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# Do Productive Activities Reduce Inflammation in Later Life? Multiple Roles, Frequency of Activities, and C-Reactive Protein

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***Purpose of the Study:*** The study investigates whether productive activities by older adults reduce bodily inflammation, as indicated by C-reactive protein (CRP), a biomeasure associated with the risk of cardiovascular diseases. ***Design and Methods:*** The study uses a representative survey of adults aged 57–85 from the National Social Life, Health, and Aging Project ($N$ = 1,790). Linear regression models were used to analyze the effects of multiple roles (employment, volunteering, attending meetings, and caregiving) and the frequency of activity within each role on log values of CRP concentration (mg/L) drawn from assayed blood samples. ***Results:*** Number of roles for productive activities was associated with lower levels of CRP net of chronic conditions, lifestyle factors, and socioeconomic resources. When specific types of activity were examined, volunteering manifested the strongest association with lower levels of inflammation, particularly in the 70+ group. There was no evidence that frequent engagement in volunteer activity was associated with heightened inflammation. ***Implications:*** Productive activities—and frequent volunteering in particular—may protect individuals from inflammation that is associated with increased risk of hypertension and cardiovascular disease.

*Key Words: Productive activities, Volunteering, Social participation, Acute-phase protein*

Considerable research reveals that the vast majority of older adults engage in *productive activities*, including employment, volunteering, and other forms of social participation (Morrow-Howell, Hinterlong, & Sherraden, 2001). Productive activities refer to paid or unpaid actions that make a constructive contribution to community life (Herzog, Kahn, Morgan, Jackson, & Antonucci, 1989), and many models of successful or optimal aging consider them essential to well-being in later life (Rowe & Kahn, 1997). Indeed, productive activities are widely extolled as salutary, and considerable research identifies that these activities can enhance mental (Li & Ferraro, 2005) and physical health (Morrow-Howell, Hinterlong, Rozario, & Tang, 2003) and reduce mortality risk (Pynnönen, Törnmakägas, Heikkinen, Rantanen, & Lyyra, 2012).

Despite extensive scholarly interest examining productive activities and health in later life, most studies rely upon self-reported measures of health, disability, or physician-diagnosed illnesses, each of which can be influenced by psychosocial resources or access to health care. One wonders whether productive activities exert effects on subclinical measures of biological processes that are predictive of major disease outcomes. If the relationship exists, productive activities may be a palpable way to prevent the development and onset of chronic disease.

This study attempts to explicate the "upstream" health protective effects of productive activities by studying a marker of biological risk in older adults. Specifically, we examine the link between productive activities and C-reactive protein (CRP), a measure of inflammation. CRP is a useful biomarker for this investigation because it typically rises in later life, and high levels of CRP are linked to cardiovascular diseases including heart attack (Crimmins & Vasunilashorn, 2011). The main aims of the article are twofold: (a) Identify the association between the number of roles for productive activities and inflammation; and (b) systematically examine whether the relationship between productive activity and CRP varies by the frequency of engagement within each activity.

### *Productive Activities and Health in Later Life*

Considerable evidence supports the claim that productive activity is beneficial to older adults' health. Research on successful aging pioneered by Rowe and Kahn (1997) points to the importance of engaging in productive activities to maintain health and well-being. Productive activity is a significant element of maintaining health and functioning, distinct from social relations or general social embeddedness. Role theory has often been used to explicate the health benefits of productive activities: volunteering or attending organized meetings provides individuals with a unique opportunity to hold a meaningful social role and remain similarly active in later life (Thoits, 2012). Because most Americans subscribe to a busy ethic and strive to engage in meaningful roles (Ekerdt, 1986), productive activities become a viable alternative for adults who typically experience multiple role transitions in later life.

Previous research has used somewhat distinct definitions of productive activities to predict health outcomes. Volunteering and paid employment are most commonly recognized as productive activities (Burr, Mutchler, & Caro, 2007; Hinterlong, 2008; Matz-Costa, Besen, James, & Pitt-Catsouphes, 2013; Musick & Wilson, 2003). Studies show that volunteering is associated with well-being, whether the outcome considered is depressive symptoms (Li & Ferraro, 2005; Musick & Wilson, 2003), self-rated health (Lum & Lightfoot, 2005), or hypertension (Tavares, Burr, & Mutchler, 2013). Employment has similar health-promoting effects in that employed men and women show virtually no decline in self-rated health and physical functioning; however, healthier people are also more likely to be employed (Ross & Mirowsky, 1995).

Caregiving is also widely recognized as an important form of productive activity (Burr et al., 2007; Hinterlong, 2008; Matz-Costa et al., 2013). The contribution of middle-aged and older caregivers generates enormous benefits for the nation and for those served. Despite a large body of research documenting caregivers' depression and worse physical health (Pinquart & Sörensen, 2003), some studies demonstrate that caregiving behaviors may improve adults' well-being (Brown, Nesse, Vinokur, & Smith, 2003). Moen, Robison, and Dempster-McClain (1995), however, found no direct effects of concurrent or past caregiving on health.

Although studied less frequently, community engagement is another component of productive activity that may have health benefits. Community engagement includes a wide range of activities such as voting, attending community meetings, and contributing financially to or holding a leadership position in a community organization (Burr, Caro, & Moorhead, 2002; Mendes De Leon, Glass, & Berkman, 2003). Some of these activities require a considerable investment of resources, but Mendes De Leon and coworkers (2003) argue for the importance of tapping activities in which older adults are commonly involved. Meeting attendance is one of the more prevalent forms of community engagement for older adults, even though it requires a commitment of time and skills (Burr et al., 2002). Few studies, however, have examined whether meeting attendance has a salutary effect on health in later life.

Health benefits from such roles in later life may accrue from the meaning attached to them, including status, influence, and emotional gratification (Moen et al., 1995; Thoits, 1986, 2012). When the types of productive activity are profiled across the life course, younger adults typically engage in roles that are related to their other statuses (e.g., parent or employee), whereas older adults are motivated by more intrinsic reasons such as their values in helping others or their interests in local community (Herzog et al., 1989; Van Willigen, 2000). Thus, the meanings and values associated with nonobligatory roles may be more salutary to health than is the case for obligatory roles. If the person feels generative by contributing to the well-being of others, the benefits are manifest in lower risk of impairment in activities of daily living and

mortality (Gruenewald, Liao, & Seeman, 2012; Piliavin & Siegl, 2007).

Several theoretical and empirical studies also suggest that productive activities may be *especially beneficial for older adults*. Role accumulation theory suggests that multiple role occupancy is relevant in older ages because reduction rather than accumulation of roles becomes more commonplace in later life (Moen et al., 1995). Empirical studies confirm this thesis. For instance, Van Willigen (2000) used longitudinal data to demonstrate that older volunteers (aged 60 and older) are more likely than younger adults to experience additional psychological health benefits for each hour of participation. Also, Musick and Wilson (2003) reported that volunteering had a negative effect on depressive symptoms for older adults but not for those less than 65 years old. Because older adults may be more likely than younger persons to derive a psychological benefit from productive activity, one wonders whether the effect extends to physical health phenomena such as inflammatory processes.

### *Advancing the Literature*

The literature on the health benefits of productive activities in older adults has yielded several notable discoveries. Perhaps most impressive is the breadth of outcomes considered. Previous research demonstrates that productive activities among older adults are associated with better self-rated health (Hinterlong, Morrow-Howell, & Rozario, 2007; Lum & Lightfoot, 2005), fewer depressive symptoms (Thoits & Hewitt, 2001), and greater life satisfaction (Baker, Cahalin, Gerst, & Burr, 2005). Recent discoveries also reveal that productive activities reduce the risk of hypertension in Americans (Tavares et al., 2013) and the risks of institutionalization and mortality in Finnish older adults (Pynnönen et al., 2012). As Rowe and Kahn (1997) argue, productive activities have distinctive health benefits because they provide not only a sense of belonging to a group with whom one shares common interests and activities but also a unique chance to hold social roles that give purpose and meaning to life (Thoits, 2012). Building on the contributions of previous research demonstrating the health benefits of productive activities, we articulate three ways to advance the current body of research.

First, most studies of productive activities rely on self-reported measures of physical and mental health. Although self-reported measures are widely accepted as valid, investigations are warranted that examine the influence of productive activities on biological measures, which are harbingers of subsequent health problems. Indeed, the power of using biomarkers in health research is the *early detection of bodily risks* that might not yet register clinically.

CRP, produced in the liver, is a useful biomarker because it indicates systemic levels of inflammation and is linked to risk of heart attack, stroke, and mortality (Crimmins & Vasunilashorn, 2011). CRP is related to some *modifiable* cardiovascular risk factors such as smoking, physical activity, and obesity (McDade, Hawkley, & Cacioppo, 2006) but is also inversely related to social integration: Maintaining ties to a larger community and having close and supportive relationships are related lowering chronic inflammation (Loucks, Berkman, Gruenewald, & Seeman, 2006). Accordingly, CRP presents an important and novel way to explore links between productive activities and physical health in older adults.

Productive activities may, in fact, lower older adults' inflammation through multiple pathways, particularly when they select the role. One potential pathway involves stimulating healthier responses to environmental challenges or stressors. Indeed, an observational study showed that social integration is related to quicker cardiovascular recovery from a day's exertions (Evans & Steptoe, 2001). Perhaps productive activities are similarly beneficial by improving bodily response to stressors, but we are unaware of any studies that examine the link between productive activity and CRP.

Second, though the majority of existing research examines a single indicator of productive activity, some studies point to the importance of considering a more complex picture of individuals who remain active (Baker et al., 2005; Hinterlong, 2008). Because concurrent engagement in multiple activities is common, failure to consider multiple roles may be misleading because the purported salubrious effects of productivity activities might be due to a related role that is not measured.

Third, though multiple roles may be beneficial to health, the level of involvement in each role may be consequential to the purported health benefits (Matz-Costa et al., 2013). Scholarship on volunteering also points to how burnout or overcommitment can lead to termination of the volunteer role or unfavorable health outcomes (Li & Ferraro, 2006; Rotolo, 2000). Such role overload

can manifest itself on inflammation in two ways. First, high level of time commitment in productive activities may offset the purported benefits (i.e., diminishing returns). Second, and more generally, it raises the question of whether the health benefits of productive activities accrue primarily by regular engagement in one role, modest engagement in multiple roles, or some combination of both. A longitudinal study of older adults included multiple roles, suggesting that both the number of roles and the amount spent engaging in each role are significant predictors of happiness (Baker et al., 2005). The current investigation examines both the number of productive activities performed by older adults and the frequency of participation within each type of activity in predicting levels of CRP.

Drawn from the extant literature, we specify four hypotheses to guide the analysis. First, we hypothesize that *older adults reporting more roles of productive activity will have lower levels of inflammation*, measured by C-reactive protein. Second, we hypothesize that the *frequency of participation within a role is negatively related to CRP*. Testing the first two hypotheses leads us to specify a third that may be referred to as a role overload hypothesis: *The health benefits of productive activities accrue until the person reaches very high levels of participation in multiple roles* (interaction hypothesis). Fourth, given that other studies reveal that older adults are more likely than younger adults to reap health benefits from productive activity, we hypothesize that *the effect of productive activities on CRP is stronger for adults 70 or older than for those who have not yet reached 70* (interaction hypothesis; Van Willigen, 2000).

## Method

### Sample

The study used data from the National Social Life, Health, and Aging Project (NSHAP), a nationally representative, population-based sampling during 2005–2006 of 3,005 adults aged 57–85 in the United States. In order to ensure representation of particular groups, the sample includes an oversampling by age, race, and gender. Additional information on the NSHAP sample is available in a report by O'Muircheartaigh, Eckman, and Smith (2009).

A random 83% sample of the 3,005 respondents ($n$ = 2,494) was selected to undergo whole blood spot collection, and 1,939 individuals (85% response rate) provided usable samples. The reasons for eliminating cases include refusal, equipment problem, and insufficient volume of blood. As is standard in the literature, 136 additional cases with very high CRP levels (>8.6 mg/L), which may be indicative of inflammatory response to acute conditions such as cold, flu, or injury, were dropped from the analyses (Herd, Karraker, & Friedman, 2012). Regardless, sensitivity tests demonstrated no meaningful differences in the pattern of findings when including the highest CRP values. Finally, 13 cases with missing information for race or emphysema were excluded because the number of these cases is small. The final analytic sample size is 1,790.

### Measurement

*CRP Concentration.*—During the interview, a blood sample was collected via a fingerstick and disposable lancet and applied to filter paper for transport and storage. The blood spot assays were conducted at the Laboratory for Human Biology Research at Northwestern University (Williams & McDade, 2009). As shown in Table 1, mean CRP was 2.08 ($SD$ = 1.98). Given the highly skewed distribution of CRP, values were transformed for the statistical analyses (natural logarithm; Herd et al., 2012).

*Productive Activities.*—Four productive activities were examined: employment, volunteering, attending meetings, and caregiving. We created a binary variable for each role and summed them to create *number of roles* (range from 0 to 4).

The *frequency of activity* was assessed by items asking respondents how often they engage in each activity. For employment, respondents reported the number of hours they typically work during 1 week. We defined those who work 40 hr or more a week as full-time workers. Additional analyses examined alternative thresholds for full-time employment, but the conclusions were unchanged. For volunteering, respondents were asked how often they volunteered for religious, charitable, political, health-related, or other organizations in the past 12 months. Responses ranged from *never* (0) to *several times a week* (6). Using the same response categories as for volunteering, respondents were also asked about their frequency of attending meetings of any organized groups. Consistent with prior studies, meeting attendance is used as a measure of community engagement—a component of productive activity

(Burr et al., 2002). Finally, respondents were asked whether they are currently assisting an adult who needs help with day-to-day activities because of age or disability. If answered yes, they were then probed how many days per week they typically spend caring for this person. The original response ranged from 0 to 7 days. However, because only eight individuals answered that they spend 5 days on caregiving, we combined 5 and 6 days. The final response categories ranged from 0 to 6, consistent with volunteering and attending meetings.

*Additional Covariates.*—In addition to productive activities, several covariates were included because of their association with chronic inflammation (Schafer & Ferraro, 2011). Age is coded in years, and sex is dichotomized with 1 indicating female. Race was divided into a series of binary variables (White, Black, and other race) with non-Hispanic White serving as the reference group. Other race consisted of Hispanic Americans, Native Americans, Asian or Pacific Islander, and those identifying themselves as multiracial. (Whereas most Hispanic Americans identified as "other" race, supplementary analyses distinguishing them were estimated but the variable was nonsignificant in all specifications.) Marital status was also dichotomized with 1 indicating married or cohabiting with a partner. To tap socioeconomic resources, four categories of educational attainment (less than high school, high school, some college, and B.S. or more) and a binary variable for low wealth were included in the analyses. For wealth, participants were asked to estimate their net worth including all of their investment, properties, and other financial assets minus debt. Then a binary variable was created differentiating respondents in the lowest 20% of the household net worth from those in the top 80%.

For lifestyle variables known to be related to CRP, we use self-reported information. Participants who reported as currently smoking cigarettes, pipes, cigars, or chewing tobacco were classified as current tobacco users. Physical activity was measured with an item probing respondents' engagement in physical activities such as walking, dancing, or exercise (0 = *never*, 1 = *once a month*, 2 = *one to three times a month*, 3 = *one to two times a week*, 4 = *three or more times per week*). Obese individuals were identified with body mass index values ≥ 30 $kg/m^2$.

The analysis adjusts for physical and mental health conditions that may be related to CRP. For mental health, we also included depressive symptoms based on the 11-item Center for Epidemiologic Studies Depression Scale (Cronbach's $\alpha$ = .93). Clinically relevant chronic health conditions include dummy variables for whether the respondent was ever diagnosed by a physician for emphysema, asthma, and diabetes. Given the documented inverse relationship between lipid-lowering treatment and CRP (McDade et al., 2006), lipid medication use was also included in the analyses, measured with a binary variable. Supplementary analyses considered additional covariates such as income, antihypertensive medicine use, and self-reported physical and mental health. These were omitted then from the final analyses, however, because they were nonsignificant in multivariate specifications.

### Analyses

Analyses used ordinary least-squares (OLS) regression to model the natural log of CRP. We specified separate models to examine number of productive activities and frequency within each activity, as well as their joint effects. In addition to an additive model with the independent variables, multiplicative models were estimated to test interactions between the number of roles and frequency of productive activity. We also tested the robustness of our results in two supplementary analyses: (a) OLS regression predicting raw CRP values and (b) ordinal logistic regression with ordinal CRP as others have done (Sesso et al., 2003). Because CRP has clinical cutoffs that lend themselves to logistic regression (<1, 1–2.99, and ≥3mg/L), we used the three-category classification of CRP as the outcome variable in supplementary analyses. The results from the ordinal logistic regression are provided in the Supplementary Material, but we focus on the OLS results in the text.

We handled missing values on variables by employing multiple imputation (Stata 11) for 498 cases, 294 of which were missing information on volunteering variable. We imputed five values for each missing observation, averaged the coefficients and calculated new standard errors that account for the variation across multiple potential imputed values (Rubin, 2004). We used all the information available to impute for missing data on independent variables but did not impute for the outcome measure (von Hippel, 2007).

## Results

Table 1 displays the descriptive statistics for each variable, and the mean CRP level of 2.08 is regarded as average risk (>3 indicates high risk). Most NSHAP respondents engaged in two to three productive activities, with the largest proportion engaging in meeting attendance (69.1%, distribution not shown) and the lowest proportion in caregiving (17.5%). Volunteers comprised 62.5% of the sample; 31.9% of the sample was employed. Note that more than one third of the entire sample has a body mass index ≥ 30.

Turning to Table 2, the Model 1 results reveal that each role of productive activity is associated with lower CRP ($b$ = –0.05, $p$ < .05) even after adjusting for all control variables. Women and Black respondents generally had higher levels of CRP, and higher educational attainment was associated with lower CRP. Of the lifestyle factors, tobacco use and obesity were associated with higher CRP, and physical activity was associated with lower CRP. Given the gender differences, we estimated supplementary models stratified by gender but the substantive results were similar. In order to further examine possible confounding effects of lipid medication on productive activity and CRP, we conducted supplementary analyses with and without the lipid medication variable, and the conclusions were unchanged.

**Table 1. Descriptive Statistics for Variables, NSHAP ($n$ = 1,790)**

| | Range | Mean or proportion (*SD*) |
|---|---|---|
| C-reactive protein (mg/L)[a] | 0–8.57 | 2.08 (1.98) |
| Productive activities | | |
| Number of roles | 0–4 | 1.81 (1.06) |
| Employment | 0–2 | 0.47 (0.75) |
| Volunteering | 0–6 | 2.10 (2.06) |
| Attend meeting | 0–6 | 2.62 (2.16) |
| Caregiving | 0–6 | 0.73 (1.81) |
| Demographic | | |
| Age | 57–85 | 69.46 (7.87) |
| Female | 0–1 | 0.51 |
| White | 0–1 | 0.80 |
| Black | 0–1 | 0.13 |
| Other | 0–1 | 0.07 |
| Married | 0–1 | 0.62 |
| Education | 0–3 | 1.52 (1.06) |
| Low net worth | 0–1 | 0.26 |
| Lifestyle factors | | |
| Tobacco use | 0–1 | 0.15 |
| Physical activity | 0–4 | 3.20 (1.30) |
| Obese (body mass index ≥ 30 kg/m$^2$) | 0–1 | 0.37 |
| Depressive symptoms (Center for Epidemiologic Studies Depression Scale) | 0–28 | 5.43 (5.10) |
| Chronic conditions | | |
| Emphysema | 0–1 | 0.11 |
| Asthma | 0–1 | 0.10 |
| Diabetes | 0–1 | 0.21 |
| Lipid medication | 0–1 | 0.37 |

[a]Original value of C-reactive protein.

In Model 2, we examined the frequency of engaging in each productive activity while adjusting for the covariates. Of the four types, only frequent volunteering is associated with lower CRP ($p$ < .05). The other three types of productive activity were not associated with CRP.

The effects of other control variables were similar to the previous model.

The final OLS model includes both number of roles and frequency of each activity. The results shown in Model 3 reveal that the frequency of volunteering is associated with lower CRP, but number of roles is no longer significant. The results lend partial support for Hypothesis 2 stating that frequency of participation within a role (i.e., volunteer) is negatively related to CRP.

As described earlier, we also estimated the effects of productive activities on three categories of CRP (Sesso et al., 2003); the results are presented in the Supplementary Material. The pattern of results from the ordinal logistic regression is very similar to those obtained with OLS. As shown in Model 3 in the Supplementary Material, a unit difference in volunteering is associated with an 8% reduction in the odds of being in a higher category of inflammation (odds ratio = 0.92, confidence interval = 0.87–0.98).

Our next step was to complete additional analyses to examine the role overload hypothesis. We tested two specifications in the OLS analyses: (a) A quadratic term for overall frequency of productive activities (to test for nonlinearity in the relationship between frequency and CRP) and (b) an interaction between the number of roles and the sum of activity frequency (across the four types). Results from both tests give no evidence that high levels of engagement in multiple roles are detrimental to health in older adults (results not shown but available upon request).

Finally, we tested for the hypothesis that the benefits of productive activity are stronger for adults 70 years or older (OLS analysis). In doing so, we focused on volunteering frequency because the results from previous analyses revealed that

Table 2. Ordinary Least-Squares Models Predicting in C-Reactive Protein in the NSHAP ($n$ = 1,790)

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | *b* | *SE* | *b* | *SE* | *b* | *SE* |
| Productive activities | | | | | | |
| Number of roles | −0.05* | 0.02 | | | 0.05 | 0.05 |
| Employment | | | −0.05 | 0.06 | −0.10 | 0.08 |
| Volunteering | | | −0.03* | 0.01 | −0.04* | 0.02 |
| Attending meetings | | | −0.01 | 0.01 | −0.01 | 0.02 |
| Caregiving | | | −0.02 | 0.01 | −0.03 | 0.02 |
| Covariates | | | | | | |
| Age | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Female | 0.15** | 0.05 | 0.17** | 0.05 | 0.17** | 0.05 |
| Black | 0.25** | 0.08 | 0.25** | 0.08 | 0.25** | 0.08 |
| Other | −0.08 | 0.10 | −0.08 | 0.10 | −0.09 | 0.10 |
| Married | −0.09 | 0.06 | −0.08 | 0.06 | −0.09 | 0.06 |
| Education | −0.09** | 0.03 | −0.08** | 0.03 | −0.08** | 0.03 |
| Low net worth | −0.08 | 0.07 | −0.07 | 0.08 | −0.07 | 0.08 |
| Tobacco use | 0.20** | 0.07 | 0.20** | 0.07 | 0.20** | 0.07 |
| Physical activity | −0.05** | 0.02 | −0.06** | 0.02 | −0.06** | 0.02 |
| Obese | 0.51*** | 0.05 | 0.51*** | 0.05 | 0.51*** | 0.05 |
| Depressive symptoms | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Emphysema | 0.19* | 0.08 | 0.18* | 0.08 | 0.18* | 0.08 |
| Asthma | −0.03 | 0.08 | −0.03 | 0.08 | −0.03 | 0.08 |
| Diabetes | 0.03 | 0.06 | 0.03 | 0.06 | 0.03 | 0.06 |
| Lipid medication | −0.25*** | 0.05 | −0.25*** | 0.05 | −0.25*** | 0.05 |
| Constant | 0.97** | 0.31 | 0.94** | 0.32 | 0.92** | 0.32 |
| $R^2$ | 0.12 | | 0.13 | | 0.13 | |

*Note*: Natural logarithm of C-reactive protein.
*$p$ < .05. **$p$ < .01. ***$p$ < .001.

volunteering was the most consistent predictor of CRP. We first tested the interaction of age groups and volunteer frequency on CRP. The result revealed that the model with the interaction term was a better fit than the model excluding the product term ($F$ = 6.13, $p$ = .01). Thus, we proceeded to further investigate the age differences. Stratifying the sample into 58–69 years and 70–85 years, we discovered that the frequency of volunteering has distinct effects on CRP in the two groups. Although frequency of volunteering is associated with lower CRP, the effect is actually stronger for those 70 or older. As shown in Figure 1, among people with low levels of volunteering, CRP levels differed little by age group. By contrast, among persons engaged in frequent volunteering, CRP was lower among the *respondents 70 or older*. People who are 70–85 years of age and very active as volunteers exhibited lower CRP than persons aged 58–69 who were not very active as volunteers.

The test of Hypothesis 4 focused on volunteering—the most consistent predictor of CRP—but we conducted supplementary age-stratified analyses to determine whether the other forms of productive activity were related to CRP in either age group. Even in the subsample < 70, the other forms of productive activity (e.g., employment) were not related to CRP.

## Discussion

Using nationally representative data from older adults, the current study showed that older people engaged in more roles of productive activities report lower CRP (Hypothesis 1). However, when both frequency of participation and number of roles were considered simultaneously, frequency of participation in volunteering manifested the most robust association with CRP (Hypothesis 2). The findings are consistent with previous research showing that volunteer activity improves various health outcomes (Morrow-Howell et al., 2003). Volunteering is associated with better health, possibly through emotional gratification (Morrow-Howell et al., 2003), feelings of generativity (Gruenewald et al., 2012), and increases in social integration (Loucks et al., 2006). Regularly engaging in volunteering has a special way of getting

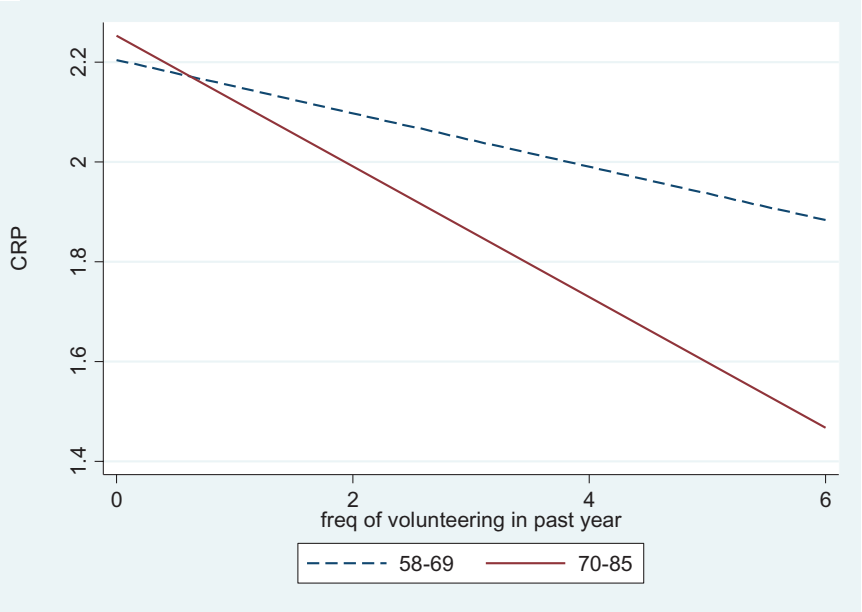


**Figure 1.** C-reactive protein by frequency of volunteering, stratified by age groups (including adjustments for all control variables in Table 2).

"under the skin," resulting in what appears as a younger biological profile for inflammation.

The study extends the research on health benefits of volunteering and clarifies the need for investigating not only self-reported measures of health but also biomeasures. Doing so will aid further understanding of the mechanisms between productive activities and health. The findings of this study point to a specific type of productive activity—volunteering—as an agent for maintaining lower levels of chronic inflammation.

The analysis also yielded an intriguing finding related to age differences in the effects of productive activities: *frequent volunteering is particularly beneficial on CRP among adults 70 years or older* (Hypothesis 4). NSHAP septuagenarians and octogenarians who were frequent volunteers had lower CRP levels than comparably active volunteers who were 58–69 years old. This finding shows that frequent volunteering benefits older adults in terms of having a "younger" biological profile. Although our findings are based on CRP as the outcome, the conclusion is consistent with findings of others that older people may reap more positive health benefits from volunteering than is the case for adults of younger ages (Van Willigen, 2000). Because it might be the case that younger and healthier individuals are more likely to be selected (or asked) into volunteering, we examined mean CRP levels in different age groups using a two-sample *t*-test. The results showed that mean CRP levels do not differ across these groups.

This study examined the effect of multiple roles of productive activity including volunteering, employment, meeting attendance, and caregiving. The results, however, showed clearly that volunteering is the type of productive activity most likely to have health benefits.

We wondered whether the emphasis on volunteering in prior studies may have neglected health benefits from other forms of productive activity, but the results from this study suggest otherwise. Perhaps some prior studies examined other forms of social activities but, like the present investigation, found volunteering to be the most consequential to health. Whatever the case, our findings add to the accumulated body of research demonstrating that volunteering is distinctive in its health-giving properties (Hinterlong et al., 2007; Li & Ferraro, 2006; Morrow-Howell et al., 2003; Tavares et al., 2013; Van Willigen, 2000).

We also hypothesized that role overload may nullify the purported health from productive activity (i.e., when older people are highly engaged in many productive roles). We found no evidence for the role overload hypothesis even if people were very active in many roles (Hypothesis 3). Although our findings are consistent with much of the literature regarding the overall benefits of productive activity, we could not replicate the adverse effect on health due to a high time commitment to volunteering (Van Willigen, 2000). Perhaps the role overload thesis applies to other health outcomes, but not to CRP,

or it may be due to measurement issues described subsequently.

This study is limited in important ways, and one may be related to our inability to replicate the adverse effects of very high time commitments in productive activities. Unlike other studies that capture actual hours of productive activity, the maximum value for productive activity in NSHAP is "several times a week." In comparison to accumulated hours in an activity, this is a crude measure, perhaps resulting in a ceiling effect. We thought that seven categories of frequency in most of the productive activities, coupled with four roles, would be sufficient to tap intense engagement in multiple productive activities, but it would be preferable to have a more detailed measurement of frequency within each role.

Second, the measurement of productive activity in the NSHAP is notably limited. When volunteer activity is considered, the number of organizations and types of activities may have significant implications on volunteers' health, but these are not assessed in the survey. We used the available measures to examine the research question but welcome future research with more complete measurement of productive activity. Community engagement is an important component of productive activity, but our findings are limited by using one indicator: meeting attendance. It would be very helpful for future studies to tap other indicators of community engagement such as voting, leadership roles, and financial contributions to community organizations. Studies that include a more comprehensive measurement of productive activity may prove especially useful for explicating the mechanisms by which it is related to health.

Third, a notable limitation of this study is the cross-sectional nature of the data, raising the concern that healthy individuals (low CRP) might be selected into participation in productive activities. Although the measurement of CRP obviously occurred after the productive activities reported in the interview, it is still possible that health selection is operant. To address this possible concern, we accounted for health lifestyle factors, chronic conditions, and depressive symptoms—and the benefits of productive activity on CRP remained despite the inclusion of these variables and socioeconomic resources. Although we think the risk of reverse causality invalidating the results is quite low, longitudinal tracking of productive activities and CRP would be especially helpful to check on the conclusions presented herein.

Finally, the sample comprised community-dwelling adults, and the results cannot be generalized to those living in assisted living, nursing homes, or other types of congregate facilities. Future research needs to investigate whether older adults living in these environments reap the same health benefits from productive activities as was observed for community-dwelling adults in the NSHAP.

In sum, the study not only provides empirical support to the generalization that volunteer activity is beneficial to health, but it contributes to the literature by revealing that such health benefits include lower inflammation. We are unaware of any previous study to report that productive activity, especially volunteering, is associated with lower CRP. Given that CRP generally rises with age, the benefits of volunteering to counteract that trend are noteworthy. Moreover, we uncovered that the benefit of frequent volunteering was actually stronger for the oldest members of the sample, suggesting the health utility of sustained engagement in volunteer activities.

### Supplementary Material

Supplementary material can be found at: http://gerontologist.oxfordjournals.org.


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