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Objective: Prior research has shown that early life adversity is associated with physical health problems, but little is known about the health-related effects of coping in the context of having a parent with HIV/AIDS. The goal of this study was to investigate the associations between positive and negative coping strategies and diurnal cortisol among children affected by parental HIV/AIDS. ***Method:*** Participants were 645 children aged 8–15 affected by parental HIV/AIDS, who provided 4 saliva samples per day over 3 days (2 weekdays and 1 weekend day) to assess diurnal cortisol. Positive and negative coping strategies were measured via self-report prior to saliva collection. Possible confounds of the associations between coping and diurnal cortisol also were assessed, including age, gender, socioeconomic status, parenting quality, parental death, other stressful life events, sleep quality, and perceived health status. ***Results:*** Greater positive coping (e.g., problem solving, cognitive reframing) was associated with children's higher morning cortisol ($p = .037$), whereas greater negative coping (e.g., fighting, breaking things) was independently associated with lower morning cortisol ($p = .038$) and a flatter diurnal cortisol slope ($p = .003$). These associations remained significant after controlling for potential confounds. Neither positive coping nor negative coping interacted with stressful life circumstances to predict cortisol (all $ps > .27$). ***Conclusion:*** These findings indicate the extent to which a child's coping strategy is associated with indicators of stress biology in the context of having a parent with HIV/AIDS.

Keywords: coping, cortisol, HPA, parental HIV/AIDS, child health

Worldwide, 17.3 million children under the age of 18 had lost one or both parents to AIDS, and millions more were living with HIV-infected parents as of 2011 (UNICEF, 2013). Children affected by HIV/AIDS face numerous challenges, including a greatly increased risk of poverty, disrupted schooling, discrimination and stigma, inadequate health care, and social isolation (Wild, 2001). Over the last decade, there has been a growing interest in the well-being of children affected by parental HIV/AIDS, as evidenced by comprehensive reviews on the topic (Chi & Li, 2013; Cluver & Gardner, 2007; Foster & Williamson, 2000). However, less attention has been given to the links between psychosocial factors and physical health among children of parents with HIV/

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AIDS. Because such children often are traumatized, with a variety of possible negative psychological reactions to parental illness and death (Foster, 2002; Sengendo & Nambi, 1997), the potential for associated physical health problems for these children is high. One potential ameliorating factor of the difficulties of having a parent with HIV/AIDS is *coping*, defined as the thoughts and behaviors used to manage the internal and external demands of situations that are appraised as stressful (Folkman & Moskowitz, 2004). In this article, we report the results of a study that investigated the associations between positive and negative coping strategies and diurnal cortisol, a biomarker of physiological stress, among children affected by parental HIV/AIDS in rural China.

Cortisol is the body's primary stress hormone, produced by the hypothalamic-pituitary-adrenal (HPA) axis. The HPA axis has attracted particular attention from researchers because of its sensitivity to psychological stress and its effects on multiple biological systems throughout the body. This system is present in a wide range of organisms from birds to humans and can be activated by an array of psychological and physical stressors (McEwen, 1998; McEwen & Stellar, 1993; Miller, Chen, & Zhou, 2007; Sapolsky, Romero, & Munck, 2000). It is difficult to overstate the biological reach of cortisol, for which receptors exist in nearly every cell of the human body. As a regulatory hormone, cortisol is involved in learning, memory, and emotion in the central nervous system, regulation of gluconeogenesis in the metabolic system, particularly in times of threat (the fight-or-flight response), and regulation of the immune system (Miller et al., 2007; Sapolsky et al., 2000).

There is a diurnal rhythm to cortisol, with levels peaking approximately 30 minutes after a person wakes, then slowly decreasing over the course of the day to its nadir shortly before bedtime. Flattened diurnal cortisol slope (less decline throughout the day) is thought to be less "healthy" and a marker of a dysregulated stress response system because it indicates that one's stress hormones are remaining unusually high as the day progresses, thus contributing to greater allostatic load (McEwen, 1998). Dysregulation of the HPA axis is associated with a number of poor health outcomes, including compromised immune functioning (Cohen, Janicki-Deverts, et al., 2012), inflammation (DeSantis et al., 2012; Rueggeberg, Wrosch, Miller, & McDade, 2012), diabetes (Schoorlemmer, Peeters, van Schoor, & Lips, 2009), lung disease (Schoorlemmer et al., 2009), hippocampal atrophy (Sapolsky, 2000), and cardiovascular disease (Matthews, Schwartz, Cohen, & Seeman, 2006). The available evidence suggests that flatter diurnal cortisol slopes especially are indicative of poorer future health, with links to mortality in at least four recently published studies of adults (Cohen, Cole, et al., 2012; Kumari, Shipley, Stafford, & Kivimaki, 2011; Sephton et al., 2013; Sephton, Sapolsky, Kraemer, & Spiegel, 2000). It is thought that cortisol dysregulation during childhood, marked by flatter diurnal cortisol slopes, may be a pathway through which early life adversity can negatively impact future health in young adulthood and beyond (Miller, Chen, & Parker, 2011; Slatcher & Robles, 2012). To our knowledge, no studies have examined the links between psychosocial factors and diurnal cortisol function among children affected by parental HIV/AIDS.

Recently, much attention has been given to understanding how some children can thrive in the face of massive adversity (Chen & Miller, 2012). It is likely that one key to understanding how children thrive during adverse experiences is the extent to which they have strong coping skills. Coping is a key predictor of well-being among children affected by parental HIV/AIDS (Chi & Li, 2013) and likely plays a role in buffering the physiological effects of HIV/AIDS-related stressors. Although research examining the connections between coping and HPA function in childhood is scant, adult research has shown that coping style is associated with daily cortisol production (O'Donnell, Badrick, Kumari, & Steptoe, 2008; Sjögren, Leanderson, & Kristenson, 2006; Wrosch, Schulz, Miller, Lupien, & Dunne, 2007). For example, positive coping characteristics such as personal mastery and sense of control are associated with steeper (healthier) cortisol slopes over the course of the day, and problem engagement and support-seeking are associated with lower overall cortisol levels (O'Donnell et al., 2008). Among patients who recently underwent arthroscopic knee surgery, higher levels of avoidance, considered a negative coping strategy, were associated with higher serum cortisol levels and poorer physical functioning in the days following the operation (Rosenberger, Ickovics, Epel, D'Entremont, & Jokl, 2004).

The current study examined the associations between positive and negative coping styles and diurnal cortisol patterns in a large sample of children aged 8 to 15 years, who were affected by parental HIV/AIDS in rural China. We hypothesized that a positive coping style—including the use of cognitive reframing, problem solving, and expressing feelings—would be associated with steeper (healthier) diurnal cortisol slopes, whereas a negative coping style—assessed as a propensity to hurt others or oneself as a reaction to stressful life experiences—would be associated with flatter (less healthy) cortisol slopes. We also examined the associations between coping and cortisol values at wakeup and the cortisol awakening response (CAR; i.e., the typical rise in cortisol approximately 30 minutes after awakening). Although wakeup cortisol levels and CAR often are examined in daily cortisol studies, their association with coping remains unclear, as does their relevance for physical health. In secondary analyses, we controlled for potential confounds of the associations between coping and diurnal cortisol, including age, gender, socioeconomic status, parenting quality, stressful life events, parental death from HIV/AIDS, daily sleep quality, wake time, weekday versus weekend, and perceived health status. Finally, we explored whether positive or negative coping interacted with two different measures of stress: stressful life events and the death of a parent from HIV/AIDS. This allowed us to test whether the links between coping and diurnal cortisol are especially strong in the context of stressful events (a *buffering* effect) or whether coping skills are associated with diurnal cortisol across both more stressful and less stressful contexts (*main* effects).

Method

Participants

Baseline data from a randomized controlled trial of a psychosocial intervention study were utilized in the current study. A community sample of 790 children aged 6–17 affected by parental HIV and their current primary caregivers were recruited in the intervention trial in a rural county in central China, where many residents have been infected with HIV through unhygienic blood collection practices. Of the larger sample of 790 children, 746 fit the inclusion criterion of 8 to 15 years of age, based on the age

range for which the self-report measures used in the present analyses were normed. Of those 746 children, 645 (86.4%) provided saliva samples for cortisol analyses. Thus, the final sample for our analyses was 645. Among the participants (335 boys, 310 girls), 12.8% reported that one or both of their parents succumbed to HIV/AIDS. Mean age was 10.67 years (SD = 1.79). Approximately 99% were of Han ethnicity, which is the predominant ethnic group in China. About 78% reported that they were living with one or both parents; other children reported they were living with nonparent caregivers (i.e., grandparents, relatives, siblings, and nonrelatives). A majority of caregivers (88.8%) reported a household income under 2,000 Yuan (approximately $U.S.324) per month. Most of the caregivers (94.1%) reported an educational level of middle school or below.

Procedure

Data were collected in 2012 with a protocol that was approved by the Institutional Review Board at Wayne State University in the United States and Henan University in China. We recruited the children and their primary caregiver through the village, together with the local school system. We first accessed village-level HIV surveillance data from the county's anti-epidemic station to identify villages with the highest numbers of HIV-infected individuals and HIV-related deaths in the area. We then worked with the local staff to generate lists of families caring for orphans or with confirmed diagnosis of parental HIV/AIDS.[1] We randomly selected families on the lists and approached them. One child per family and his or her primary caregiver were invited to participate in the study.

Children and caregivers completed survey questionnaires. Each participating child completed a confidential survey in Chinese. The survey included detailed measures of demographic information and several psychosocial scales. Most of the surveys were self-administrated in a small group in the presence of two interviewers. For a few children who had reading difficulties, an additional interviewer read the survey items and recorded their responses in a separate room. If there was no available room, the reviewer read the survey items to the child and asked the child to indicate his or her response directly on the questionnaire without saying the answer. About 2% of the participating children were administrated the questionnaire in an individual-based approach. Children also were instructed to collect their saliva samples on particular days (two weekdays and one weekend day following the baseline surveys). Each child received an age-appropriate gift (toys or school supplies) at completion of the survey as a token of appreciation.

Measures

Coping style. A coping strategies checklist was developed for the purpose of this study based on the Children's Coping Strategies Checklist (Ayers, Sandier, West, & Roosa, 1996) and the School-Age Coping Strategies Inventory (Ryan-Wenger, 1990). The children were asked to indicate the typical coping style they used when they faced difficulties and problems (e.g., being criticized by teachers or parents, failing a exam) on a 4-point Likert-type scale ranging from 1 (*unlike me*) to 4 (*like me*). Positive coping style (12 items) tapped three dimensions: cognitive reframing, problem solving, and expressing feelings. Negative coping (4 items) involved "acting out" behaviors, including fighting, breaking something, teasing others, and hurting oneself in the context of facing difficulties and problems. Alpha reliabilities for positive coping and negative coping were .75 and .66, respectively. Our aim in using this coping measure was to select specific dimensions and items that are highly relevant to this population, and ones that we viewed as being most likely to be effectively targeted with the psychosocial intervention currently underway with this sample.

Socioeconomic status (SES). An SES index was created by *z* scoring family income, maternal education, and paternal education and then averaging those three components together to form a single composite.

Parenting quality. Parenting quality was assessed using youth reports of (a) parental responsiveness and (b) having a trusting relationship with their caregiver. Parental responsiveness was assessed with a 6-item scale adapted and back-translated from a previously validated parental responsiveness scale (Jackson, Henriksen, & Foshee, 1998; α = .76 in the current sample). Children were asked to indicate their perception of their caregivers' responsiveness on a 4-point Likert-type scale, ranging from 1 (*never*) to 4 (*always*). Sample items included, "He or she wants to hear about my problems," and "He or she makes me feel better when I am upset." Caregiver relationship trust was assessed using a 19-item scale (Mustillo, Dorsey, & Farmer, 2005). The scale has been adapted and used in this population before and demonstrated good reliability and validity (Zhao et al., 2011; α = .90 in the current sample). Children were asked to indicate the degree of trust in their primary caregiver on a 5-point Likert-type scale from 1 (*never*) to 5 (*very frequently*). Sample items included "Do you initiate contact with him/her during times of crisis?" and "Do you share personal information about yourself with him/her?" Scores on each measure were then z-scored and averaged to form a composite index of parenting quality.

Daily sleep quality. On each of the three mornings that children provided saliva samples for cortisol, they were asked to report on the quality of the prior night's sleep. Children indicated the quality of their sleep on a 4-point Likert-type scale, ranging from 1 (*very bad*) to 4 (*very good*). Sleep quality values were examined at the daily level in their relation to cortisol and also averaged across the 3 days of data collection to create an aggregate measure of overall sleep quality. Thus, we were able to simultaneously account for both daily sleep quality and average sleep quality in our analyses.

Perceived health status. The children were asked to rate their overall health status on a 5-point Likert-type scale, ranging from 1 (*very poor*) to 5 (*very good*).

Parental death from AIDS. A total of 76 youth reported having a parent who died from HIV/AIDS, 528 reported having

[1] Because assessment of child awareness of HIV via self-report questionnaire is often unreliable (especially among younger children) and because we did not want to inadvertently disclose parental HIV status to child participants, parental HIV awareness was not measured directly in this study. In our previous fieldwork (e.g., Chi, Li, Zhao, & Zhao, 2014) we showed that nearly 90% of children are aware of parental HIV status. For those children who were unaware their parents' HIV status, all knew through observation (e.g., regular pill taking, hospitalization) that their parent had a serious health problem.

neither parent died, and 41 youth did not indicate whether or not they had lost a parent to HIV/AIDS.

Other stressful life events. On the basis of a stressful life events checklist used in our previous work among this population (Li, et al., 2009; Zhang, et al., 2009), we used 15 items to assess children's experience of a number of stressful life events (in addition to HIV-related parental illness and death). Children reported whether these events occurred in their life in the last six months. Sample items included being in a traffic accident, being a witness to violence, being hospitalized, surviving a natural disaster, witnessing the severe sickness or death of friends, relocation of family, and death of family members.

Salivary cortisol assessment and analysis plan. From Thursday morning through Saturday evening, participants self-collected saliva samples at four time points each day: immediately upon waking (prior to any eating, drinking, or exercise), 30 min later to assess cortisol awakening response (CAR), 1 hr before dinnertime, and then at bedtime. The timing of these samples corresponds to recommendations for assessing salivary cortisol in large-scale studies (Adam & Kumari, 2009). Prior to saliva collection, the investigators showed children the correct procedure to collect saliva samples using Salivettes (Sarstedt, Rommelsdorft, Germany) and emphasized the importance of compliance with the time of collection. Each child was given a text instruction and a signaling wristband with cartoon characteristics and a slogan "Did you collect saliva today?" to remind them of the timing of saliva collection. Children were asked to place Salivette samples in plastic bags provided by the investigators at the end of day, which then were returned to the investigators the following Monday. Because household refrigerators are uncommon among most of the families in this population—who live in one of the poorest counties in China—children were not asked to refrigerate the Salivettes. Prior work has shown that Salivette storage at room temperature for as long as two weeks (much longer than in this study) does not adversely affect cortisol concentration (Garde & Hansen, 2005). After the Salivettes were returned to the investigators the following Monday, they were refrigerated until they were assayed at Huaihe Hospital, which is an affliated hospital of Henan University. Cortisol levels were determined via chemiluminescent immunoassay (Access Cortisol kit YZB/U.S.A. 2802, Beckman Coulter, Inc, Fullerton, CA). Compliance with the saliva collection procedures was excellent. Participants provided a total of 11.17 out of 12 samples on average ($SD = 1.60$), with 93% of all possible saliva samples collected. Altogether, 61.3% of participants did not miss any samples, with 90.4% providing between 10 and 12 samples, and 96% of participants providing at least 8 of the 12 possible saliva samples across the 3 days.

To address outliers, cortisol values were winsorized (Adam & Kumari, 2009; Wilcox, 1998) to three standard deviations above and below the mean value at each time point (waking, CAR, before dinner, bedtime). Because of the strong circadian rhythm of cortisol, a three-level multilevel modeling (MLM) growth curve approach was used for data analyses. MLM allows researchers to simultaneously estimate multiple cortisol parameters (e.g., elevation of curve at waking, slope, and CAR), and to predict individual differences in diurnal cortisol parameters from individual difference variables of interest as well as covariates (Hruschka, Kohrt, & Worthman, 2005). Furthermore, MLM can estimate slopes and intercepts even with missing cortisol data. In line with previous diurnal cortisol research (Adam, Hawkley, Kudielka, & Cacioppo, 2006), time since waking, time since waking^2, and CAR (dummy coded 0 or 1) were modeled at Level 1 to provide estimates of each child's diurnal cortisol rhythm. The effect of time since waking provides an estimate of cortisol slope, whereas time since waking^2 provides an estimate of the curvilinear effect of time (e.g., the normative slight increase in cortisol toward the end of the day). Next, we estimated Level-3 (person-level) associations between positive and negative coping and cortisol. Then we controlled for potential confounds, including effects of weekdays versus weekends (dummy coded 0 and 1, respectively), daily sleep quality and daily wake time at Level 2 (day level), and gender, SES, other stressful life events, parental death from HIV/AIDS, average sleep quality, average wake time, and perceived health status at Level 3. Cortisol intercept, slope (effect of time) and CAR were all allowed to vary randomly at Level 2 and Level 3 (e.g., treated as random effects), whereas, following prior work (e.g., Adam et al., 2006), time since waking^2 was treated as a fixed effect with no Level-2 or Level-3 predictors. Level-3 variables were all grand-mean centered, with the exception of gender, whereas Level-2 variables were all group-mean centered, with the exception of weekdays versus weekends. All significance tests were two-tailed with robust standard errors.

Results

As shown in the top panel of Table 1 (Model 1), positive coping was associated with higher cortisol at wakeup but not significantly associated with cortisol slope. Negative coping was significantly associated with both lower cortisol at wakeup and a flatter (less healthy) diurnal cortisol slope. Neither positive nor negative coping was related to CAR ($ps > .70$) and thus not included as predictors of CAR in the final model. The diurnal cortisol slopes of children high ($+1$ *SD*) and low (-1 *SD*) in positive coping are depicted in Figure 1A; cortisol slopes of children high and low in negative coping are depicted in Figure 1B.

As displayed in the bottom panel of Table 1 (Model 2), the associations between positive and negative coping, wakeup cortisol, and cortisol slope remained significant after controlling for potential confounds. Among the covariates, age was positively associated with higher wakeup cortisol levels, as was being male; weekends and daily wake time were associated with lower wakeup cortisol. Age also was associated with a steeper cortisol slope, whereas weekends were associated with a flatter cortisol slope. None of the other covariates were associated with wakeup cortisol or cortisol slope.

Notably, there was not a detectable CAR overall in the sample, as is evidenced by the nonsignificant average CAR (β10) in Models 1 and 2 (see Table 1). Examination of the effects of covariates on CAR showed that boys had a stronger CAR compared with that of girls ($t = 2.53$, $p = .011$), and older children had a stronger CAR ($t = 2.56$, $p = .011$). The effects of coping on wakeup cortisol and cortisol slope remained significant when entering those covariates as predictors of CAR; however, because coping was not a significant predictor of CAR in the first model, the second model presented in Table 1 includes only covariate

Table 1
Time of Day, Coping Style, and Covariates Predicting Cortisol

Fixed effect (Independent variable)	Coefficient (*SE*)	*t*	*p*
Model 1 (Simple Model With Time of Day and Coping)			
Intercept (average cortisol at wakeup), β00	0.983 (0.012)	79.35	<.001
Positive Coping, β001	0.045 (0.021)	2.09	.037
Negative Coping, β002	−0.033 (0.016)	−2.08	.038
Average CAR, β10	−0.015 (0.012)	−1.29	.20
Average slope of time since waking, β20	−0.075 (0.003)	−23.28	<.001
Positive Coping, β201	−0.003 (0.002)	−1.29	.20
Negative Coping, β202	0.004 (0.001)	2.97	.003
Average slope of time since waking^2, β30	0.002 (0.000)	10.71	<.001
Model 2 (Combined Model With Covariates)			
Intercept (average cortisol at wakeup), β00	1.026 (0.022)	46.41	<.001
Positive Coping, β001	0.043 (0.021)	2.00	.046
Negative Coping, β002	−0.034 (0.016)	−2.14	.033
Age, β003	0.016 (0.007)	2.42	.016
Gender, β004	0.046 (0.022)	2.07	.038
Socioeconomic status, β005	0.010 (0.017)	0.57	.57
Average waketime, β006	0.009 (0.018)	−0.49	.63
Average sleep quality, β007	0.001 (0.026)	0.03	.97
Life events, β008	−0.007 (0.005)	−1.48	.14
Parental death, β009	−0.002 (0.016)	−0.12	.90
Perceived health status, β0010	−0.001 (0.011)	−0.12	.91
Parenting quality, β0011	0.014 (0.014)	0.95	.34
Weekend, β010	−0.210 (0.017)	−12.54	<.001
Daily waketime, β020	−0.048 (0.014)	−3.47	<.001
Daily sleep quality, β030	−0.007 (0.018)	−0.38	.71
Average CAR, β10	−0.018 (0.012)	−1.56	.12
Average slope of time since waking, β20	−0.074 (0.004)	19.58	<.001
Positive Coping, β201	−0.003 (0.002)	−1.70	.089
Negative Coping, β202	0.004 (0.001)	2.71	.007
Age, β203	−0.001 (0.001)	−2.26	.024
Gender, β204	−0.002 (0.002)	−0.84	.40
Socioeconomic status, β205	0.000 (0.001)	0.10	.92
Average waketime, β206	−0.002 (0.002)	−0.95	.34
Average sleep quality, β207	−0.000 (0.002)	−0.22	.83
Life events, β208	0.000 (0.000)	0.83	.41
Parental death, β209	0.002 (0.002)	1.15	.25
Perceived health status, β2010	−0.000 (0.001)	−0.21	.84
Parenting quality, β2011	0.001 (0.001)	1.25	.21
Weekend, β210	0.015 (0.002)	9.77	<.001
Daily waketime, β220	0.002 (0.001)	1.58	.12
Daily sleep quality, β230	0.001 (0.002)	0.43	.67
Average slope of time since waking^2, β30	0.002 (0.000)	8.89	<.001

Note. Intercepts indicate average cortisol values at wakeup; average slopes of time since waking indicate change in cortisol per 1-hr change in time; average slopes of time since waking^2 indicate change in cortisol per 1-hour change in time^2; CAR = cortisol awakening response, indicating amount of change in cortisol during the 30 min after waking. Female = 0, male = 1; weekday = 0, weekend = 1.

predictors of wakeup cortisol and slope and treats CAR as a fixed effect at Level 2 and Level 3.

Finally, we tested whether either positive or negative coping interacted with stress, which we assessed in two ways: via child reports of stressful life events and via parental death from HIV/AIDS. We first centered both coping measures and stressful life events around their respective means and then computed Coping × Stressful Events interaction terms and Coping × Parental Death (dummy coded 0 or 1) interaction terms. Separate regression analyses were then run to test interactions between positive and negative coping and stressful life events and between positive and negative coping and parental death. All analyses included main effects, two-way interaction effects, and covariates. The results of these analyses showed that neither positive coping nor negative coping interacted with stressful life events (all *p*s > .54). Further, neither positive nor negative coping interacted with parental death (all *ps* > .27). Thus, positive and negative coping had main associations with diurnal cortisol parameters but did not interact with stressful life circumstances to predict cortisol.

Discussion

This study investigated the links between positive and negative coping and diurnal cortisol patterns among children affected by parental HIV/AIDS. We found that positive coping was associated

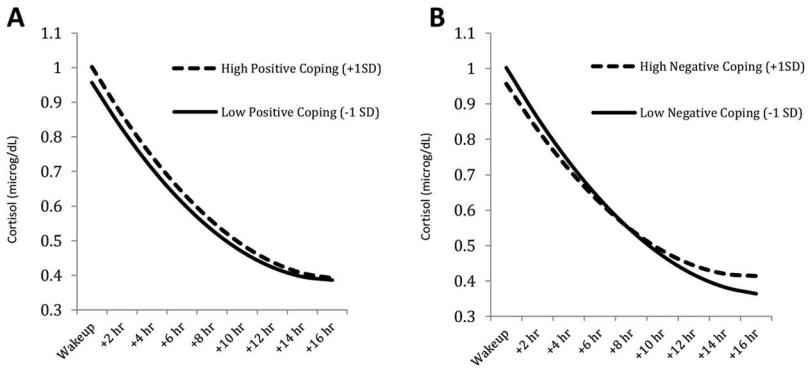

Figure 1. Associations between children's positive and negative coping and diurnal cortisol. Positive coping is displayed in Panel A; negative coping is displayed in Panel B. High values for positive and negative coping are plotted at +1 standard deviation, and low values are plotted at −1 standard deviation from the mean (Aiken & West, 1991).

with higher cortisol levels at wakeup, whereas negative coping was associated with lower cortisol at wakeup and with a flatter diurnal cortisol slope across the course of the day. These associations remained significant after controlling for possible confounds such as socioeconomic status, sleep quality, parental death, other stressful life events and self-rated health. Neither positive coping nor negative coping interacted with stressful life circumstances, assessed via stressful life events and parental death, to predict cortisol.

Although previous work has demonstrated associations between coping and daily cortisol production among adults (O'Donnell et al., 2008; Sjögren, et al.; Wrosch et al., 2007), this is the first published study to our knowledge to demonstrate links between coping and daily cortisol in children. This study also is the first that we know of to examine how psychosocial factors of any kind are associated with stress hormone production among children affected by parental HIV/AIDS. Our findings relating to the association between children's negative coping strategies and flatter cortisol slopes are especially notable, as flatter diurnal cortisol slopes are predictive of negative health consequences in adulthood, including mortality (Cohen, Cole, et al., 2012; Kumari et al., 2011; Matthews et al., 2006; Sephton et al., 2013) and are considered a marker of allostatic load (McEwen, 2007). This particular finding is also very much in line with prior work examining negative psychosocial factors and diurnal cortisol patterns in children. For example, recent research has shown that higher levels of psychosocial risk factors (i.e., parenting stress, multiple caregiver transitions, and interparental violence) are associated with flatter cortisol slopes in preadolescent youth (Martin, Bruce, & Fisher, 2012). Similarly, our work has shown that naturalistically observed conflict at home is associated with flatter cortisol slopes among preschoolers (Slatcher & Robles, 2012). The current findings similarly demonstrate that a negative coping style is associated with a less healthy diurnal cortisol profile in late childhood and adolescence.

Although the associations between negative coping and lower wakeup cortisol and between positive coping and higher wakeup cortisol are less clear in their implications for health, they are consistent with prior studies of children going through adverse life experiences in other populations. For instance, previous research has reported associations between children's externalizing behaviors and lower morning cortisol (Shirtcliff, Granger, Booth, & Johnson, 2005), whereas other work has shown that foster children with lower morning cortisol levels experienced more severe physical neglect (Bruce, Fisher, Pears, & Levine, 2009). Lower morning cortisol levels in children have been theorized to signal down regulation of the HPA axis subsequent to heightened HPA activity following early life adversity (Loman, Gunnar, & the Early Experience, Stress, and Neurobehavioral Development Center, 2010). The present findings suggest that effective coping strategies are associated with better HPA axis function in daily life among children affected by parental HIV/AIDS.

Identifying protective factors and risk factors that are associated with biomarkers of stress has important implications for preventive intervention programs that aim to strengthen the psychosocial resources of children affected by parental HIV/AIDS. Intervention work aimed at counteracting the negative effects of at-risk environments on HPA axis functioning in children has been promising, showing, for example, that atypical diurnal cortisol patterns of preschoolers in foster care can be altered to be comparable to those of nonfoster preschoolers (e.g., higher morning levels and/or steeper slopes) following a family-based treatment intervention (Fisher, Stoolmiller, Gunnar, & Burraston, 2007) or following an intervention designed to build social and behavioral competencies (Graham et al., 2012). The current findings suggest that coping skills are a worthwhile target for intervention efforts geared toward improving the health of children affected by HIV/AIDS. Although we controlled for a number of potential confounds in the current analyses, only through intervention work will we be able to definitively address the causal effects of coping behaviors on diurnal cortisol patterns.

There are some important limitations of this study that should be considered when interpreting these findings. The main limitation is the cross-sectional nature of this study; it is possible that that HPA axis dysregulation may lead to more maladaptive coping behaviors or that the associations between coping and diurnal cortisol are bidirectional. A second limitation is that the large size of our sample precluded us, financially, from being able to assess children's compliance with the timing of cortisol sampling measures. The timing of cortisol sampling is important, particularly for

assessing CAR, and the use of compliance tracking such as electronic time–date stamps or Medication Event Monitoring System (MEMS) caps are recommended (Adam & Kumari, 2009), albeit expensive approaches. The lack of a statistically significant CAR overall in this sample suggests potential problems with compliance in terms of the timing of CAR saliva collection (i.e., participants may have self-collected their saliva samples substantially more or less than 30 min after waking, leading to a nonsignificant CAR). An alternative possibility is that this group of youth differs from other sample populations in showing a lack of CAR. Prior research shows that adverse early life experiences can have a long-term impact on the function and regulation of the HPA axis (Shonkoff, Boyce, & McEwen, 2009), resulting in a blunted CAR, especially at earlier, as compared with later, stages of puberty (Quevedo, Johnson, Loman, LaFavor, & Gunnar, 2012). However, both of these possible explanations for the lack of CAR in this sample are at this point speculative and require further investigation.

Another limitation is that there are other coping strategies not measured in this study that could be relevant for understanding the links between having a parent with HIV/AIDS and cortisol production. Coping can be assessed in many ways and it would be worthwhile for future studies to include longer and more extensively validated coping measures that tap into other aspects of coping, such as avoidance. Although prior evidence for the links between avoidant coping and cortisol, for example, is mixed (O'Donnell et al., 2008; Rosenberger et al., 2004), avoidance is a commonly used coping strategy known to be associated with physical health problems in adults (Billings, Folkman, Acree, & Moskowitz, 2000) and thus warrants additional investigation. Further, future research should examine whether the findings reported here replicate across cultures. Although stress and coping are considered near-universal experiences, members of different cultures might consider and respond to stressors in different ways with respect to coping goals, strategies, and outcomes (Kuo, 2011).

A final limitation is that we did not have a control group of children unaffected by parental HIV/AIDS. A key question for future research is whether the associations we found between coping and cortisol would generalize to children in a general population or whether these associations are specific to vulnerable children (such as living with a parent with HIV/AIDS or other adverse life conditions). The fact that we did not find evidence for positive or negative coping interacting with either stressful life events or parental death suggests that the links between coping and diurnal cortisol may not be specific to youth going through difficult life circumstances.

Despite these limitations, this work represents an important advance in generating an understanding of the links between coping and health-related biological processes in children. These findings indicate that positive coping is predictive of what is believed to be a healthier diurnal cortisol profile, whereas negative coping, independent of positive coping strategies, is associated with a less healthy cortisol profile. Further, these findings come from a large sample of children over multiple days of saliva collection, providing confidence that these findings are robust. Diurnal cortisol dysregulation in childhood has been hypothesized to be linked to poorer child health (Gunnar & Quevedo, 2007) and a pathway through which early life adversity may "stay under the skin" to negatively impact physical health in adulthood (Miller et al., 2011). It is our hope that this work will spur on future researchers to investigate other psychosocial factors associated with health and health-related biology among children of parents with HIV/AIDS.

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