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Volunteering and Subsequent Health and Well-being in Older Adults: An Outcome-wide Longitudinal Approach

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Abstract

Introduction—Growing evidence documents strong associations between volunteering and favorable health and well-being outcomes. However, epidemiological studies have not evaluated whether changes in volunteering are associated with subsequent health and well-being outcomes.

Methods—Data were from 12,998 participants in the Health and Retirement Study—a large, diverse, prospective, and nationally representative cohort of U.S. adults aged >50 years. Using multiple logistic, linear, and generalized linear regression models, this study evaluated if changes in volunteering (between t_0;2006/2008 and t_1;2010/2012) were associated with 34 indicators of physical health, health behaviors, and psychosocial well-being (in t_2;2014/2016). Models adjusted for sociodemographics, physical health, health behaviors, psychosocial factors, personality, as well

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as volunteering and all outcomes in the pre-baseline wave (t_0;2006/2008). Results accounted for multiple testing and data were analyzed in 2019.

Results—During the 4-year follow-up period, participants who volunteered ≥100 hours/year (vs 0 hours/year) had reduced risk of mortality and physical functioning limitations, higher physical activity, and better psychosocial outcomes (higher: positive affect, optimism, purpose in life; lower: depressive symptoms, hopelessness, loneliness, infrequent contact with friends). Importantly, volunteering was not associated with other physical health outcomes (diabetes, hypertension, stroke, cancer, heart disease, lung disease, arthritis, overweight/obesity, cognitive impairment, chronic pain), health behaviors (binge drinking, smoking, sleep problems), or psychosocial outcomes (life satisfaction, mastery, health/financial mastery, depression, negative affect, perceived constraints, contact with other family/children).

Conclusions—With further research, volunteering is an activity that physicians might suggest to their willing and able patients as a way of simultaneously enhancing health and society.

INTRODUCTION

In 2017, a total of 77 million adults in the U.S. spent 6.9 billion hours volunteering with organizations—generating $167 billion in economic value to their communities.[1] In addition to benefitting their communities, growing evidence suggests that volunteers reap health and well-being benefits from their altruistic activities. Thus, physicians and policymakers are being encouraged to “prescribe” volunteering to their willing and able patients as a way of simultaneously enhancing health and society.[2–4]

Observational studies show that volunteering is associated with reduced risk of functional decline,[5,6] a range of chronic conditions (e.g., reduced risk of hypertension, cardiovascular disease, cognitive impairment),[7–9] and mortality.[6,10–15] Several mechanisms are hypothesized to underlie the salubrious effects of volunteering, including the fostering of psychological assets (e.g., increased life satisfaction, positive affect, purpose in life, self-efficacy, and reduced depression)[6,16–21] and social assets (e.g., increased perceived social support).[19] In turn, these assets might promote: (1) people’s ability to buffer against activation of the stress-linked neurohormonal cascade,[10,22,23] (2) healthier behaviors (e.g., increased use of preventive healthcare services),[24] and (3) better biological functioning (e.g., lower inflammation and blood pressure).[25,26] Results from experimental volunteering studies sometimes converge with results from observational studies (e.g., improved physical health [physical function, cognitive/neural function]),[27–31] biological function (cholesterol and inflammation levels),[32,33] health behaviors (physical activity),[29,34–36] and psychosocial health (higher social integration, lower depression).[27,29]

However, some results from the two study designs diverge (e.g., null associations with positive affect, negative affect, depressive symptoms, life satisfaction).[32,37,38] Owing to such discrepancies, some reports indicate that there is still insufficient evidence to demonstrate a consistent influence of volunteering on various outcomes and that more research is needed before volunteering can be considered a public health intervention.[37]

These prior studies have contributed substantially to the literature. However, for volunteering to be considered a viable public health intervention,[2–4] a slightly different question must be answered that no past observational studies (that the authors are aware of) and only some experimental studies have addressed: What health and well-being outcomes might be observed within a relatively short time horizon (4-year follow-up) if people were encouraged to volunteer more?

Past observational research has been unable to address this question for several reasons. First, many studies are cross-sectional, making it challenging to assess causality. Second, some studies use data from small and specific subpopulations (e.g., college students and patient groups), and results might not generalize to older adults or healthy populations. Third, many studies do not adequately account for important potential confounders. Fourth, most longitudinal studies have not controlled for volunteering, or outcomes, in the pre-baseline wave. Controlling for such variables helps readers evaluate how changes in volunteering are associated with changes in health and well-being. Experimental studies have overcome some of these limitations, but they often feature other limitations that inhibit their ability to answer this study's specific question.[39] First, most experimental studies have yet to evaluate a range of other outcomes that are core components of healthy aging. Second, many experimental studies were conducted among younger populations (e.g., high school students) and these results might not generalize to older adults (the landmark Experience Corp studies are a notable exception). Third, many studies might be underpowered to detect associations that require much larger samples. Fourth, trials often take place in artificial environments (laboratory studies), which often raise generalizability issues.[39] Fifth, most studies have short follow-up times, and it remains unknown what the effects of volunteering are on outcomes over longer durations.

Building on the seminal work of others, this study used a new outcome-wide analytic approach (described further in the Statistical Analysis section),[40] and evaluated whether changes in volunteering hours were associated with better health and well-being across 34 separate outcomes, including indicators of physical health, health behaviors, and psychosocial well-being. These outcomes were chosen because they are frequently included in the conceptualization of key gerontological models that characterize the antecedents, processes, and outcomes that foster people's ability to age well.[41–45]

METHODS

Study Population

Data were from the Health and Retirement Study (HRS), a nationally representative panel study of people aged >50 years. Starting in 2006, study staff visited a randomly selected half of the HRS participants for an enhanced face-to-face interview. The other half was assessed in 2008. After the interview, study participants were given a psychosocial questionnaire to complete and return by mail to the University of Michigan.[46] Response rates for this questionnaire were 88% in 2006 and 84% in 2008. Each sub-cohort alternates reporting on psychosocial factors, so that each participant reports psychosocial data every 4 years. To increase sample size and statistical power, data from both sub-cohorts were combined. The sample was restricted to individuals who completed the psychosocial questionnaire at

baseline because more than half of study outcomes were included in this assessment; this resulted in a final sample size of 12,998.

This study used data from three time points (t_0, t_1, t_2). All covariates were assessed in the pre-baseline wave (t_0;2006/2008). Then the exposure, volunteering, was assessed 4 years later in the baseline wave (t_1;2010/2012). Finally, all outcomes were assessed another 4 years later in the outcome wave (t_2;2014/2016). The HRS website (hrsonline.isr.umich.edu/) provides documentation about the study. Because the present study used de-identified, publicly available data, the IRB at the Harvard T.H. Chan School of Public Health exempted it from review.

Measures

Volunteering hours were assessed by asking HRS participants: *Have you spent any time in the past 12 months doing volunteer work for religious, educational, health-related or other charitable organizations?* If they responded *yes*, then HRS asked how many hours they volunteered: *1–49 hours*, *50–99* hours, *100–199 hours*, or *≥200 hours*. Based on past research suggesting that approximately100 hours/year of volunteering is an optimal threshold for health and well-being,[2] and to increase statistical power, the top two volunteering groups were collapsed in the main analyses. Results that did not collapse the top two volunteering groups are shown in Appendix Table 1, and results were very similar to results from the main analyses.

All covariates were assessed via self-report in the pre-baseline wave (t_0;2006/2008) and included: sociodemographic factors (age (continuous), sex (male/female), race/ethnicity (white, African American, Hispanic, other), marital status (married/not married), annual household income (<$50,000, $50,000–$74,999, $75,000–$99,999, ≥$100,000), total wealth (based on quintiles of the score distribution in this sample), educational attainment (no degree, GED/high school diploma, ≥college degree), employment (yes/no), health insurance (yes/no), geographic region (Northeast, Midwest, South, West), religious service attendance (none, once or less/week, once or more/week), personality (openness, conscientiousness, extraversion, agreeableness, neuroticism; continuous), and childhood abuse (yes/no).

In 2014/2016 (t_2), 34 outcomes were evaluated, including: physical health factors (all-cause mortality, number of chronic conditions, diabetes, hypertension, stroke, cancer, lung disease, arthritis, overweight/obesity, physical functioning limitations, cognitive impairment, chronic pain, self-rated health), health behaviors (binge drinking, smoking, physical activity, sleep problems), psychological well-being (positive affect, life satisfaction, optimism, purpose in life, mastery, health mastery, financial mastery), psychological distress (depression, depressive symptoms, hopelessness, negative affect, perceived constraints) and social factors (loneliness, frequency of contact with children, other family, and friends). The HRS guides (and Appendix Text 1) provide further details about each assessment.[46–48]

Statistical Analysis

This study took an outcome-wide analytic approach,[40] which features several analytic decisions not widely used in disciplines outside of biostatistics and causal inference. Thus, these decisions are summarized here. First, if covariates are assessed at the same time point

as the exposure (t_1), it remains unclear if the covariates are confounders or mediators[40]; thus, covariates were adjusted for in the pre-baseline wave (t_0), which helps reduce this concern and allows for a rich set of control variables to address confounding. Second, all outcome variables in the pre-baseline wave (t_0) were adjusted for in each model to reduce potential reverse causality. Third, to evaluate "change" in volunteering hours, volunteering hours was adjusted for in the pre-baseline wave (t_0). This helps "hold constant" pre-baseline levels of volunteering. Those who volunteer ≥100 hours in pre-baseline wave (t_0) and continue doing so in the baseline wave (t_1) contribute to the final estimate. However, the estimate produced from this analysis also corresponds to those who did not volunteer in t_0 and start volunteering ≥100 hours in t_1. The model effectively assumes that the coefficient for ≥100 hours of volunteering is constant across past volunteering levels (i.e., no interaction between past and current volunteering). Thus, readers are able to evaluate how changes in volunteering hours (between t_0 and t_1), are associated with subsequent health and well-being outcomes (at t_2; Appendix Text 2 provides further details). Controlling for pre-baseline levels of volunteering (t_0) also has several other advantages including helping to reduce risk of reverse causality by "removing" the accumulating effects that volunteering already had on outcomes in the past ("prevalent exposure"), and allowing readers to instead focus on the effects of change in volunteering hours ("incident exposure") on outcomes; thus, the focus is on how short-term changes in volunteering are associated with short-term changes in the outcomes.

Separate models were run for each outcome. Depending on the nature of the outcome, a different model was run: (1) for each binary outcome with a prevalence <10%, logistic regression was used; (2) for each binary outcome with a prevalence ≥10%, generalized linear model (with a log link and Poisson distribution) was used; and (3) for each continuous outcome, a linear regression model was used. Further, each continuous outcome was standardized (mean=0, SD=1) so their effect size could be interpreted in terms of SD change in the outcome variable. In the tables, multiple *p*-value cut offs were marked because practices for multiple testing vary widely and this is an evolving research area.[49,50] All data were analyzed in 2019.

Several additional analyses were conducted. First, to assess the robustness of the volunteering–health/well-being associations to unmeasured confounding, E-values were calculated to assess the minimum strength that unmeasured confounding must have on the RR scale (with both volunteering and the outcome) to entirely explain the association away.[51] Second, all models were re-analyzed using a reduced list of covariates that are more conventionally used in the volunteering-health/well-being literature (e.g., sociodemographics factors). This analytic approach asks a different question: What are the potential long-term cumulative effects that the whole history of volunteering (approximated by its current measure, but not controlling for the past) has on outcomes? Third, the main models were re-analyzed but first removed people with a history of any given physical condition at baseline. Fourth, all models were re-analyzed using only complete cases to evaluate the impact of multiple imputation on results.

All missing data on the exposure, covariates, and outcomes were imputed using an imputation by chained equations approach and five data sets were created. This approach

was chosen because it provides a more flexible approach than many other methods of handling missing data,[52–54] and helps address problems that emerge due to attrition.[55–60]

RESULTS

In the covariate wave (t_0;2006/2008) participants were aged 66 (SD=10) years on average, mostly women (59%), and married (66%). Table 1 provides the distribution of covariates by volunteering hours. Appendix Table 2 describes the change in volunteering hours from t_0 to t_1.

During the 4-year follow-up period, those volunteering ≥100 hours/year (vs 0 hours/year) had 44% reduced risk of mortality (95% CI=0.44, 0.71), 17% reduced risk of physical functioning limitations (95% CI=0.72, 0.96), and higher self-rated health (β=0.14, 95% CI=0.08, 0.19) (Table 2). There was no evidence that volunteering was associated with other physical health outcomes, including number of chronic conditions, diabetes, hypertension, stroke, cancer, heart disease, lung disease, arthritis, overweight/obesity, cognitive impairment, or chronic pain. When considering health behaviors, volunteering was associated with 12% increased likelihood of frequent physical activity (95% CI=1.03, 1.23), but not associated with binge drinking, smoking, or sleep problems. Among psychological factors, those volunteering ≥100 hours/year (vs 0 hours/year) had higher positive affect (β=0.13, 95% CI=0.08, 0.19), optimism (β=0.06, 95% CI=0.00, 0.12), and purpose in life (β=0.11, 95% CI=0.05, 0.16), as well as lower depressive symptoms (β= –0.06, 95% CI= –0.11, 0.00) and hopelessness (β= –0.08, 95% CI= –0.14, –0.02). However, there was no evidence that volunteering was associated with life satisfaction, mastery, health mastery, financial mastery, depression, negative affect, or perceived constraints. Finally, among social factors those volunteering ≥100 hours/year (vs 0 hours/year) had lower loneliness (β= –0.06, 95% CI= –0.13, 0.09) and were 29% less likely to report lack of contact with friends (95% CI=0.62, 0.80). For the volunteering ≥100 hours/year group, although associations with physical functioning limitations, frequent physical activity, optimism, depressive symptoms, hopelessness, and loneliness met conventional $p<0.05$ thresholds, they did not do so after Bonferroni correction. By contrast, associations with all-cause mortality, self-rated health, positive affect, purpose in life, and contact with friends did surpass the $p<0.05$ threshold even after Bonferroni correction.

First, E-values suggested that several of the observed associations were at least moderately robust to unmeasured confounding (Table 3). Second, conventionally adjusted covariates models showed estimates that generally had larger coefficients than fully adjusted models (Appendix Table 3). Third, when reanalyzing the fully adjusted models after removing anyone with history of a given physical condition at baseline, estimates generally had larger coefficients (Appendix Table 3). Complete-case analyses provided similar results to results in the main analyses (Appendix Table 4). Finally, an illustrative table was created to display coefficient estimates of all study variables, including covariates, for one of the outcomes—mortality (Appendix Table 5).

DISCUSSION

In a large, longitudinal, and nationally representative sample of adults aged >50 years, those volunteering ≥100 hours/year (vs 0 hours/year) had substantially reduced risk of mortality and onset of physical functioning limitations, better self-rated health, and higher physical activity. However, volunteering was not associated with ten other physical health outcomes or three health behaviors. Further, volunteering ≥100 hours/year (vs 0 hours/year) was associated with better outcomes on some indicators of psychosocial well-being (e.g., higher purpose in life), but not others (e.g., negative affect). In line with prior work,[2] many volunteering–health/well-being associations emerged only among people who volunteered ≥100 hours/year, suggesting evidence of a threshold effect.

Results from this study both converge with (e.g., associations with mortality, physical functioning, physical activity, positive affect, purpose) and diverge with results from past research (no associations with specific health outcomes such as heart disease, cognitive impairment). As one illustrative example, volunteering was associated with higher positive affect and this finding both converges[18,19] and diverges[32,38] with some prior research. Methodologically, the underlying reasons for diverging results might be attributable to several sources, including differences in: (1) study design (observational versus experimental), (2) composition of the sample (e.g., past work suggests that the volunteering–psychological well-being association is stronger in older adults,[61] and most experimental work on positive affect outcomes has focused on younger adults, whereas most observational work has focused on older adults), (3) measurement/categorization of the exposure and/or outcome, (4) inclusion/exclusion of covariates, and (5) control/no control for pre-baseline volunteering and outcome(s).

These diverging results also highlight how future research should consider important candidate moderators of the volunteering-health/well-being association, including age,[61] SES,[32] social connection,[62] depression,[63] baseline health,[38] personality,[10] motivations for volunteering,[11] as well as type and quality of the volunteering experience.[64] Some of these factors might also act as important mechanistic pathways and should be evaluated formally as such.

In this study, people who volunteered ≥100 hours/year (vs 0 hours/year) had a substantially reduced risk of mortality, yet volunteering was not associated with most physical health indicators. Several factors might explain this perplexing observation. First, volunteering was associated with several biopsychosocial mechanisms that past research has identified as independent risk/protective factors for mortality risk (e.g., physical activity, purpose in life).[65,66] Second, although data on incidence of chronic conditions were captured, specific causes of death data were missed. A study participant could have been stroke free throughout their life but died from stroke and such information was missed. HRS collects information about some causes of death but the categories do not map cleanly onto the chronic condition categories that were evaluated; thus, composite variables that capture both incidence of disease and death due to disease were not created (Appendix Text 3 provides further details). Third, emerging research suggests that important factors moderate the volunteering–mortality association (e.g., self- versus other-focused motivations for

volunteering, belief that others are fundamentally good/bad),[10,11] and future research should evaluate if such factors also moderate associations between volunteering and chronic conditions. Fourth, when considering the top causes of death among older adults (e.g., injury, pneumonia/influenza, or suicide), many causes are not well captured by existing HRS assessments of health/well-being.

Limitations

Many variables were self-reported, thus vulnerable to self-report bias. However, study participants were unaware of this study's hypothesis when completing the HRS survey and volunteering was reported prior to the assessment of outcomes. Future research should evaluate the outcomes using objective assessments. Confounding by unmeasured third variables is a limitation, but the prospective nature of the data, robust covariate control, and E-value analyses, help reduce this concern. In the main analyses, all participants were included at baseline, even if they had chronic conditions. Thus, incidence of a condition was evaluated. To help further isolate incidence, secondary analyses were conducted, and they removed people with a given condition at baseline. Reoccurrence could not be evaluated because the HRS only asks if a person ever had a condition. Although some study outcomes were correlated, there were unique and differential associations between volunteering and closely related outcomes. For example, volunteering was associated with positive affect, but not life satisfaction. Such differential findings provide some evidence that the associations are not entirely induced by correlated outcomes. Further, even if the effect of volunteering on some outcomes impacts other outcomes, this is important information for health promotion because correlated outcomes might highlight potential mediators that can be formally evaluated in future work (e.g., reduced loneliness might lead to increased positive affect). The study also had several strengths including the use of a large, diverse, prospective, and nationally representative sample of U.S. adults aged >50 years. Further, "incident" rather than "prevalent exposure" was evaluated, and this provides stronger evidence for causality around this study's main question of interest.[67–69]

CONCLUSIONS

Volunteering ≥100 hours/year (approximately 2 hours/week) was associated with reduced risk of mortality and physical functioning limitations, higher physical activity, and several beneficial psychosocial outcomes. The growing older adult population possesses a vast array of skills and experiences that can be leveraged for the greater good of society via volunteering. With further research, policies and interventions aimed at encouraging more volunteering might be an innovative way of simultaneously enhancing society and fostering a trajectory of healthy aging (on some indicators) in the large and rapidly growing population of older adults.[3]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Characteristics of Participants at Baseline by Categories of Volunteering (N=10,979)[a,b]

Participant characteristics	Hours of volunteering/year							
	0 Hours/Year (n=6,714)		1–49 Hours/Year (n=1,336)		50–99 Hours/Year (n=967)		≥100 Hours/Year (n=1,962)	
	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)
Sociodemographic factors								
Age, years (range: 46–99)		68.1 (9.6)		67.3 (9.5)		67.6 (9.5)		68.4 (9.0)
Female	3,903 (58.1)		829 (62.1)		609 (63.0)		1,199 (61.1)	
Race/Ethnicity								
White	5,051 (75.2)		1,072 (80.2)		800 (82.7)		1,645 (83.4)	
Black	805 (12.0)		162 (12.1)		113 (11.7)		219 (11.2)	
Hispanic	677 (10.1)		73 (5.5)		38 (3.9)		70 (3.6)	
Other	180 (2.7)		29 (2.2)		16 (1.7)		28 (1.4)	
Married	4,256 (63.4)		916 (68.6)		686 (70.9)		1,450 (73.9)	
Annual household income								
<$50,000	4,121 (61.4)		650 (48.7)		456 (47.2)		916 (46.7)	
$50,000–$74,999	1,034 (15.4)		222 (16.6)		156 (16.1)		372 (19.7)	
$75,000–$99,999	593 (8.8)		151 (11.3)		105 (10.9)		251 (12.8)	
≥$100,000	966 (14.4)		313 (23.4)		250 (25.9)		423 (21.6)	
Total wealth								
1st quintile	1,655 (24.7)		198 (14.8)		120 (12.4)		219 (11.2)	
2nd quintile	1,461 (21.8)		253 (18.9)		160 (16.6)		329 (16.8)	
3rd quintile	1,297 (19.3)		286 (21.4)		205 (21.2)		401 (20.4)	
4th quintile	1,209 (18.0)		296 (22.2)		232 (24.0)		462 (23.6)	
5th Quintile	1,092 (16.3)		303 (22.7)		250 (25.9)		551 (28.1)	
Education								
Less than high school	1,481 (22.1)		135 (10.2)		82 (8.5)		144 (7.4)	
High school	3,822 (57.1)		749 (56.4)		526 (54.5)		967 (49.5)	
At least some college	1,395 (20.8)		445 (33.5)		357 (37.0)		841 (43.1)	
Employed	2,658 (39.6)		662 (49.6)		476 (49.2)		791 (40.3)	
Health insurance	5,820 (86.8)		1,146 (85.8)		825 (85.4)		1,720 (87.7)	
Geographic region								

Participant characteristics	Hours of volunteering/year							
	0 Hours/Year (n=6,714)		1–49 Hours/Year (n=1,336)		50–99 Hours/Year (n=967)		≥100 Hours/Year (n=1,962)	
	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)
Northeast	1,067 (15.9)		171 (12.8)		121 (12.5)		285 (14.6)	
Midwest	1,670 (24.9)		435 (32.6)		302 (31.2)		554 (28.3)	
South	2,691 (40.2)		500 (37.5)		347 (35.9)		743 (38.0)	
West	1,274 (19.0)		229 (17.2)		197 (20.4)		375 (19.2)	
Childhood abuse	436 (7.2)		78 (6.3)		56 (6.3)		117 (6.4)	
Physical health								
Diabetes	1,311 (20.0)		214 (16.1)		105 (10.9)		296 (15.1)	
Hypertension	3,693 (55.1)		680 (51.0)		491 (51.0)		1,001 (51.1)	
Stroke	438 (6.5)		63 (4.7)		47 (4.9)		94 (4.8)	
Cancer	946 (14.0)		166 (12.5)		128 (13.3)		253 (12.9)	
Heart disease	1,417 (21.2)		249 (18.7)		175 (18.1)		383 (19.6)	
Lung disease	602 (9.0)		80 (6.0)		50 (5.2)		109 (5.6)	
Arthritis	3,925 (58.5)		745 (55.8)		538 (55.7)		1,101 (56.2)	
Overweight/Obesity	4,817 (72.8)		943 (71.3)		676 (70.8)		1,376 (70.7)	
Physical function limitations	1,562 (23.3)		195 (14.6)		125 (12.9)		237 (12.1)	
Cognitive impairment	1,170 (17.8)		138 (10.4)		86 (9.0)		129 (6.6)	
Chronic pain	2,448 (36.5)		398 (29.8)		291 (30.1)		516 (26.3)	
Self-rated health (range: 1–5)		3.1 (1.1)		3.5 (1.0)		3.5 (0.9)		3.6 (1.0)
Health behaviors								
Binge drinking	793 (14.5)		148 (14.2)		96 (12.0)		157 (9.9)	
Smoking	1,092 (16.4)		107 (8.1)		67 (7.0)		106 (5.4)	
Frequent physical activity	4,818 (71.8)		1,070 (80.2)		809 (83.7)		1,688 (86.1)	
Sleep problems	1,559 (42.8)		296 (40.3)		216 (40.5)		386 (34.6)	
Religious service attendance								
Never	2,200 (33.1)		139 (10.4)		82 (8.5)		180 (9.2)	
<1x/week	2,466 (36.8)		425 (31.9)		262 (27.1)		407 (20.8)	
≥1x/week	2,023 (30.2)		770 (57.7)		622 (64.4)		1,374 (70.1)	
Psychological well-being								
Positive affect (range: 1–5)		3.5 (0.8)		3.7 (0.7)		3.8 (0.7)		3.8 (0.6)

Participant characteristics	Hours of volunteering/year							
	0 Hours/Year (n=6,714)		1–49 Hours/Year (n=1,336)		50–99 Hours/Year (n=967)		≥100 Hours/Year (n=1,962)	
	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)
Life satisfaction (range: 1–7)		4.9 (1.5)		5.2 (1.4)		5.4 (1.3)		5.5 (1.3)
Optimism (range: 1–6)		4.4 (1.0)		4.6 (0.9)		4.8 (0.9)		4.8 (0.9)
Purpose in life (range: 1–6)		4.5 (0.9)		4.8 (0.8)		4.9 (0.8)		4.9 (0.8)
Mastery (range: 1–6)		4.8 (1.1)		4.9 (1.0)		4.9 (1.0)		4.9 (1.0)
Health mastery (range: 1–10)		7.3 (2.4)		7.5 (2.1)		7.6 (2.0)		7.7 (1.9)
Financial mastery (range: 1–10)		7.3 (2.7)		7.5 (2.4)		7.6 (2.3)		7.7 (2.2)
Psychological distress								
Depression	1,016 (15.5)		117 (8.8)		75 (7.9)		115 (5.9)	
Depressive symptoms (range: 0–8)		1.5 (2.0)		1.0 (1.7)		0.9 (1.5)		0.8 (1.4)
Hopelessness (range: 1–6)		2.5 (1.3)		2.1 (1.2)		1.9 (1.0)		1.9 (1.0)
Negative affect (range: 1–5)		1.7 (0.7)		1.6 (0.6)		1.6 (0.5)		1.5 (0.5)
Perceived constraints (range: 1–6)		2.2 (1.2)		2.0 (1.0)		1.9 (1.0)		1.9 (1.0)
Social factors								
Loneliness (range: 1–3)	1.5 (0.6)		1.4 (0.5)		1.4 (0.5)		1.3 (0.5)	
Living with spouse/partner	4,054 (67.8)		882 (72.1)		653 (73.0)		1,373 (76.1)	
Contact children <1x/week	1,578 (26.2)		270 (22.2)		193 (22.0)		407 (22.7)	
Contact other family <1x/week	2,882 (47.7)		584 (47.6)		418 (46.9)		887 (49.0)	
Contact friends <1x/week	2,423 (39.9)		370 (30.1)		231 (25.7)		399 (22.0)	
Personality								
Openness (range: 1–4)		2.9 (0.6)		3.0 (0.5)		3.1 (0.5)		3.1 (0.5)
Conscientiousness (range: 1–4)		3.4 (0.5)		3.4 (0.4)		3.4 (0.4)		3.5 (0.4)
Extraversion (range: 1–4)		3.1 (0.6)		3.3 (0.5)		3.3 (0.5)		3.4 (0.5)
Agreeableness (range: 1–4)		3.5 (0.5)		3.6 (0.4)		3.6 (0.4)		3.6 (0.4)
Neuroticism (range: 1–4)		2.1 (0.6)		2.0 (0.6)		2.0 (0.6)		1.9 (0.6)

[a] This table was created based on non-imputed data.

[b] All variables in Table 1 were used as covariates, and assessed in the pre-baseline wave (t_0;2006/2008).

Table 2.

Volunteering and Subsequent Health and Well-being (Health and Retirement Study [HRS]: N=12,998)[a,b,c,d]

Variable	Hours of volunteering/year			
	0 Hours/Year (n=8,064) (ref)	1–49 Hours/Year (n=1,794) RR/OR/β (95% CI)	50–99 Hours/Year (n=1,150) RR/OR/β (95% CI)	≥100 Hours/Year (n=1,990) RR/OR/β (95% CI)
Physical health				
All-cause mortality	1.00	0.85 (0.70, 1.04)	**0.72 (0.55, 0.93)** *	**0.56 (0.44, 0.71)** ***
Number of chronic conditions	0.00	−0.03 (−0.06, 0.00)	**−0.08 (−0.12, −0.04)** ***	−0.03 (−0.07, 0.01)
Diabetes	1.00	0.98 (0.88, 1.10)	1.91 (0.79, 1.05)	0.91 (0.80, 1.03)
Hypertension	1.00	0.99 (0.92, 1.06)	0.97 (0.89, 1.06)	1.00 (0.93, 1.09)
Stroke	1.00	1.08 (0.91, 1.29)	0.87 (0.67, 1.12)	0.90 (0.73, 1.12)
Cancer	1.00	0.99 (0.87, 1.12)	0.90 (0.77, 1.05)	0.92 (0.81, 1.06)
Heart disease	1.00	1.01 (0.90, 1.12)	0.94 (0.82, 1.07)	0.95 (0.84, 1.06)
Lung disease	1.00	0.91 (0.76, 1.08)	0.97 (0.78, 1.21)	1.05 (0.87, 1.27)
Arthritis	1.00	0.98 (0.92, 1.05)	0.99 (0.91, 1.08)	1.02 (0.95, 1.11)
Overweight/Obesity	1.00	0.98 (0.92, 1.05)	0.99 (0.90, 1.08)	1.01 (0.94, 1.09)
Physical functioning limitations	1.00	0.99 (0.89, 1.10)	**0.84 (0.72, 0.98)** *	**0.83 (0.72, 0.96)** *
Cognitive impairment	1.00	0.91 (0.79, 1.06)	**0.83 (0.71, 0.98)** *	0.86 (0.73, 1.00)
Chronic pain	1.00	0.99 (0.91, 1.09)	0.96 (0.86, 1.08)	0.95 (0.85, 1.06)
Self-rated health	0.00	0.04 (0.00, 0.09)	**0.09 (0.03, 0.15)** **	**0.14 (0.08, 0.19)** ***
Health behaviors				
Binge drinking	1.00	0.98 (0.72, 1.32)	0.98 (0.64, 1.49)	0.92 (0.58, 1.48)
Smoking	1.00	0.79 (0.58, 1.08)	0.87 (0.60, 1.27)	0.89 (0.58, 1.36)
Frequent physical activity	1.00	1.04 (0.96, 1.13)	1.06 (0.96, 1.17)	**1.12 (1.03, 1.23)** **
Sleep problems	1.00	0.99 (0.90, 1.09)	1.02 (0.91, 1.14)	0.99 (0.89, 1.11)
Psychological well-being				
Positive affect	0.00	0.04 (−0.02, 0.09)	**0.09 (0.03, 0.15)** **	**0.13 (0.08, 0.19)** ***
Life satisfaction	0.00	0.00 (−0.05, 0.05)	−0.02 (−0.10, 0.06)	0.05 (−0.03, 0.13)
Optimism	0.00	0.03 (−0.02, 0.08)	0.03 (−0.03, 0.09)	**0.06 (0.00, 0.12)** *
Purpose in life	0.00	0.03 (−0.02, 0.09)	0.06 (0.00, 0.13)	**0.11 (0.05, 0.16)** ***
Mastery	0.00	0.01 (−0.05, 0.07)	0.00 (−0.08, 0.08)	0.08 (−0.01, 0.17)
Health mastery	0.00	0.01 (−0.05, 0.07)	0.01 (−0.08, 0.10)	0.05 (−0.04, 0.14)
Financial mastery	0.00	0.02 (−0.05, 0.08)	0.03 (−0.04, 0.11)	0.08 (−0.03, 0.19)
Psychological distress				
Depression	1.00	0.92 (0.77, 1.09)	0.92 (0.71, 1.19)	0.90 (0.73, 1.12)
Depressive symptoms	0.00	−0.05 (−0.09, 0.00)	**−0.06 (−0.13, −0.01)** *	**−0.06 (−0.11, 0.00)** *
Hopelessness	0.00	−0.04 (−0.09, 0.01)	−0.05 (−0.11, 0.02)	**−0.08 (−0.14, −0.02)** *
Negative affect	0.00	0.02 (−0.03, 0.07)	0.01 (−0.06, 0.08)	−0.01 (−0.08, 0.06)
Perceived constraints	0.00	−0.03 (−0.09, 0.03)	−0.03 (−0.10, 0.05)	−0.06 (−0.13, 0.02)

Variable	Hours of volunteering/year			
	0 Hours/Year (n=8,064) (ref)	**1–49 Hours/Year (n=1,794) RR/OR/β (95% CI)**	**50–99 Hours/Year (n=1,150) RR/OR/β (95% CI)**	**≥100 Hours/Year (n=1,990) RR/OR/β (95% CI)**
Social factors				
Loneliness	0.00	0.00 (−0.05, 0.04)	−0.06 (−0.12, 0.00)	**−0.06 (−0.13, −0.00)** *
Contact children <1x/week	1.00	0.95 (0.85, 1.05)	0.94 (0.81, 1.09)	0.99 (0.86, 1.13)
Contact other family <1x/week	1.00	0.99 (0.92, 1.08)	1.00 (0.89, 1.12)	1.07 (0.98, 1.17)
Contact friends <1x/week	1.00	**0.88 (0.79, 0.98)** *	**0.83 (0.73, 0.94)** **	**0.71 (0.62, 0.80)** ***

Notes: Boldface indicates statistical significance (*p<0.05 before Bonferroni correction; **p<0.01 before Bonferroni correction; ***p<0.05 after Bonferroni correction [the p-value cutoff for Bonferroni correction is p=0.05/34 outcomes=p<0.001]).

[a] If the reference value is "1," the effect estimate is OR or RR; if the reference value is "0," the effect estimate is β.

[b] The analytic sample was restricted to those who had participated in the baseline wave (t_1;2010 or 2012). Multiple imputation was performed to impute missing data on the exposure, covariates, and outcomes. All models controlled for sociodemographic characteristics (age, sex, race/ethnicity, marital status, annual household income, total wealth, level of education, employment status, health insurance, geographic region), pre-baseline childhood abuse, pre-baseline religious service attendance, pre-baseline values of the outcome variables (diabetes, hypertension, stroke, cancer, heart disease, lung disease, arthritis, overweight/obesity, physical functioning limitations, cognitive impairment, chronic pain, self-rated health, binge drinking, current smoking status, physical activity, sleep problems, positive affect, life satisfaction, optimism, purpose in life, mastery, health mastery, financial mastery, depressive symptoms, hopelessness, negative affect, perceived constraints, loneliness, living with spouse/partner, contact children <1x/week, contact other family <1x/week, contact friends <1x/week), personality factors (openness, conscientiousness, extraversion, agreeableness, neuroticism) and the pre-baseline value of the exposure. These variables were controlled for in the wave pre-baseline to the exposure assessment (in t_0;2006 or 2008).

[c] An outcome-wide analytic approach was used, and a separate model for each outcome was run. A different type of model was run depending on the nature of the outcome: (1) for each binary outcome with a prevalence of ≥10%, a generalized linear model (with a log link and Poisson distribution) was used to estimate a RR; (2) for each binary outcome with a prevalence of <10%, a logistic regression model was used to estimate an OR; and (3) for each continuous outcome, a linear regression model was used to estimate a β.

[d] All continuous outcomes were standardized (mean=0; SD=1), and β was the standardized effect size.

Table 3.

Robustness to Unmeasured Confounding (E-Values) for the Associations Between Volunteering (≥100 Hours/Year vs 0 Hours/Year) and Subsequent Health and Well-Being (N=12,998)[a]

Variable	Effect estimate[b]	CI limit[c]
Physical health		
All-cause mortality	2.97	2.17
Number of chronic conditions	1.20	1.00
Diabetes	1.43	1.00
Hypertension	1.00	1.00
Stroke	1.46	1.00
Cancer	1.39	1.00
Heart disease	1.29	1.00
Lung disease	1.28	1.00
Arthritis	1.16	1.00
Overweight/obesity	1.11	1.00
Physical functioning limitations	1.70	1.25
Cognitive impairment	1.60	1.00
Chronic pain	1.29	1.00
Self-rated health	1.52	1.36
Health behaviors		
Binge drinking	1.39	1.00
Smoking	1.50	1.00
Frequent physical activity	1.49	1.21
Sleep problems	1.11	1.00
Psychological well-being		
Positive affect	1.51	1.37
Life satisfaction	1.27	1.00
Optimism	1.30	1.05
Purpose in life	1.44	1.27
Mastery	1.36	1.00
Health mastery	1.26	1.00
Financial mastery	1.37	1.00
Psychological distress		
Depression	1.43	1.00
Depressive symptoms	1.29	1.07
Hopelessness	1.36	1.16
Negative affect	1.10	1.00
Perceived constraints	1.29	1.00
Social factors		
Loneliness	1.31	1.06
Contact children <1x/week	1.11	1.00
Contact other family <1x/week	1.34	1.00

Variable	Effect estimate[b]	CI limit[c]
Contact friends <1x/week	2.17	1.81

[a] See VanderWeele and Ding (2017) for the formula for calculating E-values.

[b] The E-values for effect estimates are the minimum strength of association on the risk ratio scale that an unmeasured confounder would need to have with both the exposure and the outcome to fully explain away the observed association between the exposure and outcome, conditional on the measured covariates.

[c] The E-values for the limit of the 95% CI closest to the null denote the minimum strength of association on the risk ratio scale that an unmeasured confounder would need to have with both the exposure and the outcome to shift the CI to include the null value, conditional on the measured covariates.