Research Article

Psychological Science
1–10

DOI: 10.1177/0956797615572904
pss.sagepub.com

Perceived Stigmatization, Resilience, and Diurnal Cortisol Rhythm Among Children of Parents Living With HIV

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Abstract

Stigmatization often puts at risk the health and well-being of children from marginalized groups. One potential protective factor for such children is resilience—one's capability to adapt flexibly, persistently, and resourcefully to stressful situations. In this study, we investigated the associations among stigmatization, resilience, and hypothalamic-pituitary-adrenal (HPA) axis function in a sample of 645 youths affected by parents infected with HIV. Perceived stigmatization was associated with lower cortisol levels at awakening and flatter cortisol slopes, whereas resilience was independently associated with higher levels of salivary cortisol at awakening and steeper cortisol slopes. We found evidence for an indirect effect of resilience on diurnal cortisol through lower perceived stigmatization. These associations remained significant after we controlled for demographic and health factors and stressful life events. Our findings demonstrate that perceived stigmatization and resilience are associated with HPA-axis functioning in childhood. Broadly, the data suggest that resilience-promoting and stigma-reducing efforts should be considered to improve the health of children from disadvantaged groups.

Keywords

stigmatization, stigma, resilience, salivary cortisol, children, HIV

Received 4/29/14; Revision accepted 1/22/15

Being stigmatized has negative and far-reaching effects on people. In the short term, stigmatization can adversely affect people's feelings, thoughts, and behaviors. Cumulatively, it can negatively influence one's mental and physical health (Benetti & Kambouropoulos, 2006; Pascoe & Richman, 2009; Schmitt, Branscombe, Postmes, & Garcia, 2014). For children whose parents are living with HIV, perceived stigmatization is a salient stressor (Chi & Li, 2013). Although many studies have demonstrated the deleterious effect of stigmatization on the psychosocial well-being of these children (e.g., Chi, Li, Zhao, & Zhao, 2014), little is known about how perceived stigmatization may influence underlying physiologic processes that are associated with health. Conversely, resilience, defined as an individual's capability to adapt flexibly, persistently, and resourcefully to adverse situations (Connor & Davidson, 2003), is suggested to be beneficial for health outcomes. The purpose of this investigation was to examine the associations among perceived stigmatization, resilience, and diurnal salivary cortisol rhythm in children whose parents are living with HIV.

Stigma against people living with HIV involves physical rejection and social exclusion derived from the fear of infection and moral judgments on behaviors perceived to be associated with HIV infection such as drug use,

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commercial sex, and homosexual behaviors (Chi et al., 2014). These stigmatizing perceptions are not limited only to people infected with HIV; they also extend to their children. Children of parents with HIV report experiencing humiliation, rejection by peers, neglect from family members, and reduced social support (Cluver, Gardner, & Operario, 2008). Moreover, perceived stigmatization is associated with internalizing and externalizing problem behavior among these children (Chi et al., 2014; Cluver et al., 2008). However, the extent to which the negative impact of perceived stigmatization "gets under the skin" to affect children's physical health and health-related biology is unknown.

People in stigmatized groups are at greater risk for problems with mental and physical health, including depression, hypertension, and coronary heart disease (Major & O'Brien, 2005). Prior work suggests that stigmatized individuals' health is at risk because they are exposed to disadvantageous physical and social settings. For example, stigmatized individuals may suffer from limited educational opportunities and may be deprived of access to quality health care (Schmitt et al., 2014). Stigmatization can also affect health when people engage in unhealthy behaviors as maladaptive responses to being stigmatized (Klonoff, 2014). In addition, various cognitions and emotions associated with stigmatization, such as being excluded, avoided, ignored, and treated with disrespect, may lead to negative health outcomes (Fuller-Rowell, Doan, & Eccles, 2012).

It has been argued that the subjective perception and interpretation of being stigmatized—compared with the objective experience of being stigmatized—may have unique consequences for an individual's health (Schmitt et al., 2014). Indeed, individuals who perceive higher levels of stigma show greater cardiovascular reactivity to and slower recovery from an acute laboratory stressor (Richman, Bennett, Pek, Siegler, & Williams, 2007), and they have unhealthy diurnal cortisol profiles, including greater overall cortisol output, higher cortisol awakening response (CAR), and flatter diurnal cortisol slope (i.e., less change in salivary cortisol levels across daytime hours; Fuller-Rowell et al., 2012; Zeiders, Doane, & Roosa, 2012). Although these associations have been extensively examined among both adults and adolescents of ethnic minorities, they have not been studied among children.

A substantial amount of research has documented the significance of trait resilience in ameliorating people's psychological distress in response to a wide range of life adversities, such as maltreatment, poverty, parental illness, violence exposure, and other stressful life events (Cicchetti & Rogosch, 2007; Gewirtz & Edleson, 2007; Werner, 1993). In the current research, we took the perspective that resilience is a psychological trait shaped by both genetic and environmental factors. It can be present from birth and emerges in part from the socialization process of child development. It accounts for significant individual differences in the capacity to adapt in the face of trauma and stress (e.g., parental HIV). A few studies have directly examined the effects of resilience on health-related processes and outcomes in the context of various environmental threats. For example, among 5-year-old children, greater resilience was associated with attenuated cortisol reactivity in response to negative interactions with parents (Smeekens, Riksen-Walraven, & Van Bakel, 2007). Resilience was also linked to lower risk for cardiovascular problems such as metabolic syndrome, inflammation, and sleep disturbance among children in adverse environments (Matthews, McGrath, Chen, & Miller, 2013).

We propose that resilience may be especially protective among children of parents living with HIV by helping to shape a healthy biological-stress-response system. Cortisol is a hormone sensitive to psychological stress, and its release is governed by the hypothalamic-pituitary-adrenal (HPA) axis. It demonstrates a strong basal diurnal rhythm; levels typically peak approximately 30 to 45 min after waking and then reach a nadir around midnight. Diurnal cortisol rhythms vary significantly across the population (Adam, Hawkley, Kudielka, & Cacioppo, 2006). Flatter diurnal cortisol slope is viewed as a marker of a dysregulated HPA axis, because it indicates that stress hormone levels remain high as the day progresses (McEwen, 1998). Dysregulation of the HPA axis is associated with a number of poor health outcomes, including compromised immune functioning, inflammation, diabetes, lung disease, and cardiovascular disease (Miller, Chen, & Zhou, 2007). Existing evidence suggests that flatter cortisol slopes are indicative of poorer future health, and at least four recent studies of adults have linked flatter cortisol slopes with increased mortality (Cohen et al., 2012; Kumari, Shipley, Stafford, & Kivimaki, 2011; Sephton et al., 2013; Sephton, Sapolsky, Kraemer, & Spiegel, 2000). It has been suggested that HPA dysregulation during childhood may be a pathway through which early-life adversity negatively influences health outcomes in adulthood (Miller, Chen, & Parker, 2011; Slatcher & Robles, 2012).

Less is known about how resilience may serve as a salutary factor against the physiological wear and tear of daily stressors, such as having a parent with HIV. Intuitively, and as suggested by some theoretical reasoning (e.g., Shih, 2004), one would expect that resilience should moderate the negative impact of stigmatization on diurnal cortisol levels. From this perspective, the association between perceived stigmatization and diurnal cortisol levels might be weaker or absent for children high in resilience compared with those low in resilience. However, resilience may instead influence diurnal cortisol levels indirectly through perceived stigmatization. Given that resilience is a person's ability to adapt to

adversity in flexible and resourceful ways (Connor & Davidson, 2003), it follows that one resourceful (and self-protective) way to adapt to potentially stigmatizing situations is by perceiving lower levels of stigmatization. According to this logic, youths affected by parents infected with HIV who are more resilient may perceive lower levels of stigmatization and, in turn, show healthier diurnal cortisol profiles. We explored these two possible ways in which resilience might positively affect diurnal cortisol profiles—either as a moderator of the effects of perceived stigmatization or indirectly through lower perceived stigmatization.

In the current study, we examined the associations among perceived stigmatization, resilience, and diurnal cortisol rhythm in a large sample of children (8–15 years old) whose parents were living with HIV. We hypothesized that perceived stigmatization would be associated with lower cortisol levels at awakening and flatter diurnal cortisol slopes, whereas resilience would be associated with higher cortisol levels at awakening and steeper cortisol slopes. In addition, although the links between physical health and total cortisol secretion—assessed via an analysis of the area under the curve (AUC) for diurnal salivary cortisol—are not as well established as the links between physical health and cortisol slope, we conducted ancillary AUC analyses. Finally, we tested whether resilience buffers the negative effect of stigmatization on diurnal cortisol rhythm (a moderation model) or influences diurnal cortisol rhythm indirectly through perceived stigmatization (a mediation model).

Method

Participants and procedure

In the current study, we used the baseline data from a sample collected for a randomized, controlled trial of a psychological intervention project.[1] The total sample from the intervention study consisted of 790 children ages 6 through 17 years. We took a subsample (Slatcher et al., in press) consisting of only the children between the ages of 8 and 15 years (n = 746), to match the age range for which the self-report measures used in present analyses were normed. Among this subsample, 645 children (51.9% boys) provided valid saliva specimens for cortisol analysis and therefore constituted the sample in the current study. The average age of the children was 10.67 years (SD = 1.79). Approximately 12.6% of the children in our sample had lost one or both parents to AIDS. The children and their primary caregivers were recruited from five administrative villages in an HIV-endemic area in central China. The parental education levels were as follows: 2.3% of fathers and 6.3% of mothers had never attended school (coded as 1), 32.4% of fathers and 33.5% of mothers had completed elementary school (coded as 2), 24.8% of fathers and 18.4% of mothers had completed middle school (coded as 3), 7.2% of fathers and 8.2% of mothers had completed high school (coded as 4), and 5.8% of fathers and 6.0% of mothers had postsecondary education (coded as 5). The household income levels were as follows: 58.0% of households had monthly incomes from 0 to 999 Chinese yuan (¥; coded as 1), 29.9% of households had monthly incomes from ¥1,000 to ¥1,999 (coded as 2), 7.7% of households had monthly incomes from ¥2,000 to ¥3,999 (coded as 3), 2.5% of households had monthly incomes from ¥3,000 to ¥4,999 (coded as 4), 1.0% of households had monthly incomes from ¥4,000 to ¥4,999 (coded as 5), and 0.8% of households had monthly incomes greater than of ¥5,000 (coded as 6). The mean paternal education level was 2.64 (SD = 1.06), and the mean maternal education level was 2.75 (SD = 0.97). The mean income level was 1.61 (SD = 0.91). The study participants' household income and parental education levels were lower than those of the broader population in the province or in the country, according to the census data at the year of data collection (National Bureau of Statistics of China, 2013).

Children and their primary caregivers were recruited through the village social-welfare system and local school system. We obtained village-level HIV surveillance data to identify villages with the highest rates of HIV infection. Then, for each village, we generated a list of families caring for children affected by HIV/AIDS. Because of the eligibility criteria of the intervention study from which our data were obtained, children with known HIV infection were not included in that study and, hence, were not included in the current study. Children's HIV-infection status (along with age eligibility and parents' viral status) was verified through the current caregivers or local community workers. We then randomly selected families on the lists and invited one child and his or her primary caregiver to participate in the study until the target sample size (i.e., a total of 800 children of parents living with HIV) was achieved. Appropriate informed consent/assent was obtained before participation. Data were collected in 2012 using a research protocol that was approved by the institutional review boards at Wayne State University in the United States and Henan University in China.

Both children and caregivers answered a survey questionnaire that included demographic information and several psychosocial scales. The survey was self-administrated either individually or in a small group in the presence of two interviewers. A few children (2% of the sample) had reading difficulties, so interviewers read the survey items and recorded their responses in a private room. If such a room was not available, 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. Children were instructed to collect their saliva samples four times a day for 3 days. Each child received age-appropriate gifts at completion of the survey and saliva collection as tokens of appreciation.

Measures

Perceived stigmatization. Perceived stigmatization was measured using the Stigma Against Children Affected by AIDS Scale (Zhao et al., 2010). The scale consists of 15 items assessing three dimensions of subjective awareness of social stigmatization: social exclusion (e.g., "people think children of parents living with HIV should leave their villages"), purposive avoidance (e.g., "people do not want their children to play with children of parents living with HIV"), and perceived inferiority (e.g., "people think children of parents living with HIV are unclean"). The children were asked to indicate their perception on a 4-point Likert scale (1 = *strongly disagree*, 4 = *strongly agree*). Cronbach's α for the scale was .93.

Resilience. The 25-item Connor-Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003) was used to evaluate children's resilience. The scale taps various personality characteristics, such as tenacity, tolerance of negative effect, positive acceptance of change, sense of control, optimism, recognition of limits to control, and perception of stress as a challenge or opportunity. The scale has been translated and validated among Chinese youths who survived an earthquake and demonstrated good reliability and validity (Yu, Lau, Mak, Zhang, & Lui, 2011). The participants were asked to rate each item with reference to the previous month. If a particular situation (e.g., stressor, change, and challenge) described in the items had not happened within the time frame, the participants were asked to respond to how they would react if such a situation occurred. A 5-point scale was used (0 = *not true at all*, 4 = *true all the time*). Cronbach's α for the CD-RISC in this study was .88.

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.

Daily sleep quality. The children were asked to answer the question, "How did you sleep last night?" on a 4-point scale (1 = *terrible*, 4 = *great*) on each day of saliva collection.

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

Other stressful life events. To assess children's experience of a number of stressful life events (in addition to HIV-related parental illness and death), we used 15 items from a stressful-life-events checklist used in our previous work among a similar population (Li et al., 2009). Children reported whether these events had occurred in their lives in the past 6 months. Sample items included being in a traffic accident, being a witness to violence, hospitalization, natural disaster, severe sickness or death of friends, involuntary family relocation, and death of family members.

Parental death from HIV/AIDS. The information on parental death related to HIV/AIDS was acquired from village welfare-registration offices. The villages are responsible for issuing monthly subsidies for families affected by HIV and AIDS. Thus, they have the most up-to-date and accurate information on the health and mortality status of parents in the household.

Salivary cortisol assessment and analysis. From Thursday morning through Saturday evening, children self-collected saliva samples using Salivettes (Sarstedt, Rommelsdorft, Germany). The children were instructed to collect saliva samples and record the collection times at four time points on each of the 3 days: immediately on awakening, 30 min later to assess CAR, 1 hr before dinner time, and then right before bedtime. The timing of saliva collection was determined using recommendations on assessing salivary cortisol in large-scale studies (Adam & Kumari, 2009). Each child was provided with a wristband to remind them of the timing of saliva collection. Children were asked to place the Salivette samples in plastic bags at the end of the day and to return them to the local research team on Monday. Salivettes were refrigerated until they were assayed at Huaihe Hospital, a hospital affiliated with Henan University. Cortisol levels were determined via chemiluminescent immunoassay (Access Cortisol kit YZB/USA 2802; Beckman Coulter, Inc, Fullerton, CA). Compliance with the saliva collection procedures was excellent: 96% of participants provided at least 8 of the 12 possible saliva samples across the 3 days.

Data analysis

To correct for positive cortisol skewness and kurtosis, a $\log_{10}$ transformation was performed; a constant of 1 was added before transformation so that all values would be positive. Because of the strong circadian rhythm of cortisol, a three-level multilevel modeling (MLM) growth-curve approach was used for diurnal cortisol analyses. MLM allows researchers to simultaneously estimate multiple cortisol parameters (e.g., level at awakening, slope, and CAR), and to predict individual differences in diurnal cortisol parameters from individual difference variables

Table 1. Intercorrelations Among the Predictor Variables

Variable	1	2	3	4	5	6	7	8	9	10
1. Perceived stigmatization	—									
2. Resilience	–.11**	—								
3. Age	–.22**	.13**	—							
4. Male gender	–.05	–.02	–.10**	—						
5. Socioeconomic status	.08*	–.03	–.24**	.05	—					
6. Average wake time	.03	–.05	.01	.06	.06	—				
7. Average sleep quality	.01	–.03	–.14**	.04	.03	–.14**	—			
8. Stressful life events	.13**	.05	.05	–.04	–.01	.04	–.14**	—		
9. Parental death	.10*	–.05	.03	–.04	.00	.09*	.00	.10**	—	
10. Perceived health status	–.02	.03	–.10**	.05	.03	.01	.15**	–.18**	–.06	—

Note: The average wake time was approximately 6:31 a.m. (*SD* = ~1 hr, 10 min), the average sleep quality was 3.40 (*SD* = 0.49), the average number of stressful life events was 2.46 (*SD* = 2.11), the average perceived health status was 4.25 (*SD* = 1.05), and the standard deviation for the composite score of socioeconomic status was 0.68.
*$p < .05$ (two-tailed). **$p < .01$ (two-tailed).

of interest as well as covariates (Hruschka, Kohrt, & Worthman, 2005).

To be sure that our results were comparable with those of previous diurnal cortisol research (Adam et al., 2006), we modeled time since waking, time-since-waking^2 (i.e., the square of the time since waking), and CAR (dummy coded 0 or 1) at Level 1 to provide estimates of each child's diurnal cortisol rhythm. This approach is optimal because it simultaneously estimates all three cortisol parameters of interest (levels at awakening, CAR, and slope) as well as the curvilinear effect of the time-since-waking^2 (e.g., it estimates cortisol slope and takes into account a person's cortisol levels at awakening and CAR, rather than estimating these parameters separately). Second, we estimated Level 3 (person-level) effects of perceived stigmatization and resilience on cortisol. Third, we controlled for potential confounds, including differential effects of weekdays and weekends (dummy-coded 0 and 1, respectively), daily sleep quality, and daily wake time at Level 2 (day level) and gender, socioeconomic status, parental death, other stressful life events, average wake time, average sleep quality, and perceived health status at Level 3. Cortisol intercept, slope (effect of time), and CAR were all allowed to vary randomly at Level 3 (i.e., they treated as random effects), whereas the time-since-waking^2 was treated as a fixed effect with no Level 2 or Level 3 predictors. Next, we tested whether perceived stigmatization mediated the association between resilience and diurnal cortisol levels.

Finally, we tested whether the association between perceived stigmatization and diurnal cortisol levels was moderated by resilience. All person-level variables except gender were grand-mean-centered. All significance tests were two-tailed with robust standard errors. In addition to examining diurnal cortisol profiles, we examined the effects of perceived stigmatization and resilience on cortisol AUC with respect to ground across the 3 days of cortisol sampling for each participant. We used standard formulas to compute AUC as described in Pruessner, Kirschbaum, Meinlschmid, and Hellhammer (2003). We then used linear regression to regress AUC on perceived stigmatization and resilience, along with the previously described covariates.

Results

Intercorrelations among study variables are shown in Table 1. In initial MLM analyses, we entered perceived stigmatization and resilience separately as predictors of diurnal cortisol parameters at Level 3 without any other covariates. Perceived stigmatization ($M = 1.70$, $SD = 0.64$) was associated with lower cortisol levels at awakening, $\beta001 = -0.034$, $SE = 0.009$, 95% confidence interval, or CI = [–0.052, –0.016], $p < .001$, and with a flatter cortisol slope, $\beta201 = 0.004$, $SE = 0.001$, 95% CI = [0.002, 0.006], $p < .001$. In addition, resilience ($M = 2.02$, $SD = 0.63$) was significantly associated with higher cortisol at awakening, $\beta001 = 0.036$, $SE = 0.010$, 95% CI = [0.004, 0.056], $p < .001$, and a steeper cortisol slope, $\beta201 = -0.002$, $SE = 0.001$, 95% CI = [–0.004, 0.000], $p = .021$. Neither stigmatization nor resilience was related to CAR (ps > .82); thus, CAR was set as a fixed effect with no predictors in subsequent analyses. The diurnal cortisol slopes of youths high (1 *SD* above the mean) and low (1 *SD* below the mean) in perceived stigmatization are depicted in Figure 1a; cortisol slopes of youths high and low in resilience are depicted in Figure 1b.

We then examined whether the associations among perceived stigmatization, resilience, and cortisol remained significant when we controlled for potential confounds. As displayed in Table 2 (Model 1), the associations between stigmatization and cortisol levels at awakening and between stigmatization and cortisol slope remained

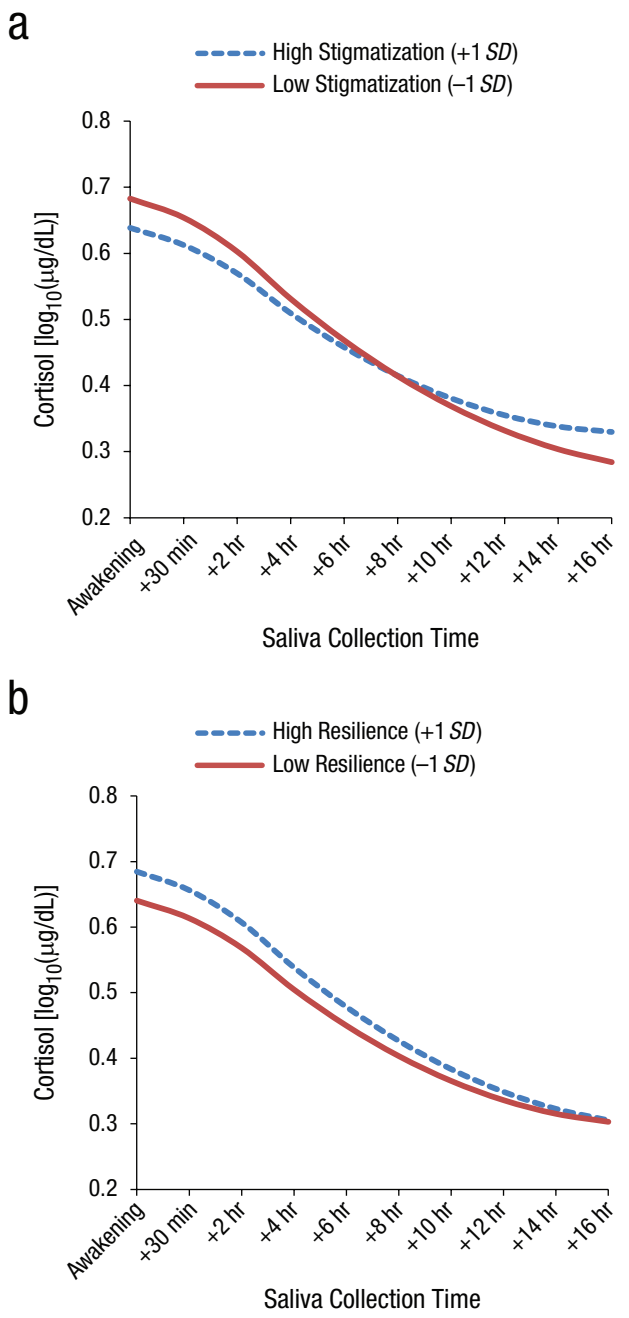

Fig. 1. Effects of perceived stigmatization and resilience on diurnal cortisol levels. Cortisol level is graphed as a function of time since waking for (a) participants who reported high and low levels of perceived stigmatization (i.e., levels 1 *SD* above and below the mean) and (b) participants rated high and low on resilience (i.e., 1 *SD* above and below the mean).

significant after controlling for age, gender, socioeconomic status, daily and average wake time, daily and average sleep quality, stressful life events, parental death, perceived health status, and weekend versus weekday. By contrast, greater resilience significantly predicted higher cortisol levels at awakening but not cortisol slope, possibly because the effects of resilience on cortisol levels at awakening and cortisol slope were mediated by perceived stigmatization.

We next tested whether the associations between resilience and diurnal cortisol levels were mediated by perceived stigmatization. CIs for indirect effects were estimated using the Monte Carlo method for MLM with 20,000 repetitions (Selig & Preacher, 2008). We first used simple regression and found that perceived stigmatization was significantly predicted by resilience, $b = -0.132$, $SE = 0.040$, 95% CI = [–0.210, –0.054], $p = .001$. Next, when we entered perceived stigmatization and resilience into the MLM model together to predict diurnal cortisol parameters, and after we controlled for covariates, the effect of resilience on levels at awakening was reduced but still remained significant, whereas the effect of resilience on cortisol slope was no longer significant. The indirect effects of resilience on cortisol levels at awakening (95% CI = [0.001, 0.008]) and cortisol slope (95% CI = [–0.0010, –0.0002]) via perceived stigmatization were both found to be significant, which suggests a mediating effect of perceived stigmatization in the association between resilience and a healthier diurnal cortisol rhythm.

Next, we explored whether the negative effect of perceived stigmatization on diurnal cortisol levels might be moderated by resilience. Perceived stigmatization, resilience, and the Perceived Stigmatization × Resilience interaction term were entered together with the control variables to predict diurnal cortisol levels. As shown in Table 2 (Model 2), the interaction effect between stigmatization and resilience was not significant. These results, along with the findings described previously, suggest that the effect of perceived stigmatization on diurnal cortisol levels is not dependent on the level of resilience; rather, children higher in resilience perceive lower levels of stigmatization, and those lower levels of stigmatization, in turn, are associated with healthier HPA functioning in daily life.

We then conducted AUC analyses, regressing AUC on perceived stigmatization and resilience. Initial simple regression models without covariates showed that perceived stigmatization was not associated with AUC, $b = -0.152$, $SE = 0.106$, 95% CI = [–0.360, 0.056], $p = .154$. Resilience was significantly associated with higher AUC, $b = 0.291$, $SE = 0.109$, 95% CI = [0.077, 0.505], $p = .008$, which indicates that higher resilience was associated with higher daily output of cortisol. We next tested whether the associations between stigmatization and AUC and between resilience and AUC were significant when we controlled for demographic and health covariates. We entered perceived stigmatization and resilience together, along with all of the person-level covariates described previously in the MLM diurnal cortisol analyses, in a regression model predicting AUC. After we controlled for the effects of perceived stigmatization and covariates, resilience remained a significant predictor of

Table 2. Results of Multilevel Modeling Predicting Cortisol Profiles

	Model 1		Model 2	
Fixed effect (independent variable)	Coefficient (*SE*)	*p*	Coefficient (*SE*)	*p*
Average cortisol at awakening	0.687 (0.010)	< .001	0.699 (0.010)	< .001
Perceived stigmatization	–0.027 (0.009)	.005	–0.027 (0.009)	.004
Resilience	0.029 (0.010)	.004	0.031 (0.010)	.002
Perceived Stigmatization × Resilience	—	—	0.013 (0.014)	.341
Age	0.007 (0.003)	.048	0.007 (0.003)	.052
Gender	0.020 (0.012)	.077	0.021 (0.011)	.069
Socioeconomic status	0.009 (0.010)	.230	0.009 (0.007)	.218
Average wake time	–0.002 (0.010)	.825	–0.003 (0.010)	.774
Average sleep quality	0.001 (0.014)	.969	0.000 (0.014)	.980
Life events	–0.004 (0.002)	.090	–0.004 (0.002)	.087
Parental death	0.002 (0.009)	.823	0.002 (0.009)	.822
Perceived health status	–0.000 (0.006)	.960	–0.000 (0.006)	.965
Day of week	–0.111 (0.009)	< .001	–0.111 (0.009)	< .001
Daily wake time	–0.023 (0.007)	.002	–0.023 (0.007)	.002
Daily sleep quality	–0.004 (0.009)	.669	–0.004 (0.009)	.670
Average CAR	–0.011 (0.006)	.081	–0.011 (0.006)	.080
Average cortisol slope of time since waking	–0.039 (0.002)	< .001	–0.039 (0.002)	< .001
Perceived stigmatization	0.004 (0.001)	< .001	0.004 (0.001)	< .001
Resilience	–0.002 (0.001)	.093	–0.002 (0.001)	.055
Perceived Stigmatization × Resilience	—	—	–0.002 (0.001)	.124
Age	–0.000 (0.000)	.134	–0.000 (0.000)	.151
Gender	–0.000 (0.001)	.699	–0.000 (0.001)	.640
Socioeconomic status	–0.000 (0.000)	.695	–0.000 (0.001)	.651
Average wake time	–0.002 (0.001)	.097	–0.001 (0.000)	.119
Average sleep quality	–0.000 (0.001)	.693	–0.000 (0.001)	.703
Life events	0.000 (0.000)	.429	0.000 (0.000)	.414
Parental death	0.001 (0.001)	.451	0.001 (0.001)	.453
Perceived health status	–0.000 (0.000)	.972	–0.000 (0.000)	.962
Day of week	0.008 (0.001)	< .001	0.008 (0.001)	< .001
Daily wake time	0.000 (0.001)	.802	0.000 (0.001)	.810
Daily sleep quality	0.001 (0.001)	.588	0.001 (0.001)	.588
Average cortisol slope of time-since-waking^2	0.000 (0.000)	< .001	0.001 (0.000)	< .001

Note: At Level 1, the change in cortisol levels across 3 days was modeled separately for each individual, using log-transformed cortisol as the outcome variable and collection time as the predictor. Average cortisol value at awakening was the intercept, or starting value of cortisol. Average cortisol awakening response (CAR) indicates the change in cortisol during the 30 min after waking; average cortisol slope of time since waking indicates the change in cortisol per 1-hr change in time; average cortisol slope of time-since-waking^2 indicates the change in cortisol per 1-hr change in time^2. At Levels 2 and 3, these cortisol-profile parameters were predicted using perceived stigmatization, resilience, and covariates. For gender, female was coded as 0 and male as 1. For day of the week, weekdays were coded as 0 and weekend days as 1.

higher AUC, $b = 0.211$, $SE = 0.107$, 95% CI = [0.001, 0.421], $p = .049$. Controlling for the effect of resilience and covariates, perceived stigmatization remained a nonsignificant predictor of AUC, $b = -0.077$, $SE = 0.107$, 95% CI = [–0.287, 0.133], $p = .470$. Finally, we tested possible interaction effects between perceived stigmatization and resilience on cortisol AUC. The interaction term of perceived stigmatization and resilience was not significantly associated with AUC, $p = .906$.

We conducted further analyses to examine whether the effect of resilience on AUC might be driven by higher cortisol levels at awakening. Using regression analyses, we found that the effect of resilience on AUC became nonsignificant, $p = .565$, when we controlled for average cortisol levels at awakening, together with stigmatization and all the person-level covariates. In contrast, the effect of resilience on cortisol levels at awakening remained significant, $b = 0.023$, $SE = 0.009$, 95% CI = [0.005, 0.041], $p = .011$, when controlling for AUC together with stigmatization and all the person-level covariates. These results suggest that the effect of resilience on higher AUC may be driven by the robust effect of resilience on higher cortisol levels at awakening, which mirrors the findings from the MLM analyses described previously.

Discussion

In a large sample of children affected by parental HIV, we found that greater perceived stigmatization was associated with lower cortisol levels at awakening and flatter diurnal cortisol slopes. Resilience did not moderate the relationship between perceived stigmatization and cortisol slopes; rather, it showed a salutary effect on diurnal cortisol rhythm via decreased perceived stigmatization. That is, children with higher resilience tend to perceive lower stigmatization and, in turn, show a "healthier" diurnal cortisol rhythm. The positive association between resilience and cortisol levels at awakening was mirrored in additional analyses assessing total daily cortisol output. Our findings suggest that the stigma associated with HIV can affect children's stress physiology in daily life and that resilience is a potentially promotive factor for such children. Note that the relationships among perceived stigmatization, resilience, and diurnal cortisol remained strong after we controlled for potential confounds such as child's age and gender, family socioeconomic status, self-rated health status, parental death, daily and average wake time and sleep quality, and other stressful life events.

This is, to the best of our knowledge, the first study to show that HIV-related stigma is associated with diurnal cortisol patterns. Our findings corroborate existing research on the relationship between stigmatization stress and psychological health (Pascoe & Richman, 2009) and extend these previous findings to a child population, showing the potential physical health consequences of perceiving stigmatization about having a parent or parents infected with HIV. Prior studies suggest that activation of the HPA axis is sensitive to stressors that are socially evaluative and uncontrollable (Schmitt et al., 2014). Naturalistic studies have found that uncontrollable stressors or stressors that pose a threat to the individual's social standing are related to flattened diurnal cortisol slopes, lower morning values, and higher afternoon values (Miller et al., 2007; Zeiders et al., 2012). Stigmatization of children affected by HIV could be considered both socially evaluative and uncontrollable. It is socially evaluative because such an experience threatens children's social standing in their peer groups and their immediate context (e.g., school) and uncontrollable because the stigmatization has nothing to do with children's actions; rather, it involves their parents' HIV infections.

Note that we found that the association between greater resilience and steeper cortisol slope was mediated by decreased perceived stigmatization. The findings are consistent with previous evidence generally derived from youths from low socioeconomic environments and racial-minority backgrounds (Chen, 2013). To our knowledge, this is the first published study of any population to examine how resilience is associated with HPA-axis function. Our findings suggest that children higher in resilience generally may have greater internal resources to cope with the multiple stressors in their lives. Children with a resilient mind-set may generally perceive the world more positively and perceive fewer external stressors such as stigmatization, thus enjoying better health outcomes. Our findings echo prior evidence emphasizing the importance of subjective interpretation of objective encounters with stigmatizing behaviors. Indeed, objective encounters with discrimination may not inevitably be perceived or interpreted as stigmatization, even for people in a disadvantaged group (Schmitt et al., 2014). Resilience appears to partially determine the extent to which other people's discrimination behaviors are perceived as stigmatization. Children are not simply passive targets of adverse environments; they are active participants in society as they seek to understand their social world and create their own lives. Therefore, in exploring the reduction of stigmatization at the sociostructural level and the promotion of supportive communities (Hatzenbuehler & McLaughlin, 2014), future researchers should also focus on identifying and fostering resilience factors that may help children to achieve healthy outcomes.

Resilience was also found to be associated with higher daily cortisol output, as determined by AUC analysis. This finding, at first, seems counterintuitive, because higher daily cortisol output is generally assumed to be related to poorer health (Pruessner et al., 2003). However, our findings suggest that the positive association between resilience and higher daily cortisol output is in fact driven by higher cortisol levels at awakening—considered to be an indicator of healthy HPA-axis functioning in childhood. Previous research among maltreated or abused children has showed similar results, suggesting that chronic stress is associated with blunted diurnal cortisol levels, particularly lower cortisol early in the morning (Fisher, Van Ryzin, & Gunnar, 2011), and positive psychological factors are associated with higher morning cortisol (Cicchetti & Rogosch, 2007).

Our study has some limitations. First, the data are cross-sectional; we cannot rule out the reverse-causality interpretation (i.e., that HPA-axis dysregulation may lead to lower resilience and higher perceived stigmatization). Second, most of the parents of the sampled children were infected with HIV via unhygienic blood-collection practices associated with sale of blood for income rather than other highly stigmatized behaviors, such as drug use and commercial sex, which limits the representativeness of the sample. This unique, largely poverty-driven cause of HIV infection may have reduced the range and severity of stigmatization experienced or perceived by the current sample. Third, the large sample size made it impossible (both financially and logistically) to closely

monitor individual children's compliance with the timing of salivary sample collection. The absence of a statistically significant CAR in this sample may suggest possible problems in compliance with the timing of saliva collection (e.g., some participants might have collected their saliva samples substantially more or less than 30 min after waking). An alternative explanation is that our sample differs from other population in showing a nonsignificant CAR. Prior research shows that adverse early life experiences may result in a blunted CAR response (Quevedo, Johnson, Loman, LaFavor, & Gunnar, 2012). However, both of these possible explanations necessitate further research.

Despite these limitations, this work makes important advances in generating evidence of associations among perceived stigmatization, resilience, and health-related biology during childhood. These findings indicate that children's perception of being stigmatized is associated with what is considered a less healthy diurnal cortisol rhythm, whereas resilience is a predictive of a healthier diurnal cortisol rhythm. The naturalistic assessment of saliva collection over multiple days from a large sample of children lends confidence to our findings. Future intervention research should focus on reducing stigma and promoting resilience to cope with the stress associated with parental HIV-related illness and death.

Author Contributions

P. Chi wrote the first draft of the manuscript and assisted in study design, data collection, and data analyses. R. B. Slatcher oversaw saliva collection and statistical analyses. X. Li was the principal investigator of the study and led the study. J. Zhao helped design the study and oversaw data collection. G. Zhao assisted in study design. X. Ren and J. Zhu carried out the cortisol assay. B. Stanton assisted in study design.

Acknowledgments

We thank Heidi Kane, Ledina Imami, George Tam, and other people from the Close Relationships Lab at Wayne State University for their comments on the manuscript.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

This research was supported by National Institute of Nursing Research Grant R01-NR13466.

Note

1. Published findings from this project include analyses of links between coping and diurnal cortisol profiles (Slatcher et al., in press). None of the findings from that article—with the exception of covariates included in the MLM models—overlap with those reported here. Further, the findings reported in this article all remained significant when we controlled for coping (both positive and negative coping).

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, USA*, *103*, 17058–17063.

Adam, E. K., & Kumari, M. (2009). Assessing salivary cortisol in large-scale, epidemiological research. *Psychoneuroendocrinology*, *34*, 1423–1436.

Benetti, C., & Kambouropoulos, N. (2006). Affect-regulated indirect effects of trait anxiety and trait resilience on self-esteem. *Personality and Individual Differences*, *41*, 341–352.

Chen, E. (2013, March). *Psychological resilience among low socioeconomic status youth and implications for cardiovascular risk profiles*. Paper presented at the 71st Annual Scientific Meeting of the American Psychosomatic Society, Miami, FL. Abstract retrieved from http://www.psychosomatic.org/anmeeting/PDF/2013abstractBooklet.pdf

Chi, P., & Li, X. (2013). Impact of parental HIV/AIDS on children's psychological well-being: A systematic review of global literature. *AIDS and Behavior*, *17*, 2554–2574. doi:10.1007/s10461-012-0290-2

Chi, P., Li, X., Zhao, J., & Zhao, G. (2014). Vicious circle of perceived stigma, enacted stigma and depressive symptoms among children affected by HIV/AIDS in China. *AIDS and Behavior*, *18*, 1054–1062. doi:10.1007/s10461-013-0649-z

Cicchetti, D., & Rogosch, F. A. (2007). Personality, adrenal steroid hormones, and resilience in maltreated children: A multilevel perspective. *Development and Psychopathology*, *19*, 787–809. doi:10.1017/s0954579407000399

Cluver, L. D., Gardner, F., & Operario, D. (2008). Effects of stigma on the mental health of adolescents orphaned by AIDS. *Journal of Adolescent Health*, *42*, 410–417.

Cohen, L., Cole, S. W., Sood, A. K., Prinsloo, S., Kirschbaum, C., Arevalo, J. M., . . . Wei, Q. (2012). Depressive symptoms and cortisol rhythmicity predict survival in patients with renal cell carcinoma: Role of inflammatory signaling. *PLoS ONE*, *7*(8), Article e42324. Retrieved from http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0042324

Connor, K. M., & Davidson, J. R. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). *Depression and Anxiety*, *18*, 76–82. doi:10.1002/da.10113

Fisher, P. A., Van Ryzin, M. J., & Gunnar, M. R. (2011). Mitigating HPA axis dysregulation associated with placement changes in foster care. *Psychoneuroendocrinology*, *36*, 531–539.

Fuller-Rowell, T. E., Doan, S. N., & Eccles, J. S. (2012). Differential effects of perceived discrimination on the diurnal cortisol rhythm of African Americans and Whites. *Psychoneuroendocrinology*, *37*, 107–118. doi:10.1016/j.psyneuen.2011.05.011

Gewirtz, A. H., & Edleson, J. L. (2007). Young children's exposure to intimate partner violence: Towards a developmental

risk and resilience framework for research and intervention. *Journal of Family Violence*, *22*, 151–163. doi:10.1007/s10896-007-9065-3

Hatzenbuehler, M. L., & McLaughlin, K. A. (2014). Structural stigma and hypothalamic-pituitary-adrenocortical axis reactivity in lesbian, gay, and bisexual young adults. *Annals of Behavioral Medicine*, *47*, 39–47. doi:10.1007/s12160-013-9556-9

Hruschka, D. J., Kohrt, B. A., & Worthman, C. M. (2005). Estimating between- and within-individual variation in cortisol levels using multilevel models. *Psychoneuroendocrinology*, *30*, 698–714.

Klonoff, E. A. (2014). Introduction to the Special Section on Discrimination. *Health Psychology*, *33*, 1–2. doi:10.1037/hea0000070

Kumari, M., Shipley, M., Stafford, M., & Kivimaki, M. (2011). Association of diurnal patterns in salivary cortisol with all-cause and cardiovascular mortality: Findings from the Whitehall II study. *The Journal of Clinical Endocrinology & Metabolism*, *96*, 1478–1485.

Li, X., Barnett, D., Fang, X., Lin, X., Zhao, G., Zhao, J., . . . Stanton, B. (2009). Lifetime incidence of traumatic events and mental health among children affected by HIV/AIDS in rural China. *Journal of Clinical Child and Adolescent Psychology*, *38*, 731–744. doi:10.1080/15374410903103601

Major, B., & O'Brien, L. T. (2005). The social psychology of stigma. *Annual Review of Psychology*, *56*, 393–421.

Matthews, K. A., McGrath, J., Chen, E., & Miller, G. (2013, March). *Childhood roots of adult cardiovascular risk: Focus on early resilience*. Paper presented at the 71st Annual Scientific Meeting of the American Psychosomatic Society, Miami, FL. Abstract retrieved from http://www.psychosomatic.org/anmeeting/PDF/2013abstractBooklet.pdf

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine*, *338*, 171–179. doi:10.1056/NEJM199801153380307

Miller, G. E., Chen, E., & Parker, K. J. (2011). Psychological stress in childhood and susceptibility to the chronic diseases of aging: Moving toward a model of behavioral and biological mechanisms. *Psychological Bulletin*, *137*, 959–997.

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.

National Bureau of Statistics of China. (2013). *China statistical yearbook 2013*. Beijing, China: China Statistics Press.

Pascoe, E. A., & Richman, L. S. (2009). Perceived discrimination and health: A meta-analytic review. *Psychological Bulletin*, *135*, 531–554.

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.

Quevedo, K., Johnson, A. E., Loman, M. L., LaFavor, T. L., & Gunnar, M. (2012). The confluence of adverse early experience and puberty on the cortisol awakening response. *International Journal of Behavioral Development*, *36*, 19–28.

Richman, L. S., Bennett, G. G., Pek, J., Siegler, I., & Williams, R. B. (2007). Discrimination, dispositions, and cardiovascular responses to stress. *Health Psychology*, *26*, 675–683. doi:10.1037/0278-6133.26.6.675

Schmitt, M. T., Branscombe, N. R., Postmes, T., & Garcia, A. (2014). The consequences of perceived discrimination for psychological well-being: A meta-analytic review. *Psychological Bulletin*, *140*, 921–948. doi:10.1037/a0035754

Selig, J. P., & Preacher, K. J. (2008). Monte Carlo method for assessing mediation: An interactive tool for creating confidence intervals for indirect effects [Computer software]. Available from http://www.quantpsy.org/medmc/medmc.htm

Sephton, S. E., Lush, E., Dedert, E. A., Floyd, A. R., Rebholz, W. N., Dhabhar, F. S., . . . Salmon, P. (2013). Diurnal cortisol rhythm as a predictor of lung cancer survival. *Brain, Behavior, and Immunity*, *30*(Suppl.), S163–S170.

Sephton, S. E., Sapolsky, R. M., Kraemer, H. C., & Spiegel, D. (2000). Diurnal cortisol rhythm as a predictor of breast cancer survival. *Journal of the National Cancer Institute*, *92*, 994–1000.

Shih, M. (2004). Positive stigma: Examining resilience and empowerment in overcoming stigma. *The Annals of the American Academy of Political and Social Science*, *591*, 175–185.

Slatcher, R. B., Chi, P., Li, X., Zhao, J., Zhao, G., Ren, X., . . . Stanton, B. (in press). Associations between coping and diurnal cortisol among children affected by parental HIV/AIDS. *Health Psychology*. Advance online publication. doi:10.1037/hea0000169

Slatcher, R. B., & Robles, T. F. (2012). Preschoolers' everyday conflict at home and diurnal cortisol patterns. *Health Psychology*, *31*, 834–838.

Smeekens, S., Riksen-Walraven, J. M., & Van Bakel, H. J. A. (2007). Cortisol reactions in five-year-olds to parent–child interaction: The moderating role of ego-resiliency. *Journal of Child Psychology and Psychiatry*, *48*, 649–656. doi:10.1111/j.1469-7610.2007.01753.x

Werner, E. E. (1993). Risk, resilience, and recovery: Perspectives from the Kauai Longitudinal Study. *Development and Psychopathology*, *5*, 503–515.

Yu, X., Lau, J. T. F., Mak, W. W. S., Zhang, J., & Lui, W. W. S. (2011). Factor structure and psychometric properties of the Connor-Davidson Resilience Scale among Chinese adolescents. *Comprehensive Psychiatry*, *52*, 218–224.

Zeiders, K. H., Doane, L. D., & Roosa, M. W. (2012). Perceived discrimination and diurnal cortisol: Examining relations among Mexican American adolescents. *Hormones and Behavior*, *61*, 541–548. doi:10.1016/j.yhbeh.2012.01.018

Zhao, J., Li, X., Fang, X., Hong, Y., Zhao, G., Lin, X., . . . Stanton, B. (2010). Stigma Against Children Affected by AIDS (SACAA): Psychometric evaluation of a brief measurement scale. *AIDS and Behavior*, *14*, 1302–1312. doi:10.1007/s10461-009-9629-8