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The Influences of Daily Stressors on Morning Cortisol Levels in Midlife and Older Retirees: The Moderating Roles of Age and Gender

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Abstract

Objectives: This study extends the field of retirement and health by examining the impacts of daily stressors on morning cortisol levels in 253 retirees between 55 and 75 years of age (M = 66.80, SD = 4.96) and the moderating roles of age and gender. **Method:** Participants derived from the second wave of the Daily Diary Study portion of the National Survey of Midlife Development in the United States (MIDUS-II). Across eight consecutive evenings, participants completed telephone interviews about their daily experiences and provided saliva samples across 4 days. **Results:** Findings from the multilevel models showed that in the context of navigating the day-to-day responsibilities, older retirees were at a greater risk for subsequent hypothalamic pituitary adrenal (HPA) dysregulation than younger retirees. **Discussion:** Together, better identification of the associations between daily stressors and physiological functioning will help contribute to the knowledge on ways to promote greater quality of life in retirement.

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Introduction

Retirement has been linked to both positive and negative psychological and physical health outcomes (e.g., Buxton, Singleton, & Melzer, 2005; Drentea, 2002; van der Heide, van Rijn, Robroek, Burdorf, & Proper, 2013). Past studies have shown an improvement in well-being (e.g., increased positive affect, lower levels of stress) and health behaviors (e.g., more regular exercise; Mein, Martikainen, Hemingway, Stansfeld, & Marmot, 2003; Oksanen et al., 2011; Syse, Veenstra, Furunes, Mykletun, & Solem, 2015), while others have documented negative impacts of retirement on well-being and health (e.g., Butterworth et al., 2006; Buxton et al., 2005). A defining feature of the literature on retirement and well-being/health is its emphasis on global measures of well-being and health. Much of the focus has been directed toward the areas of satisfaction, adjustment, depression, and self-reported health in retirement (Butterworth et al., 2006; Smith & Moen, 2004; van Solinge & Henkens, 2008). Although global measures of retirement well-being and health can be informative, the retirement literature can be benefited by assessing health at the daily level. Assessments of daily health may better capture the responsibilities, opportunities, and challenges that individuals experience day to day. The present study moves the field of retirement and health by examining the impacts of daily stressors on physiological functioning by the way of cortisol in a sample of retirees and the moderating roles of age and gender.

Cortisol

The examination of physiological functioning through cortisol has become more prevalent in the study of aging and health. Cortisol is one of main products of the hypothalamic pituitary adrenal (HPA) axis and is considered to be a primary marker of biological stress reactivity (Adam & Gunnar, 2001). In humans, cortisol secretion typically peaks 20 to 30 minutes after awakening and gradually declines throughout the day (e.g., Fries, Dettenborn, & Kirschbaum, 2009). The HPA axis activates and secretes cortisol under conditions of threat or distress (Dickerson & Kemeny, 2004). Cortisol helps the body adapt to the environment and maintain homeostasis through various processes, including the stabilization of glucose levels, cell metabolism, and inflammatory responses (Heim, Ehlert, & Hellhammer, 2000). Importantly, cortisol has been implicated in a range of psychological, physiological, and physical health functioning, including depression, immune functioning, and cardiovascular diseases (e.g., Bhattacharyya, Molloy, & Steptoe, 2008; McEwen et al., 1997).

Employment and Cortisol

In the examination of physiological functioning in midlife and late adulthood, much of the focus has been on the linkages between work stress and cortisol. However, the study of physiological functioning via cortisol response in retirees has largely been ignored. Of the studies that have examined the associations between work stress and cortisol, the results have been mixed. Take the work of Eller, Netterstrøm, and Hansen (2006), who found that working women with high level of time pressure exhibited greater increase in awakening cortisol level than working women without time pressure. In contrast, Bellingrath, Weigl, and Kudielka (2008) did not find an association between burnout or vital exhaustion and basal cortisol activity in their sample of schoolteachers. The mixed findings could be due to methodological differences, including the sample of participants as well as the types of work stressors examined.

In addition, there have been studies investigating cortisol in the context of unemployment. Ockenfels and colleagues (1995) examined cortisol levels and responsivity between workers and individuals receiving unemployment benefits. Ockenfels et al. (1995) found that unemployed individuals exhibited higher morning cortisol levels as compared with employed individuals. Examining a sample of long-term unemployed individuals, Grossi, Perski, Lundberg, and Soares (2001) documented that long-term unemployed women with high financial strain exhibited significantly greater overall cortisol level than women with low financial strain. Furthermore, in a study investigating the effects of short- and long-term unemployment, Maier et al. (2006) observed significantly higher serum cortisol levels in long-term unemployed individuals when compared with short-term unemployed individuals.

Although these studies offer insights into the physiological functioning of working individuals and those who experienced short- or long-term unemployment, overlooked in the literature is the examination of the physiological functioning of individuals who transitioned into retirement. In contrast to the predominately negative effects of short- and long-term unemployment (e.g., D. W. Brown et al., 2003; Maier et al., 2006; McKee-Ryan, Song, Wanberg, & Kinicki, 2005), retirement has been linked to both positive and negative psychological and physical health outcomes (e.g., Buxton et al., 2005; Drentea, 2002; van der Heide et al., 2013). Retirement may offer individuals opportunities to be relieved of the stressors associated with paid work;

thereby, leading to healthier HPA regulation. At the same time, changes in role status may lead to a recalibration of one's daily lives and result in some degree of stress (George, 1993). The present study furthers the retirement and health literature by investigating the impacts of daily stressors on cortisol in a sample of retirees in midlife and late adulthood.

Life Course Daily Stress Perspective

In the study of retirement, the life course perspective (Elder, Johnson, & Crosnoe, 2003) has long been important with its focus on development as a lifelong process, human agency, transition timing, social embeddedness, and historical context. One limitation of the life course perspective is that it does not account for the role that day-to-day stressors play in health and emotional adjustment (Zautra, 2003). According to the stress perspective, stress tends to increase during periods of uncertainty. Transitions, such as retirement, often challenge past routines and require new adaptation (G. W. Brown & Harris, 1989; Dohrenwend & Dohrenwend, 1974). Changes in status may adversely affect physical health. In the study of transitions, it is important to consider social structures, timing, and context; however, these considerations often are overlooked in the stress literature (George, 1993). This study utilizes the Life Course Daily Stress perspective (Almeida & Wong, 2009), which integrates the life course framework with the daily stress literature, to better understand the importance of life transitions on exposure and reactivity to daily stressors and the subsequent influences on physiological functioning.

Daily Stressors

The change in social role from worker to retiree may be advantageous in that individuals no longer have to experience the challenges associated with the work environment. For others, the shift from work to retirement may be negative. Because changes in one's social role may entail possible transformations in identities, activities, and environment (George, 1993), the shift from worker to retiree may increase or decrease one's vulnerability to stressors and the stress responses in their daily experiences. Daily stressors are the routine challenges of day-to-day living (Almeida, 2005). Examples of daily stressors include arguments with a family member, avoiding an argument with a family member, or experiencing a stressful event at home. Unlike major life events, daily stressors occur more frequently and unexpectedly and can disrupt daily life (Almeida, 2005). These interruptions have immediate negative impacts on psychological and physical functioning (Almeida, Wethington, & Kessler, 2002; Bolger, DeLongis, Kessler, & Schilling, 1989). Daily stressors can pile up over a series of days, which may result in more detrimental stress reactions (e.g., anxiety, depression; Lazarus, 1999; Zautra, 2003). Because daily stressors are likely to have immediate impacts that disrupt day-to-day living, we expect that daily stressors will influence cortisol levels in our sample of retirees and that the association between daily stressors and cortisol will be moderated by age and gender.

Age

It is important to consider the ways in which age affects the daily retirement experiences in the examination of daily stressors and cortisol. Past studies have shown that younger individuals are more emotionally and physically reactive to daily stressors than older individuals (Birditt, Fingerman, & Almeida, 2005; Neupert, Almeida, & Charles, 2007). Specifically, younger individuals may have less effective cognitive resources to regulate their emotions and manage their physical reactions to daily stressors than individuals in late adulthood (Blanchard-Fields & Cooper, 2004; Carstensen, Isaacowitz, & Charles, 1999). In addition to the association of age and daily stressors, age has been implicated in cortisol levels. There is increasing evidence that advancing age is associated with higher cortisol secretion (e.g., Deuschle et al., 1997; Larsson, Gullberg, Rastam, & Lindbald, 2009; Van Cauter, Leproult, & Plat, 2000; Wrosch, Miller, Lupien, & Pruessner, 2008). In line with these past research, age is expected to affect exposure and reactivity to daily stressors in retirees and in turn influences retirees' physiological functioning.

Gender

Gender represents an important life course factor in shaping employment patterns and subsequent health. As compared with men, women are more likely to experience career interruptions due to child-rearing and caregiving demands (O'Rand, Henretta, & Krecker, 1992), which place women at a greater disadvantage than men at retirement in the areas of psychological, physical, and financial well-being (Slevin & Wingrove, 1995). The literature on the effects of gender on the retirement experiences has been mixed. Studies have found men to be more satisfied and better adjusted to retirement than women (e.g., Gall, Evans, & Howard, 1997; Quick & Moen, 1998), while others found that women are psychologically better equipped for retirement than men due to more experiences with role transitions and career interruptions (e.g., Price, 2003). Furthermore, past research (Almeida, 2005) has documented gender differences in exposure to different types of daily stressors with men reporting more stressors at work or school and women reporting more network stressors, which are stressors involving their network of relatives or close friends.

It is also important to account for gender because of its implication in the study of cortisol. In general, women were more likely to exhibit greater or more sustained cortisol awakening response than men (e.g., Almeida, Piazza, & Stawski, 2009; Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004). There also is evidence suggesting that cortisol release is greater for men than women (e.g., Kirschbaum, Wüst, & Strasburger, 1992). Yet, there have been studies documenting no association between gender and cortisol (e.g., S. Edwards, Evans, Hucklebridge, & Clow, 2001; Kudielka & Kirschbaum, 2003). The inconsistent findings in the study of gender and cortisol could be attributed to differences in measurement issues, and warrant greater examination.

Study Aims

Guided by the Life Course Daily Stress perspective (Almeida & Wong, 2009), this study investigates the associations between daily stressors and cortisol, and the moderating roles of age and gender, in a sample of retirees in midlife and older adults. Although there are various approaches to assess cortisol, the current study focuses on morning cortisol levels. In contrast to the cortisol levels assessed later in the day, morning cortisol levels reflect the body's ability to mobilize energy to handle the tasks of the upcoming day (Clow, Thorn, Evans, & Hucklebridge, 2004). Assessing morning cortisol levels also allows us to more confidently interpret the time–order effects of prior stressors on the next day's cortisol level.

The first study aim examines the main and interaction effect of number of daily stressors from the previous day and age on cortisol levels at awakening and 30 minutes post awakening. It is predicted that greater number of daily stressors from the previous day will be significantly associated with higher levels of cortisol at awakening and 30 minutes post awakening. This prediction is based in line with past studies documenting that acute stressors, such as daily stressors, typically lead to a temporary increase in cortisol (see Miller, Chen, & Zhou, 2007, for a review). Although a pattern of hypocortisolism (reduced or blunted pattern of cortisol response) is possible, we did not predict this pattern of association because hypocortisolism often is observed in individuals with a history of chronic stressors (e.g., burnout, posttraumatic stress disorders; Neeck, Federlin, Graef, Rusch, & Schmidt, 1990; Pruessner, Hellhammer, & Kirschbaum, 1999; Yehuda, 2000). In our study of retirees, we did not select retirees by specific disease conditions or disorders. Because we are not specifically examining a subgroup of individuals that previously has been demonstrated to exhibit a pattern of hypocortisolism, we did not predict a blunted or flattened cortisol response. As a part of the first study aim, we hypothesized that greater levels of morning cortisol will be observed for older retirees as compared with younger retirees because aging has been implicated in the alteration of the HPA axis (e.g., Deuschle et al., 1997; Kudielka, Buske-Kirschbaum, Hellhammer, & Kirschbaum, 2004; Kudielka & Kirschbaum, 2003; Larsson et al., 2009).

It is hypothesized that there will be an interaction effect of number of daily stressors from the previous day and age on morning cortisol levels such that older retirees will exhibit greater morning cortisol levels as compared with younger retirees on days following greater than average number of daily stressors. We do not expect differences in morning cortisol levels between younger or older retirees who experienced fewer numbers of daily stressors from the previous day.

The second aim investigates the main and interaction effects of daily stressors from the previous day and gender on morning cortisol levels. In line with past studies (e.g., Almeida et al., 2009; Kunz-Ebrecht et al., 2004), we predict that retired women will exhibit greater levels of morning cortisol as compared with retired men. We also expect an interaction effect of number of daily stressors from the previous day and gender on morning cortisol levels such that retired women who reported greater than average number of daily stressors from the previous day will exhibit greater morning cortisol levels as compared with retired men. No differences in morning cortisol levels between men and women are expected following days when retirees experienced fewer than average number of daily stressors.

Method

Sample and Procedure

This study utilized data from the second wave of the Daily Diary Study portion of the National Survey of Midlife in the United States (MIDUS-II; Brim, Ryff, & Kessler, 2004). The Daily Diary Study comprised of 1,842 men and women aged 33 to 84. Across eight consecutive evenings, participants completed telephone interviews about daily stressors, time use, and mood (Almeida et al., 2002). On Days 2 through 5, saliva samples were collected across four occasions on each day. Respondents were instructed to record the time they provided each sample; to collect their first sample before eating, drinking, or brushing their teeth; not to consume any caffeinated products before taking their samples; and to store all samples in the refrigerator.

A set of criteria was used to determine the analytic sample. Of the 1,842 participants in the Daily Diary Study, 235 did not provide saliva samples and were dropped. Because age has been associated with the probability to work and retire (i.e., younger individuals are more likely to work, older individuals are more likely to retire; Banerjee & Blau, 2013; Lu, 2010), the analytic sample was limited to those between 55 and 75 years of age; thus, reducing the sample to 754 men and women. Of the remaining 754 respondents, 412 did not meet our retirement status selection criteria and were dropped. Participants self-reported their current employment situation using the following question, "What is your current employment situation?" Respondents reported "yes," "no," or "do not know" to each of the following response options: working now, self-employed, unemployed, temporarily laid off, retired, homemaker, full-time student, and part-time student, and were instructed to select all response options that applied. Do not know responses and conflicting employment status responses (e.g., working and retired) were excluded. Based on this approach, individuals who self-identified as retired were retained. This approach aimed for a mutually exclusive conceptualization of retirement status by reducing the potential murkiness in retirement situations. Individuals who did not follow the cortisol collection procedures (n = 10) and those who did not provide complete data on medication use (n = 79) were dropped. The analytic sample consisted of 253 retirees.

Measures

Outcome variable

Salivary cortisol. Saliva was collected on awakening, 30 minutes post awakening, before lunch, and before bed on Days 2 to 5 of the Diary Study. Samples were assayed for cortisol via a commercially available luminescence immunoassay (IBL International, Hamburg, Germany), with intra-assay coefficients of variation below 5%. Following the Winsorization statistical approach (Dixon & Yuen, 1974), salivary cortisol values higher than 60 nmol/L were recoded as 61 to minimize the influence of extreme outliers. This study focused on the awakening cortisol level and 30 minutes post awakening cortisol level. Cortisol data were log transformed to correct for positively skewed distributions.

Predictor variables

Age and gender. Respondent's age was coded in years, and gender was coded as 0 = *men* and 1 = *women*.

Daily stressors. The Daily Inventory of Stressful Events (DISE; Almeida et al., 2002) was used to assess daily stressors. The DISE consisted of a series of seven stem questions that identify whether certain types of stressful events (arguments, avoided arguments, home, work, network stressors, discrimination, and ther stressors) occurred in the past 24 hr. Because the sample comprised of retirees, the item pertaining to work-related stressors was dropped from the calculation. Responses to the six items were summed to create a total number of daily stressor score per day. To better determine the time–order effect of daily stressors and morning cortisol levels, number of daily stressors was lagged from the previous day.

Covariates

To account for the characteristics of the retiree, a set of variables was included. Marital status (0 = *unmarried*, 1 = *married*) and number of chronic conditions (from a list of 31 conditions, including diabetes and migraine headaches) experienced in the past year (Cleary, Zaborski, & Ayanian, 2004) have been associated with employment processes (Kubicek, Korunka, Hoonakker, & Raymo, 2010; Nicolaisen, Thorsen, & Eriksen, 2012), and these controls were included. To control for potential medication effects on cortisol (Granger, Hibel, Fortunato, & Kapelewski, 2009), respondents reported whether they took any allergy, steroid, birth control/hormonal, or anti-depressant/anti-anxiety medications (0 = *none*, 1 = *at least one medication*) across the Daily Diary Study period. Saliva collection time (Keenan, Licinio, & Veldhuis, 2001) was coded in hours. Negative affect often explained the observed association between daily stressors and cortisol (e.g., Stawski, Cichy, Piazza, & Almeida, 2013), and thus, daily negative affect from the previous day was included. Daily negative affect was assessed with respondents reporting how frequently (0 = *none* to 4 = *all of time*) in the past 24 hr they felt each of 14 negative emotions (e.g., angry, hopeless; Ready, Akerstedt, & Mroczek, 2011).

Data Analyses

Two-level multilevel models (SAS Proc Mixed), where days were nested within persons, were conducted. The first set of analyses assessed the main and interaction effects of number of daily stressors from the previous day and age on cortisol levels at awakening and 30 minutes post awakening. The second set of models examined the main and interaction effects of number of daily stressors from the previous day and gender on cortisol levels at awakening and 30 minutes post awakening. In line with the person mean center approach outlined by Hoffman and Stawski (2009), continuous variables at Level 1 (within-person) were group mean centered and grand mean centered

Table 1. Descriptive Statistics of Demographic Characteristics of Analytic Sample.

	Retirees (N = 253)
Age	
M	66.80
SD	4.96
Range	55-75
Gender	
Men (%)	45.10
Women (%)	54.90
Marital status	
Married (%)	73.10
Unmarried (%)	26.90
Education	
Less than high school (%)	10.70
High school degree or some college (%)	50.80
College graduate or higher (%)	38.50
Number of chronic conditions	
M	3.17
SD	2.62
Range	0-17
Any medication usage	
No medications (%)	52.60
At least one medication (%)	47.40

at Level 2 (between-person). Preliminary analyses showed that a random intercept only model had acceptable fit. Because the number of chronic conditions had no significant effects on the outcomes, the covariate was dropped in the final models.

Results

Presented in Table 1 are the descriptive characteristics of the analytic sample. The average age of the retirees in this sample was 66.80 (SD = 4.96). There were more women (54.90%) than men in the study. Approximately 73.10% of the sample was married, and 50.80% had high school degree or some college education. On average, retirees experienced 3.17 chronic conditions in the past 12 months. Regarding medication usage during the saliva sample collection period, 47.40% reported taking at least one medication.

The first set of multilevel models examined the main and interaction effects of number of daily stressors from the previous day and age on cortisol level at awakening. In contrast to our expectation, no main effect of number of daily stressors from the previous day or age was observed for awakening cortisol level (see Table 2, Model A). We observed a significant interaction effect ($b = -0.033$, $SE = 0.014$, $p < .05$) of number of daily stressors from the previous day (between-person effect) and age on awakening cortisol level (see Table 2, Model B). To examine the interaction effect, the slopes of age on cortisol level at awakening were estimated at different levels of number of daily stressors from the previous day (see Figure 1). Results showed that older retirees (1 *SD* above the mean) who experienced fewer number of daily stressors from the previous day significantly exhibited higher level of cortisol at awakening as compared to younger retirees (1 *SD* below the mean) who experienced a similar amount of daily stressors from previous day (age slope estimated at 1 *SD* below the mean of number of daily stressors from previous day; $b = 0.021$, $SE = 0.009$, $p < .05$). In contrast, no significant difference was observed for older and younger retirees who reported greater number of daily stressors (1 *SD* above the mean) from the previous day on cortisol level at awakening (age slope estimated at 1 *SD* above the mean number of daily stressors from previous day; $b = 0.006$, $SE = 0.006$, $p > .05$).

Next, the main and interaction effects of daily stressors from the previous day and age on cortisol level at 30 minutes post awakening were examined. Although no main effect of number of daily stressors from the previous day or age on cortisol level at 30 minutes post awakening was observed (see Table 3, Model A), there was a significant interaction effect of number of daily stressors from the previous day (between-person effect) and age ($b = -0.030$, $SE = 0.014$, $p < .05$; see Table 3, Model B). To probe the interaction effect, the slopes of age on cortisol level at 30 minutes post awakening were estimated at different levels of number of daily stressors from the previous day (see Figure 2). Results showed that for retirees who experienced fewer number of daily *stressors* from the previous day, there was a significant positive association between age and cortisol level at 30 minutes post awakening (age slope estimated at 1 *SD* below the mean of number of daily stressors from previous day; $b = 0.032$, $SE = 0.006$, $p < .001$). Specifically, older retirees who experienced fewer numbers of daily stressors from the previous day significantly exhibited higher cortisol level at 30 minutes post awakening as compared with younger retirees who experienced a similar amount of daily stressors from previous day. There was not a significant association between age and cortisol level at 30 minutes post awakening for retirees who experienced greater number of daily stressors from the previous day (age slope estimated at 1 *SD* above the mean of number of daily stressors from the previous day; $b = 0.005$, $SE = 0.006$, $p > .05$).

Table 2. Multilevel Models Predicting Awakening (Log) Cortisol Level.

	Awakening cortisol (log)		
	Model A	Model B	Model C
Fixed effects			
Intercept	2.788 (0.084)***	2.773 (0.083)***	2.794 (0.084)***
Age	0.006 (0.006)	0.006 (0.006)	0.006 (0.006)
Gender[a]	−0.061 (0.066)	−0.063 (0.065)	−0.068 (0.065)
Marital status[b]	0.012 (0.074)	0.025 (0.073)	0.014 (0.073)
Any medication[c]	−0.076 (0.065)	−0.082 (0.065)	−0.071 (0.065)
Saliva collection time–within person	0.067 (0.026)**	0.067 (0.026)**	0.067 (0.026)**
Saliva collection time–between person	0.004 (0.027)	0.005 (0.027)	0.001 (0.027)
Negative affect–within person	−0.046 (0.083)	−0.042 (0.083)	−0.043 (0.083)
Negative affect–between person	−0.001 (0.181)	0.050 (0.180)	−0.031 (0.181)
Number of stressor-previous day–within person	0.012 (0.028)	0.018 (0.029)	0.059 (0.042)
Number of stressor-previous day–between person	0.060 (0.073)	0.006 (0.076)	0.283 (0.140)*
Age × Number of Stressor-Previous Day–within person		0.007 (0.005)	
Age × Number of Stressor-Previous Day–between person		−0.033 (0.014)*	
Gender[a] × Number of Stressor-Previous Day–within person			−0.081 (0.005)
Gender[a] × Number of Stressor-Previous Day–between person			−0.284 (0.153)†
Random effects (variance components)			
Between-person intercept (Level 2)	0.197 (0.022)*** *df* = 243	0.191 (0.021)*** *df* = 242	0.194 (0.022)*** *df* = 242
Within-person (Level 1)	0.156 (0.009)***	0.156 (0.009)***	0.156 (0.009)***

[a]Gender: 0 = *men*, 1 = *women*.
[b]Marital status: 0 = *not married*, 1 = *married*.
[c]Any medications: 0 = *no medication*, 1 = *yes, at least one medication*.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

The second set of analyses examined the main and interaction effects of number of daily stressors from the previous day and gender on cortisol levels

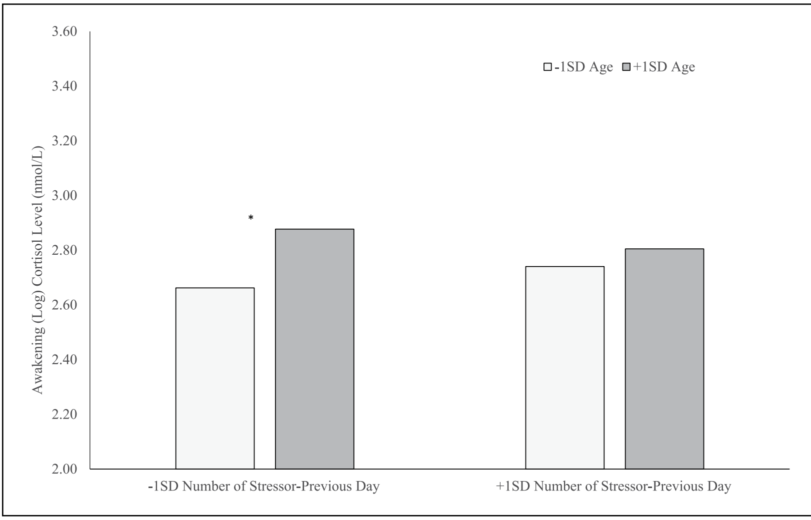

Figure 1. Age and number of daily stressors (previous day) on awakening (log) cortisol level (*p < .05).

at awakening and 30 minutes post awakening; however, no main or interaction effects of number of daily stressors from the previous day or gender was observed (see Tables 2 and 3, Models A and C).

Discussion

This study moves the field of retirement and health by examining the impacts of daily stressors on physiological functioning via cortisol in a sample of midlife and older retirees. Guided by the Life Course Daily Stress perspective (Almeida & Wong, 2009), this study also assessed the moderating roles of life course factors, specifically age and gender, in the association between daily stressors and morning cortisol levels. Our findings indicated that the physiological toll is the greatest when both daily stressors and age are considered together.

In line with the Life Course Daily Stress perspective (Almeida & Wong, 2009), findings from this study showed that contextual factors must be accounted in the identification of factors that affect health in retirement. In this study, the type of day that the retiree experiences (e.g., days with fewer than average stressful events) combined with the retiree's age are important determinants of neuroendocrine functioning. Findings from this study highlighted the importance of age in moderating the impact of daily stressors on

Table 3. Multilevel Models Predicting 30 Minutes Post Awakening (Log) Cortisol Level.

	30 minutes post awakening cortisol (log)		
	Model A	Model B	Model C
Fixed effects			
Intercept	3.043 (0.082)***	3.029 (0.082)***	3.048 (0.082)***
Age	0.018 (0.006)**	0.018 (0.006)**	0.018 (0.006)**
Gender[a]	−0.007 (0.064)	−0.010 (0.064)	−0.015 (0.064)
Marital status[b]	0.023 (0.072)	0.035 (0.072)	0.025 (0.072)
Any medication[c]	−0.001 (0.064)	−0.008 (0.063)	0.003 (0.063)
Saliva collection time–within person	−0.032 (0.025)	−0.031 (0.025)	−0.033 (0.025)
Saliva collection time–between person	−0.037 (0.025)	−0.036 (0.025)	−0.038 (0.025)
Negative affect–within person	0.216 (0.084)**	0.215 (0.084)*	0.213 (0.084)*
Negative affect–between person	−0.072 (0.178)	−0.030 (0.178)	−0.099 (0.178)
Number of stressor-previous day–within person	0.013 (0.029)	0.008 (0.030)	−0.014 (0.043)
Number of stressor-previous day–between person	0.091 (0.072)	0.041 (0.075)	0.284 (0.137)*
Age × Number of Stressor-Previous Day–within person		−0.004 (0.005)	
Age × Number of Stressor-Previous Day–between person		−0.030 (0.014)*	
Gender[a] × Number of stressor-previous day–within person			0.048 (0.006)
Gender[a] × Number of Stressor-Previous Day–between person			−0.249 (0.150)
Random effects (variance components)			
Between-person intercept (Level 2)	0.185 (0.021)*** $df = 244$	0.181 (0.021)*** $df = 243$	0.183 (0.021)*** $df = 243$
Within-person (Level 1)	0.163 (0.009)***	0.163 (0.009)***	0.163 (0.009)***

[a]Gender: 0 = *men*, 1 = *women*.
[b]Marital status: 0 = *not married*, 1 = *married*.
[c]Any medications: 0 = *no medication*, 1 = *yes, at least one medication*.
**p* < .05. ***p* < .01. ****p* < .001.

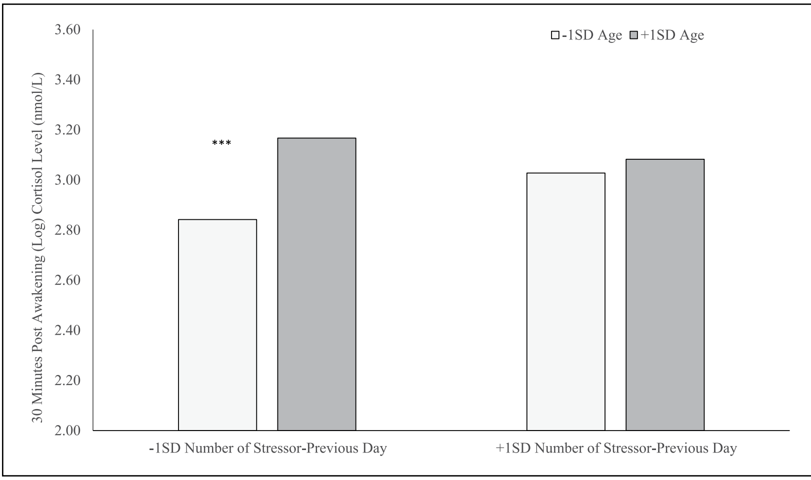

Figure 2. Age and number of daily stressors (previous day) on 30 minutes post awakening (log) cortisol level (***$p < .001$).

neuroendocrine functioning. In specifics, older retirees who experienced fewer numbers of daily stressors exhibited significantly higher cortisol levels at awakening and 30 minutes post awakening on the following morning as compared with younger retirees who experienced the similar amount of daily stressors. These findings suggest that on days with lower than average exposure to stressful events, the physiological toll is magnified for older retirees as compared with younger retirees. In the context of navigating the day-to-day responsibilities and demands that involve multiple domains of their lives, older retirees appear to be at a greater risk for subsequent HPA dysregulation than younger retirees.

It was hypothesized that there would be a main effect of number of daily *stressors* from the previous day and a main effect of age on next morning's cortisol levels. Although the number of daily stressors did not differentiate physiological functioning in our sample of retirees, our hypothesis of a main effect of age on morning cortisol levels was partially supported. We found that older retirees were more likely to exhibit higher level of cortisol 30 minutes post awakening as compared with younger retirees, and this finding resonates with past studies documenting age differences in neuroendocrine functioning via cortisol (e.g., Deuschle et al., 1997; Larsson et al., 2009; Van Cauter et al., 2000; Wrosch et al., 2008). One plausible explanation for the observed main effect of age on cortisol level 30 minutes post awakening but not for awakening cortisol level could be that cortisol level at 30 minutes post awakening is a more indicative marker of the HPA axis and perhaps better reflects the body's ability to mobilize energy to handle the tasks of the upcoming day (e.g., Clow et al., 2004; Hellhammer et al., 2007) in this sample of retirees.

We did not find a main effect of gender or an interaction of gender with number of daily stressors from the previous day on morning cortisol levels. The lack of association between gender and cortisol is in line with prior work documenting the absence of gender differences in physiological functioning (e.g., S. Edwards et al., 2001; Kudielka & Kirschbaum, 2003). It is possible that the lack of association could be due to the sample examined in the study. Prior work documenting gender differences in cortisol often focused on more homogeneous samples, including individuals with post-traumatic stress disorders or chronic health conditions (see Paris et al., 2010, for a review), whereas participants in this study varied across health conditions. Thus, future studies focusing on subsamples of retirees are warranted. It is also possible that the absence of gender differences could be attributed to the inclusion of women at different menopausal stages, for past studies have indicated that estrogen may play a role in cortisol levels (see K. Edwards & Mills, 2008, for a review). However, the study design does not allow us to separate out the different stages of menopause of the women in our analytic sample.

The present study is strengthened by the saliva collection procedures utilized in this study. In contrast to studies where participants asked to provide saliva samples in response to challenge tasks in a controlled laboratory setting (Dickerson & Kemeny, 2004), participants in the Daily Diary Study provided saliva samples in their own settings. The strength of this methodological approach is that it offers greater insights to the respondents' stress-responsive system as they live day to day in their own environment. This approach also helps to better identify the associations between naturally occurring stressors and morning cortisol levels. This study's measurement of retirement status offers advantages and disadvantages. One advantage is that individuals were able to self-identify multiple employment situations (e.g., retired and working; retired and self-employed) that they may occupy. This approach allowed us to better tease out the heterogeneity and complexity of retirement, which would be more difficult to identify had we simply asked respondents to reply "yes," "no," or "do not know" to "Are you currently working?" which is another item in MIDUS-II. The absence of a more objective measure of retirement status, such as pension receipt, could be a concern. However, the use of a more objective measurement of employment status like pension receipt would exclude individuals who do not have pension access.

In interpreting the study findings, it is important to keep in mind the issue of selection with regard to the sample of retirees. As noted by Ekerdt (2010), "Retirement is one big selection mechanism" (p. 72). The decision to retire, stay working, or re-enter the labor force after a period of exit is a self-sorting process based on multiple factors, including employment situation, family circumstances, health, and finances (e.g., Ekerdt, 2010; Johnson, 2004; McGarry, 2002). Due to the design of the MIDUS-II, we were unable to tease out these additional factors that may have affected the decision to retire. Future studies should examine the ways in which employment history and family circumstances factors may shape the associations among daily stressors, age, and physiological functioning in midlife and older retirees. The absence of data on retirement duration in the MIDUS-II also limits us from distinguishing whether the observed cortisol dysregulation is due to biological aging or a combination of social, economic, and behavioral risk that increases with longer retirement.

Findings from this study highlight the important considerations of daily stressors and age to better understand the quality of health in midlife and older retirees. By focusing on physiological functioning, this study moves the field of retirement and health beyond global assessments of health. Together, our findings illustrate the need for community wellness programs aimed at helping older individuals better navigate and cope with the daily demands and responsibilities of life in retirement. Programs directed at enhancing individuals' coping strategies could help to improve individuals' physiological functioning in midlife and late adulthood, and thus, promote overall health.

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