Role Fulfillment Mediates the Association Between Daily Family Assistance and Cortisol Awakening Response in Adolescents

Emma Armstrong-Carter
University of North Carolina at Chapel Hill and Stanford University

Susannah Ivory
University of North Carolina at Chapel Hill and Pennsylvania State University

Lynda C. Lin
University of North Carolina at Chapel Hill and University of Illinois Urbana-Champaign

Keely A. Muscatell and Eva H. Telzer
University of North Carolina at Chapel Hill

Family assistance (helping the family) is associated with both positive and negative psychological and biological outcomes during adolescence. However, the association between family assistance and the hypothalamic–pituitary–adrenal (HPA) axis remains unstudied. Thus, we assess how helping the family relates to adolescents' diurnal cortisol, an index of HPA activity, and psychological outcomes. Three hundred and seventy ethnically diverse adolescents (ages 11–18) reported daily helping behaviors and psychological experiences for 14 days and provided four saliva samples per day for 4 days. Multilevel modeling revealed that cortisol awakening response was lower the day after adolescents helped their families more. This association was explained, in part, by perceived role fulfillment (feeling like a good son, daughter, and sibling). Results highlight a possible psychological and biological benefit of assisting the family during adolescence.

Adolescents provide significant assistance to their family members, including helping around the house, taking care of siblings, and running errands for their parents. Prior research and theory regarding youths' help in the household suggest that it can be both detrimental and beneficial for their mental and physical health (Fuligni & Telzer, 2013; Telzer, Gonzales, & Fuligni, 2014). In particular, when adolescents' assistance to their family provides them with a sense of role fulfillment, or feeling like a good son, daughter, or sibling, family assistance tends to be associated with positive psychological and biological outcomes at both the level of behavior and brain (Telzer, Masten, Berkman, Lieberman, & Fuligni, 2010). Although understanding how family assistance "gets under the skin" has recently been of interest (Fuligni

& Telzer, 2013), the impact of family assistance on adolescents' hypothalamic–pituitary–adrenal (HPA) axis function, an important indicator of physical health (Chida & Steptoe, 2009) remains unknown. Thus, in the current study, we utilize daily diary methods to examine whether adolescents' daily family assistance behaviors predict variations in diurnal patterns of cortisol secretion, and whether those variations are explained by adolescents' daily psychological experiences.

Family Assistance

Although helping behaviors may be more common among some sociocultural groups than others, providing some help to the family is a typical feature of children and adolescents' daily lives around the world (Weisner, 2001). Family assistance can take many forms, including cleaning, cooking, helping siblings with homework, and providing emotional support to a sibling or parent. Family assistance during the teenage years impacts adolescents in divergent ways, as it is associated with both positive and negative biological and

psychological outcomes (Aldridge & Becker, 1993; Fuligni et al., 2009; Telzer & Fuligni, 2009a; Telzer et al., 2014). For example, contributing to the family can help maintain family connectedness for adolescents (Beach, 1997), increasing their happiness (Telzer & Fuligni, 2009b; Weisner, 2001) but it can also be burdensome, particularly if it conflicts with other social and academic demands (Bridgeland, DiIulio, & Morison, 2006; Cohen, Greene, Toyinbo, & Siskowski, 2012; East, 2010; Siskowski, 2006; Suarez-Orozco & Suarez-Orozco, 1995). Research has also chronicled associations between family assistance and a number of biological processes and outcomes during adolescence, indicating that more frequent or intense family assistance is associated with higher body mass index (Fuligni et al., 2009), higher risk for substance use (Telzer et al., 2014), and elevated circulating levels of the inflammatory markers C-reactive protein and interleukin-6 two years later (Fuligni et al., 2009). This latter effect is buffered among adolescents reporting greater role fulfillment (Fuligni et al., 2009), suggesting that finding meaning and purpose from helping the family can be protective, benefiting adolescents even when it also feels burdensome (Fuligni & Telzer, 2013; Fuligni et al., 2009). While role fulfillment may moderate the associations between family assistance and long-term outcomes, on the daily level role fulfillment also mediates or partially explains the link between family assistance and daily happiness (Telzer & Fuligni, 2009b). This suggests that role fulfillment may be a key mechanism through which family assistance relates to child proximal daily outcomes.

HPA Axis Activity

Despite growing interest in examining how family assistance predicts biological and psychological outcomes, no known studies have examined the link between family assistance and the functioning of the HPA axis. The HPA axis is an important biological mechanism linking psychological stress and physical health conditions (McEwen, 1998). One indicator of HPA axis output measured in human research is salivary cortisol. Cortisol is a hormone that regulates a number of important bodily functions, including those involved with the metabolic, cardiovascular, and immune systems (Chida & Steptoe, 2009). Cortisol levels fluctuate naturally throughout the day, typically peaking 30–45 min after waking in the morning and subsequently declining from afternoon to evening (Gunnar,

Doom, & Esposito, 2015; Stalder et al., 2016). Despite this normative pattern, individuals vary in their daily cortisol patterns (Adam, 2006; Adam & Gunnar, 2001) and social and psychological experiences have been shown to impact its release and daily fluctuations (Adam et al., 2017).

Three indices of HPA functioning are typically examined in psychological research. The first indicator, *diurnal slope*, represents the decrease in secreted cortisol from morning to evening. Deviations from the typical diurnal slope, indicated by a flatter decline over the day, have been associated with greater risk for physical illness (Adam et al., 2010). The second indicator, *area under the curve* (AUC) is a measure of total daily cortisol output (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003) and is positively associated with chronic stress (Miller, Chen, & Zhou, 2007). Both AUC and diurnal slope are impacted by events occurring throughout the course of the day and are typically examined the same day as experiences of interest (Adam, Hawkley, Kudielka, & Cacioppo, 2006; Chida & Steptoe, 2009). Finally, *cortisol awakening response* (CAR) is the steep increase in cortisol from wake-up to 30–45 min after awakening (Stalder et al., 2016). CAR is considered an indication of the body mobilizing energy to meet the anticipated demands of the upcoming day (Fries, Dettenborn, & Kirschbaum, 2009). Since CAR occurs shortly after waking and before the events of the day, it is impacted largely by events the previous day, and thus is commonly and most effectively examined the day following events or experiences of interest (Adam et al., 2006; Chida & Steptoe, 2009). Thus, CAR reflects both an anticipatory stress response based on anticipated demands of the upcoming day and also a reflection of prior-day life events. Deviations from typical CAR can be either amplified (i.e., a very large increase in cortisol upon wake-up), which is associated with depression and chronic life stress (Chida & Steptoe, 2009) or blunted (i.e., a small increase upon wake-up), which is associated with fatigue, burnout, and posttraumatic stress (Boggero, Hostinar, Haak, Murphy, & Segerstrom, 2017; Chida & Steptoe, 2009). Since moderate levels of CAR are associated with optimal functioning and outcomes, one way to illuminate whether reductions in CAR are negative (i.e., blunting to an unhealthy extent) or positive (i.e., lowering to normative, healthy levels) is to examine potential psychological mediators that shed light on the quality of the adolescent's daily experience.

Psychological and social experiences influence HPA functioning and the biological rhythm of cortisol, likely by prompting signals from the limbic system to the hypothalamus and pituitary gland, which trigger cortisol release from the adrenal cortex (Adam et al., 2006). Cortisol levels in the body are then regulated by feedback to and from multiple brain regions including the pituitary, hypothalamus, and hippocampus (Adam et al., 2006). Operating through these mechanisms, family assistance may impact HPA axis activity in divergent ways. On the one hand, if assisting the family is taxing for adolescents, it may affect the HPA axis output much like a chronic stressor. For example, family assistance may predict higher AUC, blunted or heightened CAR, or flatter diurnal slopes, all of which are associated with increased risk for poor psychological and physical health (Adam et al., 2006, 2010; Boggero et al., 2017; Ruttle et al., 2013; Williams et al., 2002). Supporting this idea, past research has shown that family demands (i.e., tasks at home that are perceived as demanding or stressful) are associated with stress and blunted CAR, but only when those demands also interfere with adolescents' sleep (Chiang et al., 2016). On the other hand, if family assistance provides emotional and social benefits to adolescents (Telzer & Fuligni, 2009b), it may be associated with a healthier cortisol profile (e.g., lower AUC or lowered CAR). As such, family assistance may provide a sense of meaning and purpose for adolescents (Telzer & Fuligni, 2009b), enabling the HPA axis to optimally adapt and cope with stressors. Thus, previous research and theory suggest that family assistance could be related to either adaptive or maladaptive cortisol patterns, and this likely varies based on whether family assistance is experienced as demanding and burdensome, or if instead it provides adolescents with a sense of happiness, meaning, and role fulfillment.

Role Fulfillment as a Possible Psychological Mechanism Linking Family Assistance and HPA Axis Activity

Understanding the psychological mechanisms by which family assistance relates to cortisol profiles may help to elucidate if such associations are likely to contribute to detrimental or beneficial effects on current and future health. For example, if a positive psychological experience such as happiness or role fulfillment mediates the link between family assistance and cortisol outcomes, this would suggest that family assistance is linked with a more adaptive HPA axis function and a lower risk profile. Conversely, if negative affect states such as distress or burnout (i.e., stress) mediate the link, this would suggest that family assistance is associated with maladaptive HPA axis function and a higher risk profile. Prior research has examined the psychological mediators of the link between adolescents' daily family assistance and adjustment in this way, highlighting role fulfillment rather than distress as a mediator (Telzer & Fuligni, 2009a). This work suggests that adolescent's role fulfillment, or derived meaning from helping their families, is part of the reason that family assistance may be associated with positive outcomes. Despite this intriguing prior research, no known studies have examined if positive psychological processes (e.g., role fulfillment, happiness) or negative psychological processes (e.g., distress, burnout) are mediators of the link between family assistance and cortisol profiles.

The Present Study

The present study used a daily diary method to examine whether family assistance is associated with diurnal cortisol patterns in a culturally diverse sample of adolescents. Specifically, we sought to answer three key questions: (a) How does family assistance relate to cortisol patterns, as indicated by CAR, AUC, and diurnal slope? (b) Is family assistance related to adolescents' psychological experiences, as indicated by daily reports of distress, burnout, happiness, and role fulfillment? We separately assessed both positive (i.e., happiness and role fulfillment) and negative (i.e., distress and burnout) psychological experiences to allow for the possibility that both may simultaneously be related to family assistance. (c) Are any observed links between family assistance and cortisol patterns mediated by a sense of role fulfillment, happiness, distress, or burnout? Finally, we conducted exploratory analyses to examine whether the association between family assistance and cortisol patterns varies by race, age, sex, or socioeconomic status (SES; operationalized as maternal education). Past research is equivocal, suggesting both that demographic characteristics may moderate associations between family assistance and adolescent functioning (Telzer & Fuligni, 2009a Telzer et al., 2010; Weisner, 2001), and also that family assistance operates similarly across groups of adolescents (Fuligni et al., 2009; Telzer & Fuligni, 2009b).

The Daily Diary Method

The daily diary method is a uniquely useful method for examining questions related to

adolescents' daily family assistance and experiences (Telzer & Fuligni, 2009b), particularly those related to cortisol, which has a unique diurnal pattern that varies day-by-day. Youth reports of their daily activities, behaviors, and feelings are more reliable and accurate than when these processes are assessed using traditional retrospective accounts from a single questionnaire (Bolger, Davis, & Rafaeli, 2003). Daily diary methods also allow researchers to examine whether specific events, behaviors, and feelings that occur on one day are associated with psychological and biological processes measured the same day or the following day. For example, do adolescents exhibit lower CAR following days that they help their family more? While not causal, data of this nature allow us to gain more confidence in the likely directionality of effects. In addition, we are able to examine individual and group differences in the associations between daily level processes. For example, is the association between family assistance and CAR the same for male and female youth? In contrast to our method, prior literature that examines links between social experiences and HPA axis functioning has averaged cortisol across days, which precludes the ability to examine diurnal variations and day-to-day associations with familial and psychological experiences (e.g., Adam et al., 2010; DeSantis et al., 2007). More recent studies emphasize the importance of examining cortisol day-by-day to capture how it varies in response to daily activities, experiences, and behaviors (Deer, Shields, Ivory, Hostinar, & Telzer, 2018; Myin-Germeys et al., 2009; Sladek & Doane, 2015). Accordingly, the current study capitalized on daily diary methods to investigate whether adolescents' daily family assistance predicts their diurnal cortisol, and whether that is explained by their daily psychological experiences.

Method

Participants

Participants included 370 adolescents (57.3% female) between the ages of 11 and 18 years (M_{age} = 14.63 years, SD = 1.39 years). The sample was racially and ethnically diverse: 39.46% non-Hispanic White (from here on referred to as White, N = 146), 25.4% Asian (N = 94, 11 of whom were mixed [i.e., Asian and White], 17.8% Hispanic (N = 66, 11 of whom were mixed [i.e., Hispanic and White]), 10.8% African American (N = 40, 9 of whom were mixed [i.e., African American and White]), and 6.5% other race (N = 24). The sample was also socioeconomically diverse. Using maternal education as an indicator of SES, approximately 10% of mothers had less than an eighth grade education, 13% did not complete high school, 24% completed high school, 27% completed postsecondary education (college, trade, or vocational school), and 23% completed graduate school (3% declined to answer). Participants were recruited from the community using convenience sampling, including posting flyers at schools, posting on listservs serving ethnic minority families, recruiting participants from previous studies who agreed to be contacted for other research studies, and word of mouth. Participants were compensated $10 in total for completing the daily diaries and $10 for completing the saliva samples. In addition, adolescents were told that they would receive a $20 bonus if inspection of the data indicated that they had completed all the diaries and saliva samples correctly and on time. All participants provided written consent or assent and all procedures were approved by the sponsoring institution's Committee on Human Subjects.

Procedure

Participants were provided with 14 days of diary checklists and a saliva collection kit to complete on Days 2 through 5 of the diaries. These days included both weekdays and weekends. The order of days differed between participants depending on the day of the week that they started; however, all participants had the same proportion of weekday to weekend data if they completed all of the diaries (completion rate 93.8%, with 345 adolescents completing all diaries across all 4 days of saliva collection). Participants were given the choice of completing the diaries with paper and pencil or via a secure website. In order to verify the time that checklists were completed, participants who chose to respond with paper and pencil responses were given 14 manila envelopes and an electronic time stamper (Dymo Corporation, Stamford, CT). The time stamper is a small device that imprints the current date and time and is programmed with a security code so that the correct date and time cannot be changed. Participants were instructed to place their completed checklists into a sealed envelope each night and to stamp the seal of the envelope with the time stamper. Participants who completed surveys online were sent an e-mail with the link to each daily diary survey, and the time and date of completion were recorded via the web site. The daily diary checklists were three pages

long and each took approximately 5–10 min to complete.

Measures

Diurnal Cortisol

Adolescents provided saliva samples via passive drool method on Days 2 through 5 of the daily diaries. These days were selected in order to ensure consistency across participants, and to minimize error by completing samples as soon as possible after the initial instructions. As with the diaries, saliva sample days included both weekdays and weekends, depending on the day of the week that the participant started their diaries. On saliva sample days, participants provided saliva at four timepoints each day for a total of 16 samples: (a) immediately upon wake-up, (b) 30 min after waking up, (c) 5 p.m. (or before dinner), and (d) 8 p.m. (or before bed). Participants were advised to take their samples before or no < 30 min after brushing their teeth, drinking, eating, or using tobacco. Participants recorded the timing of each sample using a log-card and stamped with an electronic time stamper (Dymo Corporation), which printed the current date and time and was programmed with a security code so that participants could not change the accurate and correct date and time. Participants stamped the card beside the heading for each sample and immediately placed the sample in their fridge. At the end of the saliva collection days, participants or research staff brought the samples to the research laboratory, where samples were stored in a −80°C freezer. At the end of the data collection period, the samples were shipped to the Laboratory of Biological Psychology at the Technical University of Dresden, Germany where they were assayed in duplicate using high-sensitivity chemiluminescence-immunoassays (IBL International, Hamburg, Germany). The inter-assay coefficient of variation was < 8%.

We computed diurnal slope, CAR, and AUC using standard formulas. Specifically, diurnal slopes were the difference between the fourth (bedtime) cortisol sample and the first morning sample, divided by the time elapsed between these two samples (Pruessner et al., 2003). CAR was the increase in cortisol from wake to 30 min post-wake (Pruessner et al., 2003). For samples 1 and 2, which were used to compute CAR, 15–45 min between the two samples was considered to be on time (Adam & Kumari, 2009). According to this metric, 98% of samples were collected on time. Seven

samples were collected more than 45 min apart. Four additional samples were not collected in the morning, but upon waking in the afternoon. The total cortisol AUC was computed using the trapezoid method (Pruessner et al., 2003). Raw cortisol values exceeding 60 nmol/L were flagged as outliers and excluded from analyses.

Family Assistance

Daily family assistance data from the 4 days that salivary cortisol was collected (and 1 day prior for CAR analyses) were used for our analyses in order to best capture potential associations between daily family assistance and diurnal cortisol. Daily family assistance was measured by a set of questions on the daily checklist that asked participants to indicate whether they did any of the following activities to help their family each day: helped to clean your apartment or house, took care of your brothers or sisters, ran an errand for your parents or family, helped your brothers or sisters with their schoolwork, helped to cook a meal for your family, provided emotional support to your family, (i.e., listened, gave advice, comforted). The list of activities was derived from focus group studies of adolescents and has been used successfully in previous studies with these populations (Fuligni et al., 2009; Hardway & Fuligni, 2006; Telzer & Fuligni, 2009a). A Family Assistance variable was created by summing the number activities that the adolescent performed each day, ranging from 0 to 7.

Daily Psychological Experience

Daily psychological experience was assessed with items on the daily checklist that were drawn from the Profile of Mood States (McNair, Lorr, & Droppleman, 1971). Adolescents used a 5-point scale ranging from 1 (not at all) to 5 (extremely) to indicate the extent to which they felt a number of emotions each day. A Distress variable was calculated from nine items (sad, hopeless, discouraged, on edge, unable to concentrate, uneasy, nervous, stressed, worried), overall Cronbach's $\alpha = .92$, daily $\alpha = .858–.942$. A Happiness variable was calculated from two items (joyful and happy), overall $\alpha = .80$, daily $\alpha = .740–.836$. A Burnout variable was calculated from three items (fatigue, exhausted, and worn-out), overall $\alpha = .84$, daily $\alpha = .803–.881$. A Role Fulfillment variable was calculated from two additional items in the daily diary in which participants responded on a 7-point Likert-type scale

ranging from 1 (*not at all*) to 7 (*extremely*) to report the extent to which they felt like "a good son or daughter" and "a good brother or sister" that day. Role fulfillment was calculated as the mean of the available data from these two items, overall α = .80, daily α = .664–.856.

Data Analysis

Analyses included linear mixed effect models that nested days (Level 1) within participants (Level 2). Fixed effects were tested at the level of participants (i.e., Level 2). This statistical approach accounts for dependency within participants and introduces less bias due to missing data compared to traditional statistical analyses, such as repeated measures analysis of variance (Bryk & Raudenbush, 1992; Finch, Bolin, & Kelley, 2014). To manage missing data, we used listwise deletion for person-day elimination. All analyses were conducted using Statistical Analysis Software (Version 9.4, SAS Institute, Cary, North Carolina).

To examine whether family assistance relates to cortisol, we conducted linear mixed effects models that included family assistance as a Level 1 predictor of cortisol parameters (diurnal slope, CAR, AUC), each examined independently in separate analyses. To examine whether family assistance relates to daily psychological experience, we conducted linear mixed effect models that included family assistance as a Level 1 predictor of four variables of daily psychological experience: distress, happiness, burnout, and role fulfillment. To examine whether daily psychological experiences explain the link between family assistance and cortisol outcomes, we modeled CAR as a function of family assistance and role fulfillment in a linear mixed mediation model. This allowed us to test whether family assistance-related differences in CAR persist after accounting for role fulfillment, when controlling for race, sex, and age. We conducted a mediation of lower level effect ($1 \rightarrow 1 \rightarrow 1$ mediation), which is recommended for multilevel data (Bauer, Preacher, & Gil, 2006). We used Soble's test to determine the indirect effect.

Age, sex, and race or ethnicity were included as covariates in all analyses, given that preliminary analyses indicated that each was related to cortisol, family assistance, or both (see Table 1). Sex was coded male = 0 and female = 1. Race was dummy coded within each race (i.e., African American = 1, not African American = 0). Age was entered as numeric age. Because SES (as measured by maternal education) was not significantly related to

Table 1
Descriptive Statistics for Primary Constructs, Overall and by Sample Demographics

	Overall	Female	Male	White	African American	Asian	Hispanic	Mixed/other	r Age
					M (SD)				
AUC	160.28 (88.14)	165.94 (97.70)[1]	152.51 (72.35)[0]	167.49 (89.59)[B]	155.16 (99.48)[B]	169.08 (70.92)[B]	114.74 (83.11)[C]	193.22 (94.04)[A]	−.20***
CAR	4.68 (13.74)	5.10 (14.79)[0]	4.13 (12.20)[0]	5.81 (13.93)[A]	5.82 (12.27)[A]	3.79 (15.25)[A,B]	1.35 (9.23)[B]	6.50 (15.21)[A]	−.07*
Cortisol slope	−1.27 (1.04)	−1.30 (1.14)[0]	−1.22 (0.85)[0]	−1.39 (1.04)[C]	−1.07 (1.10)[A,B]	−1.36 (0.81)[C]	−0.91 (1.31)[A]	−1.25 (0.93)[C,B]	.18***
Family assistance	1.63 (1.45)	1.86 (1.52)[1]	1.30 (1.28)[0]	1.82 (1.41)[B]	1.77 (1.34)[B]	1.24 (1.38)[D]	1.49 (1.32)[C]	2.20 (1.82)[A]	.08***
Role fulfillment	4.91 (1.34)	4.94 (1.35)[0]	4.87 (1.32)[0]	5.07 (1.32)[A]	5.07 (1.45)[A]	4.61 (1.23)[B]	4.96 (1.44)[A]	5.03 (1.36)[A]	−.01
Distress	1.64 (0.78)	1.72 (0.86)[1]	1.53 (0.65)[0]	1.66 (0.77)[A]	1.70 (0.84)[A]	1.60 (0.77)[B]	1.31 (0.56)[C]	1.65 (0.90)[A,B]	.09***
Burnout	2.09 (1.05)	2.19 (1.11)[1]	1.94 (0.94)[0]	2.19 (1.06)[B]	2.36 (1.13)[A]	1.90 (0.98)[C]	1.89 (0.97)[C]	2.13 (1.07)[B]	.12***
Happiness	3.27 (1.07)	3.27 (1.08)[0]	3.28 (1.06)[0]	3.43 (1.04)[A]	3.14 (1.24)[B]	3.11 (0.99)[B]	3.39 (1.07)[A]	3.14 (1.19)[B]	−.05**

Note. For race, means with the same letter are not significantly different. For sex, means with the same number are not significantly different. For age, correlations. AUC = area under the curve; CAR = cortisol awakening response.
*p < .05. **p < .01. ***p < .001.

family assistance (p = .33) or cortisol outcomes (ps = .3–.7), we did not include it as a covariate in analyses.

Results

Sample Characteristics

Table 1 displays sample characteristics for primary constructs, overall and by sample demographics. Table 2 displays bivariate correlations among the major constructs of interest, which represent the averages across the diary days. As indicated in Table 2, cortisol indices showed expected correlations with each other, and daily psychological experience variables also showed expected correlations with each other. The only cortisol outcome showing a significant association with family assistance was the next-day CAR, which was inversely correlated with family assistance.

Family Assistance and Cortisol

To examine the association between family assistance and diurnal cortisol, we modeled the daily level association between cortisol outcomes (diurnal slope, CAR, AUC) as a function of family assistance in three separate models. Each outcome on a particular day for a particular adolescent was modeled as a function of the average of that outcome of the adolescent across days and their daily family assistance, controlling for their race, age, and sex. A random intercept was included for each subject.

Results indicate that daily family assistance was significantly associated with CAR, such that on days when adolescents assisted their families more, they had lower CAR the next day compared to days when they assisted their families less (see

Table 3). There was no association between family assistance and AUC or diurnal slope (ps > .11).

Family Assistance and Daily Psychological Experience

To examine associations between family assistance and daily psychological experience, we next modeled happiness, burnout, distress, and role fulfillment as a function of family assistance, in a linear mixed model, again controlling for race, age, and sex. We used a similar model as with our first aim but replaced the cortisol outcomes with each daily psychological experience.

Overall, participants reported fewer negative and more positive psychological outcomes on days that they assisted their families more (see Table 4). Specifically, family assistance was negatively associated with distress and burnout, such that on days that participants helped their families more, they reported feeling less distress and less burnout compared to days when they helped their families less. Conversely, family assistance was positively associated with happiness and role fulfillment, such that on days that participants helped their families more, they reported more happiness and role fulfillment compared to days when they helped their families less. Overall, these results suggest that daily family assistance is associated with decreased negative psychological experiences and increased positive psychological experiences.

Daily Psychological Experience and Cortisol

To examine associations between daily psychological experience and cortisol, we next modeled each cortisol outcome (diurnal slope, CAR, AUC) as a function of each psychological variable (distress, burnout, happiness, and role fulfillment) in a mixed linear model, again controlling for age, sex, and

Table 2

Partial Correlations Among Major Constructs Controlling for Sex, Age, and Race

	AUC	CAR	Slope	Family assistance	Role fulfillment	Distress	Burnout
CAR	−.01						
Slope	−.45***	.07*					
Family assistance	.00	−.07**	−.05				
Role fulfillment	.00	−.08**	−.02	.25***			
Distress	.01	.04	.05	.03	−.30***		
Burnout	.02	−.01	.07*	.04*	−.16***	.58***	
Happiness	−.03	−.01	.03	.18***	.46***	−.25***	−.11***

Note. AUC = area under the curve; CAR = cortisol awakening response.
*p < .05. **p < .01. ***p < .001.

Table 3
Daily Level Associations Between Adolescents' Family Assistance and Cortisol Outcomes

	CAR B (SD)	AUC B (SE)	Diurnal slope B (SE)
Intercept	11.66 (5.71)*	314.24 (40.47)***	−3.19 (0.43)***
Sex	1.65 (0.98)	15.95 (6.96)*	−0.10 (0.07)
Age	−0.34 (0.39)	−10.41 (2.80)***	0.13 (0.03)***
Race (reference = White)			
African American	−0.26 (1.55)	−7.56 (11.21)	0.31 (0.12)**
Asian	−2.65 (1.21)*	−2.88 (8.61)	0.04 (0.09)
Hispanic	−4.07 (1.56)**	−35.58 (11.19)**	0.22 (0.12)
Other/mixed	2.74 (2.38)	6.36 (16.77)	0.10 (0.18)
Family assistance	−0.99 (0.32)**	−2.30 (2.08)	−0.04 (0.02)

Note. Sex was coded male = 0 and female = 1. Race was dummy coded within each race (i.e., African American = 1, not African American = 0). AUC = area under the curve; CAR = cortisol awakening response.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 4
Daily Level Associations Between Adolescents' Family Assistance and Psychological Outcomes

	Role fulfillment B (SE)	Happiness B (SE)	Distress B (SE)	Burnout B (SE)
Intercept	5.59 (0.70)***	4.35 (0.51)***	0.74 (0.42)	0.72 (0.51)
Sex	−0.04 (0.12)	−0.08 (0.09)	0.20 (0.07)**	0.21 (0.09)*
Age	−0.05 (0.05)	−0.07 (0.04)	0.06 (0.03)*	0.10 (0.04)**
Race (reference = White)				
African American	0.07 (0.20)	−0.30 (0.15)*	−0.03 (0.12)	0.12 (0.14)
Asian	−0.37 (0.15)*	−0.32 (0.11)**	−0.04 (0.09)	−0.24 (0.11)*
Hispanic	0.08 (0.19)	0.17 (0.14)	−0.46 (0.29)	−0.40 (0.14)**
Other/mixed	−0.23 (0.24)	−0.34 (0.18)	−0.04 (0.14)	−0.15 (0.17)
Family assistance	0.12 (0.01)***	0.05 (0.01)***	−0.04 (0.01)***	−0.03 (0.01)**

Note. Sex was coded male = 0 and female = 1. Race was dummy coded within each race (i.e., African American = 1, not African American = 0).
*$p < .05$. **$p < .01$. ***$p < .001$.

race. We used a similar model as in our first and second aims but replaced the independent and dependent variables.

We first modeled CAR as a function of each psychological variable. Role fulfillment was negatively associated with CAR, such that when participants experienced more role fulfillment, they had lower CAR the next day compared to days when they experienced less role fulfillment (Table 5). Burnout was marginally negatively associated with next day CAR, and distress and happiness were not related to next-day CAR ($p > .726$).

We also modeled diurnal slope and AUC each as a function of each psychological variable. Burnout was positively associated with diurnal slope, ($B = 0.06$, $SE = 0.03$, $p = .042$), whereas distress, happiness, and role fulfillment were not related to

diurnal slope ($p > .122$). Distress was marginally and positively associated with AUC ($B = 7.00$, $SE = 4.10$, $p = .089$), whereas burnout, happiness, and role fulfillment were not related to AUC ($p > .167$).

Does Role Fulfillment Explain Differences in CAR?

Since daily family assistance was negatively associated with next-day CAR, we examined potential psychological mechanisms that could explain this association and unpack whether this cortisol response likely represents a low-risk or high-risk profile. Of our psychological variables of interest, only role fulfillment was related to next-day CAR and family assistance and so was a potential mediator. Mediation analysis indicated that the total effect

Table 5

Daily Level Associations Between Adolescents' CAR and Psychological Outcomes

	Role fulfillment B (SD)	Happiness B (SD)	Distress B (SD)	Burnout B (SD)
Intercept	5.50 (0.72)***	4.11 (0.55)***	0.97 (0.43)*	0.85 (0.55)
Sex	0.03 (0.12)	−0.11 (0.09)	0.18 (0.08)*	0.23 (0.09)*
Age	−0.04 (0.05)	−0.04 (0.04)	0.04 (0.03)	0.09 (0.04)*
Race (reference = White)				
African American	−0.02 (0.20)	−0.40 (0.15)**	0.03 (0.11)	0.17 (0.15)
Asian	−0.29 (0.15)	−0.28 (0.12)*	0.00 (0.09)	−0.15 (0.12)
Hispanic	0.08 (0.20)	−0.00 (0.15)	−0.40 (0.27)	−0.42 (0.15)**
Other/mixed	−0.10 (0.30)	−0.38 (0.23)	0.06 (0.18)	−0.06 (0.23)
CAR	−0.89 (0.34)*	−0.047 (0.41)	0.23 (0.66)	−0.75 (0.41)

Note. Sex was coded male = 0 and female = 1. Race was dummy coded within each race (i.e., African American = 1, not African American = 0). CAR = cortisol awakening response.
*$p < .05$. **$p < .01$. ***$p < .001$.

of family assistance on CAR was significant (estimate = −.932, $p = .002$, 95% CI [−.148, −.155]). The effect of family assistance on role fulfillment was also significant (estimate = .156, $p < .001$, 95% CI [.103, .210]), as was the effect of role fulfillment on CAR (estimate = −.730, $p = .032$, 95% CI [−1.398, −.062]). The direct effect of family assistance on CAR was also significant (estimate = −.818, $p = .015$, 95% CI [−1.534, −.329]). Finally, the mediation effect of role fulfillment was significant (estimate = −.114, $p = .048$, 95% CI [−.227, −.001]). These results suggest that role fulfillment explains, in part, the association between family assistance and CAR.

We reran all models with instrumental support (six items) and emotional support (one item) separately as predictors, given previous work suggesting that instrumental support is linked with differential outcomes compared to emotional support (Tsai, Gonzales, & Fuligni, 2016). The results remained the same. We also reran all models excluding participants who were taking steroid medications ($N = 4$) and the results remained the same.

Exploratory Analysis With Demographics

Finally, we conducted exploratory analyses to examine whether the associations between family assistance and outcomes varies by race, age sex, and SES. We modeled CAR and psychological outcomes (i.e., role fulfillment, happiness, distress, and burnout) each as a function of family assistance with race, age sex, and SES entered as cross-level interactions (see Table 6). Male and White youth served as the reference group. The association

between family assistance on CAR did not vary by age, sex, or SES. We did find significant differences for Hispanic and other and mixed race youth, who differed from White youth. For both groups, their CAR was higher than White youth following days when they assisted their family more. See Table 6 for cross-level interaction for family assistance on role fulfillment, happiness, distress, and burnout.

Discussion

The present study examined family assistance, the act of providing instrumental and emotional support to one's family, which is a significant yet understudied aspect of family interactions during adolescence. Results from the present study contribute to a growing body of research that has highlighted both positive and negative psychological, social, and biological consequences of family assistance during adolescence; Here, we provide the first known evidence of how helping the family during the teenage years relates to diurnal cortisol rhythm, an index of HPA activity, as well as psychological outcomes. Our results indicate that family assistance is associated with lower next-day CAR, which is mediated by greater role fulfillment.

The primary goal of this study was to examine the association between family assistance and diurnal cortisol outcomes. Analyses indicated that greater family assistance predicts lower next-day CAR, suggesting that providing more assistance to the family on one day is associated with lower cortisol reactivity upon waking the following day. Interestingly, daily family assistance was not related to diurnal slope or AUC. Why might

Table 6

Cross-Level Interactions in the Association Between Family Assistance and Outcomes

	CAR B (SD)	Role fulfillment B (SD)	Happiness B (SD)	Distress B (SD)	Burnout B (SD)
Individual level					
Intercept	9.47 (5.87)	5.59 (0.70)***	4.35 (0.52)***	0.72 (0.43)	0.76 (0.52)
Sex	1.32 (1.01)	−0.04 (0.12)	−0.08 (0.09)	0.18 (0.08)*	0.19 (0.09)*
Age	−0.27 (0.40)	−0.05 (0.05)	−0.07 (0.04)	0.07 (0.03)*	0.10 (0.04)**
SES	0.05 (0.32)	0.04 (0.04)	0.02 (0.03)	−0.03 (0.02)	−0.02 (0.03)
Race (reference = White)					
African American	−0.21 (1.61)	0.08 (0.20)	−0.25 (0.14)	−0.08 (0.12)	0.01 (0.14)
Asian	−2.63 (1.31)*	−0.39 (0.16)*	−0.34 (0.11)**	0.00 (0.09)	−0.21 (0.11)
Hispanic	−3.92 (1.80)*	0.12 (0.21)	0.18 (0.16)	−0.25 (0.26)	−0.46 (0.16)**
Other/mixed	1.44 (2.47)	−0.16 (0.29)	−0.35 (0.22)	0.02 (0.18)	−0.08 (0.22)
Family assistance	−1.08 (0.67)	0.16 (0.03)***	0.06 (0.02)*	−0.04 (0.02)*	−0.02 (0.02)
Sex	−1.02 (0.70)	−0.04 (0.03)	0.01 (0.03)	−0.05 (0.02)*	−0.06 (0.03)*
Age	−0.19 (0.28)	−0.01 (0.01)	0.00 (0.01)	0.01 (0.01)	−0.00 (0.01)
SES	0.40 (0.22)	0.02 (0.01)*	0.01 (0.01)	−0.01 (0.01)*	−0.02 (0.01)*
Race (reference = White)					
African American	1.62 (1.09)	−0.03 (0.04)	−0.03 (0.04)	0.08 (0.03)**	0.05 (0.04)
Asian	0.78 (0.87)	−0.01 (0.04)	−0.02 (0.03)	0.03 (0.02)	0.02 (0.03)
Hispanic	2.48 (1.24)*	0.08 (0.08)	0.03 (0.06)	0.13 (0.08)	0.15 (0.06)*
Other/mixed	2.91 (1.36)*	−0.05 (0.06)	−0.05 (0.05)	0.04 (0.04)	−0.04 (0.05)

Note. Sex was coded male = 0 and female = 1. Race was dummy coded within each race (i.e., African American = 1, not African American = 0). CAR = cortisol awakening response; SES = socioeconomic status.
*$p < .05$. **$p < .01$. ***$p < .001$.

family assistance be related to CAR and not to diurnal slope or AUC? Part of the explanation might be that CAR is relatively independent from cortisol output during the rest of the day and is only loosely associated with later diurnal cortisol (Schmidt-Reinwald et al., 1999; Edwards, Clow, Evans, & Hucklebridge, 2001). As such, it may operate on different regulatory mechanisms compared to diurnal slope and AUC (Chida & Steptoe, 2009). Indeed, previous meta-analyses indicate that psychosocial experiences have unique and significant associations with CAR, suggesting that it may particularly be sensitive to psychosocial processes relative to other cortisol indicators (Chida & Steptoe, 2009). A second part of the explanation might be because of temporal delay, or daily experiences taking a day to translate into biological profiles to "get under the skin." Prior literature suggests that CAR reflects both an anticipatory mobilization of the stress response system for the upcoming day, and also a reflection of prior-day life events (Adam et al., 2006; Chida & Steptoe, 2009). These results provide further evidence of the association between CAR and previous-day experiences, in contrast to other cortisol indices (Chida & Steptoe, 2009).

Understanding the psychological mechanisms by which family assistance relates to cortisol helps to elucidate if such associations are positive or negative, given that both blunted and heightened cortisol are related to negative outcomes (Chida & Steptoe, 2009). As such, we examined links between daily family assistance, positive and negative daily psychological experiences, and cortisol output. We found that adolescents reported less distress and burnout, and more happiness and role fulfillment, on days that they helped their families more. A reduction in distress and burnout and an increase in happiness and role fulfillment as a function of greater family assistance are meaningful outcomes in and of themselves, as they are key indices of psychological well-being (Telzer & Fuligni, 2009b). Furthermore, these psychological experiences are important because they contribute to a variety of other positive outcomes in youth, ranging from school achievement and school behaviors (Quinn & Duckworth, 2007) to physical health, both in the short and long term (Mahon, Yarcheski, & Yarcheski, 2005; Trzesniewski et al., 2006). These results are consistent with prior research documenting how helping the family is associated with meaningful psychological benefits for adolescents (Fuligni &

Telzer, 2013; Telzer & Fuligni, 2009b). Further, they are also consistent with work demonstrating that, generally, providing daily assistance to the family is not uniformly associated with stress (Fuligni, Yip, & Tseng, 2002; Telzer & Fuligni, 2009b) but rather can contribute to feelings of happiness and role fulfillment (Telzer & Fuligni, 2009b; Walsh, Shulman, Bar-On, & Tsur, 2006). Together, these results replicate and reiterate the beneficial psychological outcomes associated with moderate assistance to the family during adolescence.

Since moderate levels of CAR are associated with optimal functioning and outcomes, it was important to examine whether reductions in CAR were negative (i.e., blunting to an unhealthy degree) or positive (i.e., lowering to normative, healthy levels; Chida & Steptoe, 2009). We chose to examine role fulfillment as a mediator given previous evidence that role fulfillment mediates the association between family assistance and happiness on a daily level (Telzer & Fuligni, 2009b). If the association between family assistance and CAR was mediated by distress or burnout (or other negative psychological constructs), then that would suggest that lower CAR is potentially signaling a maladaptive stress response. However, the association between family assistance and CAR was explained, in part, by a positive psychological experience (i.e., role fulfillment). This suggests that family assistance is associated with a positive reduction in CAR, rather than negative blunting. Given the inconsistency of prior literature in terms of distinguishing whether relatively lower or higher CAR responses are adaptive or maladaptive, we chose to utilize this approach of examining shared variance (i.e., with role fulfillment) to untangle the potential mechanism at play. However, we also acknowledge that this is somewhat exploratory and cannot definitively indicate that lower CAR is healthier. With this acknowledgment, our findings are consistent with prior research showing that role fulfillment, in conjunction with family assistance, is associated with positive health outcomes in youth. Prior research indicates, for example, that role fulfillment partly explains the link between family assistance and happiness on a daily level (Telzer & Fuligni, 2009b) and adolescents who feel greater role fulfillment from helping their family show increased activity in reward-related brain regions when contributing to their family (Telzer, Fuligni, Lieberman, & Galván, 2013). Taken together, these findings highlight the importance of adolescents' feelings of role fulfillment when helping the family

for predicting well-being. The present findings build on existing literature by demonstrating that role fulfillment may also be an important mechanism linking adolescents' daily family experience and HPA axis functioning.

Finally, we conducted exploratory analyses to see if the associations between family assistance and CAR varied by race, age, SES, and sex (Table 6). The association between family assistance and lower CAR did not vary by these variables, with the exception of the Hispanic and Other and Mixed race group, who showed a higher CAR response following days when they assisted their family more. Given the small sample and heterogeneity of the Mixed race youth, we do not interpret this further. The effect for the Hispanic youth is consistent with previous research suggesting that Hispanic youth value family obligation and engage in more family assistance compared to other groups (Telzer & Fuligni, 2009b). Although family assistance may be valued more among Hispanic youth, it has also been linked to poorer school performance in Mexican compared to European youth, suggesting that it is a more demanding or stressful daily activity in Hispanic families, perhaps due to higher overall levels of family assistance behaviors (Telzer & Fuligni, 2009a). Indeed, the current study also shows more burnout on days of greater family assistance among Hispanic youth compared to White youth. Future research should further examine how the association between family assistance and cortisol responses is moderated by race and ethnicity. Future research should also examine other contextual variables as potential moderators, family conflict, parental distress, or extreme economic hardship (Tsai, Telzer, Gonzales, & Fuligni, 2013; Telzer, Tsai, Gonzales, & Fuligni, 2015).

In understanding the implications of helping the family during adolescence, it is important to draw a distinction between moderate levels of family assistance, such as those studied here, and intense family caregiving responsibilities. This study does not differentiate between family assistance that is perceived as excessively demanding versus that which is experienced positively, but future research should examine that distinction. Indeed, data suggest that over 1 million youth in the United States between ages 8 and 18 provide high levels of daily care for a parent, sibling, or other relative in need of assistance at home (Hunt, Levine, & Naiditch, 2005), which is distinct from the moderate levels of family assistance that are the focus of the present study. This intensity of care provided by children and adolescents may be present more often in

family contexts that are characterized by parental illness or poverty (Telzer & Fuligni, 2009a; Tsai et al., 2016; Kavanaugh, Stamatopoulos, Cohen, & Zhang, 2016). Intense levels of family care during childhood and adolescence may be associated with more negative psychological outcomes (Burton, 2007; Shifren & Chong, 2012; Siskowski, 2006; East & Weisner, 2009) compared to the family assistance studied here. Future research should establish a clear distinction between moderate levels of family assistance and intense caregiving and investigate potential differential impacts on psychological and physiological functioning.

Several limitations in the current study should be acknowledged. First, we were unfortunately unable to control for sleep, physical activity, smoking, or alcohol, all of which could impact cortisol. We were also unable to control completely for medication use as we only collected this information from a small subset of participants. Future research should carefully control for these variables. Due to the rich nature of our daily diary and cortisol assessments, there was also a level of missing data. Days that adolescents did not provide daily dairy or cortisol data might represent some of their most difficult days, and thus we may be missing important days that were more stressful for adolescents. Further, there may be selection biases, as youth who did not participate in the study may come from the most difficult home contexts, for example, those experiencing economic hardship, parental illness, or absence. Thus, we may be missing an important subset of adolescents. In addition, our measure of family assistance was a count measure of the number of different family assistance activities adolescents completed, and it did not take into consideration the amount of time spent on each activity. As such, it is unclear from the current study how timing or intensity may affect the association between family assistance, cortisol and psychological experience. Future work should measure the timing and chronicity of family assistance to provide a more nuanced index of this type of activity. In addition, many other variables could impact if, how, and when adolescents help the family. For example, this study does not address whether family assistance is internally or externally motivated, although prior evidence suggests that family assistance increases with family need (Tsai et al., 2016). Unpacking the motivation and context of family assistance behaviors in adolescence can further disentangle the complex relation between helping behaviors and psychobiological indices. Future work should also continue to distinguish between emotional support and instrumental support (Tsai et al., 2016), and examine potentially different associations between these two types of family assistance and biological and psychological outcomes. Finally, although the present study utilizes daily diary methods that can account for individual differences and thus offer robust predictive power (Telzer & Fuligni, 2009b), the direction of causality between family assistance, CAR, and role fulfillment cannot be determined in this study. Future experimental work could address this issue by randomly assigning adolescents to assist their families (or not) and examine the psychological and biological outcomes of such a manipulation.

Conclusions

The results of this study highlight a possible biological and psychological benefit of assisting the family in moderate amounts during the teenage years. This is the first known study to examine how daily family assistance relates to daily variations in cortisol output, thus providing greater insight into how cortisol varies and fluctuates in connection with normative daily behaviors in adolescents' lives. The strength of our findings lies in daily diary methodology and daily saliva sample collection, and in the diverse and relatively large sample of adolescents. This work builds on a growing body of literature chronicling positive associations with family assistance and role fulfillment, ranging from academic success (Telzer & Fuligni, 2009a) to a reduction in risk-taking behaviors (Telzer et al., 2013) and extends these findings to cortisol and the HPA axis, an important indicator of short-term and long-term physical and mental health, for the first time. Overall, our findings highlight how assisting the family may be a valuable activity for adolescents that contributes to a sense of role fulfillment, thus increasing their psychological and physiological well-being.

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