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Research Article

Everyday Support to Aging Parents: Links to Middle-Aged Children's Diurnal Cortisol and Daily Mood

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Abstract

Purpose of the Study: Middle-aged adults are often called upon to support aging parents. However, providing support to an aging parent with health problems and disability may be a stressful experience. This study asked whether giving everyday support to parents in the context of health problems and disability has implications for middle-aged children's diurnal cortisol and daily mood.
Design and Methods: During four consecutive days, 148 middle-aged adults (mean age = 55) reported the support they gave to their parents and provided saliva 4 times a day (wake, 30 min post-wake, lunchtime, and bedtime). Multilevel models estimated within-person differences in positive affect (PA) and negative affect (NA), cortisol awakening response and area under the curve with respect to ground (AUC-G) as a function of giving same-day and previous-day support. We examined whether these associations are exacerbated when a parent has health problems or activities of daily living (ADL) needs.
Results: Middle-aged children had significantly higher next-day AUC-G on days after they gave support to parents with ADL needs. When participants gave support to parents with ADL needs, they had significantly greater same-day PA and lower next-day NA. Giving support to parents with health problems was associated with significantly higher next-day NA.
Implications: Giving support to parents is an ambiguous experience with implications for biological stress and daily mood. A biopsychosocial approach reveals under what conditions giving support to parents may become detrimental to health and well-being; this knowledge is essential for the development and implementation of interventions.

Keywords: Parent–child relationships, Social support, Family issues, Intergenerational relationships

Providing support and caregiving to aging parents is a long-standing normative but stressful experience for individuals and families (Brody, 1985). Much inquiry has focused on caregiving, which by its pervasive definition is the provision of support specific to activities of daily living (ADL). However, there is growing recognition that middle-aged children are often involved in less intensive and more routine exchanges of everyday support with aging parents

including giving advice (e.g., helping with a decision or giving suggestions), practical assistance (e.g., fixing something around the house, running an errand, or providing a ride), and emotional support (e.g., listening to concerns or being available when someone is upset). Everyday support represents ordinary, albeit critical, exchanges that may have a more proximal effect on family relationships. Everyday support is often exchanged at the daily level and may be

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more fleeting than support given following a crisis or a major life event. Thus, assessing everyday support as it is exchanged at the daily level is advantageous; however, few studies have taken a daily approach to assessing everyday support exchanges between aging parents and middle-aged children. Moreover, little research has examined whether providing everyday support to elderly parents has implications for daily mood and biological stress responses of middle-aged children. The present study utilized a daily approach to explore the link between middle-aged children's daily mood, diurnal cortisol, and the everyday support they give to their aging parents. We also tested whether parent health problems and ADL needs exacerbate the association between everyday support, diurnal cortisol, and daily mood.

Health and ADL Needs in Late Life

Health problems and disability are inextricably linked to family support. Specifically, illness, health issues, or limitations in ADLs shift norms and needs such that support gravitates toward family members with greater need for support (Fingerman et al., 2011). Middle-aged children provide more support to parents with ADL needs; this support can be directly tied to assisting with ADL but may also comprise emotional, financial, and social exchanges (Kim et al., 2016). Providing social or emotional support has positive implications for the mental health and well-being of the individual giving support (Liang, Krause, & Bennett, 2001) but is also associated with psychological and emotional distress in different contexts (Strazdins & Broom, 2007). As such, middle-aged adults may find that providing support to a parent in the context of health decline may have some positive implications for well-being, but may also be more stressful than providing support to a parent who is otherwise in good health.

Giving everyday family support is associated with daily mood. Savla, Almeida, Davey, and Zarit (2008) found that providing routine assistance to aging parents had immediate negative associations with the daily mood of middle-aged children; these associations were stronger among children who had fewer socioeconomic resources and greater demands on time. Other work shows that middle-aged children reported more positive affect (PA) on days when they provided support to their own children and more negative affect (NA) on days when they provided support to their parents (Fingerman, Kim, Tennant, Birditt, & Zarit, 2016). These studies established the important link between giving support and daily mood. However, self-report measures of PA and NA do not establish how specific features and circumstances of support provision contribute to specific biological pathways which in turn affect health and well-being. This research would be improved by taking a biopsychosocial approach in order to understand the implications of giving support.

The Hypothalamus Pituitary Adrenal Axis and Cortisol

Research that explores the biological processes of stress often focuses on the hypothalamus pituitary adrenal (HPA) axis. The HPA axis is a major endocrine system that helps humans adapt to bodily and environmental challenges, thus improving ability to adjust to homeostasis (Fries, Dettenborn, & Kirschbaum, 2009). Cortisol is a critical component of the HPA axis that activates the body's response to stress and leads to behavioral changes that improve chances of survival (Chrousos & Gold, 1992; Tsiqos & Chrousos, 2002).

Cortisol secretion follows a diurnal cycle with a large increase released into the bloodstream after awakening and a steady decline throughout the day with lowest levels during the first half of the night (Tsiqos & Chrousos, 2002). The cortisol awakening response (CAR; Pruessner et al., 1997) is hypothesized to indicate HPA axis activation related to anticipation of the upcoming day (Fries et al., 2009). CAR is an indicator of negative psychosocial factors, health, well-being, and daily stressors (Chida & Steptoe, 2009; Fries et al., 2009). The overall output of daily cortisol is assessed as the area under the curve with respect to ground (AUC-G) which accounts for sensitivity (the difference between the single measurements from each other) and intensity (the distance of these measures from ground; Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). AUC-G is used to assess the overall secretion of hormones over a specific time period (e.g., over the course of a day), which may be elevated in response to stressors but may assume a blunted form with chronic exposure to more severe stressors (Miller, Chen, & Zhou, 2007). CAR and AUC-G tend to be highly interrelated and have been shown to represent two main underlying components of cortisol (i.e., total cortisol production and change in cortisol levels; Khoury et al., 2015). Some stressors may be initially distressing, indicating a more immediate association with cortisol, whereas other stressors may lead to prolonged cortisol reactivity (Brosschot, Pieper, & Thayer, 2005). Thus, the association between stressors and cortisol may vary depending on whether previous-day or same-day stressors are considered (Adam, Hawkley, Kudielka, & Cacioppo, 2006). Moreover, individual factors, such as age and gender are associated with cortisol output (Almeida, Piazza, & Stawski, 2009) as well as use of certain medications and nicotine consumption (Matta, Fu, Valentine, & Sharp, 1998). Other factors that occur at the daily level include the time of awakening and type of day (weekend/weekday; Fries et al., 2009; Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004).

Research has examined cortisol among caregivers of stroke survivors (Saban, Mathews, Bryant, O'Brien, & Janusek, 2012) and persons with dementia (Klein et al., 2016) revealing that caregiving has implications for dysregulated HPA axis. However, it is unclear if giving everyday support to aging parents has similar implications for

same-day or next-day cortisol. The present study takes a biopsychosocial approach to examine the implications of giving everyday support to aging parents by examining middle-aged children's diurnal cortisol and daily mood. We test whether parents' health problems and ADL needs exacerbate the association between diurnal cortisol and everyday support. We propose the following hypotheses:

Hypothesis 1: There is an association between giving support to aging parents on middle-aged children's PA and NA (same-day and next-day). At the daily level, we predicted that giving support to parents would be associated with lower PA (same-day and next-day) and higher NA (same-day and next-day).

Hypothesis 2: The association between giving support and PA/NA will be exacerbated by parent ADL needs and parent health problems. By testing cross-level interactions between daily support, daily mood, and parent ADL needs/parent health problems, we expected that giving support to aging parents with ADL needs or health problems would be associated with lower PA (same-day and next-day) and higher NA (same-day and next-day).

Hypothesis 3: There is an association between giving support to aging parents and middle-aged children's diurnal cortisol (same-day and next-day). At the daily level, we predicted that giving same-day and previous-day support to parents would be associated with a blunted CAR and higher AUG-G.

Hypothesis 4: The association between giving support to aging parents and middle-aged children's diurnal cortisol is exacerbated by parent ADL needs/parent health problems. We anticipated that cross-level interactions would reveal that giving support to parents with ADL needs or health problems would be associated with a more reduced CAR and higher AUG-G (same-day and next-day).

Methods

Sample
Participants are drawn from wave 2 of the *Family Exchange Study* (FES; Fingerman, Miller, Birditt, & Zarit, 2009), which sought to understand family relationships between middle-aged adults, their parents, and their adult children. Wave 1 of FES recruited a target sample of 633 middle-aged adults who had at least one living adult child and one living parent. At wave 2, 78% of FES wave 1 participants participated in

the study, which included a one-hour survey completed by telephone or via the internet. A random selection of middle-aged participants completed a daily study consisting of brief telephone interviews for seven evenings; 87% ($n = 270$) accepted the invitation and 248 participants completed daily interviews. Participants completed five to seven daily interviews (mean [M] = 6.83, standard deviation [SD] = 0.45). Of the 248 participants who participated in the daily interviews, 81% also completed the four-day saliva component of the study. Most participants (75%) reported having at least one living parent. Because the present study sought to examine cortisol responses associated with support provision to parents, participants who did not have any living parents ($n = 56$) were not considered for the present analyses.

For the saliva component, salivary collection kits with salivettes were sent to participants after they completed the main survey and scheduled their first diary interview. Interviewers prompted respondents to collect the saliva on days 2–5 of the diary calls, though allowances were made for deviations from this schedule. Participants were instructed to provide salivary samples: (1) when they woke and before they got out of bed, (2) 30 min after waking, (3) at lunchtime, and (4) before bed. Participants were instructed to not eat or drink anything other than water and to avoid caffeinated products (e.g., coffee, tea, soda) 30 min before collecting their samples. On saliva collection days, respondents were asked to report their collection times and if they had any problems with the salivary collection process. In accordance with standard saliva collection and storage procedures (Nicolson, 2008), participants stored samples in their home refrigerator and were given instructions for returning the samples in a prepaid overnight mailing package at the end of collection. Refrigeration has been shown to prolong the stability of cortisol and serves as a mechanism by which to avoid molding of saliva samples, which can occur after about four days if left at room temperature (Kierchbaum & Hellhammer, 2000). Participants received $50 for completing all four saliva days in addition to $50 for completing the diary component.

We examined saliva data for indicators that samples may not be valid. A total of 34 days with potential problems were present in our data. Saliva collection days where participants were awake for less than 12 hours during the day ($n = 9$), were awake for more than 20 hours during the day ($n = 4$), woke up after 12:00 noon ($n = 1$), or reported more than 60 min between the first and second saliva sample ($n = 21$), were removed from the data set. Further, participants who identified as nightshift workers ($n = 2$) were removed prior to analyses resulting in a final sample of 148 (See Table 1 for sample characteristics).

Measures From the Daily Interview
Support
On each day of the study, participants reported whether they gave support to their parent(s) using three items from

Table 1. Descriptive Statistics

	N (%)	M (SD)
Age		55.36 (4.56)
Gender (1 = *female*)	81 (54.73)	
Minority status (1 = *yes*)	41 (27.70)	
Married (1 = *yes*)	103 (73.65)	
Education		
Some high school	4 (2.70)	
High school	33 (22.30)	
Beyond high school	42 (28.38)	
College graduate	34 (22.97)	
Post college	35 (23.65)	
Number of living parents		1.34 (0.47)
Mother only	75 (50.68)	
Father only	22 (14.86)	
Both living	51 (34.46)	
Total daily support given to parents		0.53 (0.91)
Parent had health problem in the past 2 years	90 (60.81)	
Parent needs help with ADL	94 (63.51)	
Parent ADL needs[a]		2.15 (1.86)
Personal care	35 (23.65)	
Housework	67 (45.27)	
Transportation	84 (56.76)	
Finances	59 (39.86)	
Frequency of help with ADL[b]		5.00 (2.88)
Positive affect		3.19 (0.52)
Negative affect		1.29 (0.42)
Area under the curve with respect to ground		197.26 (73.82)
Cortisol awakening response		15.17 (24.37)
Cortisol measurement occasion	Time, *M* (*SD*)	Cortisol (nmol/l), *M* (*SD*)
Wake time	6.74 (1.37)	22.12 (11.02)
30 min after wake time	7.28 (1.38)	30.06 (11.75)
Lunchtime	13.08 (1.62)	9.05 (5.74)
Bedtime	23.01 (1.23)	4.74 (4.95)

Notes: Participant, *N* = 148; Day, *N* = 484. ADL = activities of daily living; *M* = mean; *SD* = standard deviation.
[a]Participants indicated whether their parents needed help with: (1) personal care, (2) housework, (3) transportation, and (4) finances. [b]Participants indicated how often they helped their parents with ADL needs; 1 = *daily*, 2 = *a few times per week*, 3 = *weekly*, 4 = *a few times per month*, 5 = *monthly*, 6 = *a few times per year*, 6 = *yearly*, 7 = *once a year*, and 8 = *less than once a year/never*.

the Intergenerational Support Scale (ISS; Fingerman et al., 2011). ISS items assessed whether or not the participant gave their parent: (1) emotional support, (2) practical assistance (e.g., fixing something around the house, running an errand), and (3) advice. The ISS asks respondents to indicate "Did you give your mother/father… [insert type of support]… since we spoke yesterday?" Items were summed (α = .76), and a dichotomous variable was created to indicate whether support was provided on a particular day (i.e., same-day support or no same-day support) or on a previous day (i.e., previous-day support or no previous-day support).

Affect
During each day of the diary interview, participants indicated their PA by rating six positive emotions (e.g., happy, determined, calm) and NA by rating nine negative emotions (e.g., distressed, lonely, nervous) drawn from assessments of daily emotions (Birditt, 2014). Responses were rated from 1 (*none of the day*) to 5 (*all of the day*), and mean scores were calculated across items (α = .68 for PA; α = .89 for NA).

Salivary Cortisol
Saliva samples were frozen and stored at –80 °C. After thawing, salivettes were centrifuged at 3000 rpm for 5 min, which resulted in a clear supernatant of low viscosity. Salivary concentrations, reported in nmol/l, were measured using commercially available chemiluminescence immunoassay with high sensitivity (IBL International, 2016, Hamburg, Germany).

Area Under the Curve
AUC-G was calculated for each day to estimate total daily output of cortisol using the following formula (Pruessner et al., 2003):

$$AUC - G = \left[\left(\frac{\{Cort\,A + Cort\,B\}}{2} \right) \times (Time\,B - Time\,A) \right]$$
$$+ \left(\frac{\{Cort\,B + Cort\,C\}}{2} \right) \times (Time\,C - Time\,B)]$$
$$+ \left(\frac{\{Cort\,C + Cort\,D\}}{2} \right) \times (Time\,D - Time\,C)].$$

Cortisol Awakening Response
CAR was calculated for each day by subtracting the first salivary cortisol measure of the day (immediately upon waking) from the second measure (~30 minutes after waking) and then dividing the difference scores by the time interval between the two measures (Fries et al., 2009): ([Cort B – Cort A]/[Time B – Time A]).

Measures From the Main Interview

Parent ADL Needs
Limitations in parent ADL was measured using four items from the Community Disability Scale (Bassett & Folstein, 1991). Participants indicated whether their parent(s) need help with: (1) personal care, (2) housework, (3) transportation, and (4) finances. Items were summed to indicate parent's total ADL needs (α = .78) and categorize parents ADL needs (0 = *no, does not have ADL need*, 1 = *yes, has ADL need*).

Parent Health Problems
Participants reported whether or not their parent(s) experienced a serious health problem or injury in the past two

years (0 = *no, did not experience a health problem or injury*, 1 = *yes, experienced a health problem or injury*). Past research examined health problems in this manner (Bangerter, Zarit, & Fingerman, 2016; Fingerman, Cheng, Birditt, & Zarit, 2012).

Covariates

An extensive literature review determined several covariates considered for models estimating daily mood and cortisol. We considered participant age and gender; at the daily level, we considered daily medication use (*yes/no*), daily smoking (*yes/no*), person-mean daily wake time, and type of day (weekend/weekday; Almeida et al., 2009; Fries et al., 2009; Kunz-Ebrecht, et al., 2004; Matta et al., 1998; Pruessner, Hellhammer, & Kirschbaum, 1999). Next, we estimated correlations between outcomes and covariates; we limited the covariates in the models to those that correlated with the outcome variable (Table 2; Rovine, von Eye, & Wood, 1988). Based on correlations between cortisol outcomes and covariates, the model estimating CAR controlled for person-mean centered daily wake time. For AUC-G, we controlled for participant gender, person-mean centered daily wake time, whether the participant smoked on that day, whether the participant used medication on that day, and whether data were collected on a weekend. For PA, we controlled for participant age. NA models controlled for participant age, whether the participant smoked on that day, and whether the participant used medication on that day.

Analysis

Multilevel modeling was used to examine variability in cortisol and daily mood among participants. Two-level multilevel models (SAS PROC MIXED) were employed to examine daily diary data nested within persons (Littell, Milliken, Stroup, & Wolfinger, 1996). Separate models were run for CAR and AUC-G. Models were built using a parsimonious approach such that variables correlated with the outcome variable (Rovine et al., 1988). Based on correlations between each daily outcome (i.e., PA, NA, CAR, and AUC-G) and covariates (Table 2), models included different sets of covariates. Specifically, the following Level 1 equations were utilized:

$$\mathrm{CAR}_{di} = \beta_{0i} + \beta_{1i}\left(\text{same day support}_{di}\right)$$
$$+ \beta_{2i}\left(\text{previous day support}_{di}\right)$$
$$+ \beta_{3i}\left(\text{wake time}_{di}\right) + e_{di}$$

$$\mathrm{AUC\text{–}G}_{di} = \beta_{0i} + \beta_{1i}\left(\text{same day support}_{di}\right)$$
$$+ \beta_{2i}\left(\text{previous day support}_{di}\right)$$
$$+ \beta_{3i}\left(\text{wake time}_{di}\right) + \beta_{4i}\left(\text{weekend}_{di}\right)$$
$$+ \beta_{5i}\left(\text{smoke day}_{di}\right)$$
$$+ \beta_{6i}\left(\text{medication day}_{di}\right) + e_{di}$$

$$\mathrm{PA}_{di} = \beta_{0i} + \beta_{1i}\left(\text{same day support}_{di}\right)$$
$$+ \beta_{2i}\left(\text{previous day support}_{di}\right) + e_{di}$$

$$\mathrm{NA}_{di} = \beta_{0i} + \beta_{1i}\left(\text{same day support}_{di}\right)$$
$$+ \beta_{2i}\left(\text{previous day support}_{di}\right)$$
$$+ \beta_{3i}\left(\text{smoke day}_{di}\right) + \beta_{4i}\left(\text{medication day}_{di}\right) + e_{di}$$

At Level 2, we included parent health problems and parent ADL needs for the intercept and slopes of same- and previous-day support in all outcomes. Thus, we examined cross-level interaction terms between daily support (same day and previous day) and parent health problems and ADL needs. For between-person controls, gender was included for AUC-G models and age for PA and NA models (See Supplementary Appendix A for the full equations).

Results

Descriptive statistics are found in Table 1. Out of 484 valid days of data used in analysis, participants provided support to parents on 144 days (29%) with an average daily total number of support of 0.54 (*SD* = 0.72; range = 0–3). Participants provided emotional support (e.g., listening to concerns or being available when someone is upset) most frequently (*n* = 102) followed by advice (e.g., helping with a decision or giving suggestions; *n* = 90) and practical support (e.g., fixing something around the house, running an errand, or providing a ride; *n* = 66). Sixty percent of participants indicated that their parent(s) had a serious health problem or injury in the past two years while 63% of participants indicated their parent(s) had at least one ADL need (*M* = 2.15; *SD* = 1.89; range = 0–6). Parent health problems and parent ADL needs were positively correlated $r(146) = .28$, $p < .01$; however, the magnitude of this correlation did not suggest problematic multicollinearity

Table 2. Correlations Between Covariates and Outcome Variables

	Age	Gender	Wake time	Smoke day	Medication day	Weekend
PA	.11*	−.04	.06	−.07	.01	.03
NA	−.13**	−.01	−.01	.31***	.11*	−.00
CAR	.05	−.05	−.15**	.02	−.04	−.03
AUC-G	−.01	.09*	−.24***	.10*	−.12**	−.10*

Notes: AUC-G = area under the curve with respect to ground; CAR = cortisol awakening response; NA = negative affect; PA = positive affect.
*$p < .05$; **$p < .01$; ***$p < .001$.

(Kennedy, 2008). Participants reported that their parents' most frequent ADL need was transportation or driving (56%), followed by daily care, shopping cooking meals and housework (45%), finances and managing money (39%), and personal care needs such as bathing and dressing (23%).

On average, participants provided usable saliva samples on 3.27 out of 4 total saliva collection days (SD = 0.85). Samples were unusable when participants missed a collection time, did not provide enough saliva to assay, did not record the time of saliva collection, or if the saliva value exceeded 60 nmol/l. The average CAR for participants was 15.17 (SD = 24.37); the mean AUC-G was 197.26 (SD = 73.82). The intraclass correlations were estimated in order to calculate the variance between persons for all outcomes. For cortisol, 16% of the variance in CAR and 35% of the variance in AUC-G was between persons, indicating that a substantial portion of variance in diurnal cortisol was drawn from within-person variation. Likewise, 24% of the variance in NA was between persons, indicating a substantial degree of variance in NA can be attributed to within-person fluctuation, whereas variance in PA was largely attributed to between-person differences (67%).

Daily Mood

Results for multilevel models can be found in Table 3. Hypothesis 1 predicted that giving support to parents would be associated with lower same-day and next-day PA, and higher same-day and next-day NA. Hypothesis 1was partially supported. Consistent with our prediction, PA was lower on days when participants gave support to their parents. In contrast to our hypothesis, PA did not fluctuate as a function of previous-day support and there were no significant within-person differences in NA based on same-day support or previous-day support.

Hypothesis 2 projected that the associations between giving support and PA/NA would be exacerbated by parent's ADL needs or health problems. In contrast to our prediction, results indicate a significant previous-day support × parent ADL interaction such that participants had lower NA on days after they gave support to parents with ADL needs. As we hypothesized, analyses show a significant previous-day support × parent health problem interaction indicating that, NA was higher on days following support provision to parents with health problems. In opposition to expectations, results reveal a significant same-day support × parent ADL interaction signifying that giving support to a parent with ADL needs was associated with greater same-day PA.

Cortisol

Hypothesis 3 predicted that giving same-day and next-day support would be associated with lower CAR and higher AUC-G. This prediction was not supported by our findings;

for CAR and AUC-G, we found no significant within-person differences based on giving same-day or previous-day support.

Finally, Hypothesis 4 predicted that when parent had a health problem or ADL needs, giving same-day and previous-day support would be associated with a lower CAR and a higher AUC-G. Hypothesis 4 was partially supported. Specifically, results indicate a significant previous-day support × parent ADL interaction such that when participants gave support to parents with ADL needs, they exhibited higher AUC-G the following day, but not on the same day. In contrast to our prediction, there were no significant interactions for parent ADL needs and giving same-day or previous-day support on CAR. We did not find any significant interactions for giving same-day or previous-day support and parent health problems on CAR or AUC-G.

In summary, results indicate that giving support to aging parents has differential implications for daily mood and diurnal cortisol of middle-aged children. When participants gave support to parents with ADL needs, they had significantly greater same-day PA and lower next-day NA. Giving support to parents with health problems was associated with significantly higher next-day NA. When examining cortisol as an outcome, middle-aged children had significantly higher next-day AUC-G on days after they gave support to parents with ADL needs.

Discussion

Support to aging parents, who are living longer than ever before, is a customary but demanding practice for middle-aged adults (Brody, 1985). Parental health problems and disability establish differential contexts in which giving support to parents may be more challenging for middle-aged children, who are faced with balancing work and family obligations associated with midlife, thereby affecting health and well-being. This notion is supported by our finding that AUC-G was higher following days when participants gave support to parents with ADL needs. Higher cortisol levels over the course of the day are associated with greater negative emotion and poorer well-being (Adam et al., 2006) and mental health outcomes. Other research has found similar lagged patterns such that negative interactions with adult children with lifestyle-behavioral problems were associated with middle-aged parents' higher cortisol on the next day (Birditt et al., 2016). It may be that giving support to a parent with ADL needs prologues the active cognitive representations of the stressor and therefore physiological activation is present in the overall secretion of next-day cortisol.

Our study suggests that giving support to aging parents is an ambiguous experience which is shaped in part by the health and ADL needs of parents. Participants reported lower PA on days when they gave support to aging parents and higher NA on days following support provision to parents with health

Table 3. Effect of Same-Day and Previous-Day Support, Parent Health Problems, and Parent ADL Needs on Cortisol and Daily Mood

	Cortisol				Daily mood			
	CAR		AUC-G		PA		NA	
	β	SE	β	SE	β	SE	β	SE
Intercept	18.39***	2.94	193.23***	10.18	2.7***	0.55	1.96***	0.06
Within-person predictors								
Same-day support	–2.58	4.78	–6.35	12.85	–0.17*	0.07	–0.01	0.03
Previous-day support	1.75	4.56	0.44	12.51	0.02	0.04	0.01	0.05
Wake time	–4.78**	1.25	–24.12***	3.72	–	–	–	–
Weekend	–	–	4.35	8.07	–	–	–	–
Smoke day	–	–	13.54	12.75	–	–	0.25**	0.86
Medication day	–	–	–9.62	6.15	–	–	0.05	0.03
Between-person predictors								
Age	–	–	–	–	0.01	0.01	–0.01	0.01
Gender (1 = *female*)	–	–	11.05	8.86	–	–	–	–
Parent ADL	–0.41	3.47	–12.26	10.67	–0.11	0.1	0.01	0.07
Parent health problem	–5.11	3.46	8.2	10.49	–0.09	0.09	–0.04	0.07
Interactions								
Same-day support × parent ADL	NS		NS		0.21*	0.09	NS	
Same-day support × parent health problem	NS		NS		NS		NS	
Previous-day support × parent ADL	NS		32.09*	14.37	NS		–0.16*	0.06
Previous-day support × parent health problem	NS		–27.02†	14.47	NS		0.17*	0.06
Intercept variance	88.65**	29.82	1748.6***	334.59	0.23***	0.03	0.16	0.02
Residual variance	481.29***	36.96	3081.44***	240.16	0.11***	0.01	0.04***	0
–2 Log likelihood	4,432.0		5381.2		609.5		269.2	
AIC/BIC	4,456.0/4,491.9		5,409.2/5,451.1		627.5/654.5		293.2/329.2	
Observation, n	484		481		484		484	

Notes: Nonsignificant (NS) interaction terms were trimmed. ADL = activities of daily living; AIC = akaike information criterion; AUC-G = area under the curve with respect to ground; BIC = Bayesian information criterion; CAR = cortisol awakening response; NA = negative affect; PA = positive affect; *SE* = standard error.
†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

problems. These finding are consistent with the notion that giving support to aging parents has negative daily implications for middle-aged children (Fingerman et al., 2016). However, giving support to parents with ADL needs was associated with higher same-day PA and lower next-day NA, mirroring the notion that social support has positive implications for those who give it (Liang et al., 2001). These results parallel themes from caregiving literature, specifically that caregivers experience a variety of positive gains as a result of providing care and support. Such gains include building a sense of purpose, increased gratification, and developing a closer relationship with the person receiving care (Cheng, Mak, Lau, Ng, & Lam, 2016).

Our results indicate different patterns between giving support when parents have ADL needs verses health problems. In circumstances where a parent has ADL needs, middle-aged children are likely burdened with the reality of parental disability and may anticipate further decline, thus exhibiting a more pronounced biological response to support provision. In contrast to ADL needs, many injuries are brief (e.g., a fall resulting in a broken hip) and chronic health problems may be treatable and manageable thanks to modern science and technology. Thus, it is feasible that parent ADL needs and health problems do in fact take on a different meaning for middle-aged children, thereby posing diverse implications for health and well-being.

Although participants exhibited some positive gains in daily mood through assisting parents who need help with ADL, these gains occurred simultaneously with heightened biological stress response as exhibited in the highest next-day AUC-G. Our study suggests that giving support to parents with ADL needs is perhaps best characterized as a psychologically and emotionally conflicting experience with some positive associations with daily mood, but also some negative biological stress implications. For example, helping a parent by providing a ride to the grocery store may serve as a pleasant interaction that could enhance PA. On the other hand, this same act of support may also cause the middle-aged child to miss out on other important obligations or tasks, and may therefore account for an

increased biological stress response the following day. Thus, it is important to consider these results within the context of challenges and obligations of midlife. In some cases, middle-aged adults simultaneously give support to, and are "sandwiched" between aging parents and dependent children (Loomis & Booth, 1995). Thus, it may be that giving support to an aging parent with ADL needs is not particularly taxing, but this support is often provided amidst other obligations and demands, which in turn contribute to a biological stress response. A biopsychosocial approach captures the idea that support to aging parents truly has dual implications for the health and well-being of middle-aged children.

This study has several limitations. Past research suggests that the mental health effects of giving family support are moderated by the appraisal of giving support as stressful or rewarding (Bangerter, Kim, Zarit, Birditt, & Fingerman, 2015). Perceptions of the support that an individual's give, and not necessarily the amount of support, may play an important role in biological stress responses associated with giving support. We did not gather appraisals of everyday support and were not able to test this theory. Next, support was given to parents rather minimally, only 29% of study days were support days, and it is therefore difficult to estimate if findings are a function of limited frequency of support provision. Moreover, we did not examine outcomes as a function of the type of support given, it is likely that giving different types of support and different combinations of support (e.g., practical, emotional, advice) may have differential associations with diurnal cortisol and daily mood. The present study did not closely examine these different types of support, or the potential overlap between these forms of support. Though our sample is not, nor is it intended to be, a caregiving sample, it is plausible that some of the participants in our sample do in fact engage in caregiving for their parents. Caregiving duties are likely embedded within practical support and personal ADL needs; however, our sample indicated that parent ADL needs were mostly in transportation and housekeeping, with personal needs reported least frequently. Participants also reported providing practical assistance least frequently, indicating that caregiving was not likely taking place. However, we did not measure daily caregiving (i.e., support with ADL) provided to parents and therefore could not estimate the association between daily caregiving and diurnal cortisol. Likewise, it is possible that parents were receiving support from other formal services (e.g., assisted living facilities, social services) or informal sources (e.g., other friends and family members); however, we did not consider alternative sources of support in our analyses. Finally, although we collected data across 4 days, this short period of data collection provides a mere snapshot of what support exchanges may look like for participants. Support is likely to ebb and flow across time, changing with needs, resources, and life events; it is difficult to capture the natural progression of support in the limited time period allotted for data collection in this study.

Future efforts toward understanding at what point support provision to aging parents begins to show consequences for biological stress is crucial for the development of resources, services, and interventions. Likewise, identifying the positive and potentially beneficial aspects of providing support to aging parents is essential. Our study highlights the ambiguity of support provision in that we highlight both positive implications (e.g., daily mood) and biological consequences (e.g., next-day AUC-G) and therefore provides an essential step toward understanding the seemingly ubiquitous process of giving support to aging parents in need, a task which, for centuries, adult children have fulfilled. Future research that identifies both the positive aspects and consequences of support provision will aid in developing an enhanced understanding of how support can be provided to aging parents in effective, sustainable, and viable ways.

Supplementary Material

Supplementary data are available at *The Gerontologist* online.

References

Adam, E. K., Hawkley, L. C., Kudielka, B. M., & Cacioppo, J. T. (2006). Day-to-day dynamics of experience-cortisol associations in a population-based sample of older adults. *Proceedings of the National Academy of Sciences of the United States of America*, **103**, 17058–17063. doi:10.1073/pnas.0605053103

Almeida, D. M., Piazza, J. R., & Stawski, R. S. (2009). Interindividual differences and intraindividual variability in the cortisol awakening response: an examination of age and gender. *Psychology and Aging*, **24**, 819–827. doi:10.1037/a0017910

Bangerter, L. R., Kim, K., Zarit, S. H., Birditt, K. S., & Fingerman, K. L. (2015). Perceptions of giving support and depressive symptoms in late life. *The Gerontologist*, **55**, 770–779. doi:10.1093/geront/gnt210

Bangerter, L. R., Zarit, S. H., & Fingerman, K. L. (2016). Moderator effects of mothers' problems on middle-aged offspring's depressive symptoms in late life. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **71**, 41–48. doi:10.1093/geront/gnt210

Bassett, S. S., & Folstein, M. F. (1991). Cognitive impairment and functional disability in the absence of psychiatric diagnosis. *Psychological Medicine*, **21**, 77–84. doi:10.1017/S0033291700014677

Birditt, K. S., Kim, K., Zarit, S. H., Fingerman, K. L., & Loving, T. J. (2016). Daily interactions in the parent-adult child tie: Links between children's problems and parents' diurnal cortisol rhythms. *Psychoneuroendocrinology*, **63**, 208–216. doi:10.1016/j.psyneuen.2015.09.027

Birditt, K. S. (2014). Age differences in emotional reactions to daily negative social encounters. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, **69**, 557–566. doi:10.1093/geronb/gbt045

Brody, E. M. (1985). The Donald P. Kent Memorial Lecture. Parent care as a normative family stress. *The Gerontologist*, **25**, 19–29. doi:10.1093/geront/25.1.19

Brosschot, J. F., Pieper, S., & Thayer, J. F. (2005). Expanding stress theory: prolonged activation and perseverative cognition.

Psychoneuroendocrinology, **30**, 1043–1049. doi:10.1016/j.psyneuen.2005.04.008

Cheng, S. T., Mak, E. P., Lau, R. W., Ng, N. S., & Lam, L. C. (2016). Voices of Alzheimer caregivers on positive aspects of caregiving. *The Gerontologist*, **56**, 451–460. doi:10.1093/geront/gnu118

Chida, Y., & Steptoe, A. (2009). Cortisol awakening response and psychosocial factors: a systematic review and meta-analysis. *Biological Psychology*, **80**, 265–278. doi:10.1016/j.biopsycho.2008.10.004

Chrousos, G. P., & Gold, P. W. (1992). The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. *JAMA*, **267**, 1244–1252. doi:10.1001/jama.1992.03480090092034

Fingerman, K., Miller, L., Birditt, K., & Zarit, S. (2009). Giving to the good and the needy: Parental support of grown children. *Journal of Marriage and the Family*, **71**, 1220–1233. doi:10.1111/j.1741-3737.2009.00665.x

Fingerman, K. L., Pitzer, L. M., Chan, W., Birditt, K., Franks, M. M., & Zarit, S. (2011). Who gets what and why? Help middle-aged adults provide to parents and grown children. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, **66**, 87–98. doi:10.1093/geronb/gbq009

Fingerman, K. L., Cheng, Y. P., Birditt, K., & Zarit, S. (2012). Only as happy as the least happy child: Multiple grown children's problems and successes and middle-aged parents' well-being. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, **67**, 184–193. doi:10.1093/geronb/gbr086

Fingerman, K. L., Kim, K., Tennant, P. S., Birditt, K. S., & Zarit, S. H. (2016). Intergenerational support in a daily context. *The Gerontologist*, **56**, 896–908. doi:10.1093/geront/gnv035

Fries, E., Dettenborn, L., & Kirschbaum, C. (2009). The cortisol awakening response (CAR): Facts and future directions. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*, **72**, 67–73. doi:10.1016/j.ijpsycho.2008.03.014

IBL International. (2016). *TECAN Inc*. Retrieved March 1, 2016 from TECAN, INC website http://www.ibl-international.com.

Kennedy, P. (Ed.). (2008). *A guide to econometrics*. Malden, MA: Blackwell Pub.

Khoury, J. E., Gonzalez, A., Levitan, R. D., Pruessner, J. C., Chopra, K., Basile, V. S., … Atkinson, L. (2015). Summary cortisol reactivity indicators: Interrelations and meaning. *Neurobiology of Stress*, **2**, 34–43. doi:10.1016/j.ynstr.2015.04.002

Kierchbaum, C., & Hellhammer, D. H. (2000). Salivary cortisol. In G. Fink (Ed.), *Encyclopedia of stress* (Vol. **3**, pp. 379–383). New York: Academic Press.

Kim, K., Bangerter, L. R., Liu, Y., Polenick, C. A., Zarit, S. H., & Fingerman, K. L. (2016). Middle-aged offspring's support to aging parents with emerging disability. *The Gerontologist*. Advance online publication. doi:10.1093/geront/gnv686

Klein, L. C., Kim, K., Almeida, D. M., Femia, E. E., Rovine, M. J., & Zarit, S. H. (2016). Anticipating an easier day: Effects of adult day services on daily cortisol and stress. *The Gerontologist*, **56**, 303–312. doi:10.1093/geront/gnu060

Kunz-Ebrecht, S. R., Kirschbaum, C., Marmot, M., & Steptoe, A. (2004). Differences in cortisol awakening response on work days and weekends in women and men from the Whitehall II

cohort. *Psychoneuroendocrinology*, **29**, 516–528. doi:10.1016/S0306-4530(03)00072-6

Liang, J., Krause, N. M., & Bennett, J. M. (2001). Social exchange and well-being: is giving better than receiving? *Psychology and Aging*, **16**, 511–523. doi:10.1037/0882-7974.16.3.511

Littell, R. C., Milliken, G. A., Stroup, W. W., & Wolfinger, R. D. (1996). *SAS system for mixed models*. Cary, NC: SAS Institute.

Loomis, L. S., & Booth, A. (1995). Multigenerational caregiving and well-being: The myth of the beleaguered sandwich generation. *Journal of Family Issues*, **16**, 131–148. doi:10.1177/019251395016002001

Matta, S. G., Fu, Y., Valentine, J. D., & Sharp, B. M. (1998). Ressponse of the hypothalamo-pituitary-adrenal axis to nicotine. *Psychoneuroendocrinology*, **23**, 103–113. doi:10.1016/S0306-4530(97)00079-6

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological Bulletin*, **133**, 25–45. doi:10.1037/0033-2909.133.1.25

Nicolson, N. A. (2008) Measurement of cortisol. In L. J. Luecken & L. C. Gallo (Eds.), *Handbook of physiological research methods in health psychology* (Vol. **1**; pp 37–74). Thousand Oaks, CA: Sage.

Pruessner, J. C., Hellhammer, D. H., & Kirschbaum, C. (1999). Burnout, perceived stress, and cortisol responses to awakening. *Psychosomatic Medicine*, **61**, 197–204. doi:10.1097/00006842-199903000-00012

Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., von Auer, K., Jobst, S., … Kirschbaum, C. (1997). Free cortisol levels after awakening: a reliable biological marker for the assessment of adrenocortical activity. *Life Sciences*, **61**, 2539–2549. doi:10.1016/S0024-3205(97)01008-4

Pruessner, J. C., Kirschbaum, C., Meinlschmid, G., & Hellhammer, D. H. (2003). Two formulas for computation of the area under the curve represent measures of total hormone concentration versus time-dependent change. *Psychoneuroendocrinology*, **28**, 916–931. doi:10.1016/S0306-4530(02)00108-7

Rovine, M. J., von Eye, A., & Wood, P. (1988). The effect of low covariate criterion correlations on the analysis-of-covariance. In E. Wegmen (Ed.), *Computer science and statistics: Proceedings of the 20th symposium of the interface* (pp. 500–504). Alexandria, VA: American Statistical.

Saban, K. L., Mathews, H. L., Bryant, F. B., O'Brien, T. E., & Janusek, L. W. (2012). Depressive symptoms and diurnal salivary cortisol patterns among female caregivers of stroke survivors. *Biological Research for Nursing*, **14**(4), 396–404. doi:10.1177/1099800412439458

Savla J, Almeida DM, Davey A, Zarit SH. Routine assistance to parents: Effects on daily mood and other stressors. *J Gerontol B Psychol Sci Soc Sci*. 2008;63(3):S154–S161.doi:10.1093/geronb/63.3.S154

Strazdins, L., & Broom, D. H. (2007). The mental health costs and benefits of giving social support. *International Journal of Stress Management*, **14**, 370–385. doi:10.1037/1072-5245.14.4.370

Tsiqos, C., & Chrousos, G. P. (2002). Hypothalamic-pituitaryadrenal axis, neuroendocrine factors and stress. *Journal of Psychosomatic Research*, **53**, 865–871. doi:10.1016/S0022-3999(02)00429-4