Volunteering and Cardiovascular Disease Risk: Does Helping Others Get “Under the Skin?”

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Received October 24, 2014; Accepted February 10, 2015

Decision Editor: Rachel Pruchno, PhD

Abstract

Purpose of the Study: This study investigated whether volunteering was related to 5 risk factors for cardiovascular disease (CVD) and the metabolic syndrome (MetS) among middle-aged and older adults.

Design and Methods: Data from the 2004 and 2006 waves of the Health and Retirement Study (N = 7,803) were examined. Logistic regression was used to describe the relationships among volunteering and central adiposity, hypertension, lipid dysregulation, elevated blood glucose levels, and high inflammation, along with 2 indexes of the MetS.

Results: Among middle-aged adults, results showed that volunteers were less likely to have high central adiposity, lipid dysregulation, elevated blood glucose levels, and MetS compared with non-volunteers. For older adults, results showed volunteers were less likely to be hypertensive and more likely to have lipid dysregulation than their non-volunteer counterparts.

Implications: These results supported findings from other studies that formal volunteering is beneficial for middle-aged adults, and to a lesser degree, older adults. Further research is required to determine what factors may mediate the volunteer–CVD risk relationships.

Keywords: Metabolic syndrome, Inflammation, Volunteer hours, Health and Retirement Study, Social engagement, CVD, Volunteerism and civic engagement, Social support, Health

Volunteering is considered a win-win-win proposition for the individuals who participate in such activities, for persons and groups on the receiving end of volunteering efforts, and for the community as a whole (Morrow-Howell, 2010). Volunteering is related to age in a non-linear fashion, with a slight downturn in later life from a peak in middle age (Bureau of Labor Statistics, 2014). In 2013, 26% of adults age 55–64 participated as a volunteer for a formal organization, whereas 24.1% of adults age 65 and older volunteered (Bureau of Labor Statistics, 2014). Volunteering allows middle-aged and older adults to remain active, productive, socially connected, and engaged in the community, and is consistently associated with a wide range of well-being indicators (Anderson et al., 2014).

Uncovering the pathways through which volunteering is related to well-being includes a focus on biological and physiological systems, or “under the skin” factors. The purpose of this study is to investigate the relationships among volunteering and several risk factors for cardiovascular disease (CVD). CVD includes coronary heart disease, stroke, and other diseases of the circulatory system. CVD is linked to risk factors associated with the metabolic system. The risk factors include dysglycemia, raised blood pressure, elevated triglyceride levels, low high-density lipoprotein cholesterol (HDL) levels, and obesity (particularly central adiposity). Systemic inflammation is also related to a number of underlying chronic and acute conditions, including CVD, and may be indicative of long-term exposure to physiological stress (Devaraj, Singh, & Jialal, 2009). One indicator of
inflammation is the amount of C-reactive protein (CRP) in the blood. A clustering of these risk factors is referred to as the metabolic syndrome (MetS; Alberti et al., 2009).

Data from the 2004 and 2006 waves of the Health and Retirement Study (HRS) are examined for this study. The HRS provides information on four CVD risk factors associated with the biochemical and physical markers of the MetS, along with one biomarker of the immune system (CRP). Two indexes of MetS are generated using these indicators; the associations among volunteering and two MetS indexes are also examined.

Literature Review

Compared with non-volunteers, volunteers show lower levels of depression, higher life satisfaction (Li, Chen, & Chen, 2013), greater executive function, and better cognitive health (Fried et al., 2013). Volunteers report higher levels of physical health, including better self-reported health, fewer functional limitations (Li et al., 2013), fewer falls, less frailty, less disability (Fried et al., 2013), and lower mortality risk (Okun, Yeung, & Brown, 2013) than non-volunteers. The relationship between volunteering and mental health is more consistent than for physical health. Some research shows that volunteering creates stress for the volunteer (Varma et al., 2014) and thus volunteering is not universally beneficial for well-being. The relationships among mental and physical health characteristics and volunteering have been shown to vary by age group, gender, race, and social class (Musick & Wilson, 2008).

The salutary effect of volunteering for general well-being is hypothesized to be related to enhancement of psychosocial resources, including the expansion of individuals’ social networks, increased self-esteem and mastery, and increased actual and perceived levels of social support, potentially buffering the impact of stress (Cohen, 2004). The potential beneficial effects of volunteering may also be related to differences in health behaviors and lifestyles among volunteers and non-volunteers. The expanded social networks of volunteers may yield support for reducing risky behaviors, such as smoking and excessive alcohol consumption, and increased support for remaining physically active (Musick & Wilson, 2008).

With regard to health and CVD risk, volunteering in some ways is fundamentally different from caregiving and informal help given to persons not living with the older adult. Formal volunteering is a discretionary activity that is less likely to produce harmful stress in the same way that many forms of caregiving generate. Unlike both caregiving and informal helping, most formal volunteering is conducted in the public domain, whereby other volunteers and the people they help provide positive feedback and recognition. As indicated earlier, these social benefits are related to the development and employment of coping strategies, more support for positive health behaviors, and support for and development of psychosocial resources expected to promote better overall health (Li & Ferraro, 2006).

Volunteering and CVD Risk

Hypertension is related to volunteer status, as well as the amount of volunteering hours committed, such that those who volunteer have lower risk of hypertension compared with non-volunteers (Burr, Tavares, & Mutchler, 2011). Further, volunteering is more likely to be related to a lower risk of hypertension among older White adults than among older Black adults (Tavares, Burr, & Mutchler, 2013). Personality traits do not appear to mediate these relationships (Sneed & Cohen, 2013). Compared with not volunteering at all, a moderate amount of hours committed to volunteering is related to lower risk of hypertension, but higher amounts of volunteer hours do not appear to confer any benefits. The results are equivocal with respect to the point at which volunteering hours are no longer associated with better health, in part due to variability in the way volunteer hours is measured, and whether a prevalence or incidence model is examined (Burr et al., 2011; Sneed & Cohen, 2013).

Data from the National Social Life, Health and Aging Project show that one of the most consistent activities related to inflammation (CRP) is volunteer status (Kim & Ferraro, 2014), whereby volunteers had lower levels of inflammation than non-volunteers. However, no relationship between volunteering hours and CRP was identified. We are not aware of any studies that have examined the relationship between volunteering and other biomarkers, such as lipids and blood glucose.

In any study of volunteering and health, causal relationships may be reciprocal, especially in observational designs (Li & Ferraro, 2006). Nevertheless, two recent studies of volunteering and well-being using randomized control trial (RCT) designs provide additional evidence that volunteering may predict better health among older adults (Fried et al., 2013; results based on a pilot study) and adolescents (Schreier, Schonert-Reichl, & Chen, 2013). Thus, studies based on RCT designs are demonstrating results consistent with the larger body of research based on surveys.

We expect that adults who volunteer and who volunteer a moderate amount of time will have lower risk for CVD, as measured by central adiposity, hypertension, blood glucose, low HDL cholesterol, and CRP. In addition, compared with non-volunteers, volunteers are expected to be less likely to have MetS. This study contributes to the existing literature on the volunteer-health relationship by including multiple risk factors associated with CVD, along with two modified indexes of the MetS. Bringing to bear nationally representative data is also a contribution because many previous studies are based on small samples of local community or clinical populations.

Design and Methods

The data were taken from the HRS, a panel survey based on a national probability sample of adults age 51 and older (Servais, 2010). African Americans and Hispanics were
over-sampled. In 2006, the HRS selected a random one-half sample of the core sample to participate in the collection of physical measures and biomarkers by trained interviewers through direct measures of physical attributes and blood spots (Crimmins et al., 2008, 2013).

Study Sample

The 2004 and 2006 waves of the HRS were used here. Most of the variables were taken from the public-use files available from the University of Michigan Survey Research Center. However, household wealth, smoking, and health conditions were taken from a file distributed by the Rand Corporation. Volunteering activity was taken from the 2004 wave. The indicators of CVD risk and all other covariates were taken from the 2006 wave (see later).

Respondents with missing values on any of the variables were excluded. The percentage excluded is relatively small (2.9% missing among the independent variables), and thus, a listwise deletion of cases was deemed acceptable. The final study sample included a maximum of 7,803 respondents. We used all cases available for each CVD indicator and two indexes of MetS; thus, sample sizes varied by age group and CVD indicator and MetS index. The disparity in missingness among the CVD risk factors is likely due to variability in the capacity to generate biomarker information from blood spots, differential survival of the markers prior to processing, and differences in processing methods.

Measurement

Cardiovascular Disease Risk Factors

CVD risk factors included high central adiposity, hypertension, lipid dysregulation, and high levels of blood glucose (Crimmins et al., 2008). Inflammation, measured with CRP, has been shown to be a risk factor for CVD, and as such has been advocated as another indicator that may be included in indexes of MetS (Marsland, McCaffery, Muldoon, & Manuck, 2010). Measurement cut-points for elevated risk of CVD for these indicators were taken from Alberti and colleagues (2009) and Crimmins and colleagues (2013).

Central adiposity was measured separately for males and females by waist circumference at the navel using a tape measure. A dichotomous indicator of central adiposity was generated (1 = obese), where males were considered at increased risk of CVD if waist circumference was greater than or equal to 102 cm; for females, the cut-off was greater than or equal to 88 cm. Hypertension was based on a dichotomous indicator (1 = hypertensive) and was considered present if systolic blood pressure was 130 mm Hg or higher or diastolic blood pressure was 85 mm Hg or higher. 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 the readings was taken. If only one successful reading was obtained, then that reading was used.

Biomarkers were collected from respondents through the collection of blood spots (Crimmins et al., 2013). Lipid dysregulation was measured with HDL cholesterol, such that low levels of this lipid indicate increased risk of CVD. Lipid dysregulation was measured as a dichotomous variable (1 = low HDL) and categorized differently for males and females, where males with less than 40 mg/dl (1.0 mmol/L) and females with <50 mg/dl (1.3 mmol/L) of HDL cholesterol were considered at increased risk of CVD. Another marker of CVD risk was found in blood glucose characterized by elevated levels of glycosylated hemoglobin (HbA1c). A dichotomous variable was generated (1 = high levels of HbA1c), where respondents with greater than or equal to 6.4% HbA1c were considered to be at increased risk of CVD. A dichotomous indicator of high levels of inflammation (1 = high CRP) was generated, where respondents with greater than or equal to 3.0 μg/ml CRP were considered at increased risk of CVD.

Two modified versions of the MetS index were created (MetS1 and MetS2). MetS1 was created by summing the number of CVD risk factors from the five indicators. Respondents were considered to have the MetS if they reported at least three of the five indicators of risk. In order to be included in the index, respondents had to have scores on at least three indicators (Ninomiya et al., 2004). MetS2 was based on whether a respondent was obese (high-risk central adiposity) and had two or more of the remaining four CVD indicators.

Another CVD risk factor associated with the MetS is triglyceride levels (a serum lipid). The HRS did not report information on this biomarker and thus we could not include this metabolic indicator in the indexes. Other researchers have used a reduced form version of MetS that excluded triglycerides (Yang, Li, & Ji, 2013). The absence of a measure of triglyceride levels for the MetS indexes employed herein is acknowledged and readers should take into consideration this omission when comparing results to other studies.

Volunteering

We employed two measures of volunteering in 2004: volunteer status and time commitment to volunteering based on a self-report of the number of hours volunteered in the 12 months prior to interview. HRS respondents were asked “have you spent any time in the past 12 months doing volunteer work for religious, educational, health-related or other charitable organizations?” (1 = yes; 0 = no). If respondents reported volunteering, they were asked “altogether, would you say the time amounted to less than 100 hr, more than 100 hr or what?” A set of dichotomous measures of annual hours of volunteering was generated, including (1) did not volunteer (0 hr reported, reference group in regression models), volunteered 1–99 hr, and (3) volunteered 100 or more hours. The HRS did not collect any additional information on volunteering.
We also estimated models with the 2006 indicators of volunteering in place of the 2004 indicators, finding volunteer status in 2006 was not related to CVD risk factors (results available upon request). We chose to report results for the 2004 version of the volunteer variables. By using the 2004 volunteer variables, the likelihood was increased that volunteering behavior was measured in a temporal order that would allow relationships, if any, to surface. For example, we did not expect that measures of volunteering during the 12 months prior to the measures of waist circumference or hypertension would have been a sufficient amount of time to demonstrate the expected relationships: it takes time for these conditions to develop. The statistically nonsignificant results for the 2006 volunteer measures partially support this assumption. To further elaborate on this issue, we explored the possibility that continuity in volunteering between 2004 and 2006 might be related to CVD risk. We found in bivariate analyses that persons who volunteered at both time points showed less CVD risk than persons who never volunteered.

Covariates
Age was recorded in years (range 51–104). Sex was coded as 1 = female and 0 = male. Race and Hispanic ethnicity were combined into four dichotomous variables (non-Hispanic White [reference group]; non-Hispanic Black, non-Hispanic “other race,” and Hispanic [any race]). The HRS grouped all non-White, non-Black respondents into a single “other race” category to maintain confidentiality. Marital status was coded as 1 = married and 0 = non-married. Education was coded as years of completed schooling (range 0–17). Annual household net worth was calculated as the amount of assets minus debts transformed by the natural log.

Three dichotomous indicators for self-report of a history of heart disease, stroke, and diabetes were included. In supplementary analyses, we included self-rated health as an additional control for health status. The results were similar to results reported here (results available upon request). Two health behavior variables were also included. Smoking was measured as 1 = current smoker and 0 = other. Physical activity was constructed as 1 = vigorous or moderate physical activity daily and 0 = other.

Analytic Strategy
Analyses were based on data adjusted with a centered-mean weight. The standard errors of the regression coefficients were corrected for clustering, taking into account the complex survey design. Potential bias associated with multicollinearity was examined and found to be negligible based on low variance inflation factor levels and high tolerance levels.

We expected that age may modify the relationship between volunteer behavior and CVD risk for a number of reasons. First, CVD risk is strongly correlated with age and tends to manifest itself later in life. Second, the motivation for volunteering is different at different points in the life course. Middle-aged volunteers, many of whom are in the labor force, may volunteer for work-related reasons or may volunteer to support their children’s activities. Older adult volunteers may participate as a form of generativity, as a substitute for lost family and work roles, and generally, to remain active and socially connected. We investigated whether there were age differences in the relationship between volunteering and CVD risk factors by estimating interaction models that included age by volunteer status terms. In several instances (obesity, low HDL cholesterol, and MetS2), the interaction terms were statistically significant. Thus, we stratified our sample into two age groups: middle-aged adults (age 51–64, N = 2,848) and older adults (age 65 and older, N = 4,955).

Descriptive characteristics of the samples are presented first. Next, the results from a series of logistic regression models including each of the CVD risk factors and each of the modified MetS indexes with hierarchical inclusion of sets of variables are reported for each age group. The first models included the volunteer variables only. The adjusted models included demographic characteristics, health variables, and health behaviors. The indicators of MetS were correlated and the estimation of separate models for each indicator may have increased the chances of finding statistically significant relationships. Nonetheless, we took this approach for several reasons. First, a small but growing number of studies have examined the associations among social engagements and biological and physiological markers of health using only one or two indicators (e.g., Burr et al., 2011 [hypertension]; Cline & Ferraro, 2006 [obesity]; Kim & Ferraro, 2014 [inflammation]). Our approach provided an opportunity to determine if volunteering was related to multiple indicators of biological and physiological risk within a single sample of adults. Second, we wanted to determine which, if any, of the specific risk factors were driving the observed relationships between volunteering and MetS. Third, there was precedence in the research literature for this approach (see Hill, Rote, Ellison, & Burdette, 2014). The models were estimated with STATA v12 (StataCorp, 2011).

Results
Characteristics of the full sample and the sample stratified by age group are presented in Table 1. Among adults in the full sample, 57.2% were female and 64.2% were married, with middle-aged adults reporting a higher percentage married than older adults. There were more non-Hispanic Blacks among middle-aged adults than among older adults (16.1% and 13.6%, respectively). Both the marital status and race differences by age group were likely related to differential survival of married persons and non-Hispanic Blacks. Age group differences in education (more for middle-aged adults), net worth (greater for older adults), exercise and smoking (greater for middle-aged adults), and health conditions (more for older adults) were pronounced.
Approximately, 35% of middle-aged and older adults reported they volunteered in the previous 12 months, with middle-aged adults reporting a higher rate of volunteering than older adults (37.3% and 34.5%, respectively). Among volunteers in the full sample, the difference in volunteering less than 100 hr compared with volunteering 100 hr or more was relatively small (18.5% and 17.1%, respectively). Middle-aged adults who volunteered reported a higher rate of volunteering at a moderate level (1–99 hr) than at a high level (100 or more hours; 21.2% and 16.1%, respectively) with older adults reporting small differences with respect to the amount of time volunteered. The differences in volunteering hours between age groups were statistically significant.

Descriptive information for the CVD risk factors and two modified indexes for MetS are presented in Table 2. Nearly two-thirds of the full sample had a waist circumference that put them at risk for CVD. More than half of adults were hypertensive, with older adults having a much higher prevalence. More than 30% of adults had low HDL cholesterol, with no statistically significant age group differences. Over 15% of adults demonstrated high risk levels of blood glucose, with older adults at greater risk than middle-aged adults. Approximately, 4 in 10 adults in the full sample had high levels of inflammation. Three in 10 adults were at risk for CVD based on an index of MetS (MetS1) that included at least three of the five indicators and 4 in 10 were at risk based on an index of MetS (MetS2) that required a person to have high levels of central adiposity plus two or more of the four remaining CVD risk factors.

Results of regression analyses for volunteering status and hours and the prevalence of the CVD risk factors among the middle-aged adults are presented in Table 3. In both the unadjusted and adjusted models, middle-aged adults who volunteered were less likely to have high-risk levels of central adiposity than non-volunteers (odds ratio [OR] = 0.77 and 0.78, respectively). Those who volunteered at 100 or more hours annually were not statistically different from non-volunteers when it came to having high levels of central adiposity. The results for both the unadjusted and adjusted models of hypertension showed no statistically significant relationship with volunteering.

For the lipid dysregulation models, middle-aged respondents who volunteered were less likely to have this CVD risk factor compared with non-volunteers (OR = 0.56 and

<table>
<thead>
<tr>
<th>Table 1. Sample Characteristics for Volunteering Measures and Covariates (Percentages, or Means and Standard Deviations)</th>
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<tbody>
<tr>
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<tr>
<td>Volunteer status</td>
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<tr>
<td>Not a volunteer</td>
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<tr>
<td>Volunteer</td>
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<tr>
<td>Volunteer hours</td>
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<tr>
<td>Not a volunteer</td>
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<tr>
<td>Volunteer 1–99 hr</td>
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<tr>
<td>Volunteer 100 or more hours</td>
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<tr>
<td>Age</td>
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<tr>
<td>Female</td>
</tr>
<tr>
<td>Married</td>
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<tr>
<td>Race and ethnicity</td>
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<tr>
<td>Non-Hispanic Black</td>
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<tr>
<td>Non-Hispanic other race</td>
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<tr>
<td>Hispanic</td>
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<tr>
<td>Education</td>
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<tr>
<td>Net worthb</td>
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<tr>
<td>Exercise</td>
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<td>Current smoker</td>
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<tr>
<td>Health conditions</td>
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<tr>
<td>Stroke</td>
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<tr>
<td>Heart disease</td>
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<tr>
<td>Diabetes</td>
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<td>N</td>
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</tbody>
</table>

Note: Analyses are based on data adjusted with a mean-centered person weight.

aTests of statistical significance based on t-test for continuous variables and chi-square for categorical variables.

bNet worth was first calculated as the sum of all wealth components less all debt, then it was log-transformed to adjust for skewness.

*p < .05. **p < .01. ***p < .001.
Table 2. Sample Characteristics for Cardiovascular Disease Risk Factors and Modified Metabolic Syndrome Indexes (Percentages)

<table>
<thead>
<tr>
<th>Metabolic risk factors&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Total sample</th>
<th>Middle-age sample (51–64 years old)</th>
<th>Older persons sample (65 years and older)</th>
<th>Age group differences&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central adiposity</td>
<td>63.8</td>
<td>63.7</td>
<td>63.9</td>
<td>***</td>
</tr>
<tr>
<td>Hypertension</td>
<td>53.4</td>
<td>47.4</td>
<td>56.9</td>
<td>***</td>
</tr>
<tr>
<td>Lipid dysregulation</td>
<td>30.5</td>
<td>29.5</td>
<td>31.1</td>
<td></td>
</tr>
<tr>
<td>Blood glucose</td>
<td>15.3</td>
<td>13.6</td>
<td>16.3</td>
<td>***</td>
</tr>
<tr>
<td>Inflammation risk factor&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP</td>
<td>39.0</td>
<td>40.4</td>
<td>38.1</td>
<td>†</td>
</tr>
<tr>
<td>Metabolic syndrome indexes&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MetS1</td>
<td>29.5</td>
<td>28.2</td>
<td>30.3</td>
<td>†</td>
</tr>
<tr>
<td>MetS2</td>
<td>40.5</td>
<td>39.4</td>
<td>41.2</td>
<td></td>
</tr>
</tbody>
</table>

Note: BP = blood pressure; CRP = C-reactive protein; HDL = high-density lipoprotein; MetS = modified metabolic syndrome.

<sup>a</sup>Tests of statistical significance based on chi-square for categorical variables.

<sup>b</sup>Metabolic risk factors based on the following definitions: central (abdominal) adiposity measured by waist circumference, with ≥102 cm for males and ≥88 cm for females considered as at risk; hypertension measured by BP, with systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg considered as at risk; lipid dysregulation measured by low levels of HDL cholesterol, with <40 mg/dl (males) and <50 mg/dl (females) considered as at risk; and blood glucose measured by glycosylated hemoglobin (HbA1c), with greater than or equal to 6.4% HbA1c considered as at risk.

<sup>c</sup>Inflammatory marker is based on the following definition: inflammation measured by CRP, with ≥3.0 μg/ml considered as at risk.

<sup>d</sup>MetS indexes is defined as MetS1 = three or more of five metabolic and inflammation risk factors; MetS2 = obesity plus two or more of four metabolic and inflammation risk factors.

* p < .05. ** p < .01. *** p < .001. † 0.05 < p < .01.

0.74, for unadjusted and adjusted models, respectively. Although the results for amount of time volunteered in the unadjusted model showed that volunteers were less likely to have this risk factor, in the adjusted model only those who volunteered at 100 or more hours were statistically different from non-volunteers (OR = 0.66). For high blood glucose and inflammation levels, the unadjusted models showed that volunteers were less likely to be in the high CVD risk range, but after adjustments were made for the covariates, these relationships were not statistically significant.

Results of regression analyses for the prevalence of five specific CVD risk factors among the sample of older adults are presented in Table 4. Patterns of results for the two age groups exhibited both similarities and differences. Unlike with middle-aged adults, central adiposity was not statistically related to volunteer status or volunteer hours among older adults. Further, for older adults in both the unadjusted and adjusted models, those who volunteered were less likely to be hypertensive than non-volunteers (OR = 0.80 and 0.84, respectively). Also, older adults who volunteered 100 or more hours were less likely to be hypertensive in both the unadjusted and adjusted models (OR = 0.78 and 0.83, respectively). In the unadjusted models, the relationship between volunteering and volunteer hours was not statistically related to lipid dysregulation. Unexpectedly, in the adjusted models, older adults who volunteered were more likely to be at risk for CVD based on their lipid levels than non-volunteers (OR = 1.24) and those who volunteered 100 or more hours were also more likely to be in the high-risk range than non-volunteers (OR = 1.47). Levels of blood glucose and inflammation for older adults were statistically non-significant, after introducing the set of covariates, similar to middle-aged adults.

Regression results for the relationships among volunteer status and volunteer hours and two indexes of MetS are presented in Table 5. When MetS is measured as a count of any three of the five CVD risk factors (MetS1) without consideration of whether central adiposity was high, the unadjusted coefficients showed that volunteers were less likely to have MetS1, however, these relationships were not statistically significant after the covariates were introduced. For middle-aged adults only, both the unadjusted and adjusted models demonstrated that volunteers were less likely to have MetS(2) than non-volunteers, when MetS was measured as having high levels of central adiposity plus any two of the four remaining CVD risk indicators. For older adults, the relationships among the volunteer measures and MetS2 were not statistically significant.

The relationships among the covariates and the risk factors for the full sample only from the regression models are summarized here (results available upon request). Compared with males, females were more likely to have greater central adiposity, less likely to have hypertension, and more likely to have high inflammation levels. Compared with non-Hispanic Whites, non-Hispanic Blacks were more likely to be hypertensive and be in the high-risk categories for blood glucose and inflammation. As years of education and net worth increased, the risk of CVD for all but blood glucose decreased. Also, net worth
Table 3. Logistic Regression Results (Odds Ratios and 95% Confidence Intervals) for Cardiovascular Disease Risk Factors and Volunteering for Middle-Aged Persons (51–64 Years Old)

<table>
<thead>
<tr>
<th>Cardiovascular disease metabolic risk factors</th>
<th>Inflammation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Central adiposity</strong></td>
<td><strong>Hypertension</strong></td>
</tr>
<tr>
<td>Unadjusted(^a)</td>
<td>Adjusted(^b)</td>
</tr>
</tbody>
</table>

Panel 1
Volunteer status
Not a volunteer
Volunteer
0.77** (0.64, 0.93) | 0.78* (0.64, 0.96) | 0.90 (0.75, 1.10) | 1.01 (0.83, 1.22) | 0.56*** (0.42, 0.73) | 0.74* (0.56, 0.97) | 0.62** (0.46, 0.85) | 0.71 (0.46, 1.09) | 0.70** (0.57, 0.86) | 0.83 (0.66, 1.04)

Panel 2
Volunteer hours
Not a volunteer
Volunteer 1–99 hr
0.71** (0.58, 0.88) | 0.73** (0.58, 0.92) | 0.86 (0.69, 1.07) | 0.94 (0.74, 1.19) | 0.60** (0.44, 0.81) | 0.79 (0.57, 1.09) | 0.70* (0.50, 0.97) | 0.74 (0.49, 1.13) | 0.68** (0.52, 0.89) | 0.82 (0.62, 1.10)
Volunteer 100 or more hours
0.86 (0.66, 1.12) | 0.86 (0.64, 1.15) | 0.97 (0.75, 1.25) | 1.11 (0.86, 1.45) | 0.49*** (0.36, 0.68) | 0.66* (0.48, 0.90) | 0.52* (0.32, 0.85) | 0.65 (0.34, 1.22) | 0.72* (0.53, 0.96) | 0.84 (0.62, 1.14)

N
2,494 | 2,501 | 1,681 | 2,200 | 2,119

\(^a\)Unadjusted models include volunteer status or volunteer hours only.
\(^b\)Adjusted models include volunteer status of volunteer hours plus age, female, married, race and ethnicity, education, net worth (logged), exercise, current smoker, as well as a history of stroke, heart disease, and diabetes.

\(* p < .05. \,** p < .01. \,*** p < .001.\)

Table 4. Logistic Regression Results (Odds Ratios and 95% Confidence Intervals) for Cardiovascular Disease Risk Factors and Volunteering for Older Persons (65 Years Old and Older)

<table>
<thead>
<tr>
<th>Cardiovascular disease metabolic risk factors</th>
<th>Inflammation</th>
</tr>
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<tbody>
<tr>
<td><strong>Central adiposity</strong></td>
<td><strong>Hypertension</strong></td>
</tr>
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<td>Unadjusted(^a)</td>
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Panel 1
Volunteer status
Not a volunteer
Volunteer
0.99 (0.86, 1.14) | 1.07 (0.92, 1.26) | 0.80** (0.70, 0.91) | 0.84* (0.73, 0.96) | 1.01 (0.82, 1.25) | 1.24* (1.00, 1.52) | 0.80* (0.66, 0.96) | 0.94 (0.73, 1.20) | 0.72** (0.60, 0.86) | 0.85 (0.70, 1.03)

Panel 2
Volunteer hours
Not a volunteer
Volunteer 1–99 hr
0.94 (0.77, 1.16) | 1.01 (0.81, 1.27) | 0.82* (0.70, 0.97) | 0.84 (0.71, 1.01) | 0.87 (0.66, 1.13) | 1.03 (0.79, 1.35) | 0.89 (0.68, 1.15) | 1.01 (0.75, 1.36) | 0.72** (0.59, 0.89) | 0.83 (0.67, 1.04)
Volunteer 100 or more hours
1.04 (0.89, 1.21) | 1.14 (0.96, 1.35) | 0.78** (0.67, 0.91) | 0.83* (0.71, 0.97) | 1.17 (0.91, 1.49) | 1.47*** (1.15, 1.89) | 0.72* (0.56, 0.92) | 0.87 (0.61, 1.25) | 3.73 | 3.57

N
4,235 | 4,297 | 2,743 | 2,200 | 2,119

\(^a\)Unadjusted models include volunteer status or volunteer hours only.
\(^b\)Adjusted models include volunteer status of volunteer hours plus age, female, married, race and ethnicity, education, net worth (logged), exercise, current smoker, as well as a history of stroke, heart disease, and diabetes.

\(* p < .05. \,** p < .01. \,*** p < .001.\)
was not related to lipid dysregulation. Adults who exercised once or more per day demonstrated lower risk for CVD based on central adiposity, lipid dysregulation, and high levels of blood glucose and inflammation. Smokers showed higher risk for lipid dysregulation and inflammation but lower risk of central adiposity. Adults with a history of stroke had a high risk of hypertension, whereas persons with a history of heart disease had a lower risk of hypertension and higher risk of lipid dysregulation. Finally, adults with a history of diabetes showed higher risk of each of the CVD risk factors, not including hypertension. With respect to both MetS measures, females, non-Hispanic Blacks, and persons with a history of diabetes were more at risk, whereas adults with higher socioeconomic status and higher levels of self-report physical activity demonstrated lower risk.

Discussion

The primary objective of this study was to contribute to the small research literature that demonstrates volunteering is related to CVD risk. The results not only showed some support for findings from other studies but also showed some differences. Some of these differences may be due to research design decisions based on age group identification (Burr et al., 2011; Sneed & Cohen, 2013; Tavares et al., 2013, these studies looked at persons 51 and older combined). We found older adult volunteers (65 and older) had lower risk of hypertension than older non-volunteers, but not for middle-aged volunteers (51–64 years old). In terms of volunteer hours, the results differed from those reported by Burr and colleagues (2011), in that it appears that older adults who volunteered most had less risk of hypertension, whereas Burr and colleagues (2011) reported a threshold effect for adults aged 51 and over who volunteered a moderate amount of hours. However, this finding of a relationship at higher amounts of volunteering was somewhat consistent with Sneed & Cohen (2013). Researchers using European data have also reported inconsistent results for relationships among social participation and CVD risk factors (Ellaway & Macintyre, 2009).

Among middle-aged adults, volunteers had a lower likelihood of CVD risk based on central adiposity than non-volunteers (Kouvonen et al., 2012), and a threshold effect was present for those who volunteered a moderate amount of their time compared with non-volunteers—there was no statistically significant differences among those who volunteered 100 or more hours compared with non-volunteers. The relationships among volunteer status and volunteer hours with lipid dysregulation were statistically significant among older adults. Unexpectedly, the results showed that older adult volunteers may have greater lipid dysregulation (low HDL cholesterol) than older adult non-volunteers. To further explore this finding, we examined models with a continuous measure of lipid dysregulation. For the continuous measure (logged), the direction of the relationship between volunteering (at higher levels only) and lipid dysregulation was negative and statistically significant. For older adults, volunteering 100 hr or more was associated with lower levels of HDL cholesterol; for middle-aged adults, volunteering and volunteering more than 100 hr were associated with higher levels of HDL cholesterol. HDL cholesterol has a very complex biochemistry and its independent causal relationship with CVD has been questioned (Voight et al., 2012). Further, there is some research on the relationship between exercise and lipids that shows unexpected findings: adults who were more engaged in aerobic exercise had lower HDL cholesterol levels than those who exercised less (Kelley, Kelley, & Vu Tran, 2003). Given that some forms of volunteering require more physical activity, our unexpected findings were partially in line with this study. The current findings based on accepted HDL cholesterol cut-points for CVD risk and continuous measures of HDL cholesterol should be treated with caution until further research is reported.

Kim and Ferraro (2014), using National Social Life, Health and Aging Project data, found that volunteer status was related to inflammation using a logged continuous measure of CRP among persons aged 57–85. We did not find statistically significant relationships between CRP as measured by accepted cut-points for risk and volunteering, although the direction of the relationship was as expected. In supplementary analyses, linear regression models were estimated using a logged continuous measure of CRP, and these results demonstrated a statistically significant relationship with volunteer status, supporting the findings of Kim and Ferraro (results available upon request).

There is no consensus among researchers with respect to whether obesity (measured here by waist circumference) is a necessary first-order condition for identifying the presence of MetS. Thus, we chose to estimate MetS using both approaches: one with high levels of central adiposity as a pre-requisite and one where a count of any three or more CVD risk factors was sufficient. The results indicated that volunteering was not related to a simple summation of CVD indicators but rather was related among middle-aged adults only to the central adiposity plus CVD indicators measure of the MetS. This measurement strategy may have been more sensitive for identifying relationships of this type.

The unobserved pathways that account for the relationship between volunteering and CVD risk factors are complex and largely unexplored. To elaborate on these issues further, we engaged in supplementary analyses to determine if lifestyle factors mediated the relationship between volunteer status and CVD risk. We first estimated the relationships between volunteer status and exercise and smoking. Results showed that volunteers were more likely to exercise and less likely to be current smokers. We then estimated sets of unadjusted models for volunteer status, followed by sets of fully adjusted models, adding in the exercise...
### Table 5. Logistic Regression Results (Odds Ratios and 95% Confidence Intervals) for Modified Metabolic Syndrome Indexes and Volunteering by Age Group

<table>
<thead>
<tr>
<th>Age, 51–64 Years</th>
<th>MetS1</th>
<th>MetS2</th>
<th>Age, 65 Years and Older</th>
<th>MetS1</th>
<th>MetS2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Volunteer status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not volunteer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volunteered</td>
<td>0.73** (0.58, 0.91)</td>
<td>0.91 (0.70, 1.19)</td>
<td>0.68** (0.53, 0.87)</td>
<td>0.74* (0.58, 0.94)</td>
<td>0.82* (0.68, 0.98)</td>
</tr>
<tr>
<td>Volunteer hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not volunteer</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volunteer 1–99 hr</td>
<td>0.76* (0.58, 0.99)</td>
<td>0.95 (0.70, 1.28)</td>
<td>0.67** (0.51, 0.89)</td>
<td>0.72* (0.55, 0.93)</td>
<td>0.80* (0.64, 1.00)</td>
</tr>
<tr>
<td>Volunteer 100 or more hours</td>
<td>0.68* (0.50, 0.93)</td>
<td>0.86 (0.61, 1.21)</td>
<td>0.69* (0.49, 0.99)</td>
<td>0.76 (0.51, 1.14)</td>
<td>0.84 (0.69, 1.02)</td>
</tr>
<tr>
<td>N</td>
<td>2,217</td>
<td>1,492</td>
<td>3,770</td>
<td>2,597</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** MetS = modified metabolic syndrome. MetS indexes defined as MetS1 = three of five metabolic and inflammation risk factors; MetS2 = obesity plus two of four metabolic and inflammation risk factors.

*Unadjusted models include volunteer status or volunteer hours only.

*Adjusted models include volunteer status of volunteer hours plus age, female, married, race and ethnicity, education, net worth (logged), exercise, current smoker, as well as a history of stroke, heart disease, and diabetes.

*[^p < .05. **p < .01. ***p < .001.]}
and smoking variables last. The results demonstrated that exercise and smoking had a very small mediating effect on CRP only.

Implications
Observational and RCT studies showed that volunteering was related to a wide range of indicators of well-being (Anderson et al., 2014). Some observers have posited that volunteering may be considered a public health intervention (Jenkinson et al., 2013). Among adults who are able and who desire to volunteer, opportunities should be made available and volunteering should be encouraged as one path to healthy aging.

Limitations
Causality may not be inferred using this type of research design. Nor is it possible to claim there are clinical ramifications. However, to address partially the issue of reciprocal causation, we conducted supplementary analyses with a sample of respondents who reported their health as fair or better. This strategy may eliminate persons who are unable to volunteer due to health limitations. The results were very similar to those reported for our sample that included respondents of all self-reported health levels (results available upon request). Our two indexes of MetS did not contain measures of triglycerides, common in related literatures, because these were not present in the data. The HRS did not report actual hours volunteered, and thus, we could not conclude whether the possibility of a dose effect was present. The potential mediation of psychosocial resources for the relationships among volunteering and CVD risk factors was not evaluated, but this should be a high priority for extensions of studies like the reported here.

Contributions and Conclusions
This was the first study to explore the relationships among volunteering and MetS. Further, to our knowledge, no other study has been reported that specifically examined the relationships among volunteer behaviors and biomarkers for blood glucose and lipid dysregulation has been reported. This was one of the few studies that used nationally representative data with trained interviewer-derived physical measurements and biomarkers to demonstrate whether volunteering was related to these under the skin factors. Additional investigation into what factors mediate volunteering-CVD risk and MetS relationships is required. Finally, a recent study demonstrated that MetS is a mediator between cognition and frailty (Lin, Roiland, Chen, & Qiu (2015). Future research should also focus on whether these CVD risk factors mediate the relationship between volunteering and chronic disease and mortality.

References