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An Exploration of Affective, Physiological, and Environmental Stress Among Adolescents with Chronic Medical Conditions

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An Exploration of Affective, Physiological, and Environmental Stress Among Adolescents with Chronic Medical Conditions

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Biography

The author was born in Drexel Hill, PA on January 6, 1994. She graduated from Padua Academy in Wilmington, DE in 2012. She received her Bachelor of Arts degree in Psychology from The Catholic University of America in 2016. She is currently pursuing her MA/PhD in Clinical-Child Psychology at DePaul University.

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Abstract

Youth with chronic medical conditions (CMC) may be at-risk for increased stressors. For adolescents with CMC, maladaptive stress responsivity could lead to worse psychological and physiological effects from the stressors themselves. The current study aimed to understand the relation between affective and physiological responses to stress, environmental context, and longer-term health outcomes in youth with and without CMC. A sample of 141 adolescents, 73 with CMC and 68 without CMC, were randomly matched on age and gender. Participants completed self-report questionnaires at two time points, 6 months apart. Cortisol samples were collected during different timepoints of the Trier Social Stress Test (TSST). Correlations assessed differences in the relation between affective and cortisol responses, and how chronic environmental stressors impacted affective and cortisol responses differentially in youth with and without CMC. ANOVAs assessed differences in affective and cortisol responses, and in neighborhood stress between youth with and without CMC. Linear regressions assessed the impact of affective and cortisol responses at Time 1 on health outcomes reported at Time 2. Results revealed cortisol reactivity of adolescents without CMC was related to change in positive affect. Among those with CMC, adolescents experienced less positive affect before the stressor task. In addition, those with higher levels of neighborhood stress were associated with more anxiety and less positive affect. Furthermore, higher crime was associated with lower peak cortisol reactivity and more negative affect. Finally, those who experienced more negative affect prior to the acute stress later reported less pain-free days and lower quality of health.

Keywords: chronic medical condition, adolescence, cortisol reactivity, affect response, neighborhood stress

Introduction

Every year, a significant number of children and adolescents are diagnosed with a chronic medical condition (CMC). A CMC can be defined as an illness, disease, and/or medical condition that is prolonged, does not resolve spontaneously, and cannot be cured, though treatment may help some consequences and functioning (Stanton et al., 2007; Centers for Disease Control and Prevention, 2003). According to Pais and Menezes (2009), an estimated 20 percent of all children have a chronic condition—such as asthma, diabetes, and rheumatoid arthritis— and of those with a diagnosis, 65 percent have severe enough symptoms to cause daily dysfunction (Pais & Menezes, 2009). This daily dysfunction impacts multiple life domains, such as family, academics, and healthcare (Pais & Menezes, 2009; Mokkink et al. 2008; Copas et al., 2012). Academic difficulties include the inability to attend school or complete schoolwork regularly, and health impairments include more frequent and extensive medical care (Thies, 1999; Mokkink et al. 2008; Van Cleave et al., 2010). In addition to daily dysfunction, youth with CMC may be at-risk for increased stressors, as well as emotional and behavioral issues due to the increased daily stressor burden (Grey & Thurber, 1991; Compas et al, 2012).

Experiencing increased stressors during a significant developmental period— such as adolescence when cognitive, physiological, and neurobiological changes result in new everyday stressors— could worsen the psychological and physiological effects of the stressors (Rith-Najarian et al., 2014; Kliewer, 1997). In addition, though stressors are prevalent in adolescence (Grour et al., 1992; Steinberg & Morris, 2001; Rith-Najarian et al., 2014) and impact both individuals with and without a CMC, having a CMC as an additional daily stressor may lead to increased susceptibility to negative affect and physiological outcomes. Finally, there is a need to consider larger environmental contexts with respect to youth with CMC due to the influence they have on health outcomes (Henry et al., 2014; Boardman, 2004). Neighborhoods in which youth may encounter ongoing daily stressors may lead to exacerbated stress effects (Brenner et al., 2013; Roubinov et al., 2018; Rudolph et al., 2014). Therefore, it is important to explore the impact of both acute and chronic stress on affective and physiological responsivity among adolescents with CMC to gain a comprehensive understanding of the biological, social, emotional, and behavioral interactions and their effects on health outcomes.

'Stress' and 'stressor' have not been defined or conceptualized consistently throughout research literature. Grant and Colleagues (2003) provide definitions of 'stress' and 'stressors' that attempt to address the discrepancies. According to these researchers, 'stressors' are the environmental experiences or stimuli that affect an individual, while 'stress' broadly refers to the stressors themselves, as well as the response to the stressor exposure (Grant et al., 2003). In regards to the relationship between adolescents and stress, it is particularly crucial to examine the effects of stressors. Physiologically, changes in underlying biological and hormonal processes, such as increased reactivity in the HPA axis and the autonomic nervous system (ANS), occur with puberty which may affect the way adolescents respond to stressors (Gunnar et al., 2009; Stroud et al., 2009; Grant et al., 2003). Cognitively, adolescents also have an increased perception of stress and may response to stressors accordingly (Spear, 2009; Rith-Najarian et al., 2014). Using stressor language helps clarify the processes influencing health outcomes.

In the context of youth with CMC, it is important to focus on stressors to determine effective ways to support coping efforts and available resources (Moos, 2002). Studies show that among youth with CMC, those who experience more life stressors are likely to exhibit behavioral and psychosocial problems (Timko et al., 1992; Moos, 2002). In addition, it is important to distinguish between chronic and acute stressors, as they have both been shown to independently affect psychosocial outcomes. For example, a study of adolescents with juvenile rheumatic disease (JRD) revealed that after controlling for lack of social resources, chronic and acute stressors were determined to independently serve as risk factors for increased depression and behavioral problems (Timko et al., 1992). Further investigation into the complex stress systems and their reactions to stressors for adolescents with CMC can aid in their ability to understand and cope in the most adaptive way.

Conceptual Framework

Several theoretical frameworks are relevant in examining how components of the stress response system may operate differently across adolescents with and without CMC. The biopsychosocial (BPS) model aids in the identification of mechanisms to improve lives of youth with CMC. The BPS model speaks to the importance of interrelationships between all systems in the body—including those at the psychological and physiological level—when approaching the health of individuals with chronic conditions (Engel, 1977; Suls et al., 2010). The biomedical model primarily focuses on physiological processes and disease, but lacks consideration of the larger context in which humans live. In contrast, the BPS model posits that biological, such as physiological reactivity, psychological, such as cognition and emotion, and social factors, such as friends, family, and environmental context, interact with one another, and jointly impact the illness or health of individuals (Suls et al., 2010). A thorough understanding of the problem via a multilevel approach improves diagnosis and intervention (Suls et al., 2010).

The Biopsychosocial Model of Challenge and Threat (BPM-CT) clarifies the relationship between different components of the stress response system. Specifically, this model looks at the relationship between psychological stress appraisals, physiological stress responses, and behavioral responses during exposures to stressors (Blascovich et al., 1999; Folkman et al., 1986). The BPM-CT model suggests that when an acute stressor is presented, an individual engages in a pre-task cognitive stress appraisal determining whether the stressor is perceived as a challenge or a threat (Blascovich & Tomaka, 1996; Mendes et al., 2003; Rith-Najarian et al., 2014). A positive appraisal, which occurs when an individual believes they have the resources to cope with the demands of a situation, is thought to prompt a challenge stress response. On the other hand, a negative appraisal, which occurs when an individual believes the demands are greater than their resources to cope, is thought to prompt a threat stress response (Blascovich & Tomaka, 1996; Mendes et al., 2003; Rith-Najarian et al., 2014). In accordance with the appraisal, either an efficient or inefficient physiological stress response is prompted (Blascovich et al., 1999; Rith-Najarian et al., 2014). Finally, the physiological response leads to a behavioral response which then prompts the individual to engage in a post-task cognitive stress appraisal (Blascovich et al., 1999; Quigley et al., 2002; Rith-Najarian et al., 2014).

Empirical support for cognitive, physiological, and behavioral stress responses' relation to perceptions of stress, as suggested by the BPM-CT model, have been found in several adult studies (Kelsey et al., 2000; Schneider, 2008; Tomaka et al., 1993). However, to our knowledge, only one study examined these relations in adolescents. This study found that, contrary to adult findings, physiological stress response was not predicted by pre-task stress appraisals, and it did not predict post-task stress appraisals (Rith-Najarian et al., 2014). Furthermore, results indicated that performance was not predicted by stress appraisals or stress response, which is again contrary to adult findings (Rith-Najarian et al., 2014). However, consistent with adult findings, this study found that performance predicted post-stressor appraisals (Rith-Najarian et al., 2014). Since this is the only study to examine the cognitive, physiological, and behavioral stress response through the BPM-CT lens, further examination is needed with adolescent population.

The current study builds on this model by comparing stress responses in children with and without CMC and measuring additional types of physiological response, including cortisol. Additionally, cognitive and affective stress appraisal likely occur simultaneously and influence each other. The current study will integrate affective responses to stress into the model.

Finally, the BPM-CT model has only been applied to studies investigating responsivity to acute stressors without considering chronic stressors that may impact physiological and affective responses, such as daily environmental stressors. Prolonged and frequent activation of the stress system due to stressors in one's environment elicited by threat alter physiological responses, such as cortisol output, and may impact the ability to respond efficiently to acute stressor demands (Dickerson & Kemeny, 2004). According to social and ecological theories of development, the environment in which youth live and interact with contributes to youth psychological and physical health outcomes (Henry et al., 2014; Boardman, 2004), and impacts individual's affective and physiological stress experience (Brenner et al., 2013; Roubinov et al., 2018; Rudolph et al., 2014). As such, expanding the BPM-CT model to explore the role of chronic environmental stressors in relation to acute affective and physiological responses, particularly among youth with CMC, is a goal of the current study.

Affective Stress Response

Though the BPS and BPM-CT models are helpful, neither include affect which is a gap in the theory due to the well-established relationship between the cognitive/perceptual component of stress and affective component. Studies demonstrate a strong positive correlation between perceived stress and negative affect during exposure to a stressor, while also demonstrating no significant relation between perceived stress and positive affect (Clark & Watson, 1986; Watson, 1988). There are multiple studies that demonstrate differences in affective stress responses among individuals with and without CMC, though the majority of these studies include only adult participants (Plante et al., 1998; Heinecke et al., 2008; Costanzo et al., 2012). Adolescents with chronic fatigue syndrome (CFS) had significantly higher self-reported anxiety levels before and after an acute laboratory stress task than the healthy controls (Rimes et al., 2017). In addition, adolescents with CFS expected and found the task to be more difficult before and after completion (Rimes et al., 2017). These findings lend insight into the potentially heightened negative affective response to stressors in adolescents with CMC when compared to those without.

Affective stress responses in youth with CMC have the potential to impact their health outcomes. For example, high negative affect responsivity to stressors is associated with a greater risk of developing affective disorders, CMC diagnoses, and functional impairment later in life (Charles et al., 2013; Leger et al., 2018). Individuals with lower positive affect and higher negative affect responses in the presence of stressors had elevated inflammatory biomarkers (Sin et al., 2016). Increased negative affective responsivity to stressors was associated with risk for mortality only among adults with at least one CMC and not among healthy adults (Chiang et al., 2018). This indicates that negative affective response to daily stressors may have disproportionate effect for those with a CMC as opposed to those without. The current study will examine the impact of affect on mental and physical health outcomes among adolescents with CMC.

Physiological Stress Response and the Role of Cortisol

In addition to differences in affective stress response, there is also evidence of physiological stress response differences between individuals with and without a CMC. Prolonged stressors in one's environment can reduce coping ability which leads to greater sensitivity of the hypothalamic-pituitary-adrenal (HPA) axis and changes in cortisol output (Alink et al., 2012; Dickerson & Kemeny, 2004; Doane et al., 2013). Repeated and prolonged activation of the HPA axis can lead to physiological dysfunction, and when the cumulation of stress exceed one's coping capacity, the result is referred to as allostatic load (McEwen, 1998; McEwen & Stellar, 1993; Guidi et al., 2021).

Having a CMC may put an individual at-risk for increased and prolonged stressors, altering HPA axis functioning and adding to allostatic load. For example, children with allergic asthma had a significantly blunted cortisol response compared to the healthy control group (Buske-Kirschbaum et al., 2003). Similarly, adolescents with atopic dermatitis (AD) also had significantly blunted cortisol responses during acute stressors when compared to adolescents who did not have AD (Wambolt et al. 2003). However, the researchers did not indicate how they determined blunted levels (i.e. AUC or peak cortisol). How cortisol output is determined is an important consideration as different indices indicate different measurements in the cortisol response. Specifically, peak cortisol indicates the highest cortisol value, while AUCg (Area Under the Curve with respect to ground) and AUCi (Area Under the Curve with respect to increase) indicate magnitude and rate of change over time, respectively (Khoury et al., 2015). The current study will include multiple operationalizations of cortisol to determine which one is most closely related to outcomes.

Although studies often examined cortisol and affect response separately within given populations, investigating the direct relationship between them to gains a more integrated understanding of biological, social, and behavioral functioning (Bauer et al., 2002; Allwood et al., 2011). For example, Plante and colleagues (1998)'s, as well as Rimes and colleagues (2017)'s, results lend insight into the individual stress responses and how they differ from healthy controls, but they do not examine the direct relationship between the two stress responses among individuals. Furthermore, Rith-Najarian and colleagues (2014)'s results aid in the understanding of cognitive, biological, and behavioral stress responses among adolescents, but the study did not examine affective or HPA axis responses nor did their population include adolescents with CMC. Further examination HPA axis and affect response together is needed and examining this relationship specifically among adolescents with CMC is crucial as there are no studies to our knowledge that have done so.

Environmental Stressors and the Role of Neighborhood Factors

It is important examine the impact that chronic stressors have on HPA axis and affective responses because prolonged and frequent cortisol activation is associated with development, exacerbation, and progression of CMC (Dickerson & Kemeny, 2004; McEwen, 1998; Roubinov et al., 2018). Furthermore, assessing stressors across multiple domains may better inform an understanding of how and why certain circumstances produce specific affective and physiological responses (Dickerson & Kemeny, 2004). One important domain is the neighborhood environment (Boardman, 2004; Brenner et al., 2013; Grant et al., 2003; Henry et al., 2014; Latkin & Curry, 2003; Rabinowitz et al., 2020). Neighborhoods impact physical and psychological health and health behaviors across the lifespan (Boardman, 2004; Hackman et al., 2019). Relevant neighborhood factors include socioeconomic status (SES), crime, violence, housing stability, pollution levels, graffiti, noise, crowding, and access to recreation (Boardman, 2004; Diez Roux & Mair, 2010; Grant et al., 2003; Rudolph et al., 2014; Roubinov et al., 2018;). Most of previous research has focused on the relationship between neighborhood factors and later disease onset, but there is a lack of research regarding the impact of these stressors on individuals, particularly youth, who already have a diagnosed CMC; This paper aims to address that gap.

The impact of neighborhood stress on health outcomes varies as a function of measurement (Latkin & Curry, 2003). Many studies have solely focused on census data (Diez Roux & Mair, 2010), but subjective perceptions of neighborhoods may also provide valuable insight (Brenner et al., 2013). For example, previous research has demonstrated a stronger relationship between perceived neighborhood stressors, such as perceived neighborhood disorder, on individual’s mental health than objective neighborhood characteristics (e.g. census data; Hadley-Ives et al., 2000). Furthermore, in a follow-up study, perceived neighborhood disorder mediated the relationship between objective neighborhood characteristics measured via census data and self-reported quality of health (Hadley-Ives et al., 2001). Therefore, perceived neighborhood stress seems to be a reliable measurement when assessing neighborhood influence on health outcomes.

Neighborhood Stress and the Stress System’s Response

Neighborhood stress is associated with mental health outcomes, particularly with depressive, anxious, and post-traumatic stress symptoms (Boxer et al., 2008; Buka et al., 2001; Diez Roux & Mair, 2010; Latkin & Curry, 2003). In youth, neighborhoods impact externalizing behaviors such as aggression (Leventhal & Brooks-Gunn, 2000) and internalizing behaviors such as anxiety and depression (Lee et al., 2022; Rabinovitz et al., 2016). Furthermore, there are few studies examining the relation between neighborhood stress and affect symptoms among youth with CMC. One study conducted with youth with asthma found that those who lived in higher stress neighborhood experienced more depressive and asthma symptoms (Tobin et al., 2016). Thus, more research is needed to understand the impact of neighborhoods on youth with CMC.

Studies investigating the impact of neighborhood stressors and on acute affect responses are lacking. Theory posits that the accumulation of negative affect due to the neighborhood environment adversely affects coping ability and overall emotional functioning, resulting in mood disorders (Hackman et al., 2019). However, there few studies that actually studied neighborhood environments and affective responses. To address this gap, a research team utilized virtual reality technology to simulate disadvantaged neighborhoods and found that participants experienced less positive and more negative affect responses (Hackerman et al., 2019). Given that adolescents with CMC are already at an increased risk for stressors and are associated with more negative and less positive affective responses, a better understanding of the impact of neighborhood stress on this population is needed.

In addition to the association with emotional responses and outcomes, neighborhood stress also impacts physiological stress system, both acutely and chronically (Rudolph et al., 2014). With respect to acute response, neighborhood characteristics, such as violence and crime, induce a threat response which activates the physiological stress system, producing cortisol (Dickerson & Kemeny, 2004; Ross & Mirowsky, 2001). Threats to safety can result in cortisol changes (Dickerson & Kemeny, 2004), and those who are repeatedly exposed to these types of stressors experience increased responsivity, including higher intensity of reaction and longer recovery (Hackman et al., 2012; Ross & Mirowsky, 2001; Rudolph et al., 2014). This overactivation to the stress system contributes to allostatic load (Dickerson & Kemeny, 2004; Hackman et al., 2019). With respect to long-term cortisol effects, research demonstrated mixed findings; adolescents residing in lower SES neighborhoods, were found to either have lower basal cortisol (Chen & Paterson, 2006) or higher basal cortisol (Brenner et al., 2013; Rudolph et al., 2014) when compared to those living in higher SES neighborhoods. Clarifying research on neighborhood stress and cortisol response is needed in youth, especially among youth with CMC which to our knowledge has not been conducted.

Purpose of Study and Hypotheses

Though studies have examined affective or physiological stress responses among individuals with CMC, many of these studies have been with an adult population, rather than adolescents (Evans et al., 2013). Furthermore, there is a lack of research that examines HPA axis responsivity in adolescents with and without CMC. Finally, examination of the direct relationship between affective stress and physiological stress responsivity among adolescents with CMC is needed. Previous studies have not controlled for covariates that influence stress reactivity such as age and gender/sex so the current study will address these limitations as well. The proposed study aims to understand the relation between affective and physiological responses to stress, environmental context, and longer-term health outcomes in youth with and without CMC. The following research questions will be used to accomplish the study aims:

Research Question 1: Are there differences in acute cortisol and affect stress responses between adolescents with and without CMC?

Research Question 2: Are there differences in the relation between affective and cortisol responses to acute stress depending on CMC status?

Research Question 3: Do adolescents with CMC report higher levels of neighborhood chronic stress than adolescents without CMC?

Research Question 4: How does the neighborhood chronic stress impact acute affective and cortisol responses differentially in adolescents with and without CMC?

Research Question 5: How do affective and cortisol responses to acute stress at Time 1 influence later health outcomes at Time 2 in adolescents with and without CMC?

Method

Participants

Three-hundred and seventy-nine adolescents, age 11-18, were recruited for a larger study that assessed stressors, mental and physical health, and academic outcomes among adolescents from three Chicago, IL elementary schools. For the present study, 73 adolescents were identified as having a CMC and 68 adolescents (N = 141; Mage= 14; 55.2% female) who did not have a CMC were randomly matched using case-control matching in SPSS from the larger sample based on gender and age (Carollo & Taking, 2014). Adolescents with CMC were identified based on self-reported answers to a series of health questions, such as "*Do you have asthma*?" and "*Do you have diabetes*?" Of the sample, 35.7% identified at Hispanic/Latinx, 32.5% identified as Black, 12.7% identified as White, 11.5% identified as Other, and 7.1% identified as Asian (see Table 1).

Procedure

The larger study was conducted in two waves separated by six months. Data assessing the acute stress responses of adolescents was collected during the Time 1 protocol day which consisted of an 8-hour research session held at DePaul University. First, participants were administered surveys which asked questions regarding individual demographics, general physical health, neighborhood stress, and affective experiences. Next, participants were provided with a demonstration on how to properly provide saliva sample by DePaul University staff members, prior to providing the first saliva sample. Following the completion of the surveys and baseline saliva sample collection, participants completed The Trier Social Stress Test (TSST). The TSST is a commonly used method to induce stress and consists of participants delivering a speech in front of a panel of judges and their peers (Kudielka et al., 2009). During the stress task, participants provided several more saliva samples. Finally, after the completion of the stress task, participants completed an additional survey regarding their affective experience, as well as provided the final saliva sample.

Data assessing health outcomes was collected the Time 2 protocol day. Participants administered a health survey which asked questions regarding their health, including pain, sleep, and overall perceived quality of health. Participants were debriefed regarding the nature of the study at the conclusion of the session. Transportation to the and from the session was provided, and adolescents were given $50 for their participation.

Measures

Demographics

Racial and ethnic status was measured using a self-report questionnaire. Racial status was identified based on participant response to: *"I consider my racial group to be (pick all that are true): Black or African American, Asian or Asian American, American Indian or Alaskan Native, Native Hawaiian or Other Pacific Islander, White or Caucasian, BiRacial or MultiRacial (parents from more than one group), and Other (please write in)."* Ethnic status was identified based on participant response to: *"I consider my ethnic group to be: Hispanic or Latino or not Hispanic or Latino."*

Illness Status

Illness status was measured using the Health Questionnaire (Adam et al., 2006) which is characterized as a basic health questionnaire that includes questions regarding physical health, lifestyle, and medical history. Illness status was identified by participant answers to the following: "*Do you have asthma?", "Do you have diabetes?", "Do you have allergies?", "Do you have migraines?", or "Do you have any other reason to take medication?"* For the latter question, participants' qualitative responses were assessed for chronic conditions. If the participant responded 'yes' to any of the above questionnaire items, then they were identified as having a chronic condition. Research shows that self-report of medical diagnoses are just as reliable as medical records (Okura et al., 2004). Data were coded so that 0 = chronic medical condition and 1 = no chronic medical condition.

Affective stress response

Affective stress response was measured using the Profile of Mood States- Short Form (POMS-SF) (Bourgeois, LeUnes, & Meyers, 2010). The POMS-SF is a 37-item questionnaire measuring Anxiety, Depression, Anger, Vigor, Fatigue, and Confusion. Examples of negative affect items include reports of feeling sad, anxious, embarrassed, or upset. Examples of positive affect items include reports of feeling proud, lively, full of pep, and satisfied. Participants were administered the POMS-SF before and after TSST. To measure affective stress response, both negative and positive affect scores were examined. Negative affect scores were formed by averaging the four negative items. Positive affect scores were formed by averaging the four positive items. Change in negative and positive affect scores were formed by subtracting pre-TRIER scores from post-TRIER scores.

Physiological stress response

Physiological stress response was measured using salivary cortisol levels as a marker of the Hypothalamic-pituitary adrenal (HPA) axis (Wambodlt et al., 2003). Participants provided saliva samples throughout the TSST using the passive drool technique which consisted of giving unstimulated saliva through a small straw into a small polypropylene vial six times. The first sample was collected following the collection demonstration, which was approximately 15 minutes before the start of the stressor task. Participants were then instructed to prepare to give a speech to give that would include positive and negative characteristics about themselves to a hypothetical classroom of students. Participants were told that judges would evaluate the content of their speech and their body language, and might ask them additional questions. Participants were given three minutes to prepare their speech. The second saliva sample was collected following this preparation period at approximately 0 minutes before the start of the task. Sample three was collected immediately following the group speech, approximately 15 minutes from the start, and the fourth sample was collected approximately 30 minutes from the beginning of the task. Participants were then debriefed on the nature of the study. The fifth and sixth samples were collected at approximately 40 and 50 minutes after the start of the task, respectively. All samples were labeled using an ID number only (no participant identifying information), as well as the date and time of collection. The samples were centrifuged, frozen, and then cortisol levels analyzed. To measure acute stress, peak and area under the curve (AUC) cortisol were examined using the following formulas respectively, Cort_bs2pk=Cortugdl.4-

Cortugdl.2) and AUCi=AUCg-(ts2.5-ts2.2) *Cortugdl.2. (Hostinar et al., 2014; Pruessner et al., 2003).

Health Outcomes

Health outcomes were measured using the Health Questionnaire (Adam et al., 2006) that included questions regarding pain, sleep, and perceived quality of health. Items included "*In the past 4 weeks, on how many days were you free of pain?*", "*How would you rate your overall quality of health?",* and "*On average, how many hours of sleep do you get per night?*" For pain, 1 = no days, 2 = 1-3 days, 3 = 4-6 days, 4 = 7 to 14 days, and 5 = 15 to 28 days. For quality of health, 1 = Excellent, 2 = Above average, 3 = Average, 4 = Below average, 5 = Poor. For sleep, the participants entered the number of hours they slept per night.

Environmental Stress

Neighborhood stress severity was measured using the Life Stress Interview (Hammen et al., 1991). Severe stress was operationalized as the adolescent reporting many problems with neighborhoods (e.g. rarely feels safe in neighborhood, has been a victim of a serious crime or has witnessed a serious crime take place). Serious stress was operationalized as the adolescent reporting some problems with neighborhood (e.g. moderate amount of concern about his/her safety in the neighborhood or has been a victim of a non-violent crime). Moderate stress was operationalized as the adolescent reporting a few moderate problems with neighborhood (e.g. Adolescent reports a few moderate problems with neighbors or has witnessed a non-violent crime). Average Stress was operationalized as the adolescent feeling comfortable and safe in the neighborhood, but may have heard about a non-violent crime committed in the neighborhood. Little to No Stress was operationalized as the adolescent feeling comfortable and safe in the neighborhood and no problems reported at any time. Stress severity was coded as the following, 1 = Severe, 2 = Serious, 3 = Moderate Stress, 4 = Average Stress, 5 = Little to No Stress.

Total Crime was measured using census data which captured the number of overall crimes that occurred from June to September.

Results

Preliminary Analyses

Attrition analyses were conducted to assess missing data from Time 1 to Time 2. Of the 141 adolescents who participated at Time1, 77 also participated at Time 2. A t-test examining differential patterns of drop-out revealed no significant differences between Time 1 and Time 2 participants.

Correlation analyses were conducted to explore the relationships between all study variables and possible confounding variables (Table 2). There was a negative relationship between age and anxiety change, $r(80) = -.247$, $p = .027$, such that younger adolescents' anxiety increased from the beginning to the end of the stressor task. In addition, there was a negative relationship between age and pre-TRIER positive affect, $r(80) = -.247$, $p = .013$, such that younger adolescents had more positive affect prior to the start of the stress task. Finally, there was a positive association between age and positive affect change, $r(80) = .259$, $p = .020$, such that older adolescents' positive affect increased from the beginning to the end of the stressor task. Gender was significantly correlated with pre-TRIER anxiety, $r(80) = .227$, $p = .043$ and post-TRIER anxiety, $r(81) = .227$, $p = .042$, suggesting that females were more anxious pre- and post- stress task.

Acute Stress Reactivity Differences

ANOVAs were conducted to assess the difference in affective and cortisol stress responses between youth with and without CMC. Means, standard deviations, and one-way ANOVA results are presented in Table 3. No significant differences in cortisol stress responses were found between groups. A significant difference was found for one affective variable. The effect of CMC was significant for pre-TRIER positive affect, $F(1,79) = 4.43$, $p = .039$ such that youth with CMC reported less positive affect prior to the acute stressor. No other significant differences in affective responses were found between groups.

Acute Stress Affective and Cortisol Relationship Differences

Correlations were performed to assess whether there are differences in the relation between acute affective and cortisol responses among youth with and without CMC. Bivariate correlations among youth with and without CMC variables are presented in Table 4. Among youth without CMC, higher levels of cortisol area under the curve from ground (AUCg) were associated with more change in positive affect, such that less positive affect was reported post-TRIER $r(32) = .38$, $p = .034$. Among youth with CMC, no significant correlations were found. A fischer Z test was used to compare correlations between these variables in youth with and without CMC. The associations did not significantly differ between groups ($z = 1.416$, $p = .078$).

Neighborhood Chronic Stress Differences

A one-way ANOVA was conducted to determine whether there was a difference in neighborhood stress between youth with and without CMC. Results are presented in Table 3. Results showed no difference between groups.

Neighborhood Affective and Cortisol Relationship Differences

Correlations were performed to assess how chronic environmental stressors impacted acute affective and cortisol responses differentially in youth with and without CMC. Bivariate correlations among youth with and without CMC variables are presented in Table 4. Among youth with CMC, more neighborhood stress was associated with more anxiety ($r(28) = -.39$, $p = .039$) and with less positive affect ($r(28) = .42$, $p = .024$) reported post-TRIER. Additionally, among youth with CMC, higher overall crime was associated with lower peak cortisol levels $r(50) = -.38$, $p = .007$, and with more change in negative affect, such that more negative affect was reported post-TRIER, $r(45) = .36$, $p = .016$.

No significant effects were found in youth without CMC. A fischer Z test was used to compare correlations between these variables in youth with and without CMC. Neighborhood stress and anxiety change ($z = -1.886$, $p = .03$) and crime and peak cortisol ($z = -1.846$, $p = .03$) associations significantly differed between the groups.

Responses to Stress and Later Health Outcomes

Correlations examined the relationship between affective and cortisol responses to stress at time 1 and later health outcomes at Time 2 in youth with and without CMC. Among youth with CMC, significant associations between pre-TRIER negative self-reported affect and average hours of sleep per night, pre-TRIER anxiety and fewer pain-free days, pre-TRIER anxiety and average hours of sleep per night, pre-TRIER positive affect and overall quality of health, and pre-TRIER positive affect and average hours of sleep per night were found. No significant correlations were found for youth without CMC.

Next, multiple linear regressions were performed to assess how affective and cortisol responses to acute stress at Time 1 influenced later health outcomes reported at Time 2 in youth with and without CMC while controlling for age and gender. Gender and age are important variables to consider when studying stress and health outcomes, therefore they were included as covariates in these analyses. Eight individual linear regressions were performed assessing 6 affect variables on 3 health outcome variables. Three linear regressions were performed assessing 9 cortisol variables on 3 health outcome variables. Significant results are presented in tables 5 and 6.

Among youth with CMC, pre-TRIER negative affect at Time 1 significantly predicted pain free days at Time 2 ($\beta = 0.79$, $p = .01$), such that those with higher negative affect had less pain free days. Furthermore, among youth with CMC, pre-TRIER negative affect at Time 1 also significantly predicted reported overall quality of health at Time 2 ($\beta = 0.53$, $p = .02$), such that those with higher negative affect had lower quality of health. Among youth with CMC, pre-TRIER anxiety at Time 1 significantly predicted reported overall quality of health at Time 2 ($\beta = 0.53$, $p = .007$) such that those with higher anxiety had lower quality of health. Age was also a significant predictor such that older children reported lower levels of overall quality of health ($\beta = 0.15$, $p = .04$). Among youth with CMC, overall change in positive affect at Time 1 significantly predicted reported overall quality of health at Time 2 ($\beta = 0.49$, $p = .046$) such that more change in positive affect was associated with lower overall quality of health. No significant relationships between cortisol responses and health outcomes were found among youth with CMC.

No significant relationships between affective responses stress responses at Time 1 and health outcomes at Time 2 were found for youth without CMC. No significant relationships between cortisol responses and health outcomes were found among youth without CMC.

Discussion

In order to better understand the impact of affective, physiological, and environmental stressors on adolescents with CMC, the present study analyzed how acute stress responses and neighborhood factors differentially impacted adolescents with and without CMC, as well as how acute stress responses differentially influenced later health outcomes for adolescents with and without CMC. Four main findings emerged. First, though no differences in cortisol response was found between adolescents with and without CMC, adolescents with CMC experienced less positive affect before the acute stressor task. Second, while no associations between affect and cortisol were found among adolescents with CMC, the cortisol reactivity of adolescents without CMC's was found to be related to changes in positive affect. Third, in adolescents with CMC, higher levels of neighborhood stress were associated with more anxiety and less positive affect. Furthermore, higher crime was associated with lower peak cortisol reactivity and more negative affect. Fourth, adolescents with CMC who experienced more negative affect prior to the acute stress later reported fewer pain-free days and lower quality of health. These findings will be discussed in more detail below.

Affective and Physiological Stress Responses

In contrast to what was expected, no significant differences in cortisol stress responses between groups were found in the current study. Though previous research among youth with allergic asthma and atopic dermatitis, showed blunted cortisol responses when compared to healthy youth (Buske-Kirschbaum et al., 2003; Wambolt et al. 2003), this may be specific to chronic allergic inflammatory processes specific to chronic manifestations of atopy (Buske-Kirschbaum et al., 2003). The current sample did not include any participants with allergic asthma, atopic dermatitis, or allergic rhinitis which may be one explanation for why no differences were found. Furthermore, the present study controlled for gender and age, while previous studies did not (Buske-Kirschbaum et al., 2003). Controlling for gender and age covariates is important because research has shown these factors differentially influence affective and physiological stress responses (Oldehinkel & Bouma, 2011). Particularly, adolescent females are at higher risk for internalizing symptoms, such as depressive symptoms, due to several factors including increased sensitivity to social stressors (Oldehinkel & Bouma, 2011).

In regards to the affective stress response, results revealed a significant group difference in pre-TRIER positive affect such that youth with CMC had less positive affect ratings prior to an acute stressor than youth without CMC. This finding aligns with previous research in which adults with CMC reported less positive affect (Costanzo et al., 2012) and more negative affect in response to stressors than adults without CMC (Heinecke et al., 2008; Plante et al., 1998), and lends insight into affective stress responses in adolescents with various CMC. Specifically, given that both CMC and the adolescence developmental period puts individuals at-risk for increased stressors which may lead to worsened psychological and physiological issues (Compas et al, 2012; Grey & Thurber, 1991; Kliewer, 1997; Rith-Najarian et al., 2014), lower positive affective responses may be indictive of maladaptive coping within this population. Furthermore, lower positive affect was found in our population of adolescents who have various CMC which may indicate common negative responses across conditions.

In addition to assessing the differences between those with and without CMC, the current studied also explored the differences in the relation between acute affective and cortisol responses among youth with and without CMC. While no significant relations were found among youth with CMC, results showed that among youth without CMC there was a significant positive association between cortisol AUCg and overall change in positive affect, such that higher levels of cortisol were associated with more change in positive affect resulting in less positive affect following the stressor task. Previous research demonstrates relationships between physiological and affective stress responses (Bauer et al., 2002; Dickerson & Kemeny, 2004; Gordis et al., 2006) however research specifically among youth with CMC regarding these relationships is lacking. Particularly, in general when the HPA axis is activated during a stressor, the increase in cortisol is associated with negative cognitive appraisals and affect responses (Dickerson & Kemeny, 2004). The significant finding among youth without CMC may be due to CMC youth reporting less positive affect prior to the stressor than youth without, thus resulting in less overall change in positive affect. Furthermore, the lack of relation found between cortisol and affective responses among those with CMC may be indicative of dysfunction of the stress system.

Neighborhood Influences

Consideration of chronic stressors, such as factors in the neighborhood environment, is crucial due to the effects on individuals' affective and physiological stress experiences (Brenner et al., 2013; Roubinov et al., 2018; Rudolph et al., 2014), but youth with and without CMC did not differentially report neighborhood stress. Furthermore, with respect to assess how chronic environmental stressors impact acute affective and cortisol responses differentially in youth with and without CMC, Research Question 3 examined neighborhood stress and crime data in relation to affective and cortisol responses. There were only significant findings among youth with CMC in which more neighborhood stress was associated with more anxiety and less positive affect reported following the stressor task. In addition, higher overall crime was associated with lower peak cortisol levels and with more change in negative affect, such that more negative affect was reported following the stressor task. The relationship between neighborhood stress and anxiety change, as well as between the relationship between overall crime and peak cortisol, significantly differed between youth with and without CMC.

Only finding significant relations among the CMC participants is consistent with literature on the impact of social stressors on physical health (Ahmad & Zakaria, 2015; Boardman, 2004). Specifically, neighborhood severity and crime factors may contribute to individuals' allostatic load which, in turn, could lead to physiological dysfunction, such as blunted cortisol, as well as more negative affective stress responses (Boardman, 2004; Hackman et al., 2019; Matheson et al., 2006; McEwan, 1998). Prolonged stressors in one's environment, such as higher perceived neighborhood severity and crime, as well as having a CMC, increases HPA axis sensitivity and hinders coping ability (Alink et al., 2012; Guidi et al., 2021; McEwen & Stellar; 1993). Though all adolescents encounter stressors, the influence of neighborhood stressors is likely to have a differential impact based on individual-level characteristics, such as psychosocial resources and biological attributes (Diez Roux & Mair, 2010). In other words, having a CMC as an additional daily stressor may lead to increase susceptibility to negative affect and physiological outcomes (Boxer et al., 2008). These results speak to the importance of exploring the impact of both objective (e.g. crime census data) and subjective (e.g. perceived neighborhood stressor severity) chronic environmental stressors on affective and physiological responsivity among adolescents with CMC to gain a comprehensive understanding of their effects on health outcomes.

Longitudinal Impact of Stress Responses

Finally, because it is not only important to understand how the stress system responds to stressors, but also to understand the long-term impact of the responses on health outcomes, Research Question 4 sought to understand the differential impact of having a CMC on how affective and cortisol responses to acute stress would influence later health outcomes. While cortisol responses did not predict health outcomes in either group, significant relationships were found between affective stress responses and health outcomes only among youth with CMC. Specifically, those who reported higher negative affect prior to the stress task at Time 1 reported fewer pain-free days and lower overall quality of health at Time 2. In addition, those who reported higher anxiety prior to the stress task, as well as those who had more change in positive affect (i.e. resulting in less positive affect following the stress task), at Time 1 also reported lower overall quality of health at Time 2.

Though it has been suggested that maladaptive responses to stressors are associated with poor health outcomes in the future, much of previous research has focused on acute affective response, rather than longitudinally assessing the impact of negative affect and lack of adaptation to stressful events (Leger et al., 2018). Addressing less positive and more negative affect responses is important due to the known association between lingering negative affect response and negative long-term physical health outcomes, such as functional impairment and elevated inflammatory levels (Leger et al., 2018; Sin et al., 2016). Additionally, these results aid in addressing the lack of studies examining the mental and physical health outcomes among adolescents with CMC. This is crucial as individuals with CMC seem to have higher negative affect responses to stressors, and increases in negative affective response to daily stressors may have disproportionate effect for those with a CMC (Chiang et al., 2018), such as exacerbation of health conditions (Ross & Mirowsky, 2001).

Strengths, Limitations, and Future Directions

To our knowledge, this is the first study to explore environmental, affective, and physiological functioning together in youth with CMC. Prior research has examined affective or physiological stress responses among individuals with CMC, however many of these studies have been with an adult population, rather than adolescents (Evans et al., 2013). Furthermore, this study added to the limited amount of research investigating the direct relationship between affective and physiological stress responses in youth CMC. Examining the direct relationship between affect and physiological response, as well as assessing neighborhood influence on those responses, aids in a more integrated understanding of biological, social, and behavioral functioning (Allwood et al., 2011; Bauer et al., 2002; Boardman, 2004; Henry et al., 2014).

Findings build on the BPM-CT model, which has largely been applied to adult studies (Kelsey et al., 2000; Schneider, 2008; Tomaka et al., 1993), and never among youth with CMC. Moreover, this study uniquely integrated cortisol and affect responsivity, as well as the impact of neighborhood factors. Including neighborhood factors is crucial, as they contribute to youth psychological and physcial health outcomes (Boardman, 2004; Henry et al., 2014), and impact individual’s affective and physiological stress experiences (Brenner et al., 2013; Roubinov et al., 2018; Rudolph et al., 2014). Additional studies assessing differences in cortisol and affective responsivity in youth with and without CMC in a larger sample are still needed. Future research may want to examine protective factors in youth with CMC’s environment that buffer against negative stress effects. For example, though not specific to youth with CMC, neighborhood stability has been found to be a key mediator in the relationship between stress ratings and physical health outcomes, such that higher levels of neighborhood stability buffered effects of high levels of stress of physical health outcomes (Boardman, 2004). Additionally, identifying neighborhood factors beyond SES, which the majority of previous research focuses on (Boardman, 2004), will aid in more targeted intervention and advocacy efforts. Other factors include but are not limited to violence, pollution level, access to recreational spaces, incidence of crime, noise, and crowding (Roubinov et al., 2018; Rudolph et al., 2014).

With respect to demographics, our study included a relatively ethnically diverse participant sample, expanding the generalizability of the findings to reflect urban communities. Future research may want to explore stressor impact on stress responses among Asian youth with CMC, as these individuals made up the smallest percent of our sample. Additionally, this study examined stressors and stress responses across various CMC, while previous research solely focused on individual conditions (Buske-Kirschbaum et al., 2003; Rimes et al., 2017; Tobin et al., 2016; Wambolt et al. 2003). A benefit to taking a general approach to CMC is identifying common stress patterns that youth with CMC may have in order to aid in increased preventative care implementation and intervention development. This could help broaden the scope of care from specialty clinics to reaching more of the CMC community. On the other hand, a limitation to a generalized approach is that certain condition parameters, such as medical and functional severity, unique to individual conditions may differentially impact stress responses (Thompson & Gustafson, 1996; Wallander & Varni, 1992). This study was unable to assess specific mechanisms related uniquely to CMC, thus future investigation is warranted.

Finally, though our study was able to examine the relation between stress responses and later health outcomes, our findings are limited to a 6-month time period between Time 1 and Time 2 procedures. Future research should investigate this relationship over a longer period of time, and should examine other health outcomes in addition to the pain, sleep, and perceived health outcomes included in this study. The clinical implications of a more in-depth understanding of stressors on long-term health outcomes for youth with CMC may include reducing neighborhood stress via policy change, and improving stress responses in youth with CMC by implementing preventative care and adapting or developing new interventions.

Conclusion

In summary, there are differences in affective and cortisol responses among adolescents with and without CMC. In youth with CMC, neighborhood factors were associated with acute stress responses, and those stress responses predicted later health outcomes. Results emphasize the need for a comprehensive, biopsychosocial approach to understand environmental, affective, and physiological functioning in youth with CMC. Additional research is needed to inform intervention development and policy changes to improve stress responses and decrease neighborhood stressors for youth with CMC.

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Appendix A: List of Tables

Table 1

Demographic Characteristics of Participants (N = 141)

		M (SD)
Age		14.46 (1.99)
Sex		*N (%)*
	Female	74 (55.2)
	Male	60 (44.8)
Race & Ethnicity		
	Hispanic	45 (35.7)
	Black, non-Hispanic	41 (32.5)
	Asian, non-Hispanic	9 (7.1)
	Other, non-Hispanic	15 (11.5)
	White, non-Hispanic	16 (12.7)

Table 2

Correlations among all study variables

Variables	*1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Age	-																			
2. CMC Status	.000	-																		
3. Gender	.000	.000	-																	
4. T1 Neighborhood Severity	-.168	.031	-.042	-																
5. T1 Total Crime	-.092	-.013	.153	-.272*	-															
6. T1 Pre-Anxiety	.154	-.083	.227*	-.034	-.075	-														
7. T1 Post-Anxiety	-.089	.016	.227*	-.185	.017	.620**	-													
8. T1 Anxiety Change	-.247*	.090	.085	-.190	.086	-.145	.687**	-												
9. T1 Pre-Negative Affect	.008	.104	.102	-.011	-.098	.738**	.409**	-.168	-											
10. T1 Post-Negative Affect	-.201	.141	.151	-.222	.118	.488**	.800**	.564**	.519**	-										
11. T1 Negative Affect Change	-.205	.041	.099	-.219	.207	-.149	.502**	.771**	-.356**	.614**	-									
12. T1 Pre-Positive Affect	-.276*	.261*	-.156	-.046	.157	-.654**	-.454**	.034	-.244*	-.148	.063	-								
13. T1 Post-Positive Affect	-.077	.176	-.083	.194	.035	-.485**	-.686**	-.415**	-.135	-.415**	-.329**	.775**	-							
14. Positive Affect Change	.259*	-.088	.082	.326*	-.162	.176	-.417**	-.689**	.137	-.430**	-.596**	-.217	.449**	-						
15. T1 Cortisol AUCg	.212	-.068	.031	.080	.025	-.008	.025	.042	-.126	-.018	.109	-.039	.084	.175	-					
16. T1 Cortisol AUCi	.181	-.103	.043	.240	.034	-.031	.044	.079	-.118	-.037	.064	-.080	.045	.178	.856**	-				
17. T1 Peak Cortisol	-.090	.089	-.108	.132	-.246*	-.159	-.066	.066	-.096	-.057	.029	.106	.109	.018	.700**	.000	-			
18. T2 Pain-Free Days	.180	-.049	.057	-.315	-.122	.237	.003	-.237	.401**	.204	-.143	-.061	.055	.182	-.026	-.241	-.169	-		
19. T2 Quality of Health	.152	.153	-.015	-.028	-.283*	.420**	.167	-.195	.467**	.131	-.291	-.203	.002	.306*	.111	.079	.079	.208	-	
20. T2 Hours of Sleep	-.231	-.016	.018	.187	.033	-.394**	-.250	.064	-.447**	-.295	.077	.199	.122	-.113	.065	.038	.033	.083	-.196	-

*p < .05; **p < .01; ***p < .001

Table 3
Means, Standard Deviations, and One-Way Analyses of Variance

Measures	CMC		Without CMC		*F*	*η2*
	M	SD	M	SD		
Change in Anxiety	.73	.76	.58	.76	.35[a]	.005
Post-Anxiety	1.58	1.01	1.53	.88	.01[b]	.000
Pre-Anxiety	.85	.72	.96	.69	.37[a]	.005
Change in Negative Affect	.38	.73	.32	.59	.02[a]	.000
Post-Negative Affect	.90	.80	.69	.64	1.11[b]	.014
Pre-Negative Affect	.50	.73	.37	.45	.87[a]	.011
Change in Positive Affect	-.40	.65	-.29	.55	.34[a]	.004
Post-Positive Affect	2.09	.93	1.79	.89	1.92[b]	.024
Pre-Positive Affect	2.51	.79	2.08	.88	4.43[a]*	.055
Cortisol AUCg	3.48	2.74	3.81	2.99	.04[d]	.001
Cortisol AUCi	.81	2.05	1.28	2.66	.38[d]	.005
Peak Cortisol	.20	1.09	.05	.09	.74[e]	.008
Neighborhood Severity	4.11	.99	4.08	1.02	.00[c]	.000

Note. Data collected at Time 1; AUCg = area under the curve from the ground; AUCi = area under the curve from the initial value; Peak cortisol = increase from baseline to peak value; a = 1, 79 df; b= 1,80 df; c= 1, 60 df; d=1,72 df; e= 1,91 df.

*p < .05; **p < .01; ***p < .001

Table 4.
Correlations among affective, cortisol, and environmental variables for youth with and without CMC

Variables	*1*	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1. Change in Anxiety	-	.713**	-.046	.793**	.571**	-.176	-.725**	-.594**	-.119	.170	.227	.074	-.392*	.198
2. Post-Anxiety	.657**	-	.667**	.484**	.836**	.433**	-.437**	-.738**	-.528**	.137	.178	-.083	-.252	.030
3. Pre-Anxiety	-.258	.559**	-	-.154	.594**	.804**	.149	-.419**	-.627**	.017	.000	-.196	.114	-.176
4. Change in Negative Affect	.747**	.537**	-.134	-	.549**	-.408**	-.664**	-.448**	.006	.136	.112	.030	-.287	.358*
5. Post-Negative Affect	.548**	.754**	.364*	.740**	-	.539**	-.420**	-.524**	-.281	-.010	.012	-.083	-.230	.123
6. Pre-Negative Affect	-.199	.375*	.699**	-.258	.460**	-	.210	-.117	-.313*	-.129	-.108	-.117	.062	-.244
7. Change in Positive Affect	-.633**	-.385*	.203	-.471**	-.432**	.001	-	.568**	-.137	.042	.037	.019	.424*	-.232
8. Post-Positive Affect	-.236	-.642**	-.562**	-.169	-.333*	-.254	.329*	-	.737**	-.083	-.097	.116	.350	-.028
9. Pre-Positive Affect	.156	-.409*	-.697**	.123	-.067	-.258	-.292	.807**	-	-.147	-.147	.122	.057	.165
10. Cortisol AUCg	-.121	-.140	-.042	.073	-.009	-.123	.376*	.336	.098	-	.832**	.648**	.140	-.007
11. Cortisol AUCi	-.061	-.102	-.063	.018	-.067	-.127	.342	.230	.014	.880**	-	.837**	.135	.022
12. Peak Cortisol	.045	-.033	-.092	.017	-.082	-.140	.248	.126	-.027	.746**	.907**	-	.156	-.377**
13. Neighborhood Severity	.212	-.042	-.282	-.075	-.199	-.177	.121	-.096	-.217	-.002	.433	.333	-	-.286
14 Overall Crime	-.060	.001	.066	.000	.074	.105	-.054	.049	.083	.069	.069	-.002	-.279	-

Note. CMC values above the diagonal, without CMC values below the diagonal

*p < .05; **p < .01; ***p < .001

Table 5

Linear regression T1 pre-TRIER negative affect predicting T2 pain-free days among CMC

Effects	Estimate	*SE*	95% CI		*p* value
			LL	UL	
(Constant)	1.17	.70	-.28	2.61	.108
Age	.19	.10	-.02	.39	.074
Gender	-.07	.37	-.84	.70	.847
Pre-TRIER negative affect	.79	.28	.21	1.37	.010*

Note. R-square = .0.434**; * p < .05; ** p < .01; *** p < .001

Table 6

Linear regression T1 affect predicting T2 overall quality of health among CMC

Effects	Estimate	SE	95% CI		*p* value
			LL	UL	
		Pre-TRIER Negative[a]			
(Constant)	2.07	.53	.96	3.17	.001**
Age	.15	.07	-.01	.30	.060
Gender	-.09	.29	-.68	.51	.763
Pre-negative affect	.53	.21	.10	.98	.020*
		Pre-TRIER Anxiety[b]			
(Constant)	1.88	.51	.83	2.93	.001**
Age	.15	.07	.01	.30	.040*
Gender	-.11	.27	-.68	.45	.679
Pre-anxiety	.52	.17	.16	.89	.007**
		Change in Positive Affect[c]			
(Constant)	2.64	.64	1.32	3.97	.000***
Age	.16	.08	-.00	.32	.054
Gender	-.18	.31	-.82	.45	.553
Change in positive affect	.49	.23	.01	.96	.046*

Note. a= R-square = .040**; b= R-square = .453**; c= R-square = .360*

* p < .05; ** p < .01; *** p < .001