Original Article

SAGE Open Medicine

Filial caregiving is associated with greater neuroendocrine dysfunction: Evidence from the 2005 National Survey of Midlife in the United States

SAGE Open Medicine
2: 2050312113520152

DOI: 10.1177/2050312113520152
smo.sagepub.com
SAGE

SunWoo Kang[1] and Nadine F Marks[2]

Abstract

Objectives: This study examined associations between providing caregiving for a biological or adoptive parent and clinically assessed biological risk factors (allostatic load and its three subscales—inflammatory dysfunction, metabolic dysfunction, and neuroendocrine dysfunction), as well as moderation of these associations by gender.

Methods: Regression models were estimated using telephone and self-report data from 962 men and women who participated in the National Survey of Midlife in the United States in 2005.

Results: Filial caregivers demonstrated higher levels of neuroendocrine dysfunction. No gender difference in biological risks was found.

Discussion: Filial caregiving is the most prevalent form of family caregiving, and results indicating the presence of greater neuroendocrine dysfunction among filial caregivers in contrast to noncaregivers suggest an important public health concern. Future research needs to continue to examine different relationship types of caregivers and include a range of biological risk measurement to further the understanding of how family caregiving is linked to biological health risks.

Keywords

Caregiving, gender, allostatic load, metabolic, inflammatory, neuroendocrine, hypothalamic–pituitary–adrenal axis, biological risk

Date received: 23 August 2013; accepted: 18 December 2013

Filial caregiving has significant public health implications.[1] More than 65 million people, 29% of the US population, provide care for a chronically ill, disabled, or aged family member or friend during any given year. The largest proportion of family caregivers—36%—provide care for a parent.[2] Providing care to disabled elderly parents has been associated with considerable strain, burden, psychological distress, and poorer physical health.[3–8] Research across multiple types of family caregiving has suggested that caregivers are at risk of poorer immune system functioning, increased rates of infectious illness, and other biological vulnerabilities that can increase the risk of health problems.[9]

Nonetheless, while growing evidence from caregiving research suggests that providing caregiving is linked to potential adverse effects on caregivers' physical health, relatively little of this research has addressed associations between caregiving and underlying biological factors linked to health.[7] The limited number of studies that have investigated biological factors among caregivers[10–13] have been typically based on nonrandom samples, have typically assessed only one or a few individual biological markers, and/or have not differentiated caregivers by caregiving relationship type—a difference that has been shown to be important in previous research.[14–16] Additionally, gender differences in caregiving research related to biological risks have not been consistently examined.

To address some of the limitations of previous research, the purpose of this exploratory study was to use data from a US national survey to examine the associations between one specific type of family caregiving—care for a biological or adoptive parent—and four clinically assessed biological risk factor indices (a 15-item assessment of allostatic load (AL)

[1]Department of Counseling and Human Development, South Dakota State University, Brookings, SD, USA
[2]Human Development and Family Studies, University of Wisconsin–Madison, Madison, WI, USA

Corresponding author:
SunWoo Kang, Department of Counseling and Human Development, South Dakota State University, Wagner Hall 407, Brookings, SD 57007, USA.
Email: sunwoo.kang@sdstate.edu

and its three composite subscales: inflammatory dysfunction, metabolic dysfunction, and neuroendocrine dysfunction), as well as moderation of these associations by gender.

Theoretical and empirical foundation

Biopsychosocial approach to health

In recent biomedical studies, models taking a biopsychosocial approach to health have become more prominent. These models help highlight how psychosocial factors such as extreme/chronic stress can potentially have adverse effects on biological factors related to health.[17] Also, the biopsychosocial approach posits that psychosocial factors have impact on biological factors by predisposing the individual to additional psychosocial risk factors, which can have indirect influences on health. For example, extreme stress can directly lead to biological changes linked to heart disease but also can lead the person to be more likely to be depressed and use alcohol, which, in turn, can also contribute to problematic physical health. Therefore, the effects of problematic psychosocial factors (e.g. stressful events, chronic stresses) can cause an increased probability of having physical health problems, biopsychosocial diseases, and/or higher mortality.[18]

Diverse empirical studies on caregiving and health have indicated that family caregiving is a stressful life challenge that typically includes various psychosocial stressors that can be hazardous to caregivers' health.[7] Additionally, substantial research has demonstrated the association between caregiving and poorer mental health,[4] which, in turn, is an example of another psychosocial factor that might be expected to problematically influence physical health. Drawing upon the biopsychosocial model's assumptions regarding the associations between stressful psychosocial factors and their effects on biological health factors and physical health, this study examined associations between filial caregiving (vs noncaregiving) and health-related biological risk factors.

A life course perspective on caregiving

This study was also guided by a life course theoretical perspective on caregiving. The life course principle of "linked lives"[19] draws attention to how family members' developmental trajectories (including mental and physical health trajectories) are consequentially interdependent and "linked" across time. Therefore, transitions and experiences of one member of a family (e.g. an elder experiencing a transition to greater disability or frailty) might be expected to have developmental consequences for other members of the family (e.g. an adult child who observes undesirable change in a parent's health and transitions into taking a greater role in providing care for his or her parent).

The life course perspective additionally guides us to consider important contextual factors when considering the developmental effects of a role, such as a caregiving role.[20] There is considerable evidence that in contemporary society, the social script for a caregiver role is gendered; that is, normative expectations for caregiving are typically different for women in contrast to men.[21,22] Women more often assume the role of primary caregiver (in contrast to secondary caregiver) than men; women typically engage in more hands-on tasks, especially intimate personal care than men;[21,22] and women are socialized to view caregiving as a more salient role in their role-identity repertoires than men and to be more empathetic to the suffering of a loved one than men, thereby making them even more vulnerable to compromised well-being when stresses in this role occur.[23] Additionally, the overall structural disadvantages of women in gender relations in contemporary societies (e.g. lower incomes in similar work roles, more responsibilities for child care and other extended kinship care, greater overall economic vulnerability) would lead us to expect that men might suffer less and women might suffer more in a caregiving role.[24] Nonetheless, an alternative hypothesis might be that due to being less socialized to anticipate a caregiving role, less socialized to feel comfortable seeking help when stresses accumulate, and perhaps having less access to a larger social support network, men might have their own unique health risks in a caregiving role.[25] Given these considerations, a life course perspective guided us to consider potential gender differences in health risk for a filial caregiving role.

AL

While considerable research on caregiving and physical health relies on self-reported survey measures, it is also valuable to consider clinically assessed health-related biological risk factors to understand even more clearly the mechanisms whereby caregiving may get "under the skin" and influence physical health. AL has been developed as a concept to capture the idea of overall level of cumulative biological system dysfunction resulting from stress overload.[26] This is relevant to caregiving in that evidence from previous studies suggests that caregiving can be an acute stress for caregivers, and long-term caregiving can often be a chronic stress for caregivers.[5]

Human body systems respond to both body states and external environments by adaptation activities. This adaptation process includes reactions by the neuroendocrine (hypothalamic–pituitary–adrenal (HPA) axis/sympathetic nervous system (SNS)), the inflammatory/immune system, and the metabolic/cardiovascular system. The allostasis response of these systems is activated rapidly when individuals are coping with a certain challenge and adaptation and turned off when they do not need to be activated. However, these systems become dangerous and lead to health risks when they are overly stressed, and breakdowns occur such that they are not turned off or turned down appropriately. Additionally, when these systems cannot be turned on when needed, this inappropriate response can also produce a load on the body

causing lack of normal protection and undesirable elevation of other systems' activity.[26] Adversity and stressful circumstances (e.g. caregiving) are likely to accelerate pathophysiological processes and lead to higher chances of morbidity and mortality and more susceptibility to cardiovascular disease (CVD).[26]

Although some studies of caregiving and biological risk have evaluated one biomarker measure or another (e.g. cortisol, interleukin-6 (IL-6)), a cumulative measure of biomarkers that constitutes a more complete assessment of AL has shown promise as a measure of overall underlying health risk in other areas of gerontological health research. Seeman et al.[27] helped formulate the theoretical rationale for AL measurement and further led in operationalizing AL utilizing a risk factor "count" measure based on 10 biomarkers, including measures of systolic blood pressure, diastolic blood pressure, waist–hip ratio (WHR), high-density lipoproteins (HDLs), total cholesterol, blood plasma levels of glycosylated hemoglobin (HbA1c), serum dehydroepiandrosterone sulfate (DHEA-S; a functional HPA axis antagonist), C excretion (an integrated measure of 12-h HPA axis activity), norepinephrine, and epinephrine. Utilizing data from a sample of over a thousand relatively healthy adults aged 70–79 years participating in the MacArthur Study of Successful Aging, they demonstrated that cross-sectionally AL was linked to poorer baseline physical functioning and cognitive performance. Additionally, they began to establish the predictive validity (over 2.5 years) of AL by providing evidence that it predicted greater declines in physical health status and cognitive status and a trend toward a greater incidence of problematic CVD events (controlling for sociodemographic characteristics and baseline health status). Importantly, in this initial study, they also established that no one biomarker predicted these same declines and CVD events—providing evidence that a measure that includes multisystemic biomarker components has added value over individual measures in capturing the biological changes that predict health decline and mortality.

Seeman et al.[28] extended this program of work utilizing 7-year longitudinal data from the MacArthur Study of Successful Aging to further investigate the predictive validity of AL and added more evidence of significant associations between higher AL scores and increased risks of mortality, greater declines in cognitive functioning, and greater declines in physical functioning over time.

Recent theorizing on AL has highlighted the value of including biomarkers related to inflammatory dysfunction in AL measurement (the original measure only included biomarkers related to metabolic dysfunction and neuroendocrine dysfunction) and has also suggested the possibility that various systems' components of AL may be sequentially affected over time in the stress process. For example, it may be that stress first results in neuroendocrine dysfunction, which later also leads to inflammatory dysfunction, which, in turn, may also provoke metabolic dysfunction.[29,30] Such temporal theorizing suggests the value of examining the underlying systemic components of AL separately, as well as examining a total AL score.

A recent review of 58 studies using AL to explore how stress is linked to cognitive and physical health[29] provides a considerable accumulation of evidence regarding the value of AL as a tool to help evaluate individuals at higher risk of adverse health outcomes. Establishing the predictive validity of AL for future health outcomes has also brought more attention to the importance of understanding factors that help predict higher levels of AL and that might help buffer the impact of stressors on AL—including psychosocial factors such as histories of social relationships and social integration.[31,32]

Given the important demonstrated associations between measures of AL and health, and its relevance to the potential for the stresses of caregiving to impact current and future health and mortality, this study explored the associations between caregiving and AL operationalized by a cumulative measure of 15 health-related biological indicators. We also separately examined three subscales of this full AL scale, including measures indicating neuroendocrine dysfunction (four-item subscale: cortisol, norepinephrine, epinephrine, and DHEA), inflammatory dysfunction (five-item subscale: IL-6, C-reactive protein (CRP), E-selectin, intercellular adhesion molecule (ICAM), and fibrinogen), and metabolic dysfunction (six-item subscale: systolic blood pressure, diastolic blood pressure, WHR, cholesterol, hemoglobin, and HDL-cholesterol).

Empirical research linking caregiving and biological factors linked to health

A number of studies have indicated health-related biological factor risks linked to caregiving. For example, Clark et al.[33] examined the association between caregiving and AL across 80 spousal caregivers of dementia patients, 120 veteran caregivers, and 60 noncaregivers. Results suggested that the AL score increased over 2 years among caregivers, whereas there was no significant increase over time among noncaregivers.

Studies have also indicated that compared to noncaregivers, caregivers demonstrate poorer immune function, slower wound healing, or dysregulation of natural killer cell activity;[13,34–36] are at greater risk to have elevated levels of problematic inflammatory markers in their blood and evidence of CVD;[12,37–40] and exhibit more risks in neuroendocrine, stress-related hormone dysregulation.[34,41–43] Nonetheless, while researchers have demonstrated that caregivers have more physiological problems across these multiple domains than noncaregivers, few studies have used nationally representative data, focused specifically on filial caregivers, included sociodemographic controls also associated with health, and included a noncaregiver comparison group in their research designs.

Therefore, guided by the biopsychosocial model of health, and the accumulating overall evidence suggesting a link

between caregiving and negative effects on biological health risk factors, in this exploratory population study, *we hypothesized that filial caregiving would be linked to more problematic levels of biological risk (as assessed by AL and subscales of AL)*.

Gender differences in associations between filial caregiving and biological health

Overall, research to date suggests that women caregivers experience poorer global health than men caregivers,[9,44] although there is also some evidence that men caregivers are at more risk of poorer immune function[45] and metabolic dysfunction.[46,47] Very few studies of caregiving and biological health indicators have examined gender differences in research designs that include both caregivers and noncaregivers. And we have not found a previous study that has focused specifically on potential gender differences in filial caregiving influences on biological factors. Therefore, guided by the available empirical research on caregiving and physical health, in this exploratory population study, *we hypothesized that women filial caregivers would exhibit higher levels of biological health factor risks (as measured by AL and its subscales) than men filial caregivers.*

Methods

Data and analytic sample

Data for our analyses came from the national random digit dialing (RDD) sample of the National Survey of Midlife in the United States (MIDUS).[48] The MIDUS included 3487 noninstitutionalized, English-speaking adults living in the United States at Time 1 (T1) (1995–1996) and included a telephone survey and a mail-back self-administered questionnaire. Follow-up data collection took place about 9 years later (Time 2 (T2): 2005). Siblings and a national twin sample were also included in the T2 study. The MIDUS website provides details regarding the data set and data collection procedures (http://midmac.med.harvard.edu/research.html).

The analytic sample for this study included 962 adults (women = 515 and men = 447) aged 34–84 years at T2 who participated in the biomarker study (a randomly generated subset of T2 survey respondents who came in for 2 days of clinical assessment to one of three regional medical centers after completing the telephone survey and self-administered mail-back survey). Caregiving status was not explicitly assessed at MIDUS T1, but it was added and assessed via the MIDUS phone questionnaire at T2 (see more in section "Independent variables" below). Due to our research focus on the relationship between filial caregiving, gender, and clinically assessed biological risk factors, we limited our analytic sample to T2 national survey main respondents and twin respondents who participated in the MIDUS biomarker study and who in the telephone survey reported either (1) they were not providing caregiving for anyone or (2) they were a caregiver for a parent. (This excluded 6% of the T2 sample who were "other" types of caregivers from the analytic sample. See more details on the caregiving status measure later in this section.)

Outcome variables

AL. Following the precedent of Seeman et al.[27,28] and the majority of studies that have used an AL measure,[29] this study used a risk factor "count" scale to assess respondents' AL. Our scale also included items assessing inflammatory dysfunction and therefore was a 15-item scale (in contrast to the original 10-item scale developed by Seeman et al.[27]). Our AL total scale included indicators of systolic blood pressure, diastolic blood pressure, WHR, cholesterol, hemoglobin, HDL, cholesterol, cortisol, norepinephrine, epinephrine, DHEA, IL-6, CRP, E-selectin, ICAM, and fibrinogen. Following previous precedent in creating AL scales,[27,28] quartile values for all 15 items were calculated to create dichotomous variables for each item where 1 = high-risk quartile (i.e. high risk = being in *highest quarter* of the distribution for systolic blood pressure, diastolic blood pressure, WHR, cholesterol, hemoglobin, cortisol, norepinephrine, epinephrine, IL-6, CRP, E-selectin, ICAM, and fibrinogen and high risk = being in *lowest quarter* of the distribution for HDL-cholesterol and DHEA) and 0 = otherwise. Note that overall, clinical cut points for risk for most of these variables have not been established, and typically there have not been different cut points for risk suggested for women in contrast to men—with one exception. WHR functions differently for men and women. Therefore, in the case of this one variable in the index, we used the top quarter cut point to signify high risk based on *gender-separate* distributions. The total AL variable was created by summing across the 15 dichotomous variables for "high risk": systolic blood pressure, diastolic blood pressure, WHR, cholesterol, hemoglobin, HDL-cholesterol, cortisol, norepinephrine, epinephrine, DHEA, IL-6, CRP, E-selectin, ICAM, and fibrinogen (range 0–15). (See descriptives for all analytic variables in Table 1. See correlations for all analytic variables in Table 2.)

Inflammatory dysfunction. This study also evaluated a five-item subscale of the full AL measure described above to assess respondents' inflammatory dysfunction. The inflammatory dysfunction subscale variable was created by summing five of the dichotomous variables noted above for the AL scale: IL-6, CRP, E-selectin, ICAM, and fibrinogen (range 0–5).

Metabolic dysfunction. This study also examined a six-item subscale of the full AL scale to separately assess respondents' metabolic dysfunction. The metabolic dysfunction variable was created by summing six of the dichotomous high-risk variables noted above for the AL scale: systolic

Table 1. Descriptives for all analytic variables.

	Mean	Standard deviation (SD)	Range
Caregiving status			
1. No caregiving	.95	.21	0–1
2. Parent care	.05	.21	0–1
Biological health outcomes			
3. Allostatic load	3.70	2.37	0–12
4. Inflammatory dysfunction	1.25	1.28	0–5
5. Metabolic dysfunction	1.45	1.42	0–6
6. Neuroendocrine dysfunction	1.00	1.01	0–4
Sociodemographic factors			
7. Gender (female = 1)	.54	.50	0–1
8. Age	54.92	11.77	34–84
9. Household income	82,428.27	55,162.18	0–300,000
10. Education	7.72	2.46	1–12
11. Race/ethnicity (White = 1)	.92	.27	0–1
12. Parental status (parent = 1)	.86	.34	0–1
13. Employment status (employed = 1)	.56	.50	0–1
14. Marital status (married = 1)	.73	.45	0–1

Means for dichotomous variables are proportions.

blood pressure, diastolic blood pressure, WHR, cholesterol, hemoglobin, and HDL-cholesterol (range 0–6).

Neuroendocrine dysfunction. This study also used a four-item subscale of the full AL scale to assess respondents' neuroendocrine dysfunction. The neuroendocrine dysfunction variable was created by summing four of the dichotomous high-risk variables noted for the AL scale: cortisol, norepinephrine, epinephrine, and DHEA (range 0–4).

Independent variables

Caregiving status. In the phone questionnaire at T2, participants were asked whether during the last 12 months they had given personal care for a period of 1 month or more to a family member or a friend because of a physical or mental condition, illness, or disability. Respondents who answered "yes" were asked to indicate to whom they gave the most personal care (relationship type: husband, wife, son, daughter, father, mother, brother, sister, etc.). For this study, focused solely on filial care, we created a dichotomous variable—*parent care*—which was coded 1 if the respondent indicated they had provided caregiving to a biological or adoptive mother or father (n = 46, women = 30 and men = 16) and coded 0 if respondents had answered "no" they did not provide any personal care to this extent to a family member or a friend during the past 12 months (n = 916, women = 485 and men = 431). Respondents who indicated they provided any other type of caregiving (e.g. spousal care, child care, parent-in-law care, other kin care, nonkin care) were excluded from this analysis.

Demographic control variables. Given findings from previous studies indicating that a number of sociodemographic variables are associated with physical health,[49,50] we controlled for several of these factors to avoid confounding effects: gender (dichotomous, 1 = *female*), respondents' age (continuous), household income (continuous, including respondents' reports of income from all sources, as well as their reports of all spousal income), educational attainment (continuous, using categories: 1 = *no school/some grade school (1–6)* to 12 = *PhD, EdD, MD, DDS, LLD, JD, or other professional degree*), race/ethnicity (dichotomous, 1 = *non-Hispanic White*), parental status at T2 (dichotomous, 1 = *parent of a child*), employment status (dichotomous, 1 = *currently employed*), and marital status (dichotomous, 1 = *currently married*) at T2.

Data analysis

Ordinary least squares multiple regression models were estimated (using pairwise deletion to maximize retention of cases) to investigate the associations between filial caregiving and AL and its constituent subscales. All models included all demographic control variables. To test our hypothesis regarding the main effect of filial caregiving on biological health outcomes, we estimated models for each outcome in which each outcome was regressed on the dichotomous variable (*parent care*) indicating whether respondents were filial caregivers or not (Model 1 (M1)). To examine our hypothesis regarding moderator effects of gender on associations between filial caregiving and clinically assessed health-related biological factor, Model 2 (M2) added the interaction term *Female* × *Parent care*.

Results

Parent care and clinically assessed biological risk factors

AL. No evidence was found that providing caregiving for a parent was linked to an overall higher level of AL (Table 3, M1, b = .46, not significant (NS)). Also, no subgroup difference by gender was found in the association between AL and caregiving among parent caregivers and noncaregivers (Table 3, M2, b = −.43, NS).

Inflammatory dysfunction. No evidence was found that respondents who reported they were providing caregiving

Table 2. Correlations for all analytic variables.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Caregiving status														
1. No caregiving	–													
2. Parent care		–												
Biological health outcomes														
3. Allostatic load	−.03	.03	–											
4. Inflammatory dysfunction	−.03	.03	.70	–										
5. Metabolic dysfunction	.01	−.01	.71	.20	–									
6. Neuroendocrine dysfunction	−.06	.06	.45	.06	−.00	–								
Sociodemographic factors														
7. Gender (female = 1)	−.05	.05	−.13	.07	−.43	.22	–							
8. Age	.04	−.04	.28	.08	.13	.36	−.07	–						
9. Household income	.03	−.03	−.15	−.14	−.03	−.14	−.07	−.19	–					
10. Education	.01	−.01	−.18	−.17	−.09	−.10	−.07	−.09	.28	–				
11. Race/ethnicity (White = 1)	.05	−.05	−.03	−.05	−.00	.00	−.03	.05	.03		–			
12. Parental status (parent = 1)	−.00	.00	.02	.02	−.02	.07	.07	.19	.04	−.17	.03	–		
13. Employment status (employed = 1)	.03	−.03	−.13	−.11	−.02	−.15	−.04	−.42	.21	.14	−.02	−.15	–	
14. Marital status (married = 1)	.05	−.05	.00	−.03	.06	−.04	−.16	−.01	.34	.01	.06	.31	−.05	–

for their parents were reporting higher levels of inflammatory dysfunction (Table 3, M1, $b = .16$, NS). Additionally, no subgroup difference by gender was revealed in the association between parent caregiving and inflammatory dysfunction (Table 3, M2, $b = .12$, NS).

Metabolic dysfunction. Findings did not reveal a significant difference in levels of metabolic dysfunction for parent caregivers in contrast to noncaregivers (Table 3, M1, $b = .08$, NS). No evidence was found for a difference by gender in the association between levels of metabolic dysfunction and caregiving among parent caregivers in contrast to noncaregivers (Table 3, M2, $b = -.46$, NS).

Neuroendocrine dysfunction. Congruent with our hypothesis, respondents who reported they were providing caregiving for their parents demonstrated higher levels of neuroendocrine dysfunction compared to respondents who reported they were not providing any type of caregiving (Table 3, M1, $b = .28$, $p \leq .05$). No subgroup difference by gender was found in the association between parent caregiving and neuroendocrine dysfunction (Table 3, M2, $b = -.42$, NS).

In sum, findings indicated that providing care for a parent was linked to higher levels of neuroendocrine dysfunction; this association was similar for caregiving daughters and sons.

Discussion

Guided by a biopsychosocial model, this study aimed to utilize population evidence to investigate whether caregiving for a biological or adoptive parent is linked to higher levels of clinically assessed biological health risks among caregivers in contrast to noncaregivers, as well as to evaluate whether gender moderates these health risks.

Our results provide the first population study–based evidence of which we are aware that filial caregivers, specifically, are at greater risk of neuroendocrine dysfunction than noncaregivers, adjusting also for numerous sociodemographic factors. While filial caregivers demonstrated higher risk of neuroendocrine dysfunction—which is a primary system linked to stress and adaptation, controlling reactions to stress, and regulating many body processes—we did not find that this risk extended to our additional measures of inflammatory dysfunction and metabolic dysfunction, nor to our overall evaluation of AL (that combined all three of these subscales).

Filial caregiving is the most prevalent form of caregiving, and it is the most common type of caregiving that adults are likely to experience at some point or at multiple points across their lives.[2] There are somewhat different normative expectations for filial caregiving than for spousal caregiving or caregiving for a disabled child,[51] which may have led to some earlier findings that filial caregiving is sometimes less problematic for health than other types of caregiving.[52] Nonetheless, empathizing with the suffering of an important attachment figure,[23] and participating in the "role reversal" and potential physical and emotional strain that can come for an adult child when a parent is no longer fully capable of taking care of themselves, has the potential to put filial caregivers at biological risk of poorer health outcomes. Compared to other types of caregiving, filial caregivers also may be even more likely to experience the additional stress that comes from having role conflicts between their internalized normative expectations for filial caregiving and the expectations and demands in their employment, marital/partner, and parenting roles. This stress, in turn, may become reflected in their impaired neuroendocrine profiles.

Given recent interest in determining within AL whether there is evidence of a temporal sequencing of biological

Table 3. Estimated unstandardized regression coefficients for the associations between parent care, gender, and clinically assessed biological risk factors.

	Allostatic load unstandardized coefficients *b* (standard error)		Inflammatory dysfunction unstandardized coefficients *b* (standard error)		Metabolic dysfunction unstandardized coefficients *b* (standard error)		Neuroendocrine dysfunction unstandardized coefficients *b* (standard error)	
	(15-item total scale)		(5-item subscale)		(6-item subscale)		(4-item subscale)	
	M1	M2	M1	M2	M1	M2	M1	M2
Female	−.57*** (.15)	−.55 (.16)	.13 (.09)	.13 (.09)	−1.21*** (.09)	−1.19*** (.09)	.48*** (.06)	.50*** (.06)
No caregiving (omitted)	–	–	–	–	–	–	–	–
Parent care	.46 (.35)	.74 (.59)	.16 (.20)	.08 (.33)	.08 (.20)	.38 (.33)	.28* (.14)	.56* (.24)
Female × parent care		−.43 (.73)		.12 (.41)		−.46 (.41)		−.42 (.30)
Age	.05*** (.01)	.05*** (.01)	.00 (.00)	.00 (.00)	.01** (.00)	.01**(.00)	.03*** (.00)	.03*** (.00)
Income	−.00* (.00)	−.00* (.00)	−.00* (.00)	−.00* (.00)	−.00 (.00)	−.00 (.00)	−.00 (.00)	−.00 (.00)
Education	−.15*** (.03)	−.15*** (.03)	−.07*** (.02)	−.07*** (.02)	−.06*** (.02)	−.06*** (.02)	−.02 (.01)	−.02 (.01)
Race/ethnicity	−.27 (.28)	−.27 (.28)	−.19 (.15)	−.19 (.15)	−.09 (.16)	−.08 (.16)	−.01 (.11)	.00 (.11)
Parental status	−.33 (.24)	−.33 (.24)	−.10 (.13)	−.10 (.13)	−.11 (.14)	−.11 (.14)	−.09 (.10)	−.09 (.10)
Employment status	.01 (.17)	−.01 (.17)	−.16+ (.09)	−.16+ (.10)	.06 (.10)	.06 (.10)	.08 (.07)	.08 (.07)
Marital status	.16 (.19)	.16 (.19)	.04 (.11)	.04 (.11)	.04 (.11)	.04 (.11)	.06 (.08)	.06 (.08)
Constant	2.97***	2.95***	1.94***	1.95***	2.07***	2.05***	−.90***	−.92***
R^2	.13	.13	.05	.05	.21	.21	.20	.20

M1: Model 1; M2: Model 2.
+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$ (two-tailed).

systems impacted by stress—for example, first neuroendocrine dysfunction, then immune dysfunction, leading further to metabolic dysfunction[30]—our results are not conclusive, but they may suggest that over time filial caregivers could progress to other biological risks. Future research carefully tracking any potential progression in elevation of other biological risks among filial caregivers would be helpful in better mapping this potential temporal sequence.

We note here that we undertook preliminary, supplementary analyses (not shown) where we estimated similar models across a combination of filial, spousal, child, and parent-in-law caregivers in the MIDUS study. These analyses did *not* provide evidence of a significant association between combined family caregiving and AL; there was one significant association between combined family caregiving and metabolic dysfunction, but not other subscales. No gender differences were in evidence when we examined moderating effects utilizing the combined family caregiving variable. Further supplementary analyses (not shown) indicated that spousal caregiving was associated with higher levels of metabolic dysfunction—making it likely that it was this group that was driving the finding for the combined family caregiving variable results. Because there was a limited number of male spousal caregivers, it was not optimal powerwise to examine gender differences in the effects of spousal caregiving. We believe that these supplementary analyses also strengthen our case for arguing the importance of examining each caregiving relationship type separately to provide a more nuanced understanding of potential differences in caregiving type associations with biological factors linked to health outcomes.

Regarding our second hypothesis about gender, we did not find evidence that caregiving daughters suffered more biological health risk when providing care to a parent than caregiving sons. Although Pinquart and Sorensen[5,6] have done reviews of the research that have indicated gender differences in health among caregivers, they have also found evidence that gender differences are smaller in physical health than mental health outcomes,[5] and they have speculated that gender differences in health may be diminishing among younger cohorts of persons due to more similar gender roles in contemporary society.[6] Controlling for a number of caregiver resources and supports, Pinquart and Sorensen[6] still found small gender differences in health among caregivers in their formal meta-analysis of studies, but these became similar to gender differences in health in the noncaregiving population. They speculated that additional resource differences between men and women that they did *not* adjust for may have also led to these remaining differences. In this study, we *did* adjust for a number of additional factors that can differ between men and women and that are associated with health—for example, household income, employment status, race/ethnicity, marital status, and marital quality—and this might have also influenced our finding of no gender differences among filial caregivers in biological risks.

It also may be that some of the factors that have been hypothesized to make men more vulnerable to health risks in caregiving[25] are balancing out the additional stressors of caregiving typically observed for women.[6] Our relatively smaller sample of men filial caregivers in this study may have also reduced our power to find gender differences. The

issue of inconsistencies in research on gender differences in physical health among caregivers remains one for future research to continue to investigate and explain more comprehensively.

Despite this study's conceptual and methodological strengths, several limitations need to be acknowledged. Due to the lack of measurement of caregiving due to illness or disability at T1 in MIDUS, we needed to conduct a cross-sectional analysis here, even though the data set is longitudinal. Thus, we can only describe associations here, and any inferences regarding causality must be considered tenuous.

Even though this study is from a relatively large national sample, our sample of filial caregivers is still not very large, particularly when gender differences are examined. Therefore, some of our lack of finding significant associations may be due to power considerations and must be viewed with caution.

Another limitation of our study is the fact that due to the limitation in our caregiving measure, respondents were classified as caregivers without taking into account how long they had been providing caregiving, the intensity of caregiving (e.g. hours per week), coresidence, reasons for caregiving (e.g. dementia vs surgery), and whether they were a primary or secondary caregiver. Where we did have some additional information—for example, about average hours per week of caregiving—we did not have sufficient sample size to further create subgroups. All these factors might be additional moderators of caregivers' health risk[5–7,53] and would be beneficial to include in future research.

Although due to cell sizes we were not able to control for additional differences among our caregivers, it may be of some value for readers to have a little more descriptive information about the filial caregivers in our sample when considering our results. For example, we found that about 37% of the filial caregivers in our study reported that they coresided with the care recipient while the care was being provided; an additional 2% reported coresiding "some of the time." About two-thirds (67%) of filial caregivers reported helping with such personal care as bathing, dressing, and going to the bathroom. About four-fifths (80%) reported that they helped their parent with getting around inside and outside the home. About three-quarters (74%) reported helping with things like shopping, cooking, and housework. Almost three-quarters (72%) reported helping with managing money and medications. About one-quarter (24%) reported helping their parent every week of the last 12 months. But another almost two-thirds (65%) reported helping their parent less than half the weeks (i.e. less than 26 weeks) of the last year. The average hours of helping across the weeks helped was 14 h. The modal response on caregiving hours per week was 20. This supplemental information suggests that the filial caregivers in our study were, indeed, a heterogeneous group—varying in reported intensity (and potential strain) of care. In some respects, this variation makes it even more noteworthy that we found a significant problematic difference in neuroendocrine dysfunction for this group.

In sum, findings from this study, which document the association between providing filial caregiving and greater neuroendocrine dysfunction risk, provide additional empirical support for the public health importance of enacting policies and practices supportive of filial caregivers. Filial caregivers comprise the largest proportion of informal caregivers in contemporary society. They are providing caregiving to a large number of care recipients, and in doing so, they may also be putting their own health at risk and creating a new tier of public health concern and cost.[1] Additional research is needed to better clarify these risks and evaluate factors and policy supports that may mitigate them.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

Funding

This research was supported by the National Institute on Aging (PO1 AG20166).

References

1. Gitlin LN and Schulz R. Family caregiving of older adults. In: Prohaska TR, Anderson LA and Binstock R (eds) *Public health for an aging society*. Baltimore, MD: Johns Hopkins University Press, 2012, pp. 181–203.
2. National Alliance for Caregiving and AARP. *Caregiving in the U.S*. Bethesda, MD: National Alliance for Caregiving and AARP, 2009.
3. Hoyert DL and Seltzer MM. Factors related to the well-being and life activities of family caregivers. *Fam Relat* 1992; 41: 74–81.
4. Pinquart M and Sorensen S. Association of stressors and uplifts of caregiving with caregiver burden and depressed mood: a meta-analysis. *J Gerontol B Psychol Sci Soc Sci* 2003; 58: P112–P128.
5. Pinquart M and Sorensen S. Differences between caregivers and noncaregivers in psychological health and physical health: a meta-analysis. *Psychol Aging* 2003; 18: 250–267.
6. Pinquart M and Sorensen S. Gender differences in caregiver stressors, social resources, and health: an updated meta-analysis. *J Gerontol B Psychol Sci Soc Sci* 2006; 61: P33–P45.
7. Pinquart M and Sorensen S. Correlates of physical health of informal caregivers: a meta-analysis. *J Gerontol B Psychol Sci Soc Sci* 2007; 62: P126–P137.
8. Young R and Kahana EF. Specifying caregiver outcomes: gender and relationship aspects of caregiving strain. *Gerontologist* 1989; 29: 660–666.
9. Vitaliano PP, Zhang J and Scanlan JM. Is caregiving hazardous for one's physical health? A meta-analysis. *Psychol Bull* 2003; 129: 946–972.
10. Kiecolt-Glaser JK, Dura JR, Speicher CE, et al. Spousal caregivers of dementia victims: longitudinal changes in immunity and health. *Psychosom Med* 1991; 53: 345–362.
11. Kiecolt-Glaser JK, Glaser R, Gravenstein S, et al. Chronic stress alters the immune response to influenza virus vaccine in older adults. *Proc Natl Acad Sci USA* 1996; 93: 3043–3047.

12. Shaw WS, Patterson TL, Ziegler MG, et al. Accelerated risk of hypertensive blood pressure recordings among Alzheimer caregivers. *J Psychosom Res* 1999; 46: 215–227.
13. Vedhara K, Cox NK, Wilcock GK, et al. Chronic stress in elderly carers of dementia patients and antibody response to influenza vaccination. *Lancet* 1999; 353: 627–631.
14. Marks NF, Lambert JD and Choi H. Transitions to caregiving, gender, and psychological well-being: a prospective U.S. national study. *J Marriage Fam* 2002; 64: 657–667.
15. Neal M, Ingersoll-Dayton B and Starrels ME. Gender and relationship differences in caregiving pattern and consequences among employed caregivers. *Gerontologist* 1997; 37: 804–816.
16. Strawbridge WJ, Wallhagen MI, Shema SJ, et al. New burdens or more of the same? Comparing grandparent, spouse, and adult-child caregivers. *Gerontologist* 1997; 37: 505–510.
17. Engel GL. The need for a new medicine model: a challenge for biomedicine. *Science* 1977; 196: 129–136.
18. Disorbio JM, Bruns D and Barolat G. Assessment and treatment of chronic pain: a physician's guide to a biopsychosocial approach. *Prac Pain Manage* 2006; 6: 11–27.
19. Elder GH Jr, Johnson MK and Crosnoe R. Perspective on the life course. In: Mortimer JT and Shanahan MJ (eds) *Handbook of the life course*. New York: Kluwer Academic/Plenum Publishers, 2003, pp. 3–19.
20. Bengtson VL and Allen KR. The life course perspective applied to families over time. In: Boss PG, Doherty WJ, LaRossa R, et al. (eds) *Sourcebook of family theories and methods*. New York: Plenum Publishers, 1993, pp. 469–499.
21. Campbell LD and Martin-Matthews A. The gendered nature of men's filial care. *J Gerontol B Psychol Sci Soc Sci* 2003; 58(6): S350–S358.
22. Yee JL and Schultz R. Gender differences in psychiatric morbidity among family caregivers: a review and analysis. *Gerontologist* 2000; 40: 147–164.
23. Monin JK and Schulz R. Interpersonal effects of suffering in older adult caregiving relationships. *Psychol Aging* 2009; 24(3): 681–695.
24. Calasanti T and King N. Taking "women's work" "like a man": husbands' experiences of care work. *Gerontologist* 2007; 47(4): 516–527.
25. Kramer BJ. Men caregivers: an overview. In: Kramer BJ and Thompson EH (eds) *Men as caregivers: theory, research, and service implications*. New York: Springer, 2001, pp. 9–19.
26. McEwen B. Stress, adaptation, and disease. Allostasis and allostatic load. *Ann N Y Acad Sci* 1998; 840: 33–44.
27. Seeman TE, Singer BH, Rowe JW, et al. Price of adaptation—allostatic load and its health consequences: MacArthur Studies of Successful Aging. *Arch Intern Med* 1997; 157: 2259–2268.
28. Seeman TE, McEwen BS, Rowe JW, et al. Allostatic load as a marker of cumulative biological risk: MacArthur Studies of Successful Aging. *Proc Natl Acad Sci USA* 2001; 98: 4770–4775.
29. Juster RP, McEwen BS and Lupien SJ. Allostatic load biomarkers of stress and impact on health and cognition. *Neurosci Biobehav Rev* 2009; 35: 2–16.
30. Nielsen L, Seeman T and Hahn A. *NIA workshop on allostatic load*. Washington, DC: National Institute on Aging, National Institutes on Health, 2007.
31. Seeman TE, Singer BH, Ryff CD, et al. Social relationships, gender, and allostatic load across two age cohorts. *Psychosom Med* 2002; 64: 395–406.
32. Seeman T, Glei D, Goldman N, et al. Social relationships and allostatic load in Taiwanese elderly and near elderly. *Soc Sci Med* 2004; 59: 2245–2257.
33. Clark MS, Bond MJ and Hecker JR. Environmental stress, psychological stress and allostatic load. *Psychol Health Med* 2007; 12: 18–30.
34. Bauer ME, Vedhara K, Perks P, et al. Chronic stress in caregivers of dementia patients is associated with reduced lymphocyte sensitivity to glucocorticoids. *J Neuroimmunol* 2000; 103: 84–92.
35. Damjanovic AK, Yang Y, Glaser R, et al. Accelerated telomere erosion is associated with declining immune function of caregivers of Alzheimer's disease patients. *J Immunol* 2007; 179: 4249–4254.
36. Glaser R, MacCallum RC, Laskowski BF, et al. Evidence for a shift in the Th-1 to Th-2 cytokine response associated with chronic stress and aging. *J Gerontol* 2001; 56: 470–482.
37. Cacioppo JT, Burleson MH, Poehlmann KM, et al. Autonomic and neuroendocrine responses to mild psychological stressors: effects of chronic stress on older women. *Ann Behav Med* 2000; 22: 140–148.
38. Grant I, Adler KA, Patterson TL, et al. Health consequences of Alzheimer's caregiving transitions: effects of placement and bereavement. *Psychosom Med* 2002; 64: 477–486.
39. Pradhan AD, Manson JE, Rifai N, et al. C-reactive protein, Interleukin-6, and risk of developing Type 2 diabetes mellitus. *The Journal of the American Medical Association* 2001; 286: 327–334. DOI: 10.1001/jama.286.3.327.
40. Von Kanel R, Dimsdale J, Ancoli-Israel S, et al. Poor sleep is associated with higher plasma proinflammatory cytokine interleukin-6 and procoagulant marker fibrin D-dimer in older caregivers of people with Alzheimer's disease. *J Am Geriatr Soc* 2006; 54: 431–437.
41. Brummett BH, Boyle SH, Siegler IC, et al. HPA axis function in male caregivers: effect of the monoamine oxidase-A gene promoter (MAOA-uVNTR). *Biol Psychol* 2008; 79: 250–255.
42. Gallagher-Thompson D, Shurgot GR, Roder K, et al. Ethnicity, stress, and cortisol function in Hispanic and non-Hispanic White women: a preliminary study of family dementia caregivers and noncaregivers. *Am J Geriatr Psychiatry* 2006; 14: 334–342.
43. De Vugt ME, Nicolson NA, Aalten P, et al. Behavioral problems in dementia patients and salivary cortisol patterns in caregivers. *J Neuropsychiatry Clin Neurosci* 2005; 17: 201–207.
44. Son J, Erno A, Shea DG, et al. The caregiver stress process and health outcomes. *J Aging Health* 2007; 19: 871–887.
45. Scanlan JM, Vitaliano PP, Ochs HD, et al. CD4 and CD8 counts are associated with interactions of gender and psychosocial stress. *Psychosom Med* 1998; 60: 644–653.
46. Moritz DJ, Kasl SV and Ostfeld AM. The health impact of living with a cognitively impaired elderly spouse: depressive symptoms and social functioning. *J Gerontol* 1992; 44: S17–S27.
47. Vitaliano PP, Russo J and Niaura R. Plasma lipids and their relationships with psychosocial factors in older adults. *J Gerontol B Psychol Sci Soc Sci* 1995; 50: 18–24.

48. Midlife in the U.S. (MIDUS), http://midmac.med.harvard.edu/research.html
49. Asch SM, Kerr EA, Keesey J, et al. Who is at greatest risk for receiving poor-quality health care? *N Engl J Med* 2006; 345: 1147–1157.
50. Lubetkin EI, Jia H, Franks P, et al. Relationship among sociodemographic factors, clinical conditions, and health-related quality of life: examining the EQ-5D in the U.S. general population. *Qual Life Res* 2005; 14: 2187–2196.
51. Rossi AS and Rossi PH. *Of human bonding: parent-child relations across the life course*. New York: Aldine de Gruyter, 1990.
52. Roth DL, Perkins M, Wadley VG, et al. Family caregiving and emotional strain: associations with quality of life in a large national sample of middle-aged and older adults. *Qual Life Res* 2009; 18: 679–688.
53. Perkins M, Howard VJ, Wadley VG, et al. Caregiving strain and all-cause mortality: evidence from the REGARDS study. *J Gerontol B Psychol Sci Soc Sci* 2013; 68(4): 504–512.