the conditional median and conditional mean are equal and the quantile regression at the median and the OLS results will be the same. However, along the cognitive functioning distribution, the distribution of covariates, such as contact, may change. As hypothesized in the health production model above, the relationship between cognitive functioning and contact is non-monotonic, suggesting that the distribution in contact changes across the distribution of cognitive functioning. A quantile regression examines the association between cognitive functioning and parent-child contact for different points along the cognitive recall distribution allowing for the observation of change in the distribution of contact. The quantile regression provides information about the effects on the sample distribution, not individual respondents. Therefore, the results from these indicate whether those at certain levels of cognitive functioning benefit from the receipt of more contact from their children over those individuals who do not.

Instrumental Variables (IV)

Equation (1) models the relationship between contact of parents and children with the assumption that contact is exogenous; however, as stated earlier contact may not be exogenous, but a product of a host of underlying factors, such as the marital status of parents, health of the parents, etc. Furthermore, contact with children is also a function of children's desires to interact with their parents, which could be either altruistic or motivated by expected financial gains, such as receipt of a bequest or in-vivo transfers (Becker, 1991: Altruism; Cox, 1987: Exchange Theory). Contact with children may also be a result of a parent's failing health. An estimated 15 million family members, friends, neighbors and other unpaid

[37] The variables age, age-squared, number of children and marital status are time variant.

caregivers provide about 17 billion hours of care annually for patients with some dementia valued at $202 billion dollars in 2010 (Alzheimer's Association, 2011), suggesting that reverse causality between contact and health exists.[38] Given that parents cannot be randomized into groups that keep in touch with their kids to varying degrees, the next section of analysis attempts to explain levels of contact, independent of any of the endogenous reasons for why certain parents would receive more contact than others, with a quasi-experimental method.

Using an instrumental variables approach, the natural variation in the gender mix of a family's children is exploited to predict the level of contact a parent may receive from her children. An instrument is only valid if it predicts the endogenous variable of interest and is not correlated with the error term in the estimation of the independent variable, Equation (1). The gender of a particular child is random and provides a natural experiment. If parents have a gender preference they cannot influence the sex of their child and can only affect gender mix by having additional children, holding number of children constant (Dahl and Moretti, 2008; Angrist and Evans, 1998); thus, gender mix, or the proportion of children of either gender, is the result of random natural processes and should not affect cognitive functioning many years after fertility decisions have been made. Number of children is not itself exogenous as total fertility is associated with socioeconomic factors that are also correlated with cognition such as education (Michael, 1973) and labor force participation (Devaney, 1983). Other stimuli, such as distance between parents and children or expected bequests, may be supply shifters; however, these examples do not provide clean natural experiments due to their correlations with the first stage error term.

The number of female children, or gender mix, is an appropriate predictor of contact between parents and children based on the intergenerational care literature, where women are referred to as "kinkeepers" because they are more likely to maintain connections between family members (Rosenthal, 1985; Hagestad, 1986). It is expected that those parents who happened to have a larger number of female

[38] This estimate, done by the Alzheimer's Association (2011), is based on hours of care valued at $11.93 per hour, which is the average of the minimum wage in 2010 ($7.25 per hour) and the average wage of a home health care aide in July 2010 ($16.60 per hour).

children will have more contact with their children than those parents who have more male children. Figure 4 supports this hypothesis illustrating that the average number of contact days between parents and children increases as the number of female children increases. Previous literature that has made use of child gender to instrument for endogenous processes include Ananat and Micheals (2008) and Bennedsen et al. (2007) , both using dummies for male first born children as instruments for divorce and family firm succession, respectively.

Contact is modeled by Equation (2), including Z_{ij} for instruments (i.e. the first stage of estimation):

$$contact_{ij} = \gamma_0 + \gamma_1' X_{ij} + \gamma_2 Z_{ij} + \varepsilon_{ij} \qquad (2)$$

The first stage results are used to compute an alternate estimate of β_2, β_{2IV}, by using the covariates from the Equation (1) in instrumental variable (two-stage least squares – 2SLS) estimation. This method allows for the calculation of a consistent estimate of the effect of the contact with children on cognitive recall scores. Instrumentation also eliminates any reporting error in the first stage with the independent estimation.

Results

Ordinary Least Squares

As previously stated, there is no existing analysis of the frequency of contact between parents and adult children and cognitive functioning. Using two different functional forms of contact, the first analysis examines the relationship between the contact and cognition. The OLS results in Table 2 show the coefficients on the various specifications of contact by gender. For each functional form, the results for women indicate that there is a significant positive relationship between contact and cognitive recall.[39]

[39] The cognitive recall scores were also treated as count variables in a Poisson model and fixed effects, generally estimated equations and lagged models were examined. No models yielded results quantifiably different from the OLS models. Models were also run with bounded values on missing contact data. Neither setting all missing values to 0 or maximum possible contact value changed the results significantly. The maximum possible contact value is

In Model 1, where the contact variables are a linear and squared term for contact, the terms are significant at the five and ten percent level, respectively. While small in magnitude, it appears there is a diminishing return to increased contact from children; however, a woman would have to have more than 625 days of contact from her children in order for contact to be a negative impact on her cognition. Women who have less than a year of contact with their children, for example 9 months or 270 days, have a 0.11 word increase in their cognitive recall or a one percent increase for those who score at the mean of 10.54 words; however, women who have 365 days of contact with their children receive a 1.2 percent increase and women who have 625 days of contact with their children have a 1.5 percent increase in their cognitive scores.[40]

The next model, Model 2, examines the natural-log transform value of days of contact. Here the significant positive relationship between contact and cognitive recall can be interpreted as a one percent increase in contact being associated with a 4.2 percent increase in word recall. At the mean, 10.54 words, this would increase word recall to 11 words. The log transformation provides an easier interpretation of nature between contact and cognition than Model 1 and none of the other covariates are statistically different across models; therefore, the rest of the analysis will focus on this functional form.[41] The remaining coefficients for the covariates in the models in Table 2 are consistent with the extant literature.

Fixed effects models, not shown, were run to control for individual heterogeneity and confirm that holding invariant characteristics constant continues to yield the same association between contact and cognition.[42] The fixed effects model, however, is limited in getting around the issue of selection as individual fixed effects only captures individual heterogeneity; however, it does not address the heterogeneity in the level of contact provided by the children. Fixed effects models only eliminate the time invariant characteristics of the children, but would not address the changes in behavior the children

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equal number of possible child contact days based on number of children (i.e. 365 for 1 child, 730 for 2 children, etc.). All results available from author.

[40] Nine months of contact is arbitrarily chosen simply for interpretive reasons. 625 days is the maximum point of quadratic specification.

[41] Results for all analyses are available for each functional form upon request from the author.

[42] The fixed effects models include only time variant characteristics: age, age-squared, number of children, and marital status.

made because of their parents' cognitive functioning. In addition, number of children is time-variant and that variation comes from losing a child, which affects the level of contact a parent receives from their children.

Quantile Regression

As mentioned above, the distributions of contact as well as other observables may change along different points of the cognitive functioning distribution. Table 3 examines the association between contact and cognition along various points of the distribution of cognitive recall scores. The association between contact and cognitive functioning remains the same across the distribution of cognitive scores; however, the results from these models support the existence of selection bias between contact with children and cognition.

Those at the median of the cognitive recall distribution receive similar benefit from increased contact with children and those in the 75th percentile of the contact distribution have an association between contact and cognition that is over one and a half times as large as the OLS estimate, while the lowest and highest deciles exhibit no benefit from contact. The lowest decile of the distribution may have a level of cognitive impairment low enough that contact is a result of failing health, reinforcing the idea that contact may be a product of cognitive decline and therefore endogenous. The highest decile receives no significant benefit from more contact likely due to those in the upper end of the distribution being able to engage in other forms of social engagement such that the marginal product from additional contact with children is negligible.

The association between contact and cognition is strongest within the interquartile range. Those in the middle of the cognitive distribution appear to benefit from increased levels of contact from their children than those in the same segment of the distribution who receive less contact. The largest association appears to be for those in the 75th percentile of the distribution. The individuals at that point of the distribution will have experienced the least cognitive decline therefore the marginal product of contact is largest at that point of the distribution.

Two-Stage Least Squares

Now that the relationship between amount of contact and cognition has been established, the 2SLS model can be examined. As stated before, the instrument used in this analysis is the number of female children controlling for the total number of children. Table 4 indicates that the number of female children strongly predicts contact with parents, column1. The first-stage estimation shows that the instrument has enough power to predict contact, with an F-statistic above 10 for the endogenous contact variable, F=38.72. The third column shows the second stage results. There appears to be no causal relationship between contact and cognitive scores for women. These results are not surprising, as the reduced form equation, second column of Table 4, where the instrument is substituted for contact variable (in Equation (1)), does not indicate a statistically significant relationship between number for female children and cognition. If the coefficient in the reduced form models was statistically significant, it would be assumed that the path through which child gender mix affects cognitive functioning is contact and does not itself directly affect cognition. The Hausman tests reject exogeneity, p=0.011, indicating the OLS estimates are not consistent and therefore the 2SLS estimator provides the better results for examining contact frequency and cognition.[43]

A check to see if contact with children has an effect on elderly cognitive functioning was done by including the sample of respondents who have never had children into the analysis sample, see Table 1 for summary statistics. The assumption is that individuals with no children, and by default have no contact treatment, should be statistically different from those respondents with children if contact with children effects cognitive functioning. The OLS results, not shown, do not vary statistically from the OLS results in Table 2 and the coefficient on No Children is insignificant. The 2SLS results (fourth column of Table 4) do not yield statistically different results from those in the third column and the coefficient on No Children, while negative, is not statistically significant. These estimates do not reject OLS as the

[43] LIML and GMM specifications were also run, with no difference in the results.

consistent estimates, but provide further evidence that the relationship between parent and adult-child contact is a result of selection and not causal.[44]

Exploring the Selection of Adult Child Contact

The OLS results in Table 2 show significant association of the frequency of child contact on mothers' cognitive functioning, but Table 4 fails to show a causal relationship of contact in the instrumental variables approach, suggesting that heterogeneous treatment effects of contact on cognitive functioning may exist. Quantile regressions, Table 3, indicate that those at various points of the cognition distribution have differing associations with contact, which is not captured in the OLS results. The following analyses attempt to examine the association between parent-child contact and cognitive functioning by focusing on various factors that predict contact. Table 5 examines living arrangements, Table 6 examines mode of contact, and Table 8 examines quality of parent-child relationships.

Different living arrangements of parents who do not live with their children (e.g. those who live independently as opposed to an assisted living environment or those who live further from their children) may mediate the connection between contact and cognition. Table 5 examines this possibility. The left panel examines individuals by whether they live independently or in an assisted living situation.[45] The coefficients on the contact variables are consistent with previous models; however, residing in an assisted living environment is associated with a significant loss of almost a full word of recall. The interaction term is not significant indicating the rate of cognitive decline does not differ from those who live independently.

Another mediator of contact on cognition could be the proximity to ones' children; parents or children may have moved closer to each other because of a parent's declining health (in this case

[44] Results for both OLS and 2SLS models for the sample with childless respondents are available from author.
[45] Assisted living is defined by any individual who responded to living in a nursing home, senior citizen housing, retirement community/center, or assisted living. While each of these may differ in the amount of independence for one's personal care, there are too few respondents who report living in any one of these places and are eligible for the Immediate and Delayed Recall questions to analyze them separately. Due to lack of sample size these models are also run using fully interacted models to preserve sample size.

cognition). The right panel of Table 5 continues to show the same pattern of contact on recall scores, with significant coefficients on days of contact and proximity to children. Those who live closer to their children have a recall score half a word lower than those who live further from their children, but again the rate of change does not differ.

While days of contact is an interesting measure in its ability to capture the frequency of contact between parents and their nonresident, adult children, an important question arises about the type of contact parents and children are engaged in. As mentioned before, the HRS does not have record of the types of activities individuals engage in with their children, but it does provide, in the 2004 and 2008 waves, some information about the mode of contact between parents and their children.[46] A random subsample of respondents were chosen to answer questions about how often they have in person, phone or written contact with their children by mode of contact.[47]

Figures 5a-5c show the distribution of answers for each mode of contact by the quartile of contact they report to have with their children in days (in the original measure). Figure 5a examines "In Person" contact. Those in the highest quartile of contact have seen at least one of their children weekly.[48] The lowest quartile of contact days generally sees any of their children monthly.[49] Figure 5b looks at "Phone" contact. Those in the highest two quartiles of contact primarily had phone contact 3+ times a week. This indicates that those reporting high levels of contact with their children are largely referring to phone calls; again these phone calls may result from both supervision and closer relationships. Those who have the least amount of contact still report having relatively frequent phone contact (1-2 times a week to 1-2 times a month). Phone contact frequency is highest in large part because it may be the cheapest form of contact. First, it does not require any extra time or travel to achieve interaction and, in the case of written contact, it does not take any time to wait for a response, nor does it require parents to learn new

[46] The 2006 wave also includes these variables, however because contact was not measured this information could not be used.
[47] The answers were ranged from "3+ times a week" to "less than once a year or never."
[48] The responses were primarily "1-2 times a week" or "3+ times week."
[49] The responses were primarily "1-2 times a month" or "every few months."

technologies to engage in (e.g. e-mail and computers). Figure 5c shows that across all contact quartiles most respondents state they have written contact less than once a year or never with their children.

The responses to these questions allow for the construction of days of contact by mode.[50] Table 6 examines how "Phone", "In Person" and "Written" contact relates to cognitive scores. For the full sample, only written contact is a significant predictor of cognition; however, results broken down by living arrangement show significant associations for mode of contact for women. For women in assisted living, increased "Phone" and "Written" contact is associated with higher scores. Again, the case for selection is supported as parents can only engage in telephone contact if they are able to comprehend who the person on the other end is and understand the conversation or written contact if they are able to read and write. Increased meetings with children for those in assisted living may indicate that a respondent may not be able to engage in phone or written contact often or at all supporting reverse causality; although children who are more altruistic or have better relationships with their mothers would also be more inclined to make personal visits with their mothers. If the first case is true, then the negative, coefficient on "In Person" contact, although insignificant, is the expected result. Proximity to children show similar results with positive significant results for written contact for those who live within ten miles of their children and negative significant results for "In Person" contact for women who live further than 10 miles from any of their children.

The final set of analyses attempts to examine how perceived quality of the parent-child relationship could influence how contact impacts cognitive functioning. In 2004 and 2008, the same respondents that were asked about the mode of contact with their children, were also asked questions about the nature of the relationship with all of their children. Six questions were asked about the parent's perceived relationship with all their children.[51] Table 7 shows the factor loading matrix indicating the

[50]The mean number of contact days that could be had per group (e.g. 3+ times a week is assigned an average of 5 days of contact per week multiplied by 52 weeks which equals 260 days contact). This measure is cruder than days of contact due to the broader categories of contact frequency.

[51] A seventh question of how demanding one's children were perceived to be was also available in 2008, but is left out of the analysis for consistency between the two years. Three questions asked about positive aspects of their relationships with their children, and three about negative. All negative questions were recoded onto the positive

positive questions load on the first factor and the negative question regarding criticism loads as the second factor. Two variables "supportive", the average of the 3 positive questions, and "critical" are created to represent parents' relationships with their children.

Table 8 shows the OLS results when these factors are included in the model. There are no significant coefficients for contact or quality of relationship when only the indexed variables are included, which indicates that quality of relationship between parents and children mediates the influence of contact on recall, but does not influence it directly.[52] When interactions terms are included for quality and contact, the coefficients continue to be insignificant. The rate of decline is faster for those who perceive their children to be critical of them. This again supports selection as those may be starting to experience cognitive decline and may perceive their children's attention to their cognitive deficits to be critical of them and not helpful.

The previous three sets of analysis, by living arrangement, mode of contact, and relationship quality all indicate that selection has a large role in predicting the effect of parent-child contact on cognitive functioning.

Conclusion

The rise in the elderly population, with the aging of the Baby Boomers, is of great concern among policy makers. With the rapid increase in the proportion of older individuals, the nation will be burdened with obligations of medical, retirement and disability benefits to retirees (Lee and Skinner, 1999). The health care system will be overwhelmed by larger numbers of patients seeking care for chronic conditions while facing a shortage health care professionals with geriatric training (Committee on the Future Health Care Workforce for Older Americans, Institute of Medicine, 2008). With age comes a wide variety of health problems, risk of cognitive decline and dementia among them. Currently there is no cure for

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scale (e.g. from lowest to highest) and a factor analysis was done to examine the correlation between these questions to find a more parsimonious set.

[52] The insignificant coefficients on quality of relationship could also be insignificant because CES-D scores are included in these models which could be absorbing the effect of the quality measures. Excluding CESD score does not change the estimates, results not shown.

dementia and costs for the care of those affected by the disease are not trivial. While research continues to search for better pharmaceutical treatments, there is an increase in research being done on lifestyle choices and their influences on cognitive functioning. This paper examined one such factor, the time spent with children, to determine whether there is more than an associative connection with cognitive functioning.

The first objective was to determine whether spending more time with children was linked to cognitive outcomes for elderly adults. The motivation for parent and adult child contact and its association with cognitive functioning can be a result of selection, direct causation or reverse causality, e.g. children increasing contact to supervise their parents' declining health. The OLS results show that contact with children is positively associated with better cognitive recall scores for women. The quantile regression results suggest contact is associated with increased scores for women in the interquartile range of the cognitive distribution, specifically, those in the 75^{th} percentile of the cognitive distribution.

Unfortunately the data do not provide information about the nature of activities during the time spent between parents and children, the duration of time spent engaged in interaction, or the quality of relationship between parents and children. Later waves do include limited information on the closeness respondents feel with their children and mode of contact. The analysis of these data supports both selection in contact and reverse causality. Future research is planned to utilize the American Time Use Survey to examine how it is that the elderly spend time with their adult children.

The second aim of this paper tested whether a causal relationship between the frequency of contact and cognitive functioning exists. Results did not show any causal relationship between contact with their children and cognitive scores. Several explanations exist for the null result found in the two – stage least squares estimation of the causal relationship between contact frequency with children and older parents. First, as the Hausman test suggests, the 2SLS estimator is the valid estimator of contact on cognition, and there is no causal relationship. Second, the local average treatment effect estimated on the variation of female children as the exogenous predictor for differing levels of contact may not pick up the

aspect of contact that is relevant to cognition. Third, the data on contact may not be adequate for examining how contact affects cognition. Contact quality and not contact frequency may play a greater role in protecting against cognitive decline; however, the nature of the data in the current analysis does not allow for the measurement of contact quality, i.e. cognitively stimulating or not.

Previous studies on social engagement and cognitive functioning have found that more forms of social contact are correlated with higher levels of cognition. The current work made the first attempt to identify the causal nature of this association by focusing one aspect of social engagement. The evidence indicates that relationship between higher levels of contact between elderly parents and their adult, nonresident children is not causal but an artifact of selection. Policy recommendations like those proposed by Bassuk et al (1999) for the development of social policies and programs that promote social engagement for older individuals will help keep them involved in their communities and stay cognitively stimulated. Public health professionals however should be conscious of the difference between association and causality and not rush to promote social engagement as a tool to slow or delay cognitive decline. Instead social engagement should be promoted and monitored as a potential signal for cognitive problems if significant social isolation becomes apparent. In particular, children can be advised to observe their parents' behavior to analyze whether they perceive noticeable changes in the levels of interaction initiated by their parents. The lack of causal evidence in the paper has shed light on several important aspects of relationship between contact and cognition and provides a foundation for more research to be done into the nature of interaction between parents and their adult children that may be protective against cognitive decline.

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Tables and Figures

Table 1: Summary Statistics of all Variables

	Nonresident Sample		Nonresident Women		Resident Sample		No Children	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent Variable								
Cognitive Recall Score	10.12	3.52	10.54	3.55	10.03	3.66	9.87	3.90
Contact Variables								
Days of Contact - Total Child Contact Days	377.82	294.91	396.83	297.87	384.99	319.49	0.00	0.00
Ln(Days of Contact)	5.47	1.35	5.58	1.19	5.43	1.38	-4.61	0
Instrument								
Number of Female Children	1.40	1.13	1.41	1.14	1.84	1.34	0.00	0.00
Control Variables								
Female	0.59	0.49	1.00	0.00	0.66	0.47	0.60	0.49
Black	0.06	0.24	0.07	0.25	0.14	0.34	0.09	0.28
Hispanic	0.04	0.19	0.04	0.19	0.12	0.32	0.03	0.17
Baseline Characteristics								
Age	68.43	9.37	68.54	68.28	65.65	9.75	69.31	12.21
Years of Education	12.62	2.85	12.44	12.89	11.84	3.34	12.89	3.50
Work Status	0.46	0.50	0.40	0.49	0.50	0.50	0.44	0.50
Log Income	9.89	1.07	9.81	1.06	9.07	1.38	9.86	1.41
Log Wealth	10.89	2.69	10.78	2.81	9.47	3.24	10.42	3.57
Never Married	0.00	0.07	0.01	0.07	0.01	0.10	0.34	0.47
Partnered	0.02	0.14	0.02	0.13	0.01	0.10	0.02	0.15
Married	0.65	0.48	0.57	0.50	0.55	0.50	0.27	0.44
Divorced	0.12	0.33	0.13	0.33	0.15	0.36	0.14	0.35
Widowed	0.20	0.40	0.29	0.45	0.28	0.45	0.23	0.42
Health Conditions at Baseline								
CES-D score	1.37	1.80	1.52	1.88	1.67	1.96	1.46	1.77
Number of Chronic Illnesses	1.45	1.19	1.46	1.20	1.47	1.24	1.50	1.26
Activities of Daily Living Problems	0.22	0.74	0.24	0.78	0.27	0.82	0.31	0.88
Other Functional Limitations	2.32	2.68	2.73	2.83	2.61	2.88	2.38	2.77
Instrumental Activities of Daily Living Problems	0.19	0.58	0.24	0.62	0.26	0.68	0.23	0.63

Table 1 Continued	Nonresident Sample		Nonresident Women		Resident Sample		No Children	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Fine Motor Skill Problems	0.12	0.40	0.13	0.41	0.14	0.42	0.15	0.44
Other Characteristics								
Proxy Respondent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Live with Children	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Live in Assisted Living Environment	0.03	0.16	0.03	0.17	0.01	0.08	0.03	0.18
Children Live within 10 Miles	0.59	0.49	0.61	0.49	0.62	0.49	0.25	0.44
Foreign Born	0.06	0.24	0.06	0.24	0.11	0.31	0.06	0.23
Sample Size	45888		27699		7308		2921	

Note: All means are weighted. Initial Sample consists on all observations for respondents who were surveyed between 1998 and 2008, excluding 2006. The samples for resident respondents and those with no children include men and women. Summary statistics for the missing indicator variables are available upon request from author.

Table 2: OLS Estimates of the Relationship between Contact with Children and Cognitive Recall Scores for Women

	Model 1		**Model 2**
Total Day of Contact	0.0005**	Ln(Total Days of Contact)	0.042**
	(0.0002)		(0.021)
Total Day of Contact Squared	-0.0000004*		
	(0.0000002)		
Number of Children	0.009	Number of Children	0.01
	(0.019)		(0.019)
Age	0.271***	Age	0.270***
	(0.035)		(0.035)
Age-Squared	-0.003***	Age-Squared	-0.003***
	(0.000)		(0.000)
Years of Education	0.238***	Years of Education	0.238***
	(0.012)		(0.012)
Black	-0.908***	Black	-0.910***
	(0.098)		(0.098)
Hispanic	-0.320**	Hispanic	-0.322**
	(0.135)		(0.135)
Never Married	0.061	Never Married	0.060
	(0.334)		(0.334)
Partnered	-0.094	Partnered	-0.096
	(0.183)		(0.182)
Divorced	0.314***	Divorced	0.314***
	(0.092)		(0.093)
Widowed	0.159**	Widowed	0.161**
	(0.067)		(0.067)
Baseline Characteristics			
Worked	0.283***	Worked	0.282***
	(0.068)		(0.068)
Log Income	0.144***	Log Income	0.143***
	(0.039)		(0.039)
Log Wealth	0.110***	Log Wealth	0.110***
	(0.021)		(0.021)
Health Conditions at Baseline			
CES-D score	-0.056***	CES-D score	-0.055***
	(0.016)		(0.016)
Number of Chronic Illnesses	-0.060**	Number of Chronic Illnesses	-0.059**
	(0.027)		(0.027)
Activities of Daily Living Problems	0.086	Activities of Daily Living Problems	0.086
	(0.060)		(0.060)
Other Functional Limitations	-0.040***	Other Functional Limitations	-0.040***
	(0.014)		(0.014)

	Model 1		Model 2
Instrumental Activities of Daily Living Problems	-0.344***	Instrumental Activities of Daily Living Problems	-0.343***
	(0.053)		(0.053)
Fine Motor Skill Problems	-0.088	Fine Motor Skill Problems	-0.089
	(0.101)		(0.101)
Year Indicators			
2000	0.059	2000	0.059
	(0.078)		(0.078)
2002	0.0641	2002	0.064
	(0.081)		(0.081)
2004	-0.149*	2004	-0.148*
	(0.082)		(0.082)
2008	-0.003	2008	-0.001
	(0.091)		(0.090)
Constant	0.293	Constant	0.249
	(1.283)		(1.289)
Observations	27699	Observations	27699
R-Squared	0.272	*R-Squared*	0.272

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. All estimates are unweighted. Standard errors are clustered on the individual. Models also included whether a respondent had a missing value for any demographic characteristics or baseline health conditions. Models were also run (separately) excluding the CES-D score and the interpolated contact data for the 1998 to determine whether these changes changed the results of the main model; the results were not statistically different.

Table 3: OLS and Quantile Regression Estimates of the Relationship between Contact with Children and Cognitive Recall Scores for Women

	OLS	Quantile Regression					
	Model 2	0.10	0.25	0.50	0.75	0.90	Observations
Ln(Total Days of Contact)	0.042**	0.040	0.035*	0.036*	0.071***	0.042	27699
	(0.021)	(0.029)	(0.021)	(0.020)	(0.025)	(0.027)	
R-Squared	0.266						

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on the individual. Covariates include: age, race, years of education, number of children, marital status, baseline work status, (log) income and (log) wealth, baseline health variables, and whether any demographic characteristics or baseline health conditions are missing. See Table 2 for full models covariates.

Table 4: Two-Stage Least Squares (2SLS) Estimates of Relationship between Contact with Children and Cognitive Recall Scores for Women

	First-Stage OLS	Reduced Form		2SLS	2SLS w/ Childless Sample
Dependent Variable	Ln(Days of Contact)	Cognitive Recall Score		Cognitive Recall Score	Cognitive Recall Score
Number of Female Children	0.130***	-0.049	Ln(Days of Contact)	-0.375	-0.378
	(0.011)	(0.032)		(0.246)	(0.246)
Observations	27699	27699		27699	29575
R-squared	0.145	0.272	Hausman Test Statistic	6.50	2.41
F-Statistic	38.72	--	Hausman Test p-value	0.011	0.121

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimates are weighted with inverse probability weights to control for attrition. Standard errors are clustered on the individual. All models include the same covariates as shown in Table 2. In the last column, the coefficient on the "Childless" indicator variable is -3.640, $p = 0.116$.

Table 5: OLS Estimates of the Relationship between Contact with Children and Cognitive Recall Scores for Full Sample, by Living Arrangements for Women

Assisted Living		Children Live within 10 miles	
	Women		Women
Ln(Days of Contact)	0.035	Ln(Days of Contact)	0.044*
	(0.022)		(0.026)
Live in Assisted Living Environment	-0.822**	Children Live within 10 Miles	-0.509**
	(0.419)		(0.237)
Ln(Contact) * Assisted Living	0.039	Ln(Contact) * Children Nearby	0.057
	(0.075)		(0.042)
Observations	27699	Observations	26739
R-squared	0.273	*R-squared*	0.272

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimates are weighted with inverse probability weights to control for attrition. Standard errors are clustered on the individual. All models include the same covariates as shown in Table 2. Only 3% of the sample lives in an assisted living environment, therefore the models for living arrangements have been run with interaction terms to keep consistency and retain sample size. 61% of respondents have at least one child living within 10 miles. Assisted Living is defined by an individual living in any on for the following: nursing home, senior citizen housing, retirement community/center, or assisted living, due to lack for sample size.

Table 6: OLS Estimates of the Relationship between Mode of Contact with Children and Cognitive Recall Scores for Full Sample, by Living Arrangements for Women

	Full Sample	Assist Living	Not in Assisted Living	Child lives within 10 miles	Child does not live within 10 miles
Ln(Phone Contact)	-0.047	0.430*	-0.100*	-0.075	-0.066
	(0.060)	(0.248)	(0.059)	(0.087)	(0.083)
Ln(Person Contact)	-0.022	-0.345	0.009	0.052	-0.139**
	(0.040)	(0.241)	(0.040)	(0.055)	(0.068)
Ln(Written Contact)	0.074**	0.353*	0.063**	0.067*	0.08
	(0.030)	(0.210)	(0.030)	(0.038)	(0.049)
Observations	2464	90	2374	1458	1002
R-squared	0.260	0.553	0.253	0.248	0.293

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimates are weighted with inverse probability weights to control for attrition. Standard errors are clustered on the individual. All models include the same covariates as shown in Table 2. Data on mode of contact are only available in the 2004 and 2008 waves of the HRS.

Table 7: Factor loadings (pattern matrix)

Variable	Factor1	Factor2
How much do they really understand the way you feel about things?	**0.7347**	-0.3496
How much can you rely on them if you have a serious problem?	**0.7474**	-0.3764
How much can you open up to them if you need to talk about your worries?	**0.7513**	-0.4378
How much do they criticize you?	0.5265	**0.6387**
How much do they let you down when you are counting on them?	0.7242	0.2977
How much do they get on your nerves?	0.6621	0.4760

Note: Responses available are “a lot”, “some”, “a little” or “not at all”.

Table 8: OLS Estimates of Factor Analysis Relationship Quality Measures and Contact with Children and Cognitive Recall Scores for Women

	Baseline Mode	Interacted Model
Ln(Days of Contact)	-0.026	0.141
	-0.053	(0.124)
Supportive Children	0.033	0.041
	(0.098)	(0.288)
Critical Children	-0.053	0.388
	(0.074)	(0.253)
Ln(Contact)* Supportive		-0.001
		(0.050)
Ln(Contact) * Critical		-0.081*
		(0.044)
Observations	2694	2694
R-squared	0.269	0.270

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All estimates are weighted with inverse probability weights to control for attrition. Standard errors are clustered on the individual. All models include the same covariates as shown in Table 2. Data on "relationship quality" are only available in the 2004 and 2008 waves of the HRS.

Figure 1 Distribution of Cognitive Recall

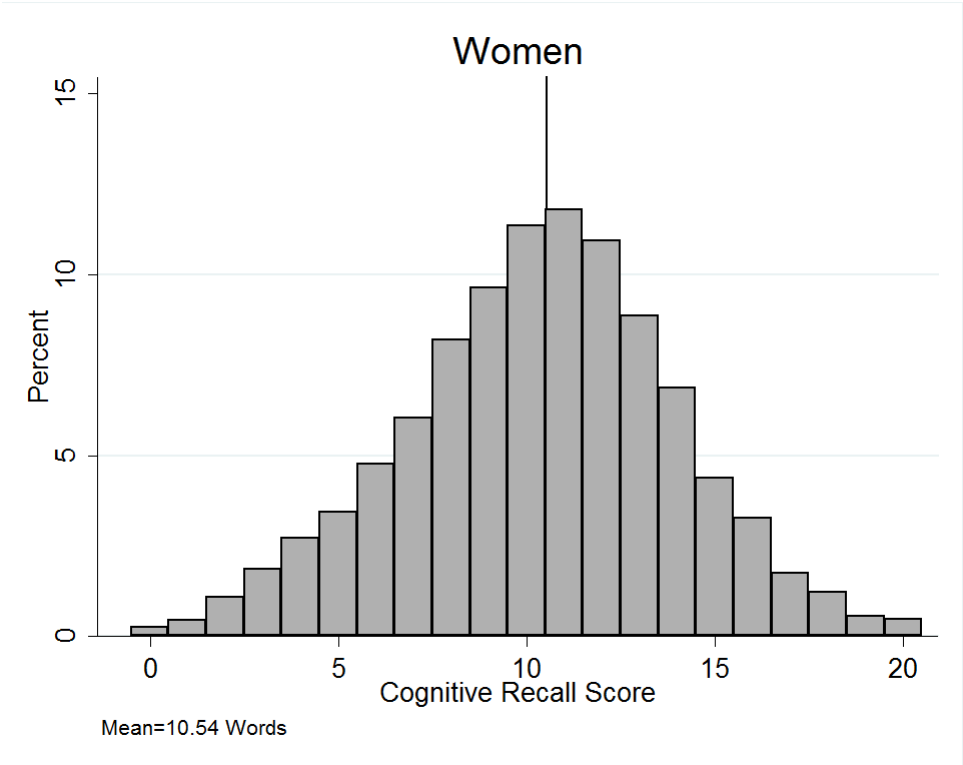

Figure 2 Cognitive Trajectories - Quadratic OLS Models

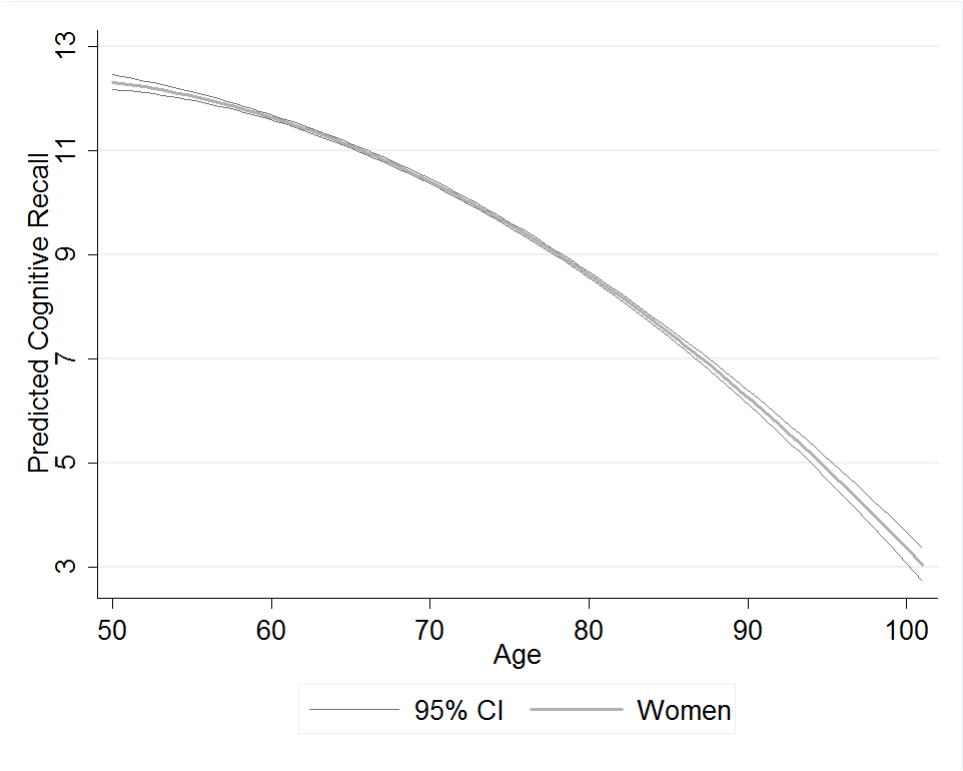

Figure 3 Distribution of Contact with Nonresident Children

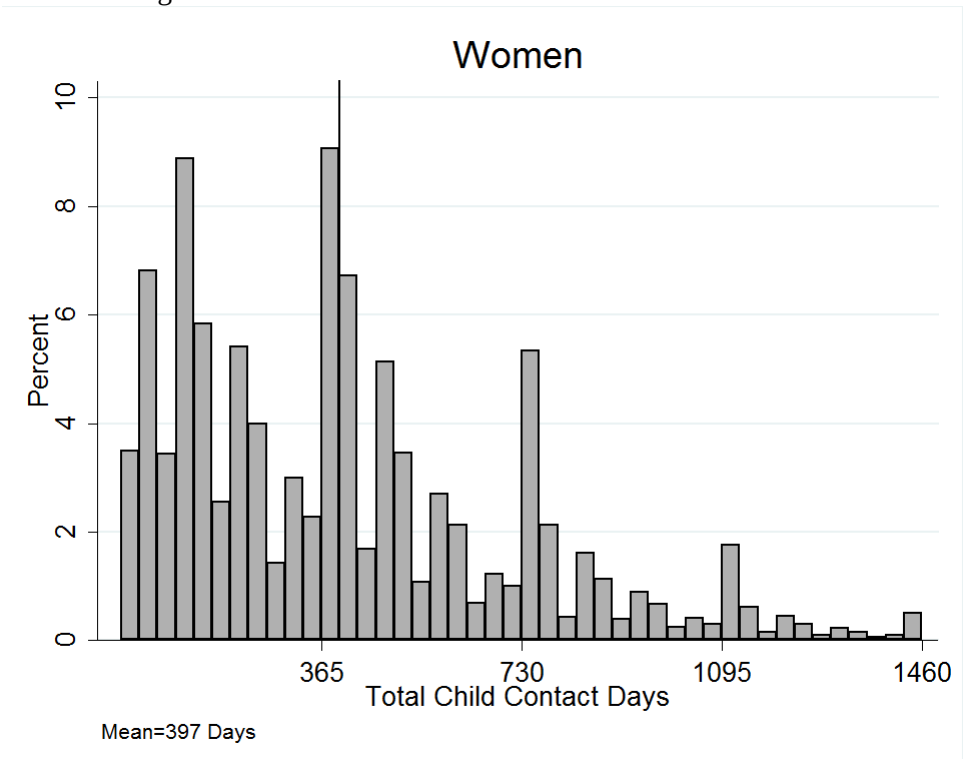

Figure 4 Days of Contact and Number of Female Children

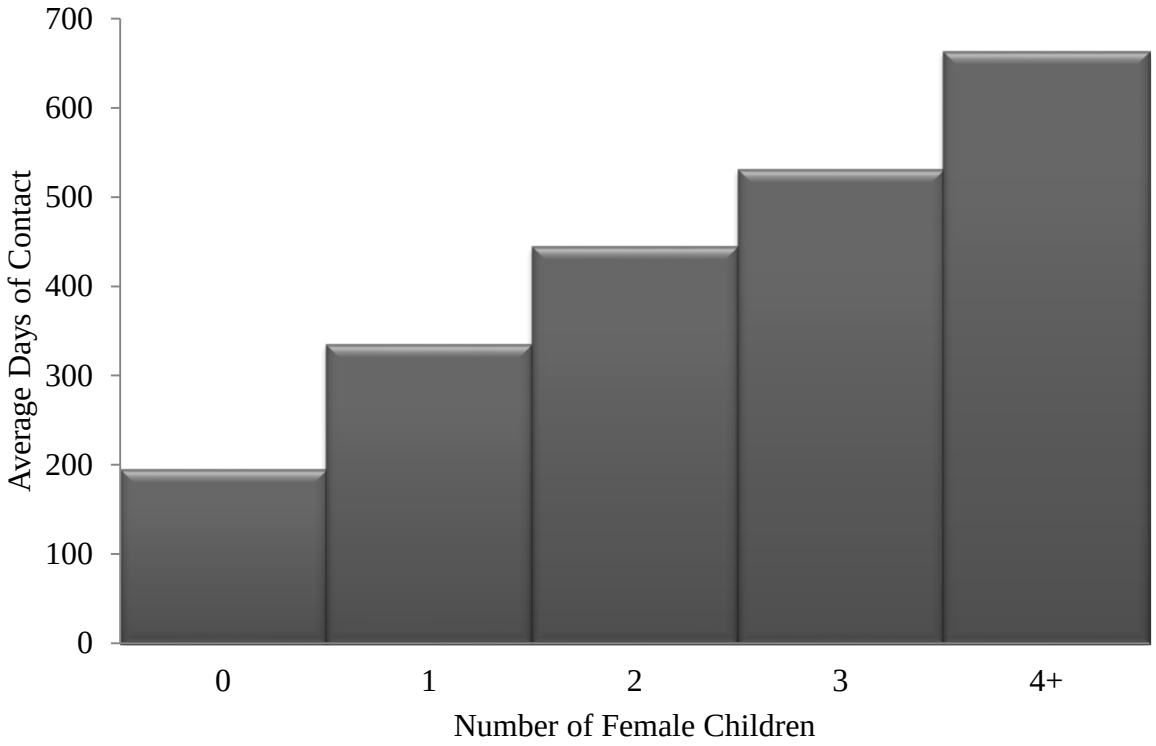

Figure 5a In-Person Contact Frequency

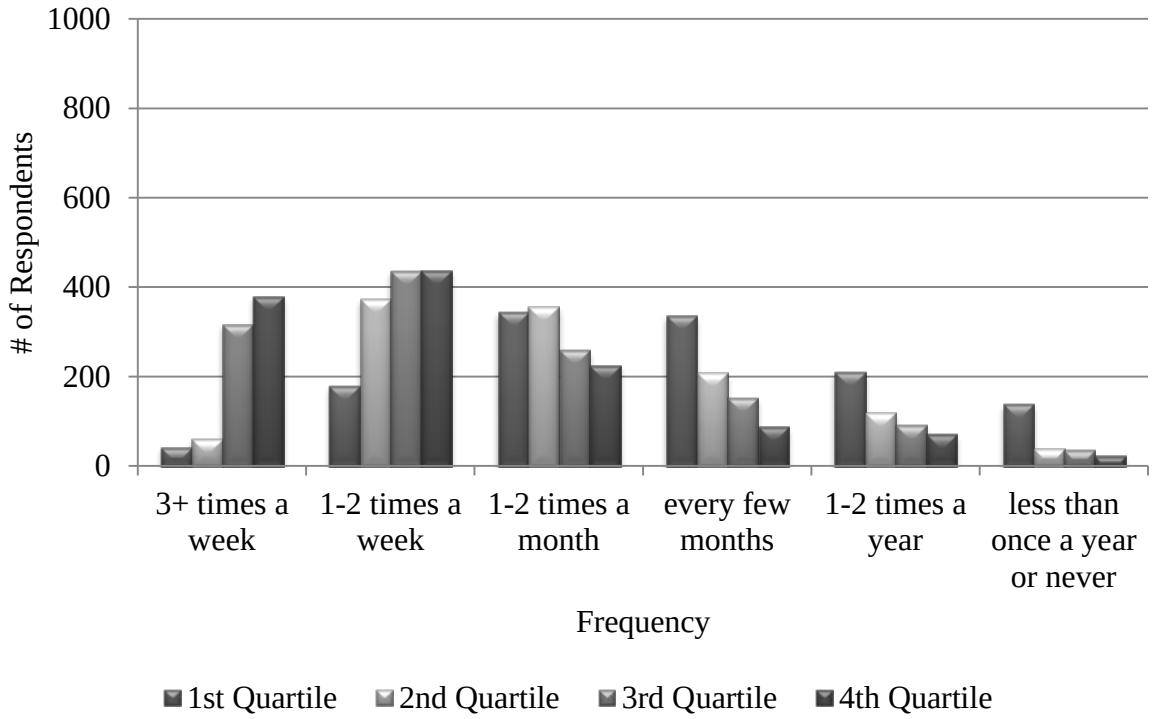

Figure 5b Phone Contact Frequency

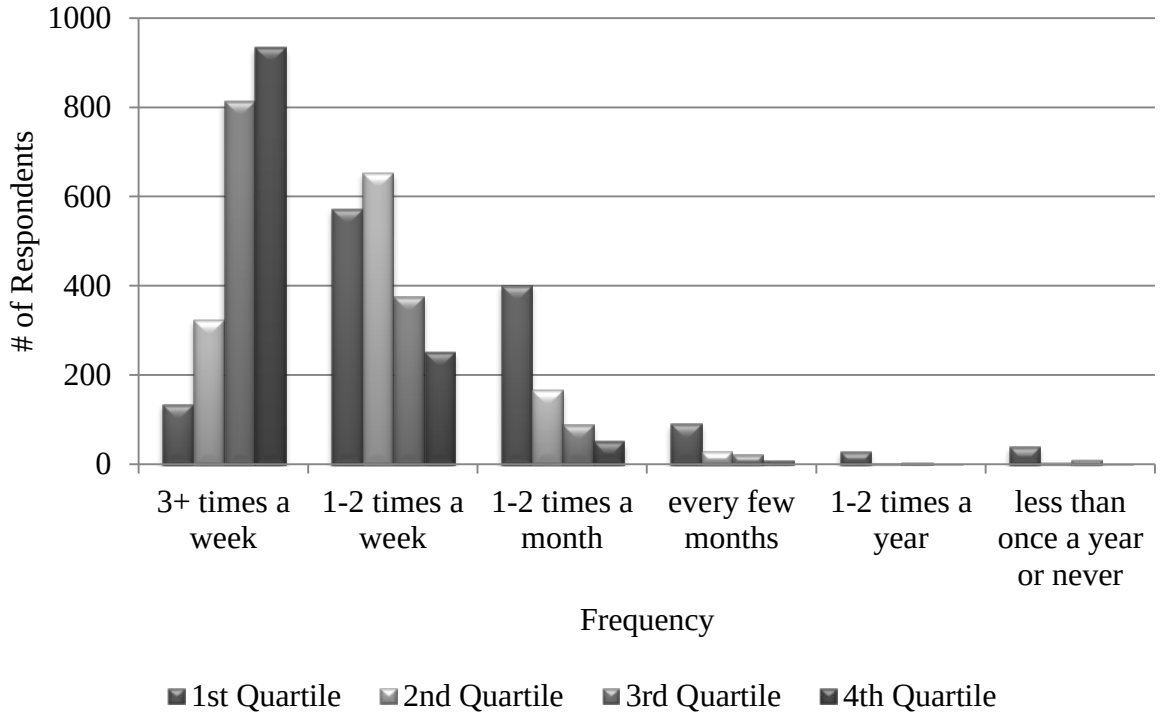

Figure 5c Written Contact Frequency