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Adolescents' Daily Worry, Morning Cortisol, and Health Symptoms

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A B S T R A C T

Purpose: To assess short-term effects of daily worries on hypothalamic-pituitary-adrenal axis activity and later implications for adolescents' health symptoms. We hypothesized that heightened worry would be associated with stronger next-morning cortisol awakening response (CAR) to prepare the body for the demands of the upcoming day. Guided by biological adaptation to stress theories, we also hypothesized that dysregulated CAR would heighten associations between worries and later health symptoms, while also testing direct associations between worries and dysregulated CAR and health.

Methods: Ninety-nine late adolescents during waves 5 and 6 of a longitudinal study reported on 26 worries for 10 days. On 3 of the 10 days, participants also provided morning saliva samples that were assayed for cortisol to capture the CAR. At both waves, participants reported on 22 common health symptoms.

Results: Multilevel models showed significant within-person associations between high daily worries and next-morning heightened CAR for females. Contrary to expectation, worries were inversely related to concurrent health symptoms. For the whole sample, CAR moderated the effect of worries on later health symptoms: Worries were positively associated with health symptoms in adolescents with high CAR and inversely associated with health symptoms for those with low CAR.

Conclusions: In this sample of typically developing adolescents, worries alone do not increase the risk for common health complaints and may be somewhat protective in the short run. However, high worries in the context of high CAR appear to increase the risk for health symptoms.

IMPLICATIONS AND CONTRIBUTION

Daily worries are common among adolescents but little is known about their health implications. In this study, females' worries relate to next-day heightened cortisol awakening response, an index of physiological preparation to meet upcoming demands. High worriers who had high cortisol awakening response also showed increased risk for future health problems.

Is the common admonishment, "You'll worry yourself sick" justified or misguided with respect to adolescents' daily worries? Worry is a complex, multidimensional process involving cognition, affect, and biologically based stress responses typically in anticipation of future events [1]. Worry is sometimes conceptualized as trait like, that is, certain people are "worriers"; it is a transdiagnostic indicator of psychopathology [2] and has been linked to adults' health symptoms including fatigue, musculoskeletal pain, and gastrointestinal problems [3]. Yet, more benign views recognize worry as quite common and as motivating constructive action. Adolescents typically report multiple worries per day [4,5], and the worries often wax and wane with everyday environmental pressures from school, peers, and family. Thus, to better articulate connections between worry and

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health, the present study investigates if ups and downs in adolescents' daily worries are associated with shifts in diurnal cortisol patterns via the daily cortisol awakening response (CAR). Drawing upon biological adaptation theories and focusing on day-to-day variation in worries, the present study tested whether worry prompts short-term physiological benefits but also occasionally long-term costs in health.

By conceptualizing worry as a process that fluctuates across days, we can measure its short-term impact on stress physiology. The hypothalamic-pituitary-adrenal (HPA) "fight or flight" response system that generates short-term mobilization of energy, attention, heightened cardiovascular activity, and cortisol release in response to stress, also regulates diurnal patterns of cortisol activity [6]. The CAR is the morning spike in circulating cortisol that occurs approximately 30–40 minutes after awakening as a preparation for the upcoming demands of the day [7,8]. Anticipated stress may affect the magnitude of the CAR [9]. For example, a comparison of adults' CAR from four weekdays to two weekend days showed more pronounced CAR on weekdays, particularly for those reporting high worry and work-related stress [10]. In 1-day assessments of worry, undergraduates who worried or ruminated at night showed higher cortisol increases the next morning [11]. Nonetheless, despite these associations between worry and heightened CAR, little is known about within-person, day-to-day fluctuations between worry and next-day HPA activity. Thus, the first objective of this study was to investigate whether within-person variability in worry reported each evening across 3 days corresponds to fluctuations in adolescents' next-day CAR. We assessed next-day CAR with the assumption that worry is the anticipation of upcoming events and hypothesized that heightened worry reported in the evening would be followed by more pronounced next-day CAR.

A frequently noted paradox of biological adaptation to stress is that short-term adaptive responses can ultimately alter the body's responses in the long term [12,13]. For the HPA axis, repeated and chronic activation can ultimately lead to an inefficient turning on or turning off of the stress response and, through allostasis, can result in persistently high or low basal cortisol activity [14]. Dysregulation of HPA levels—whether predominantly heightened [15] or attenuated [16]—has been linked to contemporaneous disease processes among adolescents. Although one cross-sectional study found flatter CAR linked with common health complaints including stomach aches and flu in 107 adolescents [17], chronically high cortisol is also associated with inadequate immune responses [18].

Thus, the second overall objective of this study was to investigate separate and combined effects of worry and CAR on either short-term or long-term health symptoms. To our knowledge, only one study has investigated direct effects between adolescents' worry and health: Global worry and duration of worry across 6 days correlated with concurrent health complaints in 171 predominantly female adolescents [5]. Our goal here was to test whether CAR strengthens associations between worry and adolescents' experience of health concerns. According to sensitivity to context hypotheses [19], adolescents who show heightened HPA activity in combination with worry may be more prone to negative consequences of worries on health. Consistent with findings that prolonged stress and elevated cortisol alter regulation of the immune system, insulin, and blood pressure [18], we anticipated that high daily worries may impair health in those with higher physiological arousal concomitant with worry. This hypothesized interaction between worries and CAR was tested not only for concurrent health symptoms but also for delayed symptoms in young adulthood, as health consequences of dysregulated CAR may emerge over time.

The present study used daily data to capture within-person variability in worries reported on three consecutive evenings and CAR on the following mornings. Self-reported health symptoms were measured during that same assessment and approximately 3 years later. Assuming worry is cognitive preparation for upcoming challenges, we hypothesized that higher worry would be associated with higher CAR the next day (hypothesis 1). With prior evidence linking worries and HPA axis to health, we hypothesized that more worries and dysregulated CAR would separately relate to more health symptoms (hypothesis 2). However, consistent with sensitivity to context perspectives and evidence that repeated HPA overactivation potentially disrupts bodily systems, we hypothesized that pronounced CAR would increase the association between worries and health symptoms, specifically at the later assessment (hypothesis 3). Investigating connections between worry, stress physiology, and health is particularly important during adolescence, which is considered a critical period when effects of perceived stress become biologically embedded [20,21]. Although chronic health concerns are somewhat infrequent during adolescence, contagious diseases (e.g., cold and sore throat) are common, and headaches, sleep difficulties, and musculoskeletal problems also increase [5,22,23].

Sex differences also are relevant due to their putative importance to key study variables at this developmental stage. Although consistent sex differences in HPA activity have not emerged [24], adolescent males sometimes show less pronounced CAR than females [25]. Some studies report that females worry more [26], whereas others report no sex differences, especially in daily worries [4,5]. Female adolescents also tend to report more health symptoms [22,23]. The present study tested sex as a moderator in associations between worries, HPA activity, and health.

Method

Overview

Data were collected during waves 5 and 6 of an ongoing longitudinal study [27] examining family relations and adolescent development. Families recruited from the Los Angeles area, through flyers, newspaper advertisements, and word of mouth, met the following eligibility criteria: both parents lived with the child for at least 3 years, family members could complete procedures in English, and the child was aged 9–10 years (cohort 1) or in middle school for families joining the project at wave 3 (cohort 2). Data collection for wave 5 occurred from 2009 to 2012 when participants were in mid-adolescence to late adolescence (mean [M] = 18.05, standard deviation [SD] = 1.08) and from 2014 to 2016 for wave 6 when participants were young adults (M = 22.24, SD = 23.00). On average, participation in wave 6 occurred 4.5 years following wave 5. At wave 5, participants completed 10 consecutive daily assessments of worry. Overlapping with the worry assessments and starting on day 2 or later, we collected three consecutive weekdays of saliva samples that were assayed for cortisol. Wave 6 participants completed an online survey that included questions about health symptoms. Procedures for both waves 5 and 6 were approved by the