

2010-3-29

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Oxford University Press

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<https://hdl.handle.net/2144/3094>

*Boston University*

# Caregiving, Metabolic Syndrome Indicators, and 1-year Decline in Walking Speed: Results of Caregiver-SOF

Lisa Fredman,<sup>1</sup> Gheorghe Doros,<sup>2</sup> Jane A. Cauley,<sup>3</sup> Teresa A. Hillier,<sup>4</sup> and Marc C. Hochberg<sup>5,6</sup>

<sup>1</sup>Department of Epidemiology, <sup>2</sup>Department of Biostatistics, Boston University School of Public Health, Massachusetts.

<sup>3</sup>Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh, Pennsylvania.

<sup>4</sup>Kaiser Permanente Center for Health Research Northwest/Hawaii, Portland, Oregon.

<sup>5</sup>Departments of Medicine and <sup>6</sup>Epidemiology and Preventive Medicine, University of Maryland School of Medicine, Baltimore.

Address correspondence to Lisa Fredman, PhD, Department of Epidemiology, Boston University School of Public Health, 715 Albany Street, Boston, MA 02118. Email: [lfredman@bu.edu](mailto:lfredman@bu.edu).

**Background.** Chronic stress may lead to health decline through metabolic syndrome. Thus, persons in stressful caregiving situations who also have more indicators of metabolic syndrome may experience more decline than other caregivers or noncaregivers.

**Methods.** The sample included 921 women (338 caregivers and 583 noncaregivers) from the Caregiver-Study of Osteoporotic Fractures study. Participants had home-based baseline and 1-year follow-up interviews between 1999 and 2003. At baseline, caregivers were categorized as long term ( $\geq 4$  years) versus short term ( $< 4$  years), and caring for someone with Alzheimer's disease/dementia or not. A metabolic risk composite score was the sum of four indicators: body mass index  $\geq 30$ , and diagnosis or using medications for hypertension, diabetes, or high cholesterol. Walking speed (m/second) was measured at both interviews.

**Results.** Walking speed declined for the total sample (adjusted mean =  $-0.005$  m/second,  $\pm 0.16$ ) over an average of 1.04 years ( $\pm 0.16$ ). Overall, caregiving was not associated with decline. Increasing metabolic risk score was associated with greater decline for the total sample and long-term and dementia caregivers, but not other caregivers or noncaregivers. Metabolic risk score modified the adjusted associations between years of caregiving and dementia caregiving with walking speed decline ( $p$  values for interaction terms were 0.039 and 0.057, respectively). The biggest declines were in long-term caregivers and dementia caregivers who also had 3–4 metabolic indicators ( $-0.10$  m/second and  $-0.155$  m/second, respectively).

**Conclusions.** Walking speed declined the most among older women who had both stressful caregiving situations and more metabolic syndrome indicators, suggesting these caregiver subgroups may have increased risk of health decline.

**Key Words:** Caregiving—Dementia caregivers—Metabolic indicators—Gait speed.

Received September 29, 2009; Accepted January 22, 2010

Decision Editor: Luigi Ferrucci, MD, PhD

CHRONIC stress, such as that experienced by informal caregivers, can adversely affect physical health. Recent theories suggest that stress-induced metabolic syndrome may contribute to this association (1–3). Evidence supporting these theories comes from findings that workers in high-stress occupations have a higher prevalence of metabolic syndrome (4,5) and that neuroendocrine and inflammatory markers that reflect chronic stress are associated with metabolic syndrome (1,5–7). Metabolic syndrome is a risk factor for functional decline (8–11) and mortality (12), and thus could be an intermediary between chronic caregiving-based stress and health decline. However, few studies have evaluated the role of metabolic syndrome on health decline in older caregivers (13–15).

Studies of caregiving and health decline have mixed results (16,17), but caregivers consistently have higher levels of self-reported stress and stress-related biomarkers than

noncaregivers (18–20). Moreover, perceived stress, biomarkers, and physical symptoms are worse in persons engaged in more stressful caregiving situations, such as caregiving for more years (21), or for a relative with Alzheimer's disease (AD) or dementia (17,18,22). In the single study that evaluated relationships among caregiving, metabolic syndrome, and health decline, both older AD caregivers and noncaregivers who also had metabolic syndrome had a higher incidence of coronary heart disease (14), but there was no consistent association between caregiving and prevalence of metabolic syndrome (14,15). Thus, the prevalence of metabolic syndrome may be similar in caregivers and noncaregivers because of differences in lifestyle and other risk factors for metabolic syndrome (23), whereas the combination of stressful caregiving circumstances and metabolic syndrome (whether resulting from chronic stress or from other factors) may increase health decline.

The current study evaluated whether having more indicators of metabolic syndrome modified the association between caregiving and 1-year decline in walking speed among older community-dwelling women. Decline in walking speed was selected as the outcome because it is influenced by metabolic syndrome (8–10) and increases the risk of disability and mortality (24,25), and hence is likely related to the ability to continue performing caregiving activities. Because stress and physical health parameters vary according to caregiving responsibilities, we examined these associations in subgroups based on years of caregiving, and whether the care recipient had AD or dementia. Furthermore, the study lacked measures to replicate the National Cholesterol Education Program Adult Treatment Panel III (ATP III) definition of metabolic syndrome (23), so we constructed a composite score from existing study variables. We hypothesized that caregivers who had more stressful situations (ie, long-term caregivers and AD or dementia caregivers) combined with more indicators of metabolic syndrome would decline more in walking speed than caregivers with fewer indicators or noncaregivers.

## METHODS

### Sample

Study participants came from the Study of Osteoporotic Fractures (SOF) (26). The SOF sample included 9,704 women who were at least 65 years old and were recruited between 1986 and 1988 from population-based listings in four areas of the United States: Baltimore County, Maryland; Minneapolis, Minnesota; Portland, Oregon; and the Monongahela Valley, Pennsylvania. Women were excluded if they could not walk without help or had a history of bilateral hip replacement. Although African American women were initially excluded, 662 African American women with similar characteristics were enrolled in 1996–1997. Participants in caregiver-SOF included members of the original and African American cohorts who participated in the sixth biennial SOF examination that was conducted between 1997 and 1999.

*Caregiver-SOF subsample.*—The study sample was identified in two phases, described elsewhere (27). The first phase consisted of administering a caregiver screening questionnaire to 5,952 SOF participants who had their sixth biennial examination at their home or SOF clinic and were not cognitively impaired, or living in long-term care facilities (Figure 1). The questionnaire asked SOF participants if they currently helped a relative or friend with each of seven instrumental activities of daily living (ADL) and seven basic ADL tasks (28) because that person was physically, cognitively, or mentally unable to perform that task independently. Caregivers were SOF participants who helped someone with at least one instrumental activity of daily living (IADL) or ADL task; noncaregivers did not help anyone with these tasks.

The second phase occurred from 1999 to 2001. We readministered this questionnaire by telephone to 841 caregivers and 1,872 noncaregivers identified in the first phase. Respondents who had stopped caregiving ( $n = 493$ ) were excluded. For each participating caregiver, we matched one or two noncaregivers on SOF site, age, race, and zip code. The resulting sample included 375 caregivers and 694 noncaregivers.

### Data Collection

Face-to-face interviews were conducted in respondents' homes within 2 weeks of the telephone reevaluation (ie, caregiver-SOF baseline interview) and 1 year later. This study was approved by the institutional review boards at each SOF site and at the Boston University Medical Center. All participants provided written informed consent.

### Independent Variables

*Caregiving status.*—Respondents were classified as caregivers or noncaregivers based on whether they assisted someone with any IADL/ADL tasks, as described above, at the caregiver-SOF baseline interview. Caregivers were asked questions about the main person whom they helped with these tasks.

*Long-term caregivers* were respondents who had been caregiving for 4 years or more; short-term caregivers had been caregiving from several months to less than 4 years.

*Dementia caregivers* were caregivers whose main care recipient had been diagnosed with AD or dementia; other caregivers were classified as nondementia caregivers.

*Metabolic risk composite score* was based on four existing study variables. Hypertension, diabetes, and high cholesterol were considered present if the respondent reported being told by a physician or health care provider that she had the condition or used a medication for that condition in the past month. Interviewers recorded the names of prescription medications taken in the past month. These names were coded according to indication using the Physicians' Desk Reference and online prescription databases, and cross-checked for reliability. Body mass index ( $\text{kg}/\text{m}^2$ ) was based on the respondent's height at her baseline SOF visit and her weight, measured at the baseline caregiver-SOF interview. Respondents with body mass index (BMI) of 30 or more were classified as "high BMI", consistent with the cutpoint used in the World Health Organization definition of metabolic syndrome (23). We calculated the total number of these four indicators. Because few respondents had all indicators present, we combined respondents with three or four indicators (possible values ranged from 0 to 3).

### Outcome Variable

*Walking speed.*—At the caregiver-SOF baseline and follow-up interviews, respondents were timed on the

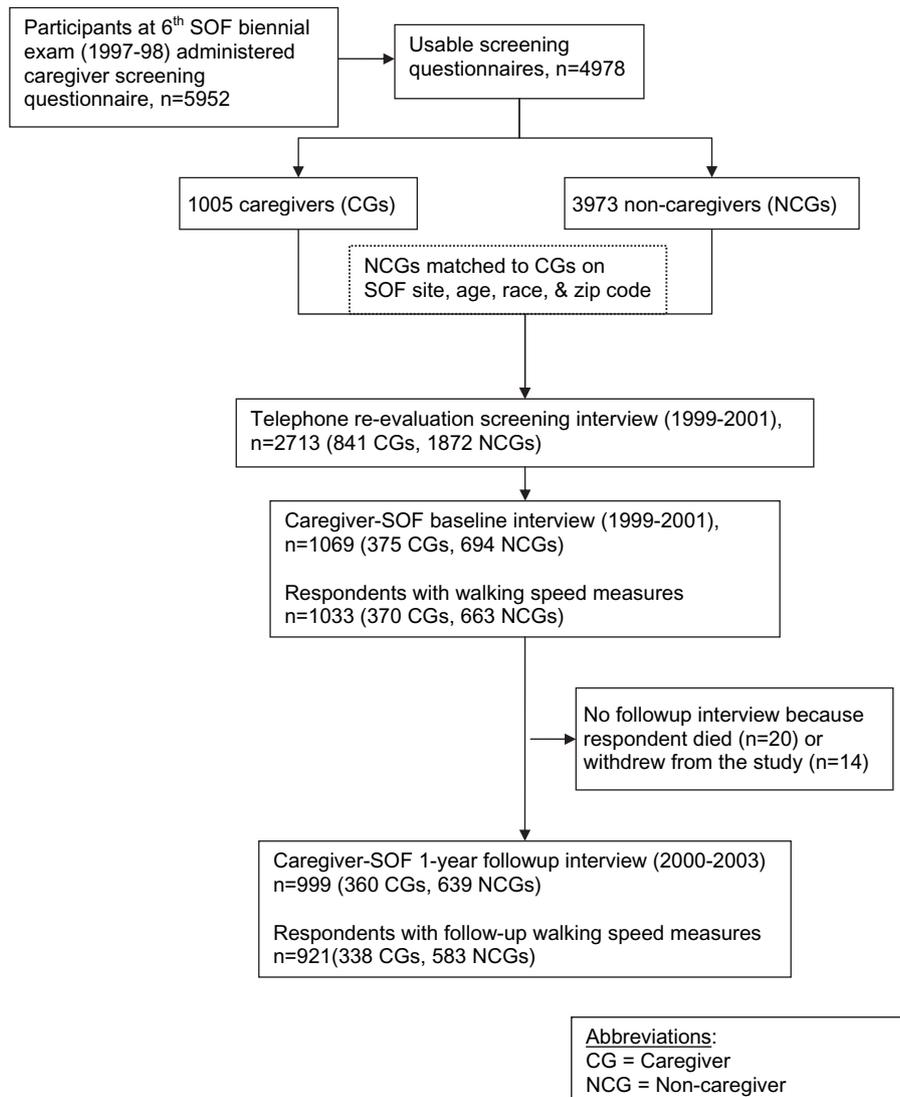


Figure 1. Flow chart of creation of caregiver-SOF sample, and sample for current analyses. *Notes:* CG = caregiver; NCG = noncaregiver.

number of seconds it took to walk a 2-m or 3-m course at their usual pace (29). After a trial walk, respondents were timed on two walks at usual pace. We calculated the average of these two walks (m/second). Respondents who used canes or walkers performed timed walks if the interviewer and respondent felt it was safe. Change in walking speed was calculated as the difference between average walking speeds at follow-up and baseline.

#### Covariables

*Sociodemographic* variables included the respondent's self-report of age, race (white or black), highest level of education (dichotomized at college or more), and current marital status.

*Leisure time exercise* was determined by a positive response to one of two questions: "Do you usually walk for

exercise (walk one block or more without stopping)?" (30), and "Do you usually engage in any regular exercise other than walking at least once a week, such as stretching or strengthening exercises, swimming or any other exercise"?

*Limitations in IADLs and ADLs* were based on the respondent's self-report of her ability to perform each of seven IADLs and seven ADLs independently. The IADLs were use the telephone, get to places out of walking distance, shop, prepare meals, manage medications, manage finances, and do heavy housework (31). The ADLs included walk across a room, groom, transfer from bed to chair, eat, dress, bathe, and use the toilet. Separate variables were constructed for the total number of ADL (0–7) and IADL (0–7) limitations.

*Perceived stress* was measured by the Perceived Stress scale (32). This 14-item scale measures general stress

Table 1. Sample Characteristics for the Total Sample and by Length of Time Caregiving, Among 921 Caregiver-SOF Participants

Characteristic	Total sample ( <i>n</i> = 921)	NCGs ( <i>n</i> = 583)	Short-term CGs ( <i>n</i> = 182)	Long-term CGs ( <i>n</i> = 156)	<i>p</i> Value comparing NCGs, short- and long-term CGs
Caregiver demographics and health characteristics					
Age in years, mean ( <i>SD</i> )	81.1 (3.6)	81.2 (3.7)	81.3 (3.6)	80.3 (3.5)	.009
Race: % African American	11.7	11.7	13.2	10.3	.70
Highest education level: % attended college or more education	53.6	51.1	54.4	62.2	.047
Marital status: % married	37.1	27.1	59.9	48.1	<.0001
Number ADL limitations: mean ( <i>SD</i> )	0.4 (0.6)	0.4 (0.7)	0.3 (0.6)	0.3 (0.5)	.28
Number IADL limitations, mean ( <i>SD</i> )	0.6 (1.0)	0.7 (1.2)	0.3 (0.6)	0.3 (0.6)	<.0001
Leisure time exercise (%)	58.6	58.5	60.8	56.8	.75
Perceived stress scale, mean ( <i>SD</i> )	16.0 (7.1)	15.2 (6.7)	17.4 (7.1)	17.4 (8.0)	<.0001
Metabolic risk composite score (%)					
0 components	29.1	29.1	26.4	31.4	.05
1 component	39.6	41.3	37.4	35.9	
2 components	22.0	18.9	29.7	25.0	
3–4 components	9.3	10.5	6.6	7.7	
Walking speed (m/s), mean ( <i>SD</i> )	0.71 (0.19)	0.70 (0.19)	0.72 (0.20)	0.75 (0.17)	.03
1-year change in walking speed (m/s), mean ( <i>SD</i> )	−0.005 (0.16)	−0.003 (0.16)	0.001 (0.17)	−0.018 (0.18)	.51
Caregiving characteristics					
Caregiver to spouse (%)	45.9		51.7	39.1	.02
Caregiver lives with care recipient (%)	48.8		51.7	45.5	.26
Care recipient has AD or dementia (%)	27.5		29.1	25.7	.48
Number of ADLs caregiver helps with, mean ( <i>SD</i> )	1.5 (1.8)		1.5 (1.7)	1.6 (1.8)	.59
Number of IADLs caregiver helps with, mean ( <i>SD</i> )	3.8 (2.0)		3.9 (2.1)	3.7 (1.9)	.35

Notes: CGs = caregivers; NCGs = noncaregivers.

experienced in the past month, with higher scores indicating more stress, and possible values ranging from 0–56.

**Caregiving characteristics.**—Caregivers reported if they were the care recipient's spouse versus another relative or other friend, if they lived with the care recipient, and the number of ADL tasks (0–7) and IADL tasks (0–7) with which they helped the care recipient.

### Statistical Analyses

We compared the baseline characteristics of respondents across the caregiver status categories using ANOVAs for continuous variables and chi-square tests for categorical variables. We conducted separate multiple linear regression analyses for the two stressful caregiving situations (ie, caregiving) on change in walking speed from baseline to the first follow-up interview. Individual covariables that were associated with both caregiving and change in walking speed were considered as potential confounders. These variables were included in the baseline regression model and were eliminated one at a time if they were not statistically significant ( $p \leq .10$ ) and their exclusion did not markedly change the association between caregiving and change in walking speed. To determine whether number of indicators of metabolic syndrome modified this association, we evaluated the statistical significance of the interaction term, caregiving  $\times$  metabolic risk composite score, in regression models containing independent variables for these terms, baseline walking speed and confounders. These models produced adjusted mean values for change in walking speed. We also evaluated whether in-

creasing number of metabolic syndrome indicators was associated with greater decline in walking speed by conducting tests for linear trend of the metabolic risk composite score within the total sample and within each caregiving subgroup.

## RESULTS

### Sample Characteristics

The sample included 921 respondents who had walking speed measures at the baseline and follow-up interviews. Of these respondents, 583 were noncaregivers, 156 (16.9%) were long-term caregivers, and 90 (27.5% of the caregivers) cared for someone with AD or dementia. Compared with respondents included in these analyses, the 148 subjects who were excluded due to lacking follow-up interviews ( $n = 34$ ) or walking speed measures ( $n = 114$ ) were significantly older, had more ADL and IADL limitations, slower baseline walking speeds, more metabolic indicators, and were more likely to care for a spouse.

The mean age of respondents was 81.1 ( $\pm 3.6$ ) years and 88% were white (Table 1). Caregivers were significantly more likely than noncaregivers to be married and stressed, but had fewer IADL limitations. Long-term caregivers had the fastest baseline walking speeds, were younger and better educated than other respondents, and less likely to be caring for a spouse. Noncaregivers were more likely than caregivers to have 3–4 metabolic syndrome indicators.

**Change in walking speed.**—Walking speed declined for the total sample over the follow-up period (mean = 1.04

years,  $\pm 0.16$ ). Mean decline, adjusted for baseline speed, was  $-0.005$  m/second ( $\pm 0.16$ ). Neither long-term caregiving ( $\beta = -0.004, p = .57$ ) nor dementia caregiving ( $\beta = 0.0005, p = .95$ ) was associated with change in walking speed, adjusted for confounders.

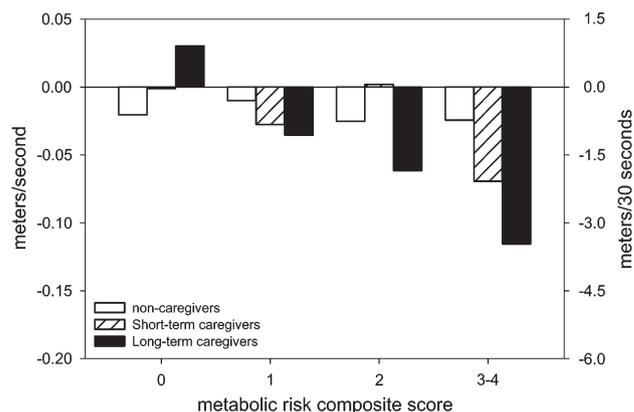
However, stressful caregiving situations combined with multiple metabolic syndrome indicators resulted in greater walking speed decline. In multiple regression analyses, long-term caregivers with 3–4 metabolic indicators declined more than other respondents: mean  $= -0.10$  m/second; interaction term  $p = .039$  (Table 2 and Figure 2). There was a significant linear trend between increasing number of metabolic syndrome indicators and walking speed decline among long-term caregivers ( $p = .002$ ), but not short-term caregivers ( $p = .24$ ) or noncaregivers ( $p = .70$ ).

Similarly, caregivers for persons with dementia who also had 3–4 metabolic risk indicators experienced more decline in walking speed ( $-0.155$  m/second) than other caregivers and noncaregivers. The interaction between dementia caregiving and metabolic risk composite score was borderline statistically significant ( $p = .057$ ; Table 3 and Figure 3). There was also more of a linear trend between increasing number of metabolic syndrome indicators and walking speed decline among dementia caregivers ( $p = .004$ ) than nondementia caregivers ( $p = .09$ ).

In both models, walking speed declined more in respondents who were African American, had less education, and more IADL limitations.

**DISCUSSION**

This study found that older women who were caregivers for 4 years or more and who also had 3–4 metabolic syndrome indicators declined more in walking speed than other respondents. Older women who cared for a person with dementia and who had more metabolic syndrome indicators showed a borderline significant trend toward more decline in walking speed. These results support our hypothesis and corroborate previous observations of poorer health outcomes in AD caregivers than other caregivers (17). They are consistent with studies that found that older adults (8,9,11) and adults with peripheral arterial disease (10) who also had metabolic syndrome had a higher risk of incident mobility



† (caregiving\*metabolic risk composite score interaction  $p=0.039$ )  
 \* Adjusted for Baseline walking speed, Race, Education level, and number of IADL limitations

Figure 2. Adjusted\* mean change in walking speed over 1 year by length of time caregiving and metabolic risk composite score combined†. Notes: \*Adjusted for baseline walking speed, race, education level, and number of IADL limitations. †Caregiving  $\times$  metabolic risk composite score interaction,  $p = .039$ .

limitations (11), decline in ADLs (8,9), mobility-related ADLs (9), and walking speed (10). They are also consistent with studies that found linear trends between increasing number of metabolic syndrome components and poorer outcomes in mobility (11) and cognitive functioning (33).

The decline in walking speed may appear minimal. Yet, even small declines increase the risk of mortality (25). Moreover, if translated into distance walked over 30 seconds (the time often allotted to cross a street), then long-term and dementia caregivers with 3–4 metabolic syndrome indicators would walk 3.0 and 4.7 m less in 30 seconds at 1-year follow-up than at baseline (Figures 2 and 3). This change may affect caregivers’ quality of life and ability to provide optimal care for the care recipient.

There are several pathways by which chronic caregiving stress combined with multiple metabolic syndrome indicators may lead to a decline in walking speed. First, the presence of both conditions may exacerbate their individual effects, such as reduced walking speed in obese persons (34) or in depressed adults resulting from chronic stress (35). Second, there may be indirect effects through disruptions in cytokine activity, notably interleukin-6 (IL-6). Both

Table 2. Adjusted\* Mean Change in Walking Speed Over 1-year by Length of Time Caregiving and Metabolic Risk Composite Score Combined

Metabolic risk composite score	Length of time caregiving, mean (SE)			
	Total sample	Noncaregivers	Short-term caregivers	Long-term caregivers
0	0.004 (0.013)	-0.007 (0.012)	0.012 (0.022)	0.044 (0.022)
1	-0.023 (0.012)	0.004 (0.010)	-0.014 (0.018)	-0.022 (0.020)
2	-0.027 (0.013)	-0.012 (0.014)	0.016 (0.021)	-0.048 (0.024)
3–4	-0.069 (0.023)	-0.011 (0.020)	-0.056 (0.044)	-0.102 (0.044)
Linear trend for increasing metabolic risk composite score	$p = .003$	$p = .70$	$p = .24$	$p = .002$

\*Adjusted for baseline walking speed ( $\beta = -.355, SE = 0.029, p < .001$ ), black race ( $\beta = -.034, SE = 0.016, p = .04$ ), high school graduate+ ( $\beta = .018, SE = 0.010, p = .08$ ), and IADL limitations ( $\beta = -.024, SE = 0.005, p < .001$ ).  $p$  Value for caregiving  $\times$  metabolic risk composite score interaction term = .039.

Table 3. Adjusted\* Mean Change in Walking Speed Over 1-year by Dementia Status and Metabolic Risk Composite Score Combined

Metabolic risk composite score	Dementia caregiving status, mean (SE)			
	Total sample	Noncaregivers	Nondementia caregivers	Dementia caregivers
0	0.005 (0.014)	-0.007 (0.012)	0.027 (0.019)	0.031 (0.029)
1	-0.016 (0.013)	0.004 (0.010)	-0.028 (0.016)	0.014 (0.028)
2	-0.021 (0.014)	-0.012 (0.014)	-0.016 (0.018)	0.003 (0.031)
3-4	-0.084 (0.025)	-0.011 (0.020)	-0.048 (0.037)	-0.155 (0.057)
Linear trend for increasing metabolic risk composite score	$p \leq .001$	$p = .70$	$p = .09$	$p = .004$

\* Adjusted for baseline walking speed ( $\beta = -.359$ ,  $SE = 0.029$ ,  $p < .001$ ), black race ( $\beta = -.033$ ,  $SE = 0.016$ ,  $p = .04$ ), high school graduate+ ( $\beta = .018$ ,  $SE = 0.010$ ,  $p = 0.077$ ), and IADL limitations ( $\beta = -.024$ ,  $SE = 0.005$ ,  $p < .001$ ).  $p$  Value for the caregiving  $\times$  metabolic risk composite score interaction term = .057.

AD caregivers (20,36) and adults with metabolic syndrome (5) have higher levels of IL-6. Older adults with elevated IL-6 levels have greater risk of mobility impairment (37). Third, chronic stress may create a cascade of disruptions in multiple physiological systems (1,3). Caregivers with more metabolic syndrome indicators may experience more decline because they are further along this pathway toward health decline than other caregivers.

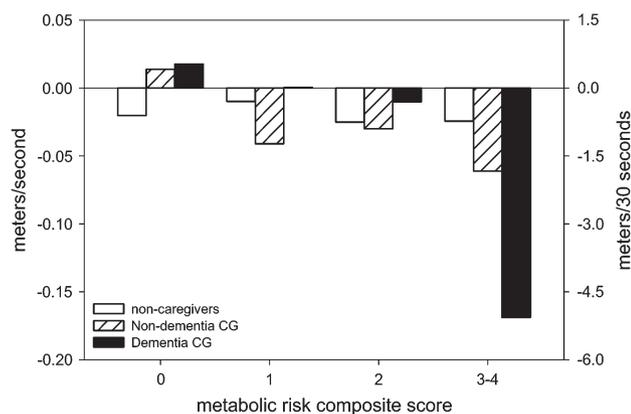
This study had several limitations. The metabolic risk composite score differed from ATP-III-defined metabolic syndrome, which is based on waist circumference and a combination of clinical assessments and medications for identifying hypertension, dyslipidemia, and elevated glucose (23), whereas our measure used BMI instead of waist circumference and a combination of self-report and medications for the other components. However, various measures of metabolic syndrome exist for clinical (23) and research purposes (33,38). Previous studies of caregivers used a "metabolic risk composite" that did not include high-density lipoprotein or triglyceride levels (15) and other modifications of metabolic variables (14), and other studies also

substituted BMI for waist circumference (33). Additionally, our measure did not include prevalent cardiovascular disease, but when terms for heart disease and stroke were added to multivariable models, they were not statistically significant.

Other potential limitations were that long-term caregivers did not have higher perceived stress than short-term caregivers. However, caregiving-related stressors and psychological distress fluctuate over time. Caregivers in this sample reported being in this role from less than 1 year to 53 years. Thus, long-term caregivers had the longest exposure to caregiving-related stressors. The fact that we found a significant, dose-response association between higher metabolic risk composite score and walking speed decline in long-term caregivers supports our hypothesis. However, interpretation of these results should consider the small number of respondents in subgroups of respondents with 3-4 metabolic indicators who were also in stressful caregiving subgroups (12 long-term caregivers and 7 dementia caregivers) as well as the possibility of regression to the mean because this group had the fastest baseline walking speed. We also lacked measures of physical activity and diet, risk factors for metabolic syndrome (23), and mobility limitations. (39) Although residual confounding may be a concern, our results were consistent with studies that adjusted for physical activity, suggesting that this was not a major limitation. Additionally, the sample was comprised of older women who were mainly white and high functioning, raising the question of generalizability of these results. However, as most caregivers in the United States are older women (40), these results apply to the majority of caregivers.

Nonetheless, this study's strengths included its large, multisite community-based sample of older women. Caregivers and noncaregivers came from the same source population, thus reducing possible biases that may result from recruiting caregivers from patient registries and noncaregivers from other sources. The inclusion criteria required that caregivers were helping the care recipient with at least one IADL/ADL at baseline, so misclassification of caregiver status was unlikely.

In summary, these results add to studies of the combined effects of caregiving and metabolic risk factors (13-15),



† (caregiving\*metabolic risk composite score interaction  $p=0.057$ )

\* Adjusted for Baseline walking speed, Race, Education level, and number of IADL limitations

Figure 3. Adjusted\* mean change in walking speed over 1 year by dementia versus nondementia caregiving and metabolic risk composite score combined†. Notes: \*Adjusted for Baseline walking speed, race, education level, and number of IADL limitations. †Caregiving  $\times$  metabolic risk composite score interaction  $p = .057$ .

and are the first, to our knowledge, to compare different caregiving situations. Additional studies are needed to replicate these findings, including studies with longer follow-up periods, larger samples, and alternative health and functioning outcomes. Given the increasing population of older caregivers, such studies will provide important information for identifying subgroups of older caregivers that may be at risk of health decline.

#### FUNDING

AG18037, AG05407, AR35582, AG05394, AR35584, and AR35583. An earlier version of this manuscript was presented at the 59th Annual meeting of the Gerontological Society of America, Dallas, Texas, 2006.

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