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Research Paper

Longitudinal impact of volunteering on the cognitive functioning of older adults: A secondary analysis from the US Health and Retirement Study

Ester Villalonga-Olives [a,*], Kayleigh R. Majercak [a], Josue Almansa [b], Tasneem Khambaty [c]

[a] Sciences and Health Outcomes Research Department, University of Maryland School of Pharmacy, Baltimore, MD, USA
[b] Department of Health Sciences, Community & Occupational Medicine, University Medical Center, University of Groningen, the Netherlands
[c] Department of Psychology, University of Maryland, Baltimore County, Baltimore, MD, USA

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ABSTRACT

Objectives: To examine the relationship of volunteering with cognitive activity, social activity, and physical activity among older adults and, ultimately, with later cognitive functioning across different time periods.
Methods: We used individual responding to three waves of the US Health and Retirement Study panel data from 2008, 2012, and 2016 (n = 2,862). Self-reported questionnaires were used to assess annual volunteering frequency (non volunteering, volunteering <100 h and ≥100 h), and an adapted version of the Telephone Interview for Cognitive Status (TICS) was used to assess memory, mental processing, knowledge, language, and orientation. A structural equation model was estimated to assess effects on cognitive functioning throughout waves.
Results: Those participants that were part of volunteering activities in 2012 showed an increase between 2008 and 2012 in moderate physical activity (β = 0.19, P < 0.001 for those volunteering less than 100 h and β = 0.21, P < 0.001 for those volunteering at least 100 h), increase in social activity (β = 0.10, P = 0.052 for those volunteering less than 100 h and β = 0.12, P = 0.018 for those volunteering at least 100 h) and increase in higher cognitive activity (β = 0.13, P < 0.001 for those volunteering at least 100 h), compared to participants who did not volunteer. Higher levels of cognitive activity in 2008 and 2012 were associated with higher cognitive functioning on the following waves (β = 0.66 and β = 0.60, P < 0.001, respectively).
Discussion: Volunteering is a modifiable activity that can be increased to bolster cognitive functioning in older adulthood, primarily mediated by increased cognitive activity.

What is known?

- Cognitive decline can involve a subsequent health decline and important functional disability.
- Volunteering allows older adults to remain physically and socially active and, consequently, keeps the brain active.

What is new?

- In our study, volunteering had an effect on positive changes on physical functioning and social activity. However, changes on physical functioning and social activity did not affect cognitive functioning in our model.
- Volunteering is a modifiable activity that can be increased to bolster cognitive functioning in older adulthood, primarily mediated by increased cognitive activity.

1. Introduction

The increase in the aging population is associated with higher

* Corresponding author.
E-mail address: ester.villalonga@rx.umaryland.edu (E. Villalonga-Olives).
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rates of age-related cognitive decline and loss of independent functioning [1]. Cognitive decline can involve subsequent health decline, important functional disability, and risk for dementia and Alzheimer's disease [2]. These consequences of cognitive decline are critical because the older adult population keeps growing. Moreover, dementia and Alzheimer's disease also impact families and caregivers [3]. The Center of Disease and Control reports that the prevalence of subjective cognitive decline is 11.1% in middle-aged adults, and 11.7% in older adults aged 65 years and higher [3]. These prevalence rates highlight the urgent need to identify population level interventions that can promote healthy brain aging [4]. Guiney et al. highlighted that factors such as a healthy diet, adequate physical activity, pursuing lifelong education and bilingualism are protective factors against cognitive decline [4]. While older adults can change their diets and physical activity routines, other factors are less amenable to change. For instance, few older adults continue to pursue education [4]. Hence, the identification of novel, modifiable, protective factors is critical to reducing age-related cognitive decline.

Previous studies have indicated that volunteering work, defined as unpaid, noncompulsory work done through an organization and for the benefit of people outside the person's household is advantageous in older age [5]. In a previous study, we point out that volunteering has acted as a protective factor against risky behaviors such as binge drinking [6]. Volunteering is an expression of commitment to a group or collective [6]. Anderson et al. indicate that volunteering has an altruistic component that is not inherent in other lifestyle activities and notes that the positive effects of volunteering have been related to the reduction of symptoms of depression, better self-reported health, fewer functional limitations, and lower mortality [7]. Volunteering is likely to be an indicator of pro-social behavior. It allows older adults to remain physically and socially active and, consequently, keeps the brain active [8]. By maximizing cognitive activity, volunteering may act as a protective factor against cognitive decline [9,10].

1.1. The development of the theoretical model

Fried et al. developed a theoretical model where volunteering could lead to improvements in older adults' health, including in their cognitive functioning for memory, mental processing, knowledge, language, and orientation [11]. Anderson et al. adapted this model and hypothesized that volunteering increases social, physical, and cognitive activity through social interactions (social activity), exercise (physical activity), and intellectually stimulating activities that require thinking and reasoning (cognitive activity). Through biological and psychological mechanisms, these activities may lead to improved functioning and reduced dementia risk. The model is broad and the authors recommend collecting objective measures of social, physical, and cognitive activities, among others, to test their hypothesis [7]. Guiney et al. aimed to simplify the work developed by Anderson et al. and concentrated on the effect of volunteering on cognitive functioning [4]. In their model, volunteering is the key factor that may improve cognitive functioning in older adulthood through three distal mechanisms: cognitive activity, social activity, and physical activity. These mechanisms, consequently, have an effect on two proximal outcomes: neurological health (defined as the physical structure and physiological functioning of the brain) and mental health (defined as psychological wellbeing such as depression, anxiety and self-efficacy). These proximal outcomes directly and positively affect cognitive functioning (Fig. 1). Some but not all components of the models developed by Fried et al. and Anderson et al. have been previously tested [7,11]. Guiney et al. showed evidence that links volunteering with significant increases in physical activity levels, adults' social interactions, and learning new skills and knowledge [4]. However, we are not aware of any prior study that has empirically tested the model considering several periods of time.

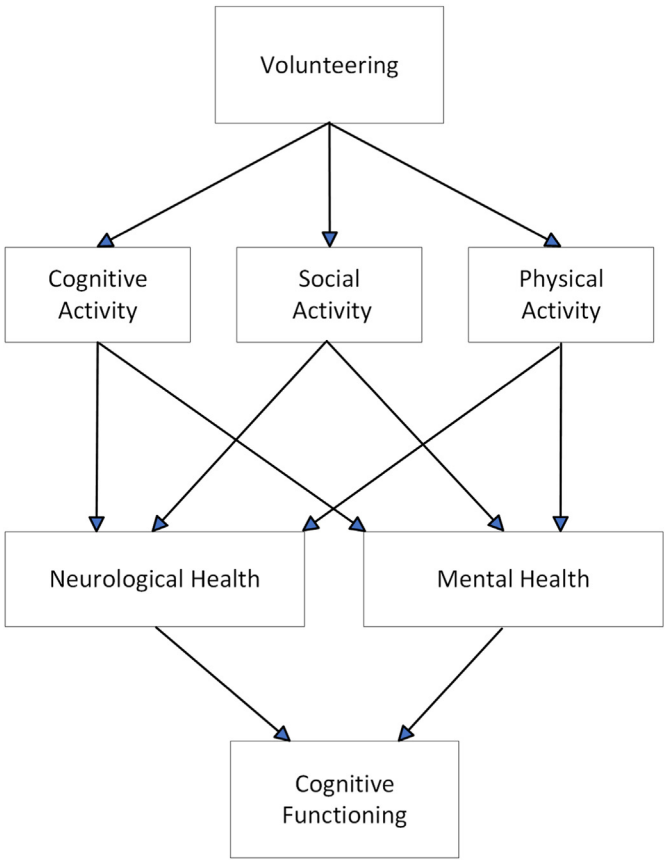

Fig. 1. The theoretical model adapted from the original one developed by Guiney and Machado (2018) with all observed variables.

1.2. Study aims

The primary objective of this study was to empirically test the theoretical model Guiney et al. developed with the data available in the Health and Retirement Study [12]. Our aim was to examine the relationship of volunteering with cognitive activity, social activity, and physical activity and, ultimately, with cognitive functioning across different time periods. When planning interventions to positively impact the cognitive functioning of older adults, this information will have relevance for identifying lifestyle activities that can be adapted to ensure positive impacts on cognitive functioning.

2. Methods

2.1. Study design and data source

The Health and Retirement Study (HRS) dataset is a nationally representative and prospective panel study of United States (US) adults aged $\geq$ 50 years, conducted by the University of Michigan's Institute for Social Research. Since 1992, the data have been collected every two years and utilizes a multi-stage area probability sampling of households. Detailed information regarding the HRS protocol, instrumentation, and complex sampling strategy is reported elsewhere (http://hrsonline.isr.umich.edu/). Response rates

for the core interview are considerably high, with the baseline response rate ranging from 47.4% to 81.3% across study entry cohorts (average response rate, 73.0%) and re-interview response rates ranging from 68.8% to 92.3% [13]. HRS is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and has been approved by several ethics committees, including University of Michigan IRB (IRB protocol HUM00061128) [14]. Informed consent was obtained from all HRS respondents.

2.2. Study sample

The study sample was derived utilizing three waves of panel data from 2008, 2012, and 2016, using both the HRS core survey and a supplemental Psychosocial and Lifestyle questionnaire completed by participants every four years. For context, in 2006, a random 50% of HRS respondents from the core survey were selected as the first cohort to receive the supplemental Psychosocial and Lifestyle questionnaire. However, items comprising cognitive activity were not available in 2006, and thus, we were unable to utilize the first cohort. Consequently, we created the sample using the years 2008, 2012, and 2016, as all variables of interest were available in these years. We describe this process in more detail in a prior study utilizing the Psychosocial and Lifestyle questionnaire [15].

Data included in this paper use HRS participants who were included in all the three waves 2008, 2012 and 2016, resulting in an analyses sample of $n = 2{,}862$. HRS has a complex sampling design (i.e., multi-stage national probability sampling and intentional oversamples of African Americans, Hispanics, and Florida residents) [16], and for this study we used the weights from wave 2008.

2.3. Variables and measurements

2.3.1. Volunteering

Volunteering was measured in the core survey and created using two questions based on previous literature [17–20]: 1) “Have you spent any time in the past 12 months doing volunteer work for religious, educational, health-related or other charitable organizations?” and 2) “Altogether, would you say the time amounted to less than 100 h, more than 100 h, or what?”. Following the content of the questions, we created variables for volunteering categorized as “non volunteering”, “less than 100 h” and “at least 100 h or more”.

2.3.2. Cognitive activity

Cognitive activity was assessed using six items selected from the “Social Participation-Social Engagement” section of the Psychosocial Lifestyle Questionnaire. These items were selected based on published literature [21,22]. The six cognitive activities selected asked how often participants: 1) attend educational or training courses, 2) read books, magazines, or newspapers, 3) do word games such as crossword puzzles or Scrabble, 4) play cards or games such as chess, 5) write (e.g., letters, stories, or journal entries), and 6) use a computer for e-mail, Internet, or other tasks. Using a 6-point scale, ranging from 0 to 5, responses were “not in the last month/never/not relevant”, “at least once a month”, “several times a month”, “once a week”, “several times a week”, or “daily”. Of note, the scale in 2008 differed from 2012 to 2016 with seven ratings instead of six ratings; we combined “not in the last month” (2008) with “never/not relevant” (2012 & 2016) to maintain a 6-point scale across years. Total scores were computed as the sum of all items (ranging from 0 to 30), with higher scores indicating higher cognitive activity.

2.3.3. Social activity

Social activity was assessed using an adapted scale of five items also used in the prior literature [23,24]. Respondents received one point for living with a husband, wife, or partner, one point for attendance of social activities/non-religious organizations at least weekly, one point each for contact (in-person, phone, mail) with other family, children, or friends at least weekly. Thus, the social activity is an ordinal scale ranging from 0 to 5 points (one point for each item), with higher scores reflecting greater social activity.

2.3.4. Moderate physical activity

Moderate physical activity was assessed following the methodology of Kim et al. (2013) using the question “How often do you take part in sports or activities that are moderately energetic such as, gardening, cleaning the car, walking at a moderate pace, dancing, floor or stretching exercises: more than once a week, once a week, one to three times a month, or hardly ever or never?”. The values for physical activity were recoded as ordinal variable, with scores 0 (Hardly ever/Never), 1 (Low: 1–4 times per month), 2 (Moderate: More than 1 time per week), and 3 (High: Daily) [25].

2.3.5. Cognitive functioning

Cognitive functioning was examined using an index of cognitive functioning [9,26] adapted from the Telephone Interview for Cognitive Status (TICS) [27]. The index, ranging from 0 to 35 points, assesses memory, mental processing, knowledge, language, and orientation. Participants receive twenty points total (one point each) for immediate recall (ten items) and delayed recall (ten items) of a word list; five points total (one point per correct response) for completing a serial 7s test; two points for a first trial and one point for second trial in counting backward; two points for object naming; four points total for date naming (one point each); two points total (one point each) for naming the President and Vice President. Higher scores reflect better cognitive functioning. Coefficient α has been evaluated in HRS data for the cognitive functioning items and ranges from 0.58 to 0.62 [28,29].

2.3.6. Demographic variables

The following sociodemographic factors were assessed for all three waves: age in wave 2008 (in years), sex (male, female), and educational attainment (no degree, high school or general educational development (GED), some college but did not graduate or college degree, masters and professional degrees).

2.4. Theoretical model

We adapted the theoretical model developed by Guiney et al. to examine the longitudinal structural relationships of variables (Fig. 1). We did not include proximal outcomes in our analysis because neurological health data was not available, and data on depression as an indicator of mental health data was collected with the Center for Epidemiologic Studies Depression Scale (CES-D) and the Composite International Diagnostic Interview-Short Form (CIDI-SF) in a reduced sample, which would have substantially limited the sample size for these analyses. Thus, we examined the relationship of volunteering with cognitive activity, social activity, and physical activity, and ultimately, with cognitive functioning using three waves of data. In order to take advantage of the available longitudinal data, we concatenated the theoretical model for consecutive waves. The predictor (volunteering) and mediators (moderate physical activity, social activity, and cognitive activity) measured in 2008 wave were used to predict the cognitive functioning of the following wave, 2012. We hypothesized that cognitive functioning of 2012 would influence changes in volunteering in 2012. We added the mediators (moderate physical activity, social activity, and cognitive activity) measured in 2012 to be affected by volunteering in 2012. Finally, the mediators measured in 2012 were

used to predict cognitive functioning in 2016 (see Fig. 2).

2.5. Statistical analysis

We used Structural Equation Modeling (SEM) to estimate structural relationships of variables of the theoretical model throughout three waves. All variables/measures from waves 2012 and 2016 were adjusted for their respective measures at the previous wave. By doing this, we aim to assess to what extent the 'predictor' measures are associated with changes of its outcome between consecutive waves. All paths from the SEM model were adjusted for age (in 3 categories 55–64, 65–74, ≥75), sex, and educational attainment. Paths to the nominal variable volunteering were modeled as multinomial logistic regression, with no-volunteering as the reference category. The other paths can be interpreted as normal linear regressions. The SEM model was estimated via Maximum likelihood estimation with robust standard errors. In order to better compare the magnitude of the effects of the mediator variables (moderate physical activity, cognitive activity, social activity), they were standardized respect to their mean and standard deviation of wave 2008. The HRS sample design was taken into account by including both sampling weights (from wave 2008) and clustered sampling design structure. The analyses on the selected subsample (individuals measured at all 3 waves) were estimated with subpopulation level analyses, in order to obtain correct standard errors by making use of the whole sample design. We fitted the model using Mplus version 8 [30].

3. Results

3.1. Descriptive results

Participants had an average age at baseline of 65.0 (*SD* 7.7). The sample consisted of a higher percentage of female than male

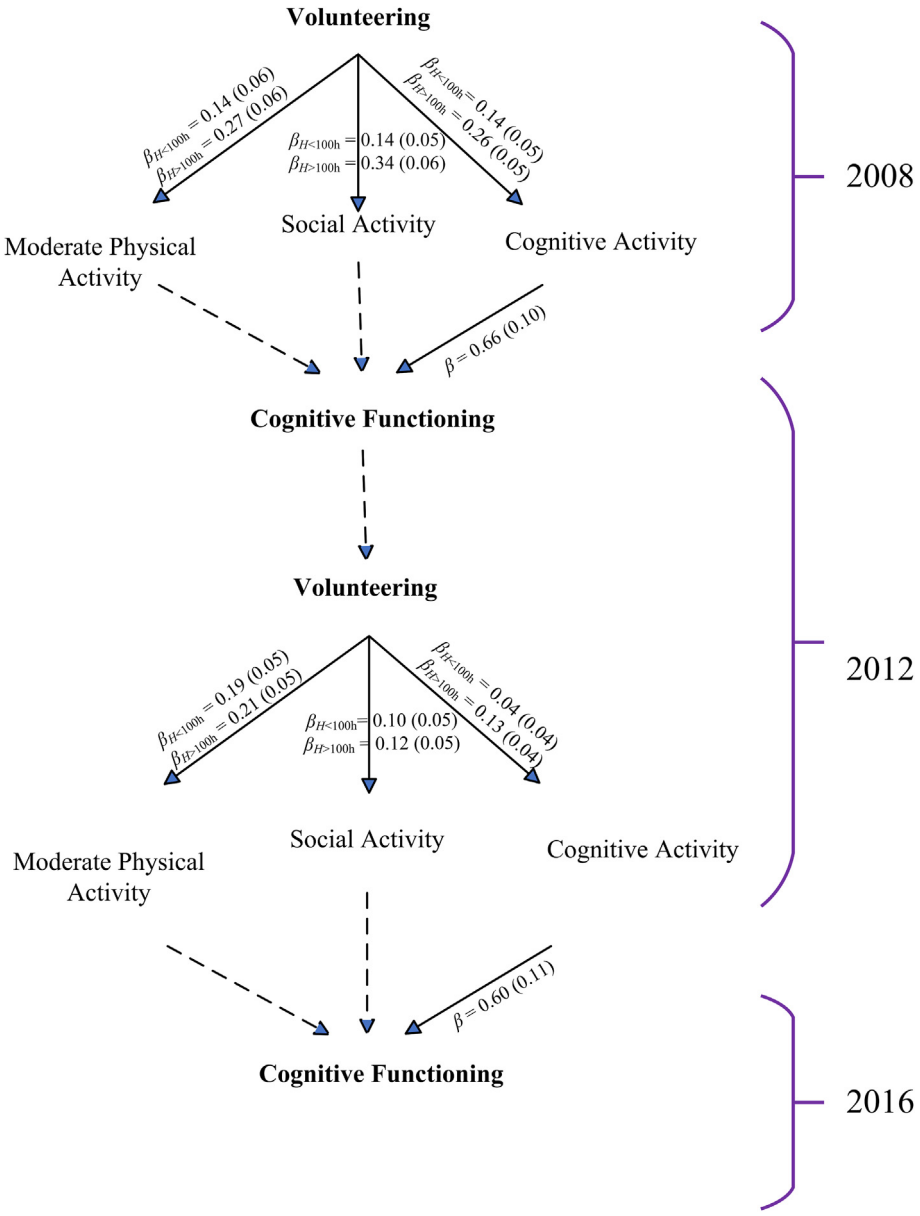

Fig. 2. Results of the SEM model assessing the relationship of the study variables.
Note: Dashed lines indicate no significant paths.

participants (55.9% at baseline) and the majority of participants were White (82.9% at baseline). Approximately half of the participants had a GED or high school diploma, which was the most frequent level of education. Likewise, most participants were born in the US. Among the HRS participants, 23.8%, 25.1%, and 21.1% had volunteered for less than 100 h in 2008, 2012, and 2016, respectively, while 17.7%, 16.4%, 16.4% of participants had volunteered at least 100 h in years 2008, 2012, and 2016, respectively (Tables 1a and 1b).

3.2. Results of the SEM model

Fig. 2 and Tables 2a–2e show the results of the SEM model assessing the relationship of the study variables. In this section, we describe the findings of the SEM model with subsections: the effect of sociodemographic information on volunteering activities, the changes of volunteering activities through time, the effects of volunteering activities and sociodemographic information on mediator variables (physical activity, social activity and cognitive activity) and the effect of mediator variables on cognitive functioning, the final outcome of the study.

All variables/measures from waves 2012 and 2016 were adjusted for their respective measures at the previous wave. Mediators, moderate physical activity, social activity and cognitive activity, have been correlated. Mediators, moderate physical activity, social activity and cognitive activity, have been standardized respect to their values in 2008 for better comparisons. Dashed lines indicated no significant paths. All estimated paths were adjusted for sex, age (in 3 categories) and educational attainment.

3.2.1. The influence of sociodemographic information on volunteering activities

Higher educational degrees were associated with higher amount of volunteering activities. In 2008, the *OR* of volunteering less than 100 h compared to non-volunteering was 3.01 for those having some college but did not graduate or a college degree and 5.90 for those having a Masters or Professional degree, compared to not having any educational degree (Table 2a). In the same year, the *OR* for volunteering at least 100 h was larger (7.76 for those having some college or a college degree and 11.61 for those having a Master's or Professional degree, compared to not having any educational degree). The association between volunteering and educational attainment remained significant in 2012 after adjusting for volunteering in 2008. Age was associated with volunteering at least 100 h: when compared to participants younger than 65 years old, those being 65 or older had significant higher odds of volunteering at least 100 h respect to non volunteering (*OR* = 1.69 and 1.75 for age groups 65–74 and ≥ 75, respectively, in wave 2008).

Table 1a
Descriptive statistics of demographic variables in the Health and Retirement Study Dataset.

Variables	*n**	Percentage (%)
Age in 2008, years, *Mean* (*SD*)	2,862	65.0 (7.7)
55–64	989	54.8
65–74	1,302	31.5
≥75	571	13.7
Sex		
Female	1,757	55.9
Male	1,105	44.1
Education		
No degree	405	11.9
GED/High school	1,607	54.7
Some college/College degree	518	20.4
Master's/Professional	327	13.0
Born in the United States		
No	252	8.3
Yes	2,607	91.7
Race		
White	2,250	82.9
African American	229	7.3
Hispanic	320	7.3
Other	63	2.5
Marital Status		
Not married	974	31.5
Married	1,888	68.5

Note: Data are *n* and percentage (%), unless otherwise indicated. *n**, unweighted sample; *Means*, *SD* and percentages, weighted sample. GED = general educational development.

3.2.2. The changes of volunteering activities through time

Those participants who were part of volunteering activities in 2008 tended to remain being part of volunteering activities in the following waves. The *OR* for volunteering less than 100 h in 2012 was 9.19 for the group that volunteered less than 100 h in 2008, and 13.30 for the group that volunteered at least 100 h in 2008 (Table 2a). This effect is much larger when predicting odds for the group volunteering at least 100 h in 2012 compared to non volunteering (*OR* = 11.20 for the group that volunteered less than 100 h in 2008 and *OR* = 77.64 for the group that volunteered at least 100 h in 2008).

3.2.3. The effects of volunteering activities and sociodemographic information on mediator variables

Those participants that were part of volunteering activities in 2008 performed more moderate physical activity the same year ($\beta = 0.14$, $P = 0.013$ for those volunteering less than 100 h and $\beta = 0.27$, $P < 0.001$ for those volunteering at least 100 h), had higher social activity ($\beta = 0.14$, $P = 0.002$ for those volunteering less than 100 h and $\beta = 0.34$, $P < 0.001$ for those volunteering at least 100 h) and higher cognitive activity ($\beta = 0.14$, $P = 0.002$ for those volunteering less than 100 h and $\beta = 0.26$, $P < 0.001$ for those volunteering at least 100 h) compared to those who did not volunteer (Table 2b). Sex was associated to social and cognitive activity, where males had less social activity and cognitive activity than females ($\beta = -0.20$, $P < 0.001$ and $\beta = -0.39$, $P < 0.001$, respectively, in wave 2008). Moreover, males showed a decrease in cognitive activity between waves 2008 and 2012, compared to females ($\beta = -0.11$, $P = 0.004$) (Table 2c). The age group that was 65–74 had more social activity than the other age groups ($\beta = 0.10$, $P = 0.030$, in wave 2008) (Table 2b). However, between waves 2008 and 2012, those being 75 years old or older at baseline had a small decline in physical, cognitive and social activities compared to younger ages ($\beta = -0.16$, $P = 0.012$; $\beta = -0.13$, $P = 0.001$ and $\beta = -0.12$, $P = 0.023$, respectively) (Table 2c). Higher educational attainment was associated with higher cognitive activity ($\beta = 0.75$, $P < 0.001$ for those with GED or high school diploma; $\beta = 1.08$, $P < 0.001$ for those having some college or a college degree; and $\beta = 1.40$, $P < 0.001$ for those having a Masters or Professional degree, in wave 2008) (Table 2b), and also showed an increase in cognitive activity between waves ($\beta = 0.20$, $P = 0.003$; $\beta = 0.32$, $P < 0.001$; and $\beta = 0.39$, $P < 0.001$, respectively, compared to no education) (Table 2c). Similar associations were found between education attainment and moderate physical activity. Those participants that were part of more volunteering activities in 2012 showed an increase in moderate physical activity between 2008 and 2012 ($\beta = 0.19$, $P < 0.001$ for those volunteering less than 100 h and $\beta = 0.21$, $P < 0.001$ for those volunteering at least 100 h), and also an increase in social activity ($\beta = 0.12$, $P = 0.018$ for those volunteering at least 100 h) and in cognitive activity ($\beta = 0.13$, $P < 0.001$ for those volunteering at least 100 h) compared to participants who did not volunteer.

Table 1b
Descriptive statistics of study variables using the Health and Retirement Study Dataset across three waves, 2008–2016.

Variables	Wave 1: Year 2008		Wave 2: Year 2012		Wave 3: Year 2016	
	*n**	Percentage (%) / *Mean* (*SD*)	*n**	Percentage (%) / *Mean* (*SD*)	*n**	Percentage (%) / *Mean* (*SD*)
Volunteering						
No	1,655	58.4	1,678	58.5	1,836	62.5
<100 h	651	23.8	686	25.1	563	21.1
≥100 h	552	17.7	496	16.4	462	16.4
Moderate physical activity						
[0] Hardly ever/Never	393	12.8	531	16.5	710	21.8
[1] Low (1–4 times/month)	753	26.1	865	30.0	807	27.4
[2] Moderate (>1 time/week)	1,373	49.4	1,226	45.8	1,096	42.3
[3] High (Daily)	343	11.7	238	7.7	240	8.5
Mean score	2,862	1.6 (0.9)	2,860	1.4 (0.9)	2,853	1.4 (0.9)
Cognitive activity	2,819	11.6 (5.3)	2,845	11.6 (5.3)	2,842	11.2 (5.3)
Social activity	2,862	2.7 (1.1)	2,861	2.7 (1.1)	2,862	2.5 (1.1)
Cognitive functioning	2,849	18.3 (5.8)	2,856	19.9 (5.4)	2,862	20.9 (5.3)

Note: *n**, unweighted sample; *Means*, *SD* and percentages, weighted sample.

Table 2a
SEM model parameters estimates assessing the longitudinal structural relationships of volunteering on Cognitive Functioning – Effects of sociodemographic variables and mediators on volunteering activities in 2008 and 2012 (Multinomial regression).

Parameters	2008			2012		
	Estimate (*SE*)	*P*	*OR* (95% CI)	Estimate (*SE*)	*P*	*OR* (95% CI)
Volunteering* < 100 h						
Intercept	−1.73 (0.21)	<0.001		−2.45 (0.32)	<0.001	
Cognitive functioning 2012				0.01 (0.01)	0.456	1.01 (0.98, 1.04)
Volunteering* 2008						
<100 h				2.22 (0.15)	<0.001	9.19 (6.82, 12.38)
≥100 h				2.59 (0.19)	<0.001	13.30 (9.10, 19.44)
Age (Ref: 55–64)						
65–74	−0.06 (0.11)	0.587	0.94 (0.76, 1.17)	−0.04 (0.15)	0.804	0.96 (0.72, 1.29)
≥75	−0.21 (0.14)	0.131	0.81 (0.61, 1.07)	−0.39 (0.20)	0.048	0.68 (0.46, 1.00)
Sex (Ref: Female)						
Male	−0.17 (0.09)	0.063	0.84 (0.70, 1.01)	−0.25 (0.15)	0.098	0.78 (0.58, 1.05)
Educational attainment (ref: no degree)						
GED/High school	0.87 (0.21)	<0.001	2.39 (1.59, 3.60)	0.53 (0.17)	0.002	1.70 (1.21, 2.38)
Some college/College degree	1.10 (0.19)	<0.001	3.01 (2.06, 4.40)	0.92 (0.23)	<0.001	2.50 (1.58, 3.96)
Master's/Professional	1.78 (0.26)	<0.001	5.90 (3.57, 9.74)	0.93 (0.26)	<0.001	2.53 (1.52, 4.22)
Volunteering * ≥100 h						
Intercept	−2.97 (0.21)	<0.001		−4.49 (0.41)	<0.001	
Cognitive functioning 2012				0.02 (0.02)	0.266	1.02 (0.99, 1.06)
Volunteering 2008						
<100 h				2.42 (0.25)	<0.001	11.20 (6.84, 18.31)
≥100 h				4.35 (0.24)	<0.001	77.64 (48.32, 124.74)
Age (Ref: 55–64)						
65–74	0.52 (0.11)	<0.001	1.69 (1.36, 2.09)	0.33 (0.19)	0.080	1.39 (0.96, 2.0)
≥75	0.56 (0.16)	0.001	1.75 (1.27, 2.41)	−0.08 (0.26)	0.767	0.93 (0.56, 1.53)
Sex (Ref: Female)						
Male	−0.14 (0.10)	0.149	0.87 (0.72, 1.05)	−0.03 (0.18)	0.885	0.98 (0.69, 1.38)
Educational attainment (ref: no degree)						
GED/High school	1.40 (0.23)	<0.001	4.07 (2.58, 6.42)	0.75 (0.37)	0.043	2.12 (1.03, 4.38)
Some college/College degree	2.05 (0.24)	<0.001	7.76 (4.85, 12.39)	1.52 (0.43)	<0.001	4.59 (1.97, 10.67)
Master's/Professional	2.45 (0.27)	<0.001	11.61 (6.79, 19.85)	1.44 (0.40)	<0.001	4.23 (1.94, 9.23)

*Note:**Non volunteering as reference category. GED = general educational development.

3.2.4. The effect of mediator variables on cognitive functioning

Higher cognitive activity was positively associated with the increase in cognitive functioning in the following wave ($\beta = 0.66$, $P < 0.001$ in 2012 and $\beta = 0.60$, $P < 0.001$ in 2016) (Table 2d). Educational attainment was positively related with changes in cognitive functioning (for example, $\beta = 3.17$, $P < 0.001$ for those having a Masters or Professional degree in 2012). Participants that at baseline were older had lower cognitive functioning in 2012 ($\beta = -0.81$, $P < 0.001$), and had a stronger decline in cognitive functioning in 2016 as their age increased ($\beta = -1.77$ for those being 65–74 years old and $\beta = -3.32$ for those being 75 or older compared to those being 55–65 years old).

4. Discussion

4.1. Theoretical model and findings

Testing of the theoretical model delineated in this study indicated that volunteering positively affects changes on moderate physical activity, social activity, and cognitive activity. The main result of this study is that cognitive activities affect positively over changes in cognitive functioning. Engaging in regular cognitive activities such as organizing educational or training courses and other type of activities may play a crucial protective role for cognitive decline. These findings are relevant and have important implications, particularly because volunteering is a modifiable

Table 2b
SEM model parameters estimates assessing the longitudinal structural relationships of volunteering on Cognitive Functioning – Effects of sociodemographic variables and volunteering activities on mediator variables in 2008.

Parameters	Physical Activity		Social Activity		Cognitive Activity	
	Estimate (*SE*)	*P*	Estimate (*SE*)	*P*	Estimate (*SE*)	*P*
Intercept	−0.43 (0.07)	<0.001	−0.03 (0.06)	0.657	−0.73 (0.07)	<0.001
Volunteering 2008 (ref: Non volunteering)						
<100 h	0.14 (0.06)	0.013	0.14 (0.05)	0.002	0.14 (0.05)	0.002
≥100 h	0.27 (0.06)	<0.001	0.34 (0.06)	<0.001	0.26 (0.05)	<0.001
Age (ref: 55–64)						
65–74	0.00 (0.05)	0.935	0.10 (0.04)	0.030	0.01 (0.04)	0.788
≥75	0.02 (0.08)	0.812	−0.06 (0.07)	0.365	−0.01 (0.05)	0.817
Sex (Ref: Female)						
Male	0.07 (0.04)	0.076	−0.20 (0.04)	<0.001	−0.39 (0.04)	<0.001
Educational attainment (ref: no degree)						
GED/High school	0.30 (0.07)	<0.001	0.00 (0.06)	0.955	0.75 (0.06)	<0.001
Some college/College degree	0.39 (0.08)	<0.001	0.01 (0.08)	0.949	1.08 (0.06)	<0.001
Master's/Professional	0.55 (0.08)	<0.001	0.02 (0.09)	0.864	1.40 (0.08)	<0.001
Residual variance	0.96 (0.03)		0.97 (0.03)		0.81 (0.03)	

Note: GED = general educational development.

Table 2c
SEM model parameters estimates assessing the longitudinal structural relationships of volunteering on Cognitive Functioning – Effects of sociodemographic variables and volunteering activities on mediator variables in 2012.

Parameters	Physical Activity		Social Activity		Cognitive Activity	
	Estimate (*SE*)	*P*	Estimate (*SE*)	*P*	Estimate (*SE*)	*P*
Intercept	−0.56 (0.08)	<0.001	−0.13 (0.07)	0.073	−0.18 (0.07)	0.012
Volunteer 2012 (ref: Non volunteering)						
<100 h	0.19 (0.05)	<0.001	0.10 (0.05)	0.052	0.04 (0.04)	0.328
≥100 h	0.21 (0.05)	<0.001	0.12 (0.05)	0.018	0.13 (0.04)	<0.001
Physical activity 2008	0.36 (0.02)	<0.001				
Social activity 2008			0.52 (0.03)	<0.001		
Cognitive activity 2008					0.67 (0.02)	<0.001
Age (ref: 55–64)						
65–74	0.00 (0.05)	0.955	−0.03 (0.04)	0.546	−0.02 (0.03)	0.575
≥75	−0.16 (0.06)	0.012	−0.12 (0.05)	0.023	−0.13 (0.04)	0.001
Sex (Ref: Female)						
Male	0.13 (0.03)	<0.001	−0.01 (0.04)	0.817	−0.11 (0.04)	0.004
Educational attainment (ref: no degree)						
GED/High school	0.22 (0.07)	0.001	0.06 (0.07)	0.423	0.20 (0.07)	0.003
Some college/College degree	0.36 (0.08)	<0.001	0.06 (0.09)	0.462	0.32 (0.08)	<0.001
Master's/Professional	0.50 (0.09)	<0.001	0.08 (0.09)	0.353	0.39 (0.09)	<0.001
Residual variance	0.79 (0.03)		0.79 (0.03)		0.47 (0.02)	

Note: GED = general educational development.

Table 2d
SEM model parameters estimates assessing the longitudinal structural relationships of volunteering on Cognitive Functioning – Effect of sociodemographic variables and mediator variables on cognitive functioning 2012 and 2016.

Parameters	2012		2016	
	Estimate (*SE*)	*P*	Estimate (*SE*)	*P*
Intercept	9.46 (0.51)	<0.001	10.41 (0.47)	<0.001
Physical activity moderate 2008	0.08 (0.11)	0.468		
Social activity 2008	0.11 (0.12)	0.370		
Cognitive activity 2008	0.66 (0.10)	<0.001		
Physical activity moderate 2012			0.04 (0.09)	0.648
Social activity 2012			−0.11 (0.11)	0.309
Cognitive activity 2012			0.60 (0.11)	<0.001
Cognitive functioning 2008	0.47 (0.03)	<0.001		
Cognitive functioning 2012			0.50 (0.02)	<0.001
Age (ref: 55–64)				
65–74	0.60 (0.32)	0.060	−1.77 (0.24)	<0.001
≥75	−0.81 (0.33)	0.013	−3.32 (0.27)	<0.001
Sex (Ref: Female)				
Male	−0.13 (0.23)	0.569	−0.16 (0.20)	0.420
Educational attainment (ref: no degree)				
GED/High school	1.83 (0.29)	<0.001	1.40 (0.34)	<0.001
Some college/College degree	2.14 (0.37)	<0.001	2.40 (0.41)	<0.001
Master's/Professional	3.17 (0.44)	<0.001	2.70 (0.51)	<0.001
Residual variance	18.12 (0.70)		17.30 (0.60)	

Note: GED = general educational development.

Table 2e
SEM model parameters estimates assessing the longitudinal structural relationships of volunteering on Cognitive Functioning – Correlations (*SE*) among the mediator variables.

Parameters	2008		2012	
	Social Activity	Cognitive Activity	Social Activity	Cognitive Activity
Physical activity moderate	0.11 (0.02) *	0.06 (0.03)	0.04 (0.02)	0.03 (0.02)
Social activity		0.17 (0.02) *		0.10 (0.02) *

Note: *$P < 0.001$.

activity that can be increased to bolster cognitive functioning in older adulthood. Volunteering may be a key protective activity for aging adults, given the high prevalence of subjective cognitive decline [3].

4.2. Comparison of previous studies

When investigating volunteering activities in age groups being 65–74 years old and 75 years old or older compared to those being 55–64 years old, we observed that, in 2008, age groups 65–74 and 75 years old or older had higher odds of volunteering at least 100 h. We compared our results with the results of McDonald and Mair, who observed that volunteering activities are more prevalent in older ages, specifically when participants are 56–65 years old in their study [31]. The authors note that people being 56–65 years transition from high-pressure jobs and take on more flexible, enriching activities (e.g., volunteering) that have significant positive effects, such as making new friends and acquaintances [31]. However, McDonald and Mair evaluated voluntary organization membership and the age frame was 22–65, which makes it difficult to directly compare their study to ours. Gupta et al. state that normal cognitive aging is aggravated by retirement. Retirement is followed by a negative income shock, loss of an engaged lifestyle and loss of the work-related social network [32]. Our results suggest that those who volunteer more are 65 or older. Sixty-five and older ages are common ages of retirement in the US. The impact of factors such as the ones mentioned by Gupta et al. can be mitigated if recent retirees are involved in volunteering activities. It is important to note that we performed our analysis on individuals that had available data on the three waves and excluded the ones who were lost at follow-up. This involves that those participants who had worse health status and could not participate in the study or died during the period of study were not included. The inclusion of a more homogeneous sample avoided that participants with a more deteriorated health impacted the associations among the study variables because a natural decline due to age.

4.3. Positive effects of volunteering

The positive effects of volunteering on several health-related outcomes have been documented, with volunteering positively associated with self-rated health, psychological well-being, physical health and social well-being, among others [4,7,33,34,34,35]. In our study, volunteering was positively associated with changes in cognitive functioning through changes in cognitive activity. We argue that because volunteering involves keeping the brain active and, at the same time, is a rewarding activity, volunteering may strongly influence cognitive activity over social or physical activities. In fact, volunteering activities have been linked to reducing stress levels, providing a sense of purpose to volunteers, and fostering mental activity [1]. This finding is in line with the path hypothesized by D.C. Carr et al. – that a possible benefit of volunteering is due to significant differences in everyday overall physical activity among those who tend to choose to volunteer versus those who do not [36–38].

In our study, volunteering had an effect on positive changes on social activity. However, changes on social activity did not affect cognitive functioning in our model. In previous literature, it has been suggested that social activity protects against dementia [39,40]. Volunteering is an indicator of social capital, and it is beneficial for the community. It involves pro-social behavior and it is a public good element and expression of commitment to the group or collective [6]. In fact, some key features of volunteering are the implications for community engagement and understanding community needs [41]. It has been linked to more cohesive communities, increased trust and bridging connections [42,43]. For example, volunteers may be connected to people they would not have otherwise encountered. When older adults retire, there is a loss of connection derived from the lack of job-related activities and job connections [32]. Volunteering activities seem to be a good substitute to develop social connections when job-related connections decrease after retirement. Nonetheless, the number of social connections may still be substantially less than in previous stages in life [44]. One limitation of our study is that we did not have a life course perspective, since participants are involved in the HRS when they are 50 years old or older. As a result, we were not able to observe if social connections change from early stages to later stages in life.

4.4. Limitations and strengths

This study has more limitations. First, we did not include proximal outcomes included in the theoretical model by H. Guiney et al. because data on neurological health was not available and the mental health data was collected in a substantially reduced sample. Second, not all domains of cognitive functioning were examined since HRS data on cognitive functioning is limited. However, we were able to observe effects of volunteering on cognitive capacities for memory, mental processing, knowledge, language, and orientation. It remains unknown whether volunteering is associated with cognitive functioning in domains we could not assess. Future studies that include a more comprehensive assessment of cognitive functioning may be able to understand whether volunteering has a stronger relationship with some cognitive domains than others. Third, we did not have early life indicators that may affect cognition later in life. This research also has a number of considerable strengths. The data used came from a large and well-characterized prospective cohort. HRS is a nationally representative sample of U.S. adults aged $\geq$50 years. We have incorporated the data of three different waves to observe if there were differences of the variables under study between waves, and have tested a reduced version of previously hypothesized theoretical models with empirical data. In spite of the fact that the model we tested was not designed to quantify the right dosage of volunteerism to maximize its effects,

future research could explore what is an appropriate dose of volunteering activities to maximize their effects.

5. Conclusion

Volunteering is a healthy lifestyle choice, especially for older adults. In comparison to other post-retirement activities, as Gupta et al. stated, volunteering is unique in its ability to provide mental, physical and social stimulation simultaneously [32]. In doing so, volunteering can be used to help reduce the burden of age-related cognitive decline. Because the literature calls for the identification of novel factors that could delay or prevent neurocognitive disorders in old age, we suggest that future interventions that help older adults select and enjoy volunteering activities may have promise for delaying or preventing cognitive decline. Public health interventions in the U.S. should work to increase accessibility of volunteering opportunities for older adults for these cognitive benefits to be realized.

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Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

CRediT authorship contribution statement

Ester Villalonga Olives: Conceptualization, Methodology, Investigation, Writing – original draft, Project administration. **Kayleigh Majercak:** Data curation, Writing – review & editing. **Josue Almansa:** Methodology, Formal analysis, Investigation. **Tasneem Khambaty:** Conceptualization, Writing - review & editing.

Declaration of competing interest

The authors declare to not have any conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2023.06.018.

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