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Volunteering and Changes in Cardiovascular Biomarkers: Longitudinal Evidence From the Health and Retirement Study

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Abstract

Background and Objectives: Growing body of research shows that volunteering is beneficial for those served, the volunteers, and the larger communities. However, major challenges remain that hinder the practical implications for volunteer activity as a public health intervention, including potential selection effects, lack of longitudinal studies that adjust for baseline characteristics, and a paucity of studies that consider multiple physical health outcomes in a single model.

Research Design and Methods: Data from 2006 to 2016 waves of the Health and Retirement Study (2006–2016) were used (N = 18,847). Outcome-wide analyses were utilized to evaluate if changes in volunteering between 2006/2008 (t_0) and 2010/2012 (t_1) were associated with 7 cardiovascular disease biomarkers 4 years later (2014/2016, t_2). These models were adjusted for demographic factors, socioeconomic status, health behaviors, chronic conditions, baseline biomarkers, and volunteering. Additionally, selection into volunteering and attrition were taken into account.

Results: Compared with nonvolunteers, volunteering more than 200 hr a year was associated with a lower risk for clinically high diastolic blood pressure. In addition, increased volunteering effort (change from 1 to 99 hr at t_0 to >100 hr at t_1) was associated with a lower likelihood of clinically high systolic and diastolic blood pressure levels. Sustained high volunteering (>100 hr at both t_0 and t_1) was associated with lower diastolic blood pressure.

Discussion and Implications: The current study adds to the evidence on the health benefits of volunteering for adults 50 and older by inferring a potential causal link between high-intensity volunteering and reduced blood pressure.

Translational Significance. The findings emphasize that prosocial activities, like volunteering, are associated with cardiovascular biomarkers and particularly systolic and diastolic blood pressure. These results encourage public health responses that promote volunteering to improve cardiovascular health in later life. The findings also call attention to the potential selection effects through this study's quasi-experimental design.

Keywords: Blood pressure, Cardiovascular disease, Inflammatory cytokines, Outcome-wide analysis, Prosocial behaviors

Background and Objectives

In the United States, one in four adults 50 and older volunteers through an organization, generating approximately 73.5 billion dollars of economic benefits for their communities (AmeriCorps, 2021). Theoretical frameworks and empirical research demonstrate that this form of prosocial activity is also beneficial for the volunteers' health and well-being (Brown & Brown, 2015; Burr et al., 2018; Kim et al., 2020; Morrow-Howell et al., 2017). In particular, volunteer activity has a potentially "calming" effect on the cardiovascular system and is associated with better cardiovascular outcomes, including lower risk of hypertension, lipid dysregulation, chronic inflammation, heart failure, and cardiovascular diseases (CVDs; Bell et al., 2022; Burr et al., 2015, 2018; Kim & Ferraro, 2014; Sneed & Cohen, 2013). Given that one in every four deaths can be attributed to CVD (Centers of Disease Control and Prevention, 2022), it is important to consider protective factors that modify CVD-related biomarkers.

Although some meta-analyses suggest that volunteering may be a cost-effective and sustainable public health intervention, there are unaddressed questions regarding the causal pathways to specific health outcomes (Jenkinson et al., 2013; Moore et al., 2021; Okun et al., 2013). Major challenges remain that hinder the practical implications

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of volunteer activity as a public health intervention. First, although the extant research examines hypertension (Burr et al., 2011, 2018; Sneed & Cohen, 2013; Tavares et al., 2013), chronic inflammation (Bell et al., 2022; Kim & Ferraro, 2014), cholesterol, and body mass index (Schreier et al., 2013) as isolated outcomes, very few studies examine them as parts of the interrelated cardiovascular functioning system (see Kim et al., 2020, for an exception). Studying these outcomes independently yields unique biological insights but research on the cardiovascular system indicates that inflammatory biomarkers, hypertension, and lipid dysregulation conjointly affect atherosclerosis (i.e., arterial plaque) and arteriosclerosis (i.e., thickening and hardening of the arteries; Tehrani et al., 2013). The current project examines cardiovascular biomarkers as separate and interrelated outcomes using the outcome-wide approach (OWA; VanderWeele et al., 2020).

Second, both voluntary activities and CVD-related biomarkers change over time, thus longitudinal studies offer several advantages. Volunteering for one event and actively volunteering for 10 years might have different implications for CVD health (Bell et al., 2022). Theoretical frameworks and empirical studies suggest that helping behaviors directly influence the cardiovascular system (Brown & Brown, 2015). However, it is unknown whether sustained volunteering influences changes in CVD biomarkers. Tracking how indicators of cardiovascular health, such as blood pressure and cholesterol levels, change over time can provide valuable insights into the etiology of CVD and aid in the development of effective interventions to reduce its incidence. Quasi-experimental longitudinal studies can also help alleviate concerns regarding reverse causality, which is often a concern in observational studies (Li & Ferraro, 2005; Morrow-Howell & Greenfield, 2016). By reducing the bias caused by the selection of already healthy individuals into volunteering, quasi-experimental studies help provide more accurate insights into the relationship between volunteering and CVD health outcomes. The current paper uses the OWA to examine the link between volunteering and changes in CVD biomarkers over time. OWA enables researchers to model all outcomes in a single model and to compare effect sizes. Because OWA controls for the same set of covariates for all outcomes, the model is less sensitive to researcher bias (VanderWeele et al., 2020). We focus on seven CVD biomarkers, including blood glucose (HbA1c), chronic inflammation (C-reactive protein [CRP]), systolic blood pressure (SBP) and diastolic blood pressure (DBP), total cholesterol/ HDL ratio, cystatin C, and obesity.

Theoretical Framework

Volunteering, defined as unpaid participation in formal organizations in which the beneficiary is typically unrelated to the volunteers (Li & Ferraro, 2005), is shown to confer physical health benefits. Several mechanisms may underlie this link, including psychological reservoirs (e.g., life satisfaction, purpose in life, and self-esteem; Gonzales et al., 2015; Tabassum et al., 2016), social connections (e.g., larger network size, frequent contact with network members; Pilkington et al., 2012) and health behaviors (e.g., greater physical activity, preventative health behaviors; Konrath et al., 2012). It is noteworthy that the associations are not consistent across studies, owing to different measurements for volunteerism, sample characteristics, and study designs. Scholars are collectively interested in whether there are unique health benefits of volunteering different from other types of helping behaviors, such as caregiving or informal helping.

The productive aging model postulates that participation in productive roles may lead to positive well-being outcomes (Morrow-Howell & Greenfield, 2016; Morrow-Howell et al., 2017). Regarding the health benefits of role occupancy, role theory stipulates that multiple roles (and identities) possessed by individuals lead to less psychological distress and better physical well-being (Thoits, 1983). Indeed, the role accumulation argument garnered substantive empirical support on a variety of health outcomes such as heightened sense of self-efficacy, greater positive affect, life satisfaction, self-reported health, and lower depressive symptoms, particularly in later life when role exits become more prevalent due to empty nest, retirement, or widowhood (Kim & Halvorsen, 2021; Kim et al., 2020; Rozario et al., 2004). The findings are consistent with the unique benefits of voluntary roles, as opposed to obligatory roles, as they are adopted by choice and can be exited fairly easily if the costs exceed the rewards (Thoits, 2012).

More recent investigations turned their attention to how frequency, involvement, or intensity of participation in a role may be consequential to the purported health benefits (Bell et al., 2022; Kail & Carr, 2020; Matz-Costa et al., 2014). This line of inquiry calls attention to a more nuanced understanding of adults 50 and older participating in volunteering roles to varying degrees. Matz-Costa et al. (2014) found that psychological well-being is not predicted by simple role occupancy, but varies by individuals' level of participation. This is in line with role salience, in that the importance of the role hinges upon how much individuals participate in the role (Thoits, 2012).

Then how does volunteering "get under the skin" and affect CVD biomarkers? A cogent explanation comes from the caregiving system model and similar theoretical frameworks rooted in cross-disciplinary literature on prosocial helping behaviors (Brown & Brown, 2015; Eisenberger & Cole, 2012; Inagaki, 2018). These perspectives characterize prosocial helping behaviors, including volunteering, as extensions of parental caregiving behavior provided to offspring, where a cascade of neurohormonal mechanisms are theorized to facilitate caregiving behavior and reduce stress and withdrawal (Brown & Brown, 2015; Inagaki, 2018). Key neural mechanisms (e.g., activities in the media optic area of the hypothalamus and septal area) and hormonal correlates (e.g., oxytocin and progesterone) implicated in caregiving behavior are known to have downstream effects on disease pathophysiology via sympathetic nervous system and hypothalamus–pituitary–adrenal (HPA) regulation, as well as inflammatory responses. Accordingly, prosocial behaviors in experimental and observational settings have been empirically linked to cardiovascular risk factors, including lower levels of SBP and DBP, lower levels of inflammation (e.g., IL-6 and CRP, as well as pro-inflammatory gene expression), and reduced cholesterol levels (Inagaki & Eisenberger, 2016; Nelson-Coffey et al., 2017; Schreier et al., 2013). Therefore, the caregiving systems model offers theoretical insights into why more active volunteers enjoy better physical health compared with nonvolunteers.

Literature Review—Volunteering and Cardiovascular Risks

Volunteering has been linked to several, albeit not all, biomarkers of cardiovascular health in later life. There are several HRS-based studies focusing on hypertension, where cross-sectional (Burr et al., 2011, 2015; Tavares et al., 2013) and longitudinal (Sneed & Cohen, 2013) evidence generally indicate that volunteering is associated with a lower risk of hypertension, as assessed with SBP and DBP. Notably, although cross-sectional evidence is suggestive of a more robust link between moderate intensity volunteering (100 annual hours) and hypertension (Burr et al., 2011, 2015; Tavares et al., 2013) Sneed and Cohen (2013) reported that only high-intensity volunteering (200+ hours/year) led to a lower risk of incident hypertension at 4-year follow-up (Sneed & Cohen, 2013). A recent outcome-wide analysis focusing on 34 health outcomes showed that the frequency of volunteering was unrelated to hypertension (Kim et al., 2020). Earlier findings linking volunteering and obesity are rare and inconsistent. Burr et al. (2015) reported that volunteering was associated with high-risk central adiposity among middle-aged adults (ages 51–64), but not older adults 65 and older. A recent randomized control trial based on Australian adults 60 and older found no relationship between volunteering at least 1 hr per week and a continuous measure of BMI at 6-month follow-up (Pettigrew et al., 2020).

In addition, there is a small but growing body of research employing blood-based biomarkers to examine whether volunteering gets under the skin to confer cardiovascular health benefits. The work by Kim and Ferraro (2014) was the first to focus on CRP, and the study findings indicated that volunteers in the National Social Life, Health and Aging Project (NSHAP) had a lower level of CRP compared with their nonvolunteer counterparts. However, two subsequent HRS-based studies found that volunteering was generally unrelated to CRP. Burr and colleagues (2015), using cross-sectional HRS data, reported that volunteering was unrelated to being at risk for elevated CRP. A recent study based on longitudinal HRS data also found limited evidence for the relationship between volunteering and CRP at 4-year follow-up (Bell et al., 2022). Apart from CRP, evidence linking volunteering and other blood-based biomarkers is sparse. Burr and colleagues' HRS-based study (2016) found no relationships between volunteering and blood glucose assessed with HbA1C; to the best of our knowledge, no study to date has examined biomarkers of lipid dysregulation (total cholesterol/HDL ratio) and renal function (cystatin C). We include cystatin C because it is a strong predictor of future coronary heart disease, ischemic stroke, and heart failure (West et al., 2022).

Guided by the theoretical framework and empirical evidence, we hypothesize that frequent volunteering and sustained volunteer activity are associated with healthier levels of biomarkers linked with CVDs.

Research Design and Methods

Study Population

The analyses included data from the biennial Health and Retirement Study (HRS) from 2006 to 2016. The HRS, sponsored by the National Institute on Aging (grant number NIA U01AG009740) and conducted by the University of Michigan, surveys a representative sample of approximately 20,000 community-dwelling Americans aged 50 and older and has low levels of attrition in comparison to other longitudinal studies of older adults. Starting in 2006, a random half of the participants went through an enhanced face-to-face interview. Each subcohort subsequently alternated reporting on health, biomarkers, and psychological factors every 4 years. The analytic sample included respondents aged 50 and older during the study's time frame whose answers were not included by proxy. To increase the sample size and statistical power, we combined the two sub-cohorts. This resulted in a sample size of 18,847. Demographic data were derived from the RAND HRS Longitudinal File 2016 V2 and volunteering variables were harvested from the RAND Enhanced HRS Fat files, and the CVD biomarkers were from the HRS biomarker files. The detailed data descriptions can be found on the HRS website (hrsonline.isr.umich.edu/).

The current study used data from three time points: pretreatment (2006 for Cohort 1 and 2008 for Cohort 2, t_0), treatment (2010 and 2012, t_1), and posttreatment (2014 and 2016, t_2). All covariates were assessed in the pretreatment wave (2006–2008). Changes in volunteering were calculated as the difference in volunteering intensity between pretreatment (2006–2008) and treatment wave (2010–2012), and outcome variables were assessed in the posttreatment wave (2014–2016). This strategy reflects the correct temporal order between antecedents (t_0), volunteering (t_0 to t_1), and CVD-related biomarker outcomes (t_2).

Measures

Volunteering

Volunteering was measured 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 answered affirmatively, then the HRS interviewers asked how many hours they volunteered a year: 1–49 hr, about 50 hr, 51–99 hr, about 100 hr, 101–200 hr, about 200 hr, and more than 200 hr (respectively coded 1–7, with nonvolunteers as the reference category). We used all available categories provided by the HRS.

In addition to the pretreatment volunteering variable (t_0, 2006 and 2008 for Cohorts 1 and 2, respectively), this project also created a categorical variable measuring changes in the number of volunteer hours between the pretreatment and treatment (t_1, 2010 and 2012) waves. If respondents were nonvolunteers at both waves, they were coded as 0 (reference). Those who became volunteers were coded as 1 ("volunteer initiation"). Those who volunteered in 2006–2008 but became nonvolunteers in 2010–2012 were coded as 2 ("volunteer cessation"). Those who volunteered 1–99 hr in both waves were coded as 3 ("low–medium"). Those who volunteered 100–200+ hr in 2006–2008 but decreased their efforts to 1–99 hr in 2010–2012 were coded as 4 ("decreased efforts"). Those who volunteered 1–99 hr in 2006–2008 and then increased their efforts to 100–200+ hr in 2010–2012 were coded as 5 ("increased efforts"). Finally, those who volunteered 100+ hr in both 2006–2008 and 2010–2012 were coded as 6 ("high-level sustained"). The categories for low, medium, and high volunteering commitment were adapted from the existing literature on volunteering (Han et al., 2020).

CVD-related biomarkers

Biomarkers were collected from respondents through blood spot collection. We used clinical thresholds to identify groups at higher risk of CVD. The clinical thresholds were discussed in multiple prior publications (Crimmins et al., 2013). Blood glucose was measured by levels of glycosylated hemoglobin (HbA1c). HbA1c level of 6.4% or greater was considered to be at higher risk of CVD. Lipid dysregulation was measured with total cholesterol/HDL ratio, such that a higher TC/HDL ratio is indicative of a higher CVD risk. A TC/HDL ratio of 5 or lower is considered normal and higher than 5 is considered an increased risk of CVD. Cystatin C level is an independent predictor of major CVD and chronic kidney disease; cystatin C greater than 1.15 mg/L was considered at higher risk for CVD. Chronic inflammation is characterized by high levels of inflammatory cytokine (CRP). Respondents with a CRP level of 3 μg/mL or higher were categorized as at increased risk of CVD. SBP and DBP was used to assess hypertension. SBP of 130 mm Hg or higher and DBP of 85 mm Hg or higher were used as thresholds for high blood pressure. Three blood pressure readings were taken using an Omron HEM-780 Intellisense Automated Blood Pressure Monitor. When two or more successful readings were obtained, the average of these readings was taken. If only one successful reading was obtained, then that reading was used. Finally, body mass index was used as a measure of CVD risk factors. Body mass index of 30 kg/m^2 or higher was considered a higher CVD risk.

Covariates

We included several relevant covariates measured at t_0 (Burr et al., 2015; Kim & Ferraro, 2014). These covariates include age, gender (0 = *male,* 1 = *female*), race (*White, Black, "other race" due to low sample sizes*), Hispanic ethnicity (0 = *not Hispanic*, 1 = *Hispanic*), and education (1 = *less than high school*, 2 = *high school graduate*, 3 = *some college*, 4 = *college and above*). Further, we included marital status (1 = *in a partnered relationship*, 0 = *not in a partnered relationship*), household wealth (continuous; assets minus debts, inverse hyperbolic sine transformed), self-rated health (1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *very good*, 5 = *excellent*), current smoking status (0 = *currently not smoking,* 1 = *currently smoking*), and having been diagnosed with heart disease (0 = *no diagnosis this wave*, 1 = *diagnosis this wave*).

Analytic Strategy

The current study employs an OWA which offers several advantages for the current analyses (VanderWeele et al., 2020). First, outcome-wide analysis accounts for correlations among outcomes although yielding individual coefficients for each outcome. Second, OWA adjusts for pretreatment covariates at t_0, which in our models include volunteering levels, CVD-related biomarkers, and sociodemographic variables to reduce potential reverse causality. Although holding constant the pretreatment levels of volunteering, this strategy also enables the evaluation of how changes in volunteering hours are associated with subsequent CVD-related biomarkers. In addition, we adjusted for clustering at the household level.

Further, this study used IPTW (inverse probability of treatment weighting; "propensity score weighting") to adjust for selection *into* volunteering. IPTW balances the treatment (volunteers) and control (nonvolunteers) on several traits. By balancing the treatment and control groups on a list of covariates from the prior wave, the current analysis can estimate the effects of volunteering although holding the selection effects constant. However, IPTW only balances measured variables that prior research has shown to predict selection. The propensity score weights were created using the *twang* machine-learning method in R (Ridgeway et al., 2022). The current IPTW balances the treated and untreated groups in terms of age, gender, race, Hispanic ethnicity, education, employment status, health, depressive symptoms, marital status, informal volunteering, wealth, and income. A detailed description of the creation of these weights can be found in Kim and Halvorsen (2021). Combined with the OWA, this study's outcome analysis is doubly robust, which has been shown to reduce bias in estimated effects (Funk et al., 2011).

Because all CVD-related biomarkers are binary, we employed a generalized linear model with a log link and Poisson distribution. Because multiple outcomes are considered and multiple tests are conducted in the same model, we used a Bonferroni correction to adjust for multiple testing. All missing data on the exposure, covariates, and outcomes were imputed using multiple imputations by chained equations (*mice* package in R) and five data sets were created. This approach provides more advantages compared with other strategies for handling missing data and addresses some issues due to attrition (Royston & White, 2011).

Several additional analyses were performed to test the robustness of the analytical model. First, all analyses were conducted using continuous, instead of binary, outcomes. Second, all models were reanalyzed only among people without a history of heart disease at baseline to evaluate the effects of pre-existing heart conditions. Third, complete case analyses were conducted to evaluate the effects of multiple imputations. In all cases, we found similar results to our final published findings. Finally, supplementary analyses considered additional covariates such as income, mental health, and depressive symptoms. They were excluded from the final analytical models because they were nonsignificant and did not change the significance levels of the independent variables.

Results

Descriptive Statistics

Table 1 describes the study variables. The mean age for the sample was 66 (range: 50–98) and the sample included more females (57%), non-Hispanic individuals (87%), and Whites (81%). The majority of the respondents had at least a high school education (80%), were partnered (66%), and were not currently working for pay (73%). Total wealth (raw values) ranged from −$2,199,392 to $43,500,000. In terms of health and health-related variables, the majority of respondents reported that their health was good or better (73%) and that they had no ADL limitations (96%). Most were nonsmokers (87%) and reported no heart problems (74%).

In terms of volunteering at t_1, 64% of the respondents were nonvolunteers in the past year. Approximately one in six (16%) volunteered for 50 hr or less, 6% volunteered for more than 50 but less than 100 hr, 8% volunteered for 100 to less than 200 hr, and 6% volunteered for 200 hr or more. Between t_0 and t_1, about half (53%) did not volunteer in the past year at both waves. About one in 10 each initiated volunteering (11%), ceased volunteering (9%), and volunteered 1–99 hr at both waves (11%). Smaller numbers decreased their volunteer effort (4.3%), increased their effort (3.8%), and were sustained high-level volunteers (i.e., greater than 100 hr in

Table 1. Descriptive Statistics of the Study Variables

Characteristics	N = 18,847
Age at 2006	66 (50, 98)
Sex	
Male	4,653 (43%)
Female	6,286 (57%)
Hispanic	
Non-Hispanic	9,550 (87%)
Hispanic	1,383 (13%)
Race	
White	14,509 (81%)
Black	2,520 (14%)
Other	860 (5%)
Education	
Less than high school	2,159 (20%)
High school	5,769 (53%)
Some college	649 (6%)
College graduated	2,362 (22%)
Self-reported health	
Poor	530 (7%)
Fair	1,592 (20%)
Good	2,420 (31%)
Very good	2,383 (30%)
Excellent	931 (12%)
Current smoking	
Nonsmoker	13,072 (87%)
Smoker	2,028 (13%)
Heart problems	
No	11,303 (74%)
Yes	3,905 (26%)
ADL limitations	
0	18,206 (96%)
1	384 (2%)
2	142 (1%)
3	53 (0.3%)
4	39 (0.2%)
5	23 (0.2%)
Partnered	
0	5,187 (34%)
1	10,023 (66%)
Wealth (inverse hyperbolic sine)	11.5 (−15.3, 18.2)
Wealth (raw)	529,225 (−2,199,392, 43,500,000)
Working for pay	
No	11,113 (73%)
Yes	4,098 (27%)
Volunteering frequency (t_1)[a]	
Nonvolunteer	10,431 (64%)
<50 hr	2,173 (13%)
About 50 hr	411 (3%)
>50, <100 hr	923 (6%)
About 100 hr	379 (2%)
>100, <200 hr	878 (5%)
About 200 hr	137 (1%)
>200 hr	901 (6%)
Volunteering changes (t_0 to t_1)[b]	
Nonvolunteer	6,824 (53%)
Initiated	1,413 (11%)
Ceased	1,194 (9%)
Low-medium	1,465 (11%)
Decreased effort	548 (4%)
Increased effort	486 (4%)
Highly sustained	876 (7%)
2006–2008 Outcomes	
HbA1c	
0	10,344 (84%)
1	2,020 (16%)
TC/HDL ratio	
0	6,866 (81%)
1	1,582 (19%)
Cystatin C	
0	8,129 (68%)
1	3,772 (32%)
C-reactive protein	
0	7,316 (61%)
1	4,683 (39%)
Systolic blood pressure	
0	7,026 (51%)
1	6,660 (49%)
Diastolic blood pressure	
0	9,692 (70%)
1	3,994 (30%)
Obesity	
0	10,235 (68%)
1	4,785 (32%)
2014–2016 Outcomes	
HbA1c	
0	7,747 (77%)
1	2,274 (23%)
TC/HDL ratio	
0	8,467 (86%)
1	1,360 (14%)
Cystatin C	
0	6,048 (58%)
1	4,419 (42%)
C-reactive protein	
0	7,053 (67%)
1	3,407 (33%)
Systolic blood pressure	
0	6,213 (54%)
1	5,223 (46%)
Diastolic blood pressure	
0	8,773 (77%)
1	2,664 (23%)
Obesity	
0	8,785 (66%)
1	4,575 (34%)

Notes: Continuous variables: median (interquartile range); categorical variables: n (%). Pretreatment (t_0; Cohort 1: 2006; Cohort 2: 2008) and treatment (t_1; Cohort 1: 2010; Cohort 2: 2012) times. Unless otherwise stated, all values are shown at the pretreatment (t_0) time.

Table 1. Continued

both waves; 6.8%). The descriptive statistics by volunteer frequency are available in Supplementary Table A.

All seven CVD-related biomarkers measured in this study were present in at least one in seven respondents at both t_1 and t_2 (2014 for Cohort 1 and 2016 for Cohort 2), and the top four biomarkers at each timepoint were the same. At t_0, the most common were high SBP (49%), high CRP (39%), cystatin C (32%), and obesity (32%). At t_2, the most common were high SBP (46%), high cystatin C (42%), obesity (34%), and high CRP (33%).

Outcome-wide analyses

Tables 2 and 3 present the results of the outcome-wide analyses. Table 2 shows categorical volunteering frequency at t_1 as a predictor of seven cardiovascular risk factors at t_2. Results show that, compared with not volunteering, volunteering more than 200 hr a year was associated with a lower risk for clinically high DBP (RR = 0.78, $p < .05$ after Bonferroni correction) at t_2 after adjusting for volunteering, CVD-related biomarkers, and covariates at t_0 and selection into volunteering at t_1 via IPTW. This roughly translates to volunteering at least 4 hr every week for a year. Volunteering about 50 hr a year was linked with higher cystatin C but the significance did not reach 0.05 after Bonferroni correction.

We then modeled changes in volunteering between t_0 and t_1. Table 3 reveals that increased volunteering effort (i.e., a change from 1–99 hr at t_0 to 100–200+ hr at t_1) was associated with a lower likelihood of clinically high diastolic and SBP levels (DBP RR = 0.786, $p < .05$ after Bonferroni correction; SBP RR = 0.852, $p < .05$ after Bonferroni correction). High and sustained volunteering (i.e., 100+ hours at both t_0 and t_1) was associated with a significantly lower risk for clinically high DBP (RR = 0.822, $p < .01$ *before* Bonferroni correction).

Discussion and Implications

Using quasi-experimental methodology and outcome-wide analysis, the present study tested the link between the intensity of formal volunteering and biomarkers linked to CVD among Americans ages 50 years and older. Our findings suggest that volunteering at least 200 hr each year—at minimum about 4 hr or more each week, on average—is linked to healthier DBP (operationalized as below 85 mm Hg). Given that we adjusted for the selection into volunteering, baseline biomarkers, and baseline volunteering, this finding suggests a potential causal link. Further, existing volunteers who increased their volunteering between waves from less than to more than 100 hr per year experienced healthier diastolic and SBP (the latter operationalized as below 130 mm Hg). Given that high blood pressure is associated with a variety of health ailments and associated health care costs for individuals and society (Rapsomaniki et al., 2014), these results provide support for the call for volunteering to be seen as a public health intervention (Jenkinson et al., 2013). The link between volunteering and blood pressure also provides empirical evidence for the caregiving systems model (Brown & Brown, 2015; Brown et al., 2012) in favor of a link between other-directed helping behaviors and decreased activities in the HPA axis, lower blood pressure, and faster recovery from stress. Importantly, this link between helping and better cardiovascular regulation may elucidate why helping others through volunteering has repeatedly been shown to predict better health and longevity (Harris & Thoresen, 2005; Okun et al., 2013).

Volunteering—operationalized in this study as volunteering for a charitable organization in the past 12 months—may confer these benefits through its inherent physical activity. The rich set of studies on volunteer outcomes in the Experience Corps program illustrates this potential link from volunteering to health. At minimum, volunteering may reduce sedentary behavior: Experience Corps program volunteers, for example, experienced decreased hours watching television through a randomized controlled trial (Rebok et al., 2011). At best, volunteering may increase physical exercise: Experience Corps volunteers also experienced increases in physical activity overall as well as increases in moderately strenuous housework such as mowing or raking the lawn (Tan et al., 2006) and, among women, walking, compared with the control groups (Varma et al., 2015). Yet the outcomes in our study were measured in 2014 and 2016 before virtual volunteering became more commonplace as a result of the COVID-19 pandemic (Lachance, 2021; Sun et al., 2021). As a result, the health benefits of volunteering after the onset

Table 2. Outcome-wide Analysis for 2010–2012 Volunteering Predicting Cardiovascular Risk Factors on 2014–2016

CVD biomarkers	<50 hr		About 50 hr		>50, <100 hr		About 100 hr		>100, <200 hr		About 200 hr		>200 hr	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
HbA1c	0.98	0.89, 1.08	0.90	0.72, 1.13	1.03	0.87, 1.32	1.03	0.85, 1.25	1.11	0.96, 1.29	0.82	0.55, 1.20	0.97	0.84, 1.12
TC/HDL	1.01	0.98, 1.04	1.01	0.96, 1.05	1.01	0.98, 1.05	1.01	0.94, 1.04	1.02	0.99, 1.05	0.97	0.90, 1.04	1.01	0.97, 1.04
Cystatin C	1.06	0.99, 1.13	1.13*	1.01, 1.26	1.02	0.96, 1.16	1.02	0.89, 1.18	1.05	0.94, 1.17	1.01	0.81, 1.25	0.96	0.87, 1.05
CRP	1.01	0.92, 1.10	1.02	0.86, 1.21	0.97	0.91, 1.17	0.97	0.80, 1.19	1.03	0.87, 1.21	1.02	0.73, 1.42	0.94	0.80, 1.09
DBP	0.93	0.83, 1.05	1.03	0.86, 1.24	1.03	0.90, 1.20	1.03	0.74, 1.42	1.00	0.87, 1.15	0.80	0.55, 1.15	0.78***	0.67, 0.92
SBP	0.96	0.89, 1.03	0.99	0.86, 1.13	0.96	0.94, 1.12	0.96	0.86, 1.07	0.92	0.84, 1.01	1.01	0.77, 1.32	0.97	0.89, 1.06
Obesity	1.01	0.96, 1.07	0.94	0.83, 1.06	1.94	0.87, 1.16	1.04	0.92, 1.18	0.99	0.90, 1.09	1.02	0.79, 1.32	1.04	0.97, 1.12

Notes. CRP = C-reactive protein; DBP = diastolic blood pressure; HDL = high-density lipoprotein; SBP = systolic blood pressure; TC = total cholesterol. All binary outcomes are common (prevalence >10%); thus, the estimates for these outcomes were risk ratios estimated via modified Poisson regression with robust standard error. Omitted exposure category (not volunteering at t_1) is the reference group.

*$p < .05$ before Bonferroni correction, ** $p < .01$ before Bonferroni correction, ***$p < .05$ after Bonferroni correction (the p value cutoff for Bonferroni correction is $p = 0.05/7 = p < .007$).

Table 3. Outcome-Wide Analysis for Changes in Volunteering (2006–2010) and Cardiovascular Risk Factors in 2014–2016

CVD biomarkers	Volunteer initiation		Volunteer cessation		Low–medium		Decreased efforts		Increased efforts		High-level sustained	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
HbA1c	1.08	0.99, 1.18	0.96	0.86, 1.07	0.90	0.67, 1.20	1.20	0.97, 1.49	1.04	0.77, 1.40	0.92	0.72, 1.17
TC/HDL	1.19	0.79, 1.78	0.97	0.62, 1.54	1.04	0.65, 1.69	0.95	0.67, 1.36	0.84	0.48, 1.46	0.91	0.61, 1.36
Cystatin C	0.96	0.85, 1.09	0.97	0.79, 1.18	0.99	0.92, 1.07	1.02	0.91, 1.15	0.94	0.85, 1.05	0.95	0.86, 1.06
CRP	0.94	0.80, 1.11	1.05	0.93, 1.19	0.95	0.82, 1.09	0.85	0.71, 1.01	0.83	0.64, 1.09	0.99	0.82, 1.19
DBP	0.95	0.86, 1.06	1.07	0.97, 1.17	0.89	0.75, 1.06	0.99	0.83, 1.17	0.79***	0.66, 0.93	0.82**	0.71, 0.95
SBP	1.03	0.94, 1.13	1.02	0.92, 1.13	0.99	0.91, 1.08	1.02	0.92, 1.13	0.85***	0.80, 0.92	0.94	0.81, 1.10
Obesity	0.97	0.91, 1.04	0.99	0.92, 1.05	1.04	0.94, 1.15	0.99	0.84, 1.17	1.08	0.98, 1.19	1.01	0.90, 1.14

Notes: CRP = C-reactive protein; DBP = diastolic blood pressure; HDL = high-density lipoprotein; SBP = systolic blood pressure; TC = total cholesterol. All binary outcomes are common (prevalence >10%); thus, the estimates for these outcomes were risk ratios estimated via modified Poisson regression with robust standard error. Omitted exposure category (not volunteering at both t_0 and t_1) is the reference group.
*$p < .05$ before Bonferroni correction. **$p < .01$ before Bonferroni correction. ***$p < .05$ after Bonferroni correction (the p value cutoff for Bonferroni correction is $p = .05/7 = p < .007$).

of the COVID-19 pandemic may be tampered with by the subsequent lack of physical activity.

The improved blood pressure results for high-intensity volunteers and those who increased their volunteer intensity may also be a result of volunteering's effect on a sense of purpose in life, which has separately been linked to reduced all-cause mortality and cardiovascular events (Cohen et al., 2016; Koizumi et al., 2008). Research suggests that volunteering can result in a stronger sense of purpose through feeling that one matters to other people, which improves well-being, and that this sense of purpose increases with the amount of time spent volunteering (Thoits, 2012). Volunteering can be especially beneficial to individuals without partners, employment, or parental role identities, buffering the adverse effects of reduced purpose in life and lacking these identities (Greenfield & Marks, 2004). However, Sneed and Cohen (2013) found that the higher psychological well-being linked to volunteering did not mediate the relationship between volunteering and hypertension, although their study considered a variety of factors related to psychological well-being and did not specifically test the mediating role of purpose in life.

Our study adds to the mixed findings on links between volunteering and blood pressure among adults 50 and older. Our study found that high-intensity volunteering (defined as 200 or more hours each year) was linked with DBP. Similarly, Sneed and Cohen (2013), using data from the HRS, found a link between volunteering for more than 200 hr each year with a reduced likelihood of developing hypertension among those with no hypertension at baseline. Yet Burr et al. (2011), also using HRS data, found that volunteering fewer than 100 hr per year was associated with reduced risk of hypertension overall as well as both SBP and DBP, but not 100 or more hours per year. The current study significantly extends the previous findings by adjusting for selection into volunteering and baseline blood pressure, still finding a link between volunteering and SBP and DBP above and beyond the selection effects. Further, and taken as a whole, the literature collectively indicates a negative relationship between volunteering and blood pressure among adults 50 and older.

More broadly, and because volunteering in this study was completed through charitable organizations, it may increase one's knowledge of health and human services or health behaviors that, when accessed or acted upon, lead to better cardiovascular health. A separate study found that lower-wealth volunteers experienced greater gains in self-reported health, which could also be explained by learning about safety net programs available to them that higher-wealth volunteers may not need or be eligible for (Kim & Halvorsen, 2021). This link between working in nonprofit and public agencies and knowledge of safety net supports has been found in low-income older adults in the Senior Community Service Employment Program (Halvorsen et al., 2022), where the participants noted that their knowledge of programs like SNAP benefits ("food stamps") increased. Future community-based research among volunteers should assess how one's knowledge of these safety net programs mediates the relationship between volunteering and cardiovascular health, and if that relationship differs by wealth or income.

Strengths and Limitations

Given the difficulties of creating real-world and ethical randomized controlled trials to study the effects of volunteering on cardiovascular health among adults 50 and older, our quasi-experimental study utilized two advanced methodologies. First, our inverse probability of treatment weights utilized pretreatment covariates at t_0 to predict volunteering at t_1 to control for selection into volunteering (Ridgeway et al., 2022). These weights, generated using machine-learning methods, were then used in the final analysis. Second, our outcome variables were analyzed concurrently using the outcome-wide analysis method, which, among its advantages, leads to a greater likelihood of reporting null effects although controlling for pretreatment outcome variables (VanderWeele et al., 2020). This outcome-wide analysis also serves as doubly robust estimation of effects within a propensity score analysis framework, which has been shown to increase the likelihood of estimating unbiased effects (Funk et al., 2011). However, these methods only control for known and measured variables; as such, confounding variables are a potential limitation to our findings. Unmeasured variables such as volunteer motivation and personality might affect the purported cardiovascular health benefits of volunteering (Dahlén et al., 2022; Moieni et al., 2020). Though we used two quasi-experimental methods (IPTW with longitudinal OWA), our study simply *infers* causality but does not prove it, due to our use of observational data and unmeasured confounding.

We also did not measure long-term volunteering (e.g., more than a decade of continuous volunteering) and it is possible that long-term volunteer activity might have a more profound effect on CVD biomarkers compared with briefer forms of volunteering. There is a potential bidirectional relationship where sustained and active volunteering leads to better CVD biomarkers, which subsequently enable volunteers to continue their prosocial activities (Li & Ferraro, 2006). Multi-wave cross-lagged models should be used for these investigations. Further, and although we controlled for gender and race, the effects of volunteering on CVD health might be different for age, gender, and racial/ethnic subgroups. For example, there is evidence that the effects of volunteering on central adiposity might be stronger for middle-aged adults (Burr et al., 2015), yet frequent volunteering is associated with lower CRP *only* for adults 65 and older (Bell & Ferraro, 2022; Kim & Ferraro, 2014). The relationship between a moderate amount of volunteer activity and hypertension was slightly stronger for white older adults (Tavares et al., 2013). Therefore, future studies should investigate how much volunteering is beneficial for which subgroups of adults and under which contexts.

Conclusion

Overall, our study adds to the rich evidence of volunteering's benefits to adults 50 and older by inferring a potential causal link between high-intensity volunteering and reduced blood pressure. Because high blood pressure is linked to several cardiovascular issues (Rapsomaniki et al., 2014), this study lends further support to the idea that volunteering itself can be a public health intervention that is encouraged within families as well as promoted by doctors and other health care professionals and policy-makers (Sneed & Cohen, 2013; Tan et al., 2006). However, given that several CVD-related biomarkers in our study were nonsignificant, we caution scholars, practitioners, and policy-makers from promoting volunteering as a cardiovascular health panacea.

Supplementary Material

Supplementary data are available at *Innovation in Aging* online.

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Conflict of Interest

None.

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