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Family Members' Education and Cognitive Functioning Among Older Adults: Investigating the Mediating Role of Health Behaviors

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FAMILY MEMBERS' EDUCATION AND COGNITIVE FUNCTIONING AMONG
OLDER ADULTS: INVESTIGATING THE MEDIATING ROLE OF HEALTH
BEHAVIORS

by

LU TIAN

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GREGORY PAVELA

A THESIS

Submitted to the graduate faculty of The University of Alabama at Birmingham,
in partial fulfillment of the requirements for the degree of
Master of Arts

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2023

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BEHAVIORS

LU TIAN

MEDICAL SOCIOLOGY

ABSTRACT

Despite a well-established relationship between education and cognitive performance in later life, few studies have considered the effects of educational attainment of the family. The education of one's parents can help prevent cognitive decline, as parents (G1) with more education can transfer more health knowledge, teach health literacy, and cultivate healthy lifestyles. This downward spillover between parental education (G1) and older adults' (G2) cognitive health is well documented. For the downstream effect, attention is often given to maternal education rather than paternal education. Another line of research examined intergenerational transmissions from children (G3) to parents (G2), finding that having well-educated children (G3) was negatively associated with dementia onset and cognitive decline. Adult children (G3) form an important part of older adults' (G2) social network, and the structural conditions enable resources to be transmitted from one generation to the other. Building on this research, the current study investigates the association between older adults' cognition and multigenerational educational attainment, focusing on the behavioral mechanisms underlying this association. Understanding how multigenerational education improves older adults' cognitive functioning contributes to our knowledge of how life-course SES affects health in older age. Because it is well-known that parents' (G1) SES plays an important role in individual (G2) early-life development.

During later adulthood, personal health status is affected by adult children's (G3) circumstances and resources. This study aims to show how the educational attainment of multiple familial generations serves as a potential resource in shaping personal cognitive health later in life. Using nationally representative data from the 2014 Health and Retirement Study, this project will test the hypotheses that (1) a positive association exists between parental (G1) and adult children's (G3) education and the cognitive function of old adults (G2), (2) behavioral factors including smoking, drinking alcohol, and physical activities account for the association between multigenerational education and older adults' cognitive functioning, and (3) older adults who have healthier behaviors have better cognitive health.

Keywords: Cognitive health, Intergenerational support, Health and Retirement Study, Education, Family, Adult children

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INTRODUCTION

The benefits of education for population health are well documented (Baker, Leon, Smith Greenaway et al. 2011, Hale, Schneider, Gampe et al. 2020). Educational attainment is generally associated with better mental and physical health, fewer chronic conditions, lower disability levels, and longer life expectancies (Assari 2017, Freedman, Martin, Schoeni et al. 2008, Hummer and Lariscy 2011, Ross and Mirowsky 2006). As an individual ages, cognitive function changes as a result of education, which emerges in early adulthood and persists as the individual ages (Lövdén, Fratiglioni, Glymour et al. 2020). Lövdén and colleagues provided some knowledge about the relationship between individual educational attainment (G2) and health. But an emerging focus examines the effects of educational attainment of multiple familial generations, especially individuals' parents (G1) and adult children (G3), on health outcomes. Research adopting a life course approach suggests a protective role of parents' (G1) schooling on the cognitive health of aging individuals (G2) (Zhang, Hayward and Yu 2016, Zhang, Liu, Li et al. 2017). Research examining the G1-G2 association underscores the downstream effect of childhood environment on older adults' cognitive functioning. Another body of research highlights the potential of adult children to influence their parents' health later in life. Adult children's schooling positively affects the longevity (De Neve and Harling 2017, Friedman and Mare 2014, Wolfe, Bauldry, Hardy et al. 2018b, Yahirun, Sheehan and Hayward 2017), physical functioning (Yahirun, Sheehan and Hayward 2016, Yahirun et al. 2017), and mental health (Lee, Gleib, Goldman et al. 2017, Yahirun, Sheehan and

Mossakowski 2021) of their aging parents, regardless of parents' education levels.

Echoing this line of research on the relationship between children's educational status and parents' health, some research indicates that parents with well-educated children tend to have better cognitive functioning as they age in Asian countries (Lee 2018, Ma 2019) and in Mexico (Ma, Yahirun, Saenz et al. 2021). Despite the role of parental and children's education in the cognitive health of older adults, little is known about the relationship between the educational attainment of family members—henceforth multigenerational educational attainment (G1 parents and G3 children)—and cognitive performance of G2 in later adulthood. The current study aims to assess the association between multigenerational educational attainment—including the educational attainment of one's children and parents, and the health of the middle generation (G2) in later life.

It is estimated that dementia and mild cognitive impairment are more prevalent among older African Americans and Hispanics, as well as those with less education. Correspondingly, we may see a disproportionate increase in the socioeconomic burden of dementia among the disadvantaged groups. Improved life course conditions and resources may reduce the projected burden of dementia. According to studies conducted in the U.S, dementia incidence has declined over the past 40 years, possibly by 10%-40% each decade (Roehr, Pabst, Luck et al. 2018).

One reason for this decline is that the aging population is becoming more educated. The cognitive performance of individuals with greater educational attainment will remain higher relative to their less educated counterparts, which may delay the onset of cognitive impairment (Lenehan, Summers, Saunders et al. 2015, Yahirun, Sheehan and Mossakowski 2020a) possibly due to better brain maintenance or cognitive reserve

(Zahodne, Mayeda, Hohman et al. 2019). Overall, these studies have tied higher educational levels to better cognitive functioning in older adulthood and generally focused on individual educational attainment rather than that of their family members. Family members' educational attainment may affect the ability to transfer quality and effective support across multiple generational lines. The education levels of network members are positively associated with individuals' health, even after controlling for their socioeconomic status (Song 2011). Within the family network, individuals' (G2) wellbeing is strongly influenced by their parents' (G1) socioeconomic assets in the early years of life (Steinberg and Morris 2001). Well-educated parents may provide lifelong advantages for cognitive health along several possible pathways (Fors, Lennartsson and Lundberg 2009). First, parental SES may affect neurophysiological development, which in turn influences lifelong cognitive abilities. Parental education is a strong predictor of brain structure in frontal regions, typically associated with cognitive functions (Lawson, Duda, Avants et al. 2013). Highly educated parents tend to engage in more cognitively stimulating interactions with their children, using a wider vocabulary and more complex sentence structures (Duncan and Magnuson 2012). Second, childhood SES may indirectly influence older adults' cognition via exerting influence on the development of modifiable risk and protective factors during adulthood. Aging individuals (G2) with more educated parents (G1) may be more likely to engage in favorable health behaviors (Pedron, Schmaderer, Murawski et al. 2021), which in turn reduce the risk of cognitive decline (Lee, Back, Kim et al. 2010).

Another factor affecting cognitive health of older adults is their socioeconomic resources in later life SES. Adult children play an increasingly important role in the

cognitive, physical, and psychological wellbeing of older adults (Ma et al. 2021, Torssander 2014, Yahirun et al. 2016, Yahirun et al. 2017). In a study examining the association between adult children's schooling and older adults' mortality, Friedman and Mare (2014) have found that this association may be explained by parents' health behaviors, including smoking and physical activity. Learning how the educational attainment of offspring influences their parents' cognitive function is crucial for revealing how individual wellbeing is shaped by the broader social and cultural environment and developing a policy that addresses the increasing resource demands of aging populations. However, few studies have examined the underlying behavioral pathways that explain how well-educated children promote the cognitive ability of older adults. This study will explore whether and to what extent parental and offspring's education influence older adults' cognition functioning, net of their own education. Therefore, in this study I ask:

Question 1: Are older adults with more-educated parents and adult children cognitively healthier than those with parents and adult children with less education?

Building on the research by Friedman and her colleague, this study explores how the educational attainment of family members may influence the cognitive functioning of older adults via changes in modifiable risk and protective factors. A growing body of evidence suggests that health behaviors protect against cognitive decline and dementia, including body mass index, diet, nutrition, physical activity, smoking, and alcohol drinking (Lee et al. 2010, Vňuková, Richards and Cadar 2017). Nonetheless, we know little about whether health behaviors help explain the associations between the

educational attainment of family members and the cognitive functioning of older adults

Thus, in this study I ask:

Question 2: To what extent do one's health behaviors account for the relationship between multigenerational (G1&G3) education levels and cognitive health in later adulthood?

To contextualize the association between multigenerational educational attainment and cognitive health of older adults, I draw on two theoretical perspectives—*linked lives* and *adjacent generations*—and consider *health spillover* as a potential mechanism to explain the association between the educational attainments of adjacent generations and the cognitive health of older adults. I use data from the Health and Retirement Study (HRS) to answer these questions. Below, I review previous research concerning educational disparities in cognition and the association between multigenerational education and health outcomes.

BACKGROUND

Importance of Education for Cognition

The relationship between socioeconomic status and health in the United States is commonly studied using educational attainment. Compared to other socioeconomic factors such as poverty and income inequality (Galea, Tracy, Hoggatt et al. 2011), education is a stronger predictor of health outcomes (Woolf, Johnson, Robert L. Phillips et al. 2007). A well-educated individual has acquired a considerable amount of human capital; the cognitive skills learned during school can contribute to the creation of a healthy lifestyle (Mirowsky and Ross 1998), the financial literacy to avoid financial strain (Boisclair, Lusardi and Michaud 2017), and adherence to complicated medication regimens (Apter, Wan, Reisine et al. 2013). As a result, highly educated individuals can gain greater control over their environment and increase their potential for a longer, healthier life by adopting healthier behaviors, adopting health-enhancing technologies, and managing dementia risk factors like hypertension and cholesterol. Hale et al. (2020), for example, found that older adults without high school degrees experienced the largest increases in the prevalence of cognitive impairment and dementia from 1996 to 2014. Throughout adulthood, education, completed early in life, is fairly stable and belongs to an individual (Ross and Mirowsky 2006). With regard to explaining large-scale intergenerational mobility, however, the contribution of multigenerational educational attainment remains in question (Zhang et al. 2016).

Families have profound and direct effects on shaping their children's health, as strong social ties within the family provide socioeconomic benefits and family supports (Thoits 2011). Education often leads to health benefits through occupational and economic attainment, such as health insurance, healthier and more expensive diets, and gym memberships. Those benefits are not merely features of individuals but cultivated and nurtured in families and in relationships between parents and children. According to research on social capital and health, which examines the importance of network members' resources to health outcomes, a network member's level of education, including that of family members, are positively associated with better health. For example, both mother's and father's schooling attainment are associated with episodic memory in China at ages 45 and above (Zhang et al. 2017). Similarly, using nationally representative data from the Mexico, studies have reported that higher level of parental schooling predicted better cognitive function (Zeki Al Hazzouri, Haan, Kalbfleisch et al. 2011). It is also worth noting that these findings remain significant even after adjusting for an individual's own education, indicating that the cognitive health benefits associated with close social ties differ from those associated with personal resources.

Linked Lives

Linked lives concept refers to the interconnectedness of network members of social relationships. It is helpful in understanding the entangled connections for the networks, across diverse life domains, formed by parents, siblings, friends, offspring, coworkers, partners, and others (Carr 2019). People in close relationships have mutually influencing roles, responsibilities, and social identities over the course of their lives (Elder, Johnson and Crosnoe 2003). This principle is especially useful in understanding

intergenerational transmission, or the ways through which the benefits of parents' (G1) and adult children's (G3) education attainments influence older adults' health (G2). Considering the possibility of a family member's education influencing the health outcome of another family member sheds light on the interdependence of parents and children, in which events in one family member's life influence the lives of others. Higher education may not only benefit the individual but may also benefit the well-being of his/her parents. Within the family network, early in life, personal health and education are greatly affected by their parents' socioeconomic resources, but in later years, the adult children's resources have consequences for the health and wellbeing of their aging parents (Milkie, Bierman and Schieman 2008). There is evidence of a connection between adult children's education and their parents' health based on empirical studies. Zimmer and Colleagues (2002) reported that people who have well-educated children are less likely to experience severe forms of their disabilities when they have some degree of functional limitations. Friedman and Mare (2014) found an association between children's schooling and parental mortality, which is independent of parents' own education.

Long Arm, Social Foreground and Adjacent Generations Perspectives

Parental resources play a significant role in their health, and the effect continues throughout later adulthood. The *long arm* perspective emphasizes the potential implications of childhood conditions and resources for the brain health of older adults (Hayward and Gorman 2004). This approach reflects a life course approach that suggests an age patterning of cognitive function over the life course. The age pattern of brain development makes this an issue of particular importance, given that the brain develops most during childhood, continues to grow into adolescence, and maintains functioning in

later life (Lupien, McEwen, Gunnar et al. 2009, Meng and D'arcy 2012). According to this perspective, prior generations' resources have independent effects on the health outcome and status attainment of subsequent generations. For example, parents' educational attainment reduce children's poor nutrition, exposure to disease, and infections and illnesses that challenge the immune system (Cohen, Janicki-Deverts, Chen et al. 2010). These conditions may weaken biological functioning and result in latent damage, if remaining for years, that cognitive health may be threatened in later life. For example, childhood malnutrition has been found to be associated with the onset of cognitive impairment (Zhang, Gu and Hayward 2008). However, some studies have different findings. They found that the severity or prevalence of older adults' cognitive impairment was not related to early childhood conditions, measured using a scale that included low levels of parent education (Zhang et al. 2016). Given the inconsistency, this paper continues to assess the role of parental (G1) education on older adults' (G2) cognitive status.

While the long-arm approach enables researchers to investigate the downward generational flow of resources, the *social foreground* perspective is concerned with the influence of adult children's socioeconomic on the prior generation's health (Torssander 2013) (Friedman and Mare 2014, Zimmer, Martin, Ofstedal et al. 2007). This approach is useful given that adult children play a more prominent role in supporting older adults, who face increasingly shrinking social networks as they age (Fischer and Beresford 2015, Goldman and Cornwell 2018). Keeping older adults healthy through their adult children reflects a life-course perspective as well, in which later life factors may influence health in a different way from earlier in their lives. Research has found that depressive

symptoms were significantly lower among parents over 50 whose children all completed college than those without college-educated children (Yahirun et al. 2021). In the context of cognitive health, studies have shown that having highly educated children is associated with better cognitive function among older adults in Mexico (Ma et al. 2021), South Korea (Lee 2018) and China (Ma 2019). However, social and cultural contexts are important to consider when extending analyses to the US regarding the influence of offspring educational attainment on the cognitive health of their parents. First, in China and South Korea, filial obligations are historically strong, and the growing body of filial support laws in Asia provides measures to discourage children from neglecting their aging parents (Serrano, Saltman and Yeh 2017). Second, the mismatch between the development of support institutions for older adults and scale of population aging is more salient in Asian and Latin American countries compared to U.S (Gutiérrez Robledo, López Ortega and Arango Lopera 2012, Serrano et al. 2017). Empirical evidence from US older adults is relatively scarce. Yahirun et al. (2020) suggested that even though parental education did not seem to influence older adults' cognitive health at later life stage, adult children's education did have a salient positive effect. But this study reveals little about the pathways, through which parents (G1) and adult children (G3) transmit health advantages to older adults (G2). Motivated by this study, this paper will address this gap by incorporating health behaviors of older adults.

Considering the long arm and social foreground perspectives in the context of aging, both shed lights on an intergenerational process. The educational levels of the generations around a focal generation, also called *adjacent generations*, determine the resources available to older individuals (Wolfe, Bauldry, Hardy et al. 2018a). A growing

body of literature suggests that health outcomes may also be linked to adjacent generations—one's parents (G1) and adult children (G3) (Wolfe et al. 2018a, Wolfe et al. 2018b). By integrating the long-arm and social foreground perspectives, the adjacent generation perspective suggests that it is important to consider how the education of previous generations (parents (G1)) and subsequent generations (adult children (G3)) shapes health in older age, in addition to the education of an individual's own generation (G2).

For example, Wolfe and colleagues identified the role of multigenerational educational attainments in older adult's mortality (Wolfe et al. 2018a, Wolfe et al. 2018b). They found that people with better education, their parents, and their children are more likely to live longer. Considering these findings, children with higher education may be able to offer better care for their ill and elderly parents. This line of research lead to the following hypotheses:

Hypothesis 1: The educational attainments of one's parents and adult children are associated with cognitive health in later adulthood.

Health Spillover

Spillover effect is a concept based on social systems theories, containing the ecological approach (Almeida, Wethington and Chandler 1999) and family network perspective (Anderson 1992). Spillover occurs because individuals are surrounded by different interdependent social systems and share assumptions with each other. Following this perspective, among close relatives, it might be possible to influence each other to change unhealthy habits and have a shared set of norms regarding health. For example, the

effects of people's education can spread to their partners (Monden, van Lenthe, De Graaf et al. 2003) and relatives like siblings through the spillover effect.

Parent (G1) to Child (G2) Spillover Effect

Previous research on intergenerational spillover effects mainly focuses on the transmission from parents (G1) to children (G2). The influence of parents' educational level on health begins as early as livebirth (Balaj, York, Sripada et al. 2021), such as cognitive development (Schady 2011)), and remains till older age morbidity (Montez and Hayward 2013, Pakpahan, Hoffmann and Kröger 2017) as well as mortality (Gakidou, Cowling, Lozano et al. 2010). It is possible for health spillovers of parental education to occur for a number of reasons.

Education can help adults become more aware of the harms caused by health-related behaviors, such as smoking and drinking excessively, and they can also access a variety of health-related resources, such as gym memberships, methods of quitting smoking, and advanced health information (Cutler and Lleras-Muney 2010). Highly educated parents may encourage health behaviors. A higher educational level of parents is associated with more children's involvement in health behaviors (Kemptner and Marcus 2013, Ruedl, Niedermeier, Wimmer et al. 2021). Parental education has long-arm impact on later life health. Maintaining lifelong health behaviors may be related to effective brain function and integrity of brain structure (Hillman, Khan and Kao 2015), which in turn generate long-term effects on cognitive health. Those studies suggested that personal (G2) health behaviors accumulated over the life course appear as important channels linking parental (G1) education and their health.

Adult child (G3) to Older Adult (G2) Spillover Effect

The spillover effect is not only transmitted downward, but also upward. The intergenerational mobility in education and health can also occur from parent to child. One's well-being could be affected in multiple ways by adult child's education. Studies have suggested that education has a spillover effect in the case of siblings (Kravdal 2008) and partners (Monden, van Lenthe, De Graaf et al. 2003). The spillover effect is believed to exert an influence through lifestyle habits, health care use, and medical treatment adherence. Well-educated adult children have more knowledge of health-related behaviors and more material resources in promoting mental health in older parents through various forms of support (Cutler and Lleras-Muney 2010). For example, they may be better able to circulate health-related knowledge within a family, persuade their parents to cease smoking and drinking, and encourage them to participate in exercise regularly. When parents are ill, children with higher education may be more knowledgeable about healthcare systems and can use social networks to help their parents find qualified healthcare professionals.

In sum, it is likely that better education of parents and adult children is a significant factor in exercise, smoking cessation and drinking controlling, specifically, light/moderate drinking. Previous research suggests that drinking moderately is associated with a significant health benefit compared with abstaining from alcohol or heavy drinking among those with poor health behaviors (little exercise, poor diet, and smokers) (Britton, Marmot and Shipley 2008).

Based on those findings, I put forward this hypothesis:

Hypothesis 2: The association between the education of parents and adult children with cognitive health in later adulthood will be significantly reduced after controlling for health behaviors.

The Current Study

The current study extends past research examining the association between individual education and cognitive functioning in older adults by additionally assessing the associations between the educational attainment of G1 and G3 with later-life cognition. Using wave 12 of data from the HRS, I test whether the education of adjacent generations is linked to cognitive functioning in later life. I further investigate whether health behaviors attenuate the estimated direct effect of multigenerational education on cognitive outcomes.

METHOD AND DATA

Sample

I will use the Health and Retirement Study (HRS), a biennial population-based panel survey of U.S. representative of non-institutionalized adults over the age of 50, including their spouses or partners. A stratified probability frame was used to select nationally representative households. In each wave, participants completed an interview that evaluated their demographic characteristics, health, and cognitive capabilities. The survey also contains child rosters with information on each child's sexes, ages, and educational levels. The raw HRS data, Tracker files of HRS, and RAND HRS are the data products for analyses. The RAND data are the cleaned, processed, and streamlined data product of HRS data, including Exit/Post-Exit Interview data information. Those data are available to the public and can be downloaded for free at <https://hrs.isr.umich.edu/data-products> after registration.

Given that questions about cognition are only asked among respondents aged 65 and over, the eligible sample is restricted to them. Thus 8,239 observations are deleted. Since most children have completed their education by the time when they are 25, we only include children in our sample when they are 25 and over. Those older than 70 are also dropped to ensure that children are neither too young to have completed secondary school nor too old to have living parents, resulting in 699 cases being dropped. Respondents should have at least one living adult child, and thus 199 ineligible cases are

removed. After dropping the missing data in variables needed for subsequent analysis, the final sample size is 16,446.

Outcomes

Cognitive function is measured using several performance measures, including episodic memory (immediate and delayed word recall), working memory and mental status (Rodgers, Ofstedal and Herzog 2003). The results of each measure were summed to create a composite score of cognitive function ranging from 0 to 35. The total score has been proven valid in several studies (Hung, Wisnivesky, Siu et al. 2009, Karlamangla, Miller-Martinez, Aneshensel et al. 2009).

Variable of Interest

Parental education: Parents' education is measured with the education of the highest-educated parents if information on both parents is available. I distinguish between parents who have less than a high school education (<12 years of schooling), a high school education (12 years of schooling), some college (13–15 years of schooling), or college or more (at least 16 years of schooling).

Adult children's schooling: Following Zimmer et al. 2002 and Zimmer et al. 2007, offspring' education is measured with the highest education among children, ranging from 0~17+ years. In this study, I treat offspring's education as a categorical variable, less than 12 years of schooling, 12 years of schooling, 13–15 years of schooling, and 16 or more years of schooling. When children tie for highest level of education, I chose the eldest adult child.

Mediating Variables

Health-related behaviors. *Exercise regularly* refers to vigorous exercise that takes place at least three times a week for 30 minutes; *smoking status* is composed of dummy variables: formerly smoking, and currently smoking; *drinking status* is measured by a dummy variable with the question "Do you ever drink any alcoholic beverages, such as beer, wine, or liquor?".

Controls

To isolate the relationship between older parents' cognitive performance and their offspring's schooling, the analysis will also include ten potentially confounding variables, collected from three domains. The first set of variables represents *demographic and familial characteristics*: respondent's age, race/ethnicity, gender, nativity (foreign born vs. non-foreign born), marital status, number of living children. The correlation between children's education and parental cognition can be driven by unobserved factors, such as family SES characteristics. I include two indicators of SES: education and wealth. Respondents have a range of education from 0 to 17 years. A spouse's highest education is included as well. All educational variables are categorized into four types: less than high school (< 12 years), high school (12 years), some college degree (13~15 years), and college degree (16+ years). Logged annual income is included. Poor health of parents may have adversely affected children's ability to complete schooling. Therefore, I control for six health conditions that respondents have ever had, including hypertension diabetes, lung disease, kidney disease, heart disease, and cancer. To assess depressive symptoms in

older adults, I include 7-item CES-D scale, which has a comparable interval consistency and accuracy as the 20-item CES-D scale (Andresen, Malmgren, Carter et al. 1994).

Analytic Strategy

In Step 1, I start with a descriptive analysis of how the total cognition score varies across parental and adult offspring's education levels. In Step 2, I use multiple linear regression models to examine the associations between education attainment of multiple generations and older adult's cognition. Step 2 will start with a bivariate analysis of multigenerational education attainments and older adults' cognition. Next, I will include controls for several sociodemographic characteristics, including health conditions and indicators of household SES. In Step 3, I examine how health behaviors influence the associations between multigenerational educational attainment and cognitive health. Statistical tests for the attenuation of coefficients across models will be conducted using Stata's *suest* command. This command uses Seemingly Unrelated Estimation to provide tests for intramodel and cross-model hypotheses.

RESULTS

Table 1 presents the descriptive results of health behaviors, multigenerational education and older adult's cognitive health. Cognitive function scores range from 0 to 35, with a mean value of 19.85. When looking at the highest level of parents' education, 63% have less than high school degree and 23% have high school degree. The proportion of those with college and some college degree is relatively small, accounting for 14%. Turning to the education of adult offspring, 60% of them have a college degree, 22% with some college degree, and 17% have children with only high school degrees. Only 1% have less than high school degree. Regarding health behaviors, only 9% are smoking currently. More than half of them have ever smoked or consumed alcohol. Most respondents never participate in vigorous physical activities, with 18% engaging in vigorous activities more than 3 times per week.

Among the sample, women account for 56%, and men for 44%. They were overwhelmingly born in the U.S (91%), non-Hispanic White (78%) and married (54%). The average number of living or in-contact children is about 3. The educational attainments of respondents and their spouse have similar distribution. The number of those who have high school or less than high school is closed to those with degree higher than high school. When checking their health conditions, 68% of them have been diagnosed as hypertension, about 27% with diabetes, 24% with cancer, 16% with lung disorder, 17% with stroke, and 36% with heart disease. The level of depression is relatively low, with a mean value of 1.

Table 1. Descriptive Results of Parental and Adult Children's Education, Health Behavior and Cognition of Adults Aged 65+ at Wave 2014 (N = 16,446)

Variables Names	Description	Mean (%)	SD
Cognition	Total cognition summary score	19.82	5.49
Parents' education	Highest level of schooling years		
Less than High School	0-12 years	0.64	
High School	12 years	0.23	
Some College	13-15years	0.07	
College Degree	16-17 years	0.07	
Adult children education	Highest level of schooling years		
Less than High School	0-12 years	0.01	
High School	12 years	0.17	
Some College	13-15years	0.22	
College Degree	16-17 years	0.60	
Health Behaviors			
Currently smokes	Respondent currently smokes (Yes=1)	0.09	
Ever smokes	Respondent ever smoke (Yes=1)	0.59	
Ever drinks any alcohol	Respondent ever drinks any alcohol (Yes=1)	0.41	
Vigorous physical activity (3+/wk?)	Respondent has vigorous physical act. 3+/wk? (Yes=1)	0.18	
Gender			
Male		0.44	
Female		0.56	
Nativity	Place of birth		
U.S. Born		0.91	
Foreign Born		0.09	
Children	Number of Living or In-Contact Children	3.45	2.09
Age (centered@65)		12.23	7.53
Race/ethnicity			
Non-Hispanic White		0.78	
Non-Hispanic Black		0.12	
Hispanic		0.07	
Non-Hispanic Other		0.02	
Marital Status			
Married		0.54	
Divorced/Separated		0.09	
Widow		0.36	
Never Married		0.01	
Socioeconomic Status	Household SES		
Respondent Education	Years of education		
Less than High School	0-12 years	0.26	
High School	12 years	0.34	
Some College	13-15years	0.20	
College Degree	16-17+ years	0.19	

Spouse's education	Spouse's years of education		
Less than High School	0-12 years	0.41	
High School	12 years	0.27	
Some College	13-15years	0.16	
College Degree	16-17 years	0.16	
Household income	Log of total household income (respondent & spouse)	10.33	0.95
Health Problems			
Ever had hypertension	Yes is 1, otherwise 0	0.68	
Ever had diabetes		0.27	
Ever had cancer		0.24	
Ever had lung disorder		0.16	
Ever had heart disease		0.40	
Ever had stroke		0.17	
CESD	0~8 Higher scores indicate poorer mental health	1.67	2.04

Parental Educational Attainment and Older Adults' Health Behaviors

The first set of analyses assesses the distribution of the four types of health behaviors. Table 2 presents results from a binary logistic regression estimating the association between parents' educational attainment and the odds of currently smoking (Model 1-2), ever smoking (Model 3-4), ever drinking (Model 5-6), and vigorous physical activity three times per week (Model 7-8). Controls for other older adults' sociodemographic characteristics (i.e., gender, nativity, number of living children, race/ethnicity, and marital status), household SES (i.e., older adults' education, spouse's education, and household income), and health conditions (i.e., diabetes, hypertension, cancer, lung disorder, heart disease, stroke, and CES-D). Subsequently, models add controls for health behaviors (i.e., Model 2, 4, 6, and 8) to check the robustness of the association between one specific health behavior and parental education.

In Model 1, there is no significant association between parents' educational level and older adults' current smoking status. In Model 3, older adults whose parents have a college degree are more likely to be ever smokers than those older adults whose parents

don't have a college degree. Similar patterns for the other health behaviors (Models 5). Having more-educated parents increases the likelihood of ever drinking. It is noteworthy, however, that older adults' engagement in physical activity does not significantly differ in parental education.

The next set of models of Table 2 (Models 2, 4, 6, and 8) test whether physical activity, drinking, and smoking status contribute to the disproportionate distribution of health behaviors among older adults across levels of educational attainment. Binary logistic regression modeling is used to assess the odds ratio of current smoking (Model 2), ever smoking (Model 4), ever drinking (Model 6), and physical activity (Model 8), net of multiple health behaviors. Having better-educated parents is less likely to smoke now (Model 2) than their disadvantaged counterparts. For both ever smoking and drinking, respondents who have more-educated parents report more exposure to them (Model 4 and 6). However, the effect of having parents with high school and some college degrees is nonsignificant. Parental educational levels do not have a role in older adults' participation in physical activity, even controlling for other measurements of health behaviors (Model 8). These findings suggest that having highly educated parents is directly related to older adults' health behaviors.

Table 2. ORs from Binary Logistic Regression for Health Behaviors Regressed on Parental Education (N=16,446)

	Currently Smoke		Ever Smoke		Ever Drink		Physical Activity	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Parental Education								
< 12 years (ref.)								
High School	1.070 (0.077)	1.057 (0.076)	1.036 (0.047)	1.008 (0.046)	1.196*** (0.053)	1.192*** (0.054)	1.027 (0.056)	1.011 (0.055)
Some College	0.913 (0.119)	0.911 (0.119)	1.025 (0.075)	0.995 (0.073)	1.224*** (0.088)	1.206*** (0.088)	1.208** (0.100)	1.178** (0.098)
College	0.909 (0.120)	0.894 (0.119)	1.263*** (0.092)	1.223*** (0.090)	1.215*** (0.087)	1.175** (0.085)	0.981 (0.081)	0.964 (0.081)
Health Behaviors								
Physical Activity		0.591*** (0.051)		0.778*** (0.036)		1.529*** (0.070)		
Ever Drink		1.366*** (0.084)		1.949*** (0.074)				1.532*** (0.070)
Currently Smoke						1.009 (0.068)		0.622*** (0.055)
Ever Smoke		–		–		1.940*** (0.076)		0.858*** (0.040)
BIC	9200.307	9157.102	20427.09	20117.87	19989.22	19622.98	14337.81	14239.19

Notes: ORs greater than 1 suggest a positive association, while <1 a negative association. Standard errors in parentheses. Less than high school is the reference group. Controls include respondent sociodemographic characteristics, SES characteristics, and health conditions. *** p<0.01, ** p<0.05, * p<0.1(two-tailed test)

Adult Children’s Education and Older Adults' Health Behaviors

Following the same modeling approach, I estimate binary logistic regression models to investigate whether adult children's education predicts older adults' health behaviors: currently smoking (Model 1-2), ever smoking (Model 3-4), ever drinking (Model 5-6), and vigorous physical activity three times per week (Model 7-8). The results of these models are presented in Table 3. Educational attainment of adult children is not significantly associated with current smoking (Model 1 and 2) and physical activity (Model 7-8). The pattern holds for ever smoking (Model 3). However, after controlling for other health behaviors, older adults who have children with a college degree are less

likely to be ever smokers (Model 4). For drinking status, respondents with better-educated adult children have a greater likelihood of ever drinking (Model 5 and 6).

Table 3. ORs from Binary Logistic Regression for Health Behaviors Regressed on Adult Children Education (N=16,446)

	Currently Smoke		Ever Smoke		Ever Drink		Physical Activity	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Adult Children Education								
< 12 years (ref.)								
High School	1.325 (0.308)	1.291 (0.300)	0.894 (0.151)	0.874 (0.148)	1.705** (0.373)	1.714** (0.377)	1.141 (0.313)	1.126 (0.310)
Some College	1.151 (0.268)	1.110 (0.259)	0.897 (0.151)	0.861 (0.146)	1.972*** (0.429)	1.988*** (0.435)	1.226 (0.335)	1.183 (0.324)
College	0.881 (0.205)	0.852 (0.198)	0.766 (0.128)	0.720* (0.121)	2.309*** (0.500)	2.364*** (0.515)	1.500 (0.408)	1.409 (0.383)
Health Behaviors								
Physical Activity		0.599*** (0.052)		0.783*** (0.036)		1.372*** (0.064)		
Ever Drink		1.391*** (0.086)		1.971*** (0.075)				1.519*** (0.070)
Currently Smoke						1.117* (0.070)		0.629*** (0.056)
Ever Smoke						1.956*** (0.077)		0.861*** (0.041)
BIC	9171.95	9128.264	20419.75	20101.71	19963.18	19590.05	14320.5	14227.89

Notes: ORs greater than 1 suggest a positive association, while <1 a negative association. Standard errors in parentheses. Less than high school is the reference group. Controls include respondent sociodemographic characteristics, SES characteristics, and health conditions. *** p<0.01, ** p<0.05, * p<0.1(two-tailed test)

Multigenerational Education and Older Adults' Health Behaviors

The last set of analyses, shown in Table 4, investigates whether multigenerational educational attainment is associated with health behaviors. In Models 1 and 2, the multigenerational educational attainment is not significantly associated with current smoking, regardless of adjustment of other health behaviors. In Model 3, the parental college degree is associated with older adults' higher likelihood of ever smoking. After controlling for other types of health behaviors, this pattern still holds. In addition, older

adults are less likely to report ever smoking if adult children have a college degree (Model 4). College degree of parents and adult children is significantly related to ever smoking, while in opposite direction. All levels of multigenerational education are associated with a greater likelihood of ever drinking (Model 5). This pattern holds even after controlling for other health behaviors (Model 6). Education of parents and children plays a slightly different role in the engagement of physical activity. When parents have some college degree, older adults are more likely to exercise (Model 7 and 8).

Table 4. ORs from Binary Logistic Regression for Health Behaviors Regressed on Multigenerational Education (N=16,446)

	Currently Smoke		Ever Smoke		Ever Drink		Physical Activity	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Parental Education								
< 12 years (ref).								
High School	1.073 (0.077)	1.058 (0.076)	1.036 (0.047)	1.007 (0.046)	1.193*** (0.053)	1.189*** (0.054)	1.026 (0.056)	1.011 (0.056)
Some College	0.929 (0.121)	0.925 (0.121)	1.029 (0.075)	1.000 (0.073)	1.213*** (0.087)	1.196** (0.087)	1.199** (0.099)	1.173* (0.098)
College	0.922 (0.122)	0.904 (0.120)	1.270*** (0.092)	1.231*** (0.090)	1.204*** (0.086)	1.164** (0.084)	0.973 (0.081)	0.959 (0.080)
Adult Children Education								
< 12 years (ref).								
High School	1.321 (0.307)	1.289 (0.299)	0.893 (0.151)	0.873 (0.148)	1.695** (0.370)	1.705** (0.374)	1.144 (0.314)	1.129 (0.311)
Some College	1.148 (0.267)	1.109 (0.258)	0.896 (0.151)	0.860 (0.146)	1.950*** (0.424)	1.967*** (0.430)	1.225 (0.335)	1.183 (0.324)
College	0.879 (0.205)	0.852 (0.198)	0.763 (0.128)	0.718** (0.121)	2.286*** (0.495)	2.341*** (0.509)	1.500 (0.407)	1.410 (0.384)
Health Behaviors								
Physical Activity		0.660*** (0.059)		0.828*** (0.039)		1.514*** (0.070)		
Ever Drink		1.121* (0.072)		1.945*** (0.077)				1.517*** (0.070)
Currently Smoke						1.117* (0.070)		0.628*** (0.056)

Ever Smoke						1.953***		0.863***
						(0.077)		(0.041)
BIC	9199	10083	22224	21883	22275	21567	15441	15021

Notes: ORs greater than 1 suggest a positive association, while <1 a negative association. Standard errors in parentheses. Less than high school is the reference group. Controls include respondent sociodemographic characteristics, SES characteristics, and health conditions. *** p<0.01, ** p<0.05, * p<0.1(two-tailed test)

To test whether differences in health behaviors between those who have more- and less-educated parents or adult children account for the estimated effects of educational attainment of parents or adult children on the cognitive performance of respondents, we include measures of parental health behaviors as controls in the OLS regression models. All models control for sociodemographic characteristics, household SES, and health conditions. Subsequent models add controls for each health behavior: currently smoking (Model 2), ever smoking (Model 3), physical activity (Model 4), ever drinking (Model 5), and all measurements (Model 6).

Table 5 presents the effect of parents' schooling on older adults' cognitive function. In Model 1, having more-educated parents is significantly associated with the better cognitive performance of older adults. I observe that whether a respondent ever drank or exercised (Model 4 and 5, respectively) reduces the strength of the relationship between parental education and respondents' cognition. Similarly, both of them change the effect of parental schooling on cognition in Model 6. Therefore, whether a respondent ever drank or did not exercise partially accounts for the parents' education-cognition link. In contrast, the smoking status does not mediate the association between parental schooling and respondents' cognition (Model 2, 3, 6). Post-estimation tests (seemingly unrelated estimation) for mediation confirm that physical activity and ever drinking

significantly reduce the size of the association between parental education and cognition when parents of older adults have a high school and above ($p < 0.05$).

Table 5. OLS Regression for Cognition on Parental Education and Health Behaviors (N=16,446)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Parental Education						
< 12 years (ref).						
High School	0.306*** (0.100)	0.307*** (0.100)	0.306*** (0.100)	0.302*** (0.100)	0.262*** (0.100)	0.261*** (0.100)
Some College	0.490*** (0.162)	0.489*** (0.162)	0.490*** (0.162)	0.461*** (0.162)	0.441*** (0.161)	0.415*** (0.161)
College	0.583*** (0.161)	0.581*** (0.161)	0.582*** (0.161)	0.582*** (0.161)	0.535*** (0.160)	0.536*** (0.160)
Health Behaviors						
Currently Smoke		-0.202 (0.135)				-0.189 (0.137)
Ever Smoke			0.021 (0.081)			-0.067 (0.084)
Physical Activity				0.872*** (0.102)		0.774*** (0.102)
Ever drink					1.040*** (0.082)	1.009*** (0.083)
R-squared	0.358	0.358	0.358	0.361	0.365	0.367

Notes: Standard errors in parentheses. Less than high school is the reference group. Control includes respondent sociodemographic characteristics, SES characteristics, health conditions. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ (two-tailed test)

Table 6 shows the effect of adult children's education on older adults' cognitive function. Older adults with more-educated adult children report better cognitive function compared to those with less-educated adult children (Model 1). The remaining models assess the effect of each health behavior. The cognitive health of respondents who are currently smoking or ever smoked does not significantly differ from that of respondents reporting none (Model 2 and 3). In checking the coefficients for the educational attainment of adult children in Models 4 and 5, the inclusion of physical activity or ever

drinking reduces the effect on cognitive functioning. This pattern holds in Model 6. Post-estimation tests for mediation confirm that physical activity and ever drinking partially mediate the effects of adult children's schooling on cognitive ability when adult children have a college ($p < 0.001$) or some college degree ($p < 0.01$).

Table 6. OLS Regression for Cognition on Adult Children's Education and Health Behaviors (N=16,446)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Adult Children's Education						
< 12 years (ref).						
High School	0.897** (0.359)	0.900** (0.359)	0.898** (0.359)	0.894** (0.359)	0.838** (0.358)	0.839** (0.357)
Some College	1.395*** (0.359)	1.395*** (0.359)	1.395*** (0.359)	1.386*** (0.358)	1.309*** (0.357)	1.307*** (0.357)
College	1.724*** (0.356)	1.721*** (0.356)	1.737*** (0.356)	1.692*** (0.356)	1.604*** (0.355)	1.574*** (0.354)
Health Behaviors						
Currently Smoke		-0.159 (0.135)				-0.158 (0.138)
Ever Smoke			0.045 (0.081)			-0.048 (0.084)
Vigorous Physical Activity				0.851*** (0.102)		0.759*** (0.102)
Ever drink					1.022*** (0.082)	0.990*** (0.083)
R-squared	0.360	0.360	0.360	0.363	0.366	0.368

Notes: Standard errors in parentheses. Less than high school is the reference group. Control includes respondent sociodemographic characteristics, SES characteristics, health conditions. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ (two-tailed test)

Table 7 shows how older adults' cognition is affected by the educational attainment of multigeneration. In Model 1, having more-educated parents and adult

children is positively associated with the cognitive function of older adults. From Models 2 to 5, I added each health behaviors separately. Finally, in Model 6, all health behaviors were added simultaneously. Models 2 and 3 show no significant difference between respondents who currently smoke or ever smoked and those who never regarding cognitive status. Physical activity and ever drinking partially attenuate the effects of multigenerational education. The patterns are observed in Model 6 as well. Post-estimation tests suggest that physical activity and ever-drinking status may explain some of the effects of parental education and older adults' cognition when parents had a high school ($p < 0.01$) or some school degree ($p < 0.01$); as well as when adult children had some college or college degree.

When the adult children had a college degree, there is a statistically significant difference in the role of physical activity and ever drinking on cognitive function-- physical activity and ever drinking attenuate more in the relationship between adult children's schooling and older adults' cognition, regardless of parental educational levels.

Table 7. OLS Regression for Cognition on Multigenerational Education and Health Behaviors (N=16,446)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Parental Education						
< 12 years (ref).						
High School	0.298*** (0.100)	0.298*** (0.100)	0.297*** (0.100)	0.294*** (0.100)	0.256*** (0.100)	0.254*** (0.100)
Some College	0.464*** (0.162)	0.463*** (0.162)	0.463*** (0.162)	0.436*** (0.162)	0.417*** (0.161)	0.393** (0.161)
College	0.559*** (0.161)	0.558*** (0.161)	0.557*** (0.161)	0.559*** (0.160)	0.514*** (0.160)	0.516*** (0.160)
Adult Children's Education						

< 12 years (ref).						
High School	0.894**	0.897**	0.894**	0.890**	0.836**	0.836**
	(0.359)	(0.359)	(0.359)	(0.358)	(0.358)	(0.358)
Some College	1.381***	1.381***	1.381***	1.372***	1.298***	1.292***
	(0.359)	(0.359)	(0.359)	(0.358)	(0.357)	(0.356)
College	1.709***	1.706***	1.711***	1.677***	1.592***	1.561***
	(0.356)	(0.356)	(0.356)	(0.356)	(0.355)	(0.354)
Health Behaviors						
Currently Smoke		-0.155				-0.152
		(0.135)				(0.138)
Ever Smoke			0.039			-0.054
			(0.081)			(0.084)
Vigorous Physical Activity				0.847***		0.756***
				(0.102)		(0.102)
Ever drink					1.010***	0.979***
					(0.082)	(0.083)
R-squared	0.361	0.361	0.361	0.364	0.367	0.369

Notes: Standard errors in parentheses. Less than high school is the reference group. Control includes respondent sociodemographic characteristics, SES characteristics, health conditions. *** p<0.01, ** p<0.05, * p<0.1(two-tailed test)

DISCUSSIONS

In light of the growing importance of social factors in cognition among older adults, previous studies have underscored the positive correlation between education and cognitive health (Langa, Larson, Karlawish et al. 2008). Although most research has examined the effect of one's own education on cognitive functioning, recent research has indicated that intergenerational education - both parents and their children - can also influence cognitive functioning of older adults (Lee 2018, Ma et al. 2021, Yahirun, Vasireddy and Hayward 2020b, Zhang et al. 2016). Expanding the line of research with an adjacent generations approach (Wolfe et al. 2018b), this paper used a nationally representative sample of adults to examine the relationships among multigenerational educational attainments, health behaviors, and cognitive health. In particular, I examined whether the schooling of parents and older adult children is linked with multiple health behaviors, in turn, places disadvantaged older adults at greater risk for cognitive health. The modeling results suggest clear relationships among intergenerational educational attainments, physical activity, ever drinking, and cognition. By assessing educational attainment of parents and adult children simultaneously, I found that the association between education of family members and brain health of older adults is robust and remains significant after adjusting for all additional covariates. Lastly, I compared the extent to which health behaviors account for the health effects of educational attainment: parental vs. adult children's education.

Effects of Multigenerational Educational Attainments

This study offers four key findings. First, the results provide clear support for the long arm perspective on cognitive performance. Respondents who have more-educated parents reported healthier cognitive status compared to their disadvantaged counterparts, even controlling for educational attainments of themselves and their spouses. This differs from prior work, which did not find a positive role of parents' resources on cognitive health once taking into account individual's education (Hayward and Gorman 2004). Nevertheless, this finding is congruent with prior studies that have found robust linkages between socioeconomic conditions in childhood and health throughout life (Pudrovskaya 2014). Specifically, it also echoes research indicating that the most robust predictor of later-life cognition was parental education compared to the father's occupational prestige and household income (Greenfield and Moorman 2018). This research suggests that early family experiences may lead to long-term mental and physical health outcomes throughout the life course. It may be because in early life, family contexts and relationships are the starting point for exposure to stress and resources, affecting later life health (Umberson, Williams, Thomas et al. 2014). For example, well-resourced families tend to provide more financial and emotional support (Swartz 2009) that can help cope with stress, make healthier choices, and enhance self-esteem, resulting in a higher degree of cognitive health.

In addition, having an educated child benefits parents beyond the effects of their own SES. This result supports the social foreground hypothesis that offspring education impacts the cognitive health of older adults. Our results suggest that the education of adult children might have a more direct connection with later life cognition--that adult

children's education is predictive of cognitive function regardless of older adults' own socioeconomic features. Prior studies have stressed the importance of adult children's schooling for cognitive outcomes of later adulthood (Vasireddy, Yahirun and Hayward 2021, Yahirun et al. 2020b). Support from adult children is a major source of assistance for older adults (Swartz 2009). Adult children who are better educated may be able to provide better preventative healthcare. It may be that highly educated children have greater access to health knowledge and technologies that can prevent cognitive impairment (Hayward, Hummer and Sasson 2015, Sasson and Hayward 2019). As adult children provide pivotal sources of care for aging adults, they play an increasingly important role in the social networks of older adults throughout their lives. Given the number of in-contact adult children that each older adult has (mean=3.45), the effect of this group should be further examined in future research. I also found slight discrepancies. Prior research showed a null association between adult children's education and the prevalence of cognitive impairment when considering the respondents' health conditions and behaviors. This discrepancy between this study and those from prior research may be attributed to the longitudinal design.

More generally, this study shows that having parents and adult children with a greater level of education is associated with better cognitive health, suggesting that parents and adult children offer distinct, independent resources that are beneficial to the cognitive health of older adults. As hypothesized, I found the evidence that multigenerational education was positively associated with older adults' cognitive status. This finding is consistent a large body of research based on *linked lives* concept, which suggests that individual actors' lives are connected through their future trajectories within

family relationships (Elder et al. 2003) . Researching how and why education of parents and adult children impacts health and well-being over generations is illustrative of the reciprocal, enduring nature of *linked lives*. This perspective is also suggested that health and aging can be better understood with a life-course paradigm. Using constellation of education of multiple generations may have obscured familial features, it could be that having both well-educated parents and adult children with high levels of education indicates that education is highly valued within the family. In turn, families that place a high value on education may also be those that place a high value on health-enhancing behaviors. Thus, the linkage between multigenerational education and older adults' cognition may be a function of some factor that is not measured here.

Differential Distribution of Health Behaviors

Second, health behaviors are disproportionately distributed at different levels of multigenerational education. In terms of ever drinking, older adults with more-educated parents or adult children reported greater levels than those with less-educated parents or adult children. It is noteworthy that drinking behavior was measured with the question "whether the respondent ever drinks alcoholic beverages" rather than binge drinking. The social contexts influence older adults' drinking behavior, and where they live and drink plays a significant role (Mollborn, Lawrence and Saint Onge 2021). For example, a study of retirement community residents finds that alcohol use was largely driven by a desire to engage in social activities and thereby maintain social ties (Sacco, Burruss, Smith et al. 2015). However, HRS does not contain relevant information about contextual factors that give rise to a different meaning of the same health behavior. Researchers need to investigate the potential impact of different contexts, such as with whom, where, and

when, on psychological distress in middle-aged and older adults. There is also a need for further research on the threshold and frequency of “heavy” drinking that may be associated with cognitive impairment among middle-aged and older adults (Yen, Wang, Lin et al. 2022).

Better education may have a non-linear effect on the participation in other behaviors. Only when parents have some college degree do respondents exercise more. Education may not necessarily lead to healthier behaviors, such that respondents whose parents have a college degree were more likely ever to smoke. However, older adults are less likely to smoke when children have a college degree. It is interesting to point out that having well-educated children correlates with fewer smoking and more drinking. Because smokers, especially smoker-nondrinkers, tend to have a lower socioeconomic and health statuses compared to nonsmokers for individuals aged 50 and older (Choi and DiNitto 2011). An assessment of the effect of interrelationship between health behaviors would be helpful in the research on the association between education and cognitive health.

Two major findings emerged from this section. First, the education of family members has a similar influence. Greater education is associated with a higher likelihood of ever drinking. Second, there is a slight difference in the role of education of family members. College-educated parents and children are in opposite directions in terms of never smoking-- well-educated children can lower the likelihood of ever smoking. When parents have some college degree, older adults tend to have more exercise, with other parental and children’s educational levels having no effect.

Relationships among Multigenerational Education, Health Behaviors, and Cognition

The third key finding is the different distribution of these health behaviors, which contributed to diverse cognitive health for intergenerational educational attainments. Accounting for ever drinking and physical activity partially explained the association between the schooling of parents as well as adult children and the cognitive function of older adults. Ever drinking and physical activity attenuated the association between parental education and cognition when parents have a high school and above. They also partially explained the association between education of adult children and cognitive function when children have some college and college degree.

In general, it is consistent with studies finding that frequent moderate drinkers (up to 3 drinks/day for women and for men 65 years and older, up to 4 drinks/day for men under 65 years) had a greater likelihood of survival to age 85 without cognitive impairment than non-drinkers (Richard, Kritz-Silverstein, Laughlin et al. 2017). It is possible that older adults with better-educated parents use drinking in the context of social facilitation, which enhances social interaction with others and thus impede cognitive decline (Hikichi, Kondo, Takeda et al. 2017). Some pathways may explain this speculative relationship. First, childhood SES has long-term consequences for social integration in old age (Byhoff, Hamati, Power et al. 2017). For example, people from lower SES backgrounds may have limited chances to gain education or employment (Luo and Waite 2005) due to multiple deprivation during childhood regarding material and financial resources. Furthermore, limited time, income, and materials may have inhibited their participation in social activities and relationships. In the study by Ross and Mirowsky (2011), moderate drinking is characterized as a healthy lifestyle given the association with higher level of education. Therefore, moderate drinking promotes health

(Rogers, Krueger, Miech et al. 2013) and reduce mortality (Britton et al. 2008) when compared to abstinence or heavy consumption.

I also found that when adult children had greater educational attainments (some college degree or above), ever drinking and physical activity partially mediate the effects of adult children's schooling on cognitive ability. With more knowledge of health-related behaviors and provision of various support, well-educated adult children may shape older adults' health behaviors, including attendance at social activities, adult children's education plays a protective role for cognition (Torssander 2012). Taking part in social activities helps maintain health. Older adults who exit the labor market may experience a crisis of role change. Their health may suffer as a result of being idle at home or having to take care of their grandchildren (Liu and Lou 2016). Active involvement in social interaction both eases the stress of role transitions and keeps them intellectually engaged (Lam, Haslam, Steffens et al. 2020). Furthermore, there is evidence that social integration plays an important role in older people's drinking (Agahi, Dahlberg and Lennartsson 2019, Vogelsang and Lariscy 2020). However, this study did not test it due to the lack of reasons for drinking in dataset. Future research should identify the social contexts of alcohol use, thereby adding the predictive ability of drinking behavior between multigenerational education and cognitive health.

Another mechanism identified is physical activity. For its role in the relationship between parental education and cognition, as some studies have suggested, the life course level of physical activity was lower among those below the median childhood SES when compared with those above the median SES (Puolakka, Pahkala, Laitinen et al. 2018). It is possible that health behavior is modeled by parents, and lower parental SES has been

shown to link to the more adverse health behavior models, which can be track from childhood to adulthood (Telama, Yang, Leskinen et al. 2014). This study indicates the importance of childhood environment, since the association between parental education and cognition remained after controlling for respondents' own educational attainment. On the other hand, our results indicate that physical activity may shape the patterns of older adults' cognitive ability against adult children's schooling. A better-educated adult child is well positioned to assist older adults in promoting better health through informational support and introducing basic personal care activities (Jiang and Kaushal 2020). They may directly convince the older adults to engage in health behaviors, such as eating well, regular sleep period and exercise. They may indirectly influence older adults as well. Some have suggested that highly educated children can also serve as role models for older parents in regard to healthier behavior (Friedman and Mare 2014). The role models parents and adult children acting as in early and late lifetimes allow the significant spillover effects that may be predictive of cognitive health outcomes.

Whose Education is Affected More?

Lastly, I compared the strength of mediating effect of physical activity and ever drinking--whose education is more affected by physical activity and drinking status? Exercise and drinking status matter more for the linkage between adult children's education and the cognition of older adults when adult children have a college degree, regardless of parental education.

This finding stresses the importance of the education of adult children. It may point to long-term health implications in that life course social ties may affect health behaviors, which in turn shape the cognitive performance of older adults. A person's

health is influenced by many social ties over their lifetime, with parents having the greatest impact on children's health, peers becoming increasingly important in adolescence, intimate partners becoming more important in adulthood, and adult children becoming especially salient as they get older. Furthermore, health behaviors change over time. Some habits (e.g., diet) form during childhood, while others (e.g., drinking) occur during adolescence and adulthood (Umberson, Crosnoe and Reczek 2010). Social ties and health habits may then work together to affect health outcomes (Umberson and Karas Montez 2010). As a result, even the same behavioral pathway may matter more for the health implication of older adults' education, with their increasingly significant role in older adults' lives.

In addition, two distinct types of health behaviors that jointly affect the association of multigenerational education with cognitive performance of older adults. These mechanisms may be intertwined to influence the linkage of multigenerational education and health from childhood through later adulthood. Qualitative data can provide useful insight into how connections between mechanisms account for the relationship between the education of multigeneration and the cognitive health of older adults.

LIMITATIONS

First, this study is cross-sectional, so the direction of the relationship between health behaviors and cognitive health could not be assessed. Prior research using longitudinal data has yielded mixed findings. Some suggest that vigorous physical activity is not beneficial to long-term cognitive performance (Wu, Zhang, Miao et al. 2021). In contrast, others find that duration of physical activity is associated with subsequent cognitive function in later life (Sabia, Nabi, Kivimaki et al. 2009). Cognitive problems may lead to social isolation and unhealthy behaviors, given that their temporal ordering is unknown. In addition, when considering the upstream effects, it is possible that parents may have developed cognitive impairments before their children completed education, which may have had an adverse effect on their offspring's education. Future research should consider those situations.

The second limitation is the omitted variable bias. HRS lack the contextual information that may be related to older adults' motivation to engage in health behaviors. It is unknown if drinking is related to bolstering social ties or how older adults get health-related information. Adult children who have the highest education may not be the person who communicates with older adults the most. In addition, although I used four types of health behaviors, various health behaviors (and other factors) may play a role in the relationship between multigenerational educational attainments and older adults' cognitive function. Medication adherence, health care system utilization, and time spent in cognitively stimulating activities may be influenced by intergenerational education.

Therefore, it will be necessary to examine many other health behaviors that may be related to multigenerational education in the future.

Only older adults who are parents are included in our sample. In spite of the fact that very few respondents in the HRS are childless, the results presented here cannot be generalized to all U.S. older adults, but rather are restricted to those with adult children. There is a complex relationship between parental status (i.e., number of children ever born and living children) and cognitive health, a relationship that warrants further study in the U.S (Saenz, Díaz-Venegas and Crimmins 2021).

Based on adjacent generations perspective, this study examines the potential effect of educational attainments from previous and subsequent generations and assesses the extent to which health behaviors contribute to cognitive health disparities. In particular, this study emphasizes the central importance of drinking and exercise behaviors for older adults. These behavioral factors, in turn, influence how cognitive health in later adulthood is shaped. Future work should account for these multiple health behaviors. The present study also contributes to a growing body of research that emphasizes a multigenerational perspective on health (Wolfe et al. 2018a, Wolfe et al. 2018b). I argue that the benefits of expanding educational opportunities extend across generational lines, so policymakers should consider them.

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