ASSOCIATIONS BETWEEN RESPIRATORY HEALTH AND EMOTION REGULATION

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ABSTRACT

The Inland Empire is notorious for having poor air quality, making the relationship between respiratory problems and aspects of children's socioemotional development that support mental health and well-being (like emotion regulation) highly interesting to investigate. The current study employs a biobehavioral approach to study the multi-dimensional construct of emotion regulation as it relates to respiratory diseases such as asthma, respiratory infections such as bronchitis, cold and croup, and allergies. Because respiratory health and emotion regulation are two very important aspects of child development, studying the links between them can help guide caregivers, teachers, health professionals, and policy makers on how best to support children's healthy development. The Physiology and Emotion Regulation in Kids (PERK) study conducted by the Emotion Regulation Lab at the University of California, Riverside from 2013 to 2015 included 184 child-parent dyads from a diverse population in the Inland Empire region of Southern California. Parents reported on their child's respiratory health and emotion regulation abilities. Respiratory sinus arrhythmia (RSA) was derived from child physiological data collected throughout the laboratory visit and observed behavioral distress was assessed through an emotional task. In support of our hypotheses, results indicate that children with respiratory illnesses experienced significantly more distress ($M = 2.02$, $SD = .57$) compared to children without respiratory illness ($M = 1.75$, $SD = .68$), $t(182) = -2.64$, $p = .01$. Contrary to hypotheses, children with respiratory illnesses ($M = 27.83$, $SD = 6.49$) and children without respiratory illnesses ($M = 25.98$, $SD = 6.96$) did not significantly differ in their emotion regulation skills, $t(182) = -1.50$, $p > .05$. Similarly, children did not have significantly different RSA baselines, $t(182) = -.14$, $p > .05$. Our research aids in highlighting the possible consequences of poor respiratory health, in addition to contributing to an important avenue of work in the Inland

Empire community where rates of pediatric asthma and allergies are notoriously high. Future research should focus on possible mechanisms or moderators that help explain the association between respiratory illness and behavioral distress (e.g., cognitive or physiological indicators of emotion regulation).

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INTRODUCTION

As increases in air pollution continue to be a pressing issue in the global climate crisis, it also remains a prevalent threat to children, who are exposed to poor air quality now more than ever before. Particulate matter is one of the major airborne pollutants and has been shown to have various aversive effects in the respiratory system (Ober, 2021). Specifically, the Inland Empire region in California is notorious for having poor air quality. The counties of San Bernardino and Riverside topped the American Lung Association's State of the Air 2019 list for most ozone-polluted cities in the United States (Zilliac, 2020). This is particularly problematic for vulnerable individuals such as children, whose bodies are still developing. Previous studies have shown that children are highly vulnerable to particulate matter, which can have serious implications for lung development (e.g., Gauderman et al., 2004; Khan, 2004; Phelps, et al., 2004; Wang et al., 2020). In fact, one study showed that children in San Bernardino county have a 59% higher chance of poor lung function (Zilliac, 2020). Respiratory diseases in children have increased significantly in recent years due to increased air pollution, yet the health implications beyond physical disease are largely unknown. In particular, the relationship between respiratory problems and aspects of children's socioemotional development that support mental health and well-being (like emotion regulation) is highly interesting to investigate. Existing research suggests that there is an intricate interplay between physical and mental health, such that they bidirectionally influence one another (Cully et al., 2014). Thus, a greater understanding of associations between children's respiratory health and emotion regulation is crucial to inform future interventions that help children as well as parents manage respiratory diseases and their impact on well-being. The goal of this Capstone project is to further our understanding of the link between physical and psychological well-being by investigating associations between

respiratory health and emotion regulation in children.

LITERATURE REVIEW

Asthma is a lung disease that is characterized by the obstruction of airways caused by inflammation, narrowing, or hyperresponsiveness to stimuli (Bacharier et al., 2004). It is the most common chronic respiratory disease in children and the incidence of asthma has increased significantly in recent years due to increasing levels of air pollutants (Hai-Ying et al., 2018). Asthma affects more than 7 million children from ages 0-17 (Adams & Marano, 1995; Akinbami et al., 2011) and disproportionately affects those from poor and minority communities (Akinbami et al., 2009; Akinbami et al., 2011). Fortunately for many children, asthma can be controlled by taking precautionary measures. For instance, people with asthma can avoid triggers like bad weather, dust, and stress, as well as take regular preventative medications (Conn, 2013).

The majority of research on respiratory illness in children focuses on asthma; less research has examined other respiratory illnesses such as allergies or respiratory infections. Of the studies that have investigated these related health concerns, comorbid uncontrolled asthma is detected in 26% of the patients with other atopic diseases, illustrating that even though these diseases are separate from asthma, a large percentage of these patients still have asthma (Kansen et al., 2020). For allergies and respiratory infections, previous research has primarily focused on the diagnoses and medications instead of preventative measures or environmental influences, in contrast with contemporary research on asthma (Emmert et al., 2019; Hofman, 2002). The current study seeks to address this gap in previous literature by examining allergies and respiratory infections (e.g., colds, bronchitis, and croup) in addition to asthma. Considering how these broad and common respiratory issues relate to psychological processes such as emotion

regulation can provide insight into the mental health and well-being implications of respiratory issues in childhood.

Emotion Regulation and Respiratory Health

Emotion regulation can be defined as the set of processes by which people manage their own and others' emotional states (Gross, 2014). This is often accomplished in practice by changing the valence or intensity of the affective experience, or by modulating the behavioral response in line with one's goals. Emotion entails three components of a coordinated response: 1) the subjective feeling of an emotion, 2) behavioral response to the emotion, and 3) the physiological response to emotion (Gross, 2001). Changing one or more of the components to manage one's emotional response indicates use of emotion regulation (Gross, 2014). Emotion regulation involves the integration of multiple systems (e.g., behavioral, biological, social, cognitive), and research has shown that these systems become more integrated with age. Thus studying the development of emotion regulation in children is especially revealing for understanding the ontogeny of health and well-being (e.g., Gross, 2014; LoBue et al., 2019). Previous research has shown that children who are able to regulate their emotions effectively are more likely to have increased academic achievement, more developed cognitive abilities, and overall exhibit less behavioral issues (Graziano et al., 2007). Emotion regulation continues to play an influential role throughout adolescence, into adulthood, and beyond, thus making the study of emotion regulation in children a field of interest for many researchers (Eisenberg et al., 2010).

Children of different ages are able to utilize different strategies to modify their emotional experience (Gross, 2014). For example, children 3-4 years of age used attention deployment (i.e., altering the amount of attention given to change emotional response) as a primary emotion

regulation strategy, whereas more advanced cognitive strategies such as situation selection (i.e., avoiding situations that one anticipates will result in a negative emotional experience), situation modification (i.e., physically changing the situation to alter an anticipated emotional experience), and cognitive change (i.e., changing the way the emotion is thought about) were all used more frequently by children 5-8 years of age (Gross, 1998). Several studies have examined the use of emotion regulation strategies across development and found consistent results. For instance, López-Pérez and colleagues conducted two studies studying children's intrapersonal (own) emotion regulation; the first study asked parents to answer questions about their children's ability to change their emotions and the second study where 3-8 year olds answered questions about how they regulate their emotions. As expected, strategies such as situation selection, situation modification, and cognitive change were used more frequently by 5–6- and 7–8-year-olds, whereas attention deployment was mainly used by 3–4-year-olds (López-Pérez et al., 2017). In general, there is a trend that the use of adaptive emotion regulation increases with age (Zimmerman et al., 2014).

It is important to note that emotion regulation strategies are highly context dependent. Adaptive emotion regulation often includes positive reappraisal and empathy whereas maladaptive emotion regulation (aka emotion dysregulation) includes suppression, catastrophizing, ruminating, and mood lability. Nevertheless, depending on the situation, even the more unhelpful strategies like mood lability or suppression might serve adaptive functions (Hoorelbeke et al., 2016). For example, if a child is experiencing an emotion that is inappropriate to express in a given setting, expressive suppression (to hide what they feel) or abruptly changing their mood might be more adaptive as a regulation strategy *in that context.* Emotion regulation abilities that develop in childhood often lay the foundation for emotion regulation functioning

throughout adulthood (Aldao et al., 2010). Additionally, more adaptive emotion regulation has been shown to improve psychological and physical well-being (Cloitre et al., 2019). Epidemiological studies have illustrated that lack of adaptive emotion regulation is associated with many health risks including cardiovascular and immune diseases whereas more adept emotion regulation can reduce the risk of minor illnesses (e.g., Booth, 2012; Mund & Mitte, 2012). Therefore, understanding how emotion regulation may relate to respiratory health can provide new insight and establish an empirical foundation for interventions to help children develop healthier patterns of emotion regulation to improve health and well-being.

Asthma is a disease that can be affected by psychological stressors, such that stress that is not effectively regulated can worsen the effects of asthma, potentially leading to emotion dysregulation (Rosenkranz, 2005). In particular, asthma is known for its vulnerability to stress and emotion-induced symptom intensification. For instance, psychological stress due to emotion dysregulation increases expression of asthma symptoms (Rosenkranz, 2012). A variety of distinctive psychological problems and affective states, such as anxiety, depression, behavioral problems and aggression have been associated with asthma (e.g., Fiese et al., 2007; Halterman et al., 2006; Marx et al., 1986; McQuaid et al., 2001; Viney & Westbrook, 1985; Wood et al., 2007; Wright et al., 1998). Studies have shown that children with asthma display a decreased use of coping strategies leading to increased anxiety, more asthma symptoms, and poor emotion regulation (Klinnert et al., 2000; Lahaye et al., 2011; Walker, 2012). Despite the accumulating evidence for links between psychological stress, emotion regulation (and dysregulation), and asthma, however, there is practically no research on how other respiratory illnesses such as respiratory infections and allergies relate to emotion regulation.

Biobehavioral Indices of Children's Emotion Regulation

Because the utility of emotion regulation is highly contextual, the expression of emotions (e.g., expressing distress) can be adaptive or maladaptive depending on the situation (Reiss, 2000). For example, if a child is injured at home while with a parent, expressing distress via crying would function to communicate pain and solicit emotional support and co-regulation from the social partner. In contrast, if a child is at a store expressing distress by throwing a tantrum because they want a particular toy, the tantrum may be perceived as a failure on the part of the child to adaptively regulate emotions. Therefore, observations of expressed distress must be interpreted in-context. Interestingly, people with asthma are more likely to show negative affect in everyday life compared to people without asthma (Ritz, 2000). Furthermore, children with asthma that actively display negative affect are more likely to struggle with their asthma compared to children who do not (Schreier & Chen, 2008). However, there has been very little research done on the associations between children with asthma and their expression of distress in stressful situations.

As a complement to observations of emotional behavior, parent reports of children's emotion regulation can provide insight into children's typical use of emotion regulation strategies in different contexts. Previous research has shown that children who tend to be more outwardly reactive to stressful situations are more prone to difficulties with emotion regulation as reported by their parents (Rothbart, 2011). Therefore, in a context-dependent manner, displaying greater behavioral distress often indicates a lack of effective emotion regulation. Observing child distress in a controlled environment such as a laboratory setting, combined with parent-report information about a child's typical behavior can together provide a more holistic view of the behaviors indexing children's emotion regulation.

An important physiological marker of emotion regulation is respiratory sinus arrhythmia (RSA), a measure of cardiac peripheral psychophysiology. While observations and parent reports are used to index emotion regulation behaviors, RSA indexes the underlying physiological response. It is well known that many coordinated systems in the body play a key role in facilitating psychological and physiological stressors (Davis, 2018). Specifically of interest to this study is the autonomic nervous system, which includes the sympathetic nervous system and the parasympathetic nervous system (Davis, 2018). The sympathetic nervous system (SNS) serves to elicit an immediate physiological response to a threat or a stressful stimulus, also known as fight or flight, whereas the parasympathetic nervous system (PNS) facilitates returning to homeostasis when the stressful stimulus has been dissipated (Davis, 2018). The SNS and PNS coordinate influence to the heart to support flexibility and adaptive reactions to different kinds of situations. Autonomic nervous system functionality in relation to emotion regulation can be quantified by respiratory sinus arrhythmia (RSA), which is a frequency measure of heart rate variability in the normative range of respiration that indexes parasympathetic activity specifically. Generally speaking, higher RSA values indicate greater PNS activation, and this has been linked to better emotion regulation capacity and effective responding in various studies (Beauchaine, 2001; Davis, 2018; Porges, 2007).

RSA is typically measured at two key timepoints during an emotional experience: 1) RSA at a resting baseline (no challenge task at hand), which indicates an individual's potential regulatory capacity and 2) RSA reactivity during a stressful task (usually characterized by decreases in RSA that enable an arousal response in order to meet the challenge) (Porges, 2003). Findings from previous studies suggest that higher baseline RSA is linked to better capacity to regulate emotions (Calkins & Keane, 2004; Graziano & Derefinko, 2013; Porges, 2003).

However, there have been inconsistencies in previous research regarding RSA reactivity that can be attributed to its highly contextual nature (e.g., Dickerson & Kemeny, 2004; Porges, 2003; Beauchaine, 2007; Hastings et al., 2008; Seng-Chee et al., 2020). Because RSA accounts for variability in rate of respiration, it can be interesting to investigate its links to respiratory health.

Incidentally, RSA has also been linked to respiratory health issues. When faced with a stressor, adults with asthma experience bronchoconstriction, which is when muscles in the respiratory tract contract, thereby restricting air flow. Controlled studies have shown that adults who do not have asthma generally do not experience bronchoconstriction (Bacharier et al., 2004). There does exist some contradictory research that found some adults without asthma do experience bronchoconstriction, however, it is very short-lived (e.g., Isenberg,1992). Moreover, one study has found that people with asthma have increased respiratory resistance, which is similar to bronchoconstriction, and linked to lower baseline RSA in these individuals. There was a weak correlation between higher baseline RSA in individuals without asthma, however it was not statistically significant due to the small sample size of the study (Ritz et al., 2001). These results are consistent with research that showed that the presence of asthma changes the vagal pathway and airway resistance as measured by RSA (Miller, 1987; Miller & Wood, 1998). Unfortunately, there exists very little research examining other respiratory diseases and RSA in adults and there are practically no studies that investigate the relationship between asthma or other respiratory diseases and RSA in children. Therefore, examining RSA as a physiological index of emotion regulation will complement behavioral assessments and this multi-method approach may provide new insights into the relationship between emotion regulation and respiratory issues in childhood.

Current Study

Because respiratory health and the ability to regulate emotions are two very important aspects of child development, studying the links between them can help guide caregivers, teachers, health professionals, and policy makers on how best to support children's healthy development. Previous research has primarily focused on associations between certain aspects of asthma and emotion regulation, like displaying negative affect and physiological changes such as symptom intensification and bronchoconstriction. And, the majority of the previous studies are limited to only adults as participants. The current study aims to investigate the relationship between respiratory health (e.g., the presence or absence of asthma and other respiratory diseases such as allergies and respiratory infections) and biobehavioral dimensions of emotion regulation in childhood. This multi-method biobehavioral approach to emotion regulation will allow examination of the observed, reported, and physiological aspects of emotion regulation individually as well as in combination to identify the aspects of emotion regulation that may be most strongly associated with respiratory issues.

The following research questions are addressed in this study:

1) What are the associations between the presence of respiratory disease (asthma, allergies, and/or respiratory infections) and observed behavioral distress in children?

2) What are the associations between the presence of respiratory disease and parent-reported emotion regulation?

3) What are the associations between the presence of respiratory disease and baseline RSA?

4) How is the presence of respiratory disease related to the biobehavioral dimensions of emotion regulation considered together, as a whole?

Based on previous studies, I hypothesized that respiratory disease would be correlated with poorer emotion regulation in each way it was assessed in this study. Specifically, I hypothesized that the presence of respiratory disease in children would relate to higher levels of observed distress in children during a stressful task, lower parent-reported emotion regulation skill, and lower baseline RSA.

METHODS

Participants

The current study utilized 184 child-parent dyads that participated in a larger study conducted by the Emotion Regulation Lab at the University of California, Riverside. The study was conducted from 2013 to 2015 and participants were recruited from a diverse population in the Inland Empire region of Southern California. The sample consisted of 4-11 year olds (M_{age}= 7.21, *SD* = 2.3, 51% female) accompanied by one parent (83% female caregivers, primarily mothers). Children were racially/ethnically diverse such that the racial/ethnic breakdown was 30.1% Hispanic, 18.6% Caucasian, 10.9% African American/Black, 2.2%, Asian American, 2.2% reported being other races, 36.1% reported being multi-racial, and one child did not have race/ethnicity information provided. Lastly, the sample reported their annual household income such that 37.4% reported $30,000 or less, 25.4% reported $31,000-$50,000, 11.4% reported $51,000-$70,000, 10.8% reported $71,000-$100,000, 14.6% reported more than $100,000, and the remaining 14.1% did not report income.

Procedure

Participants completed a series of tasks in a 3.5 hour laboratory visit as a part of a larger study called Physiology and Emotion Regulation in Kids (PERK). Parents completed

questionnaires, and children and parents participated in emotionally challenging tasks. All the study protocols were approved by the Institutional Review Board prior to the start of the study. Furthermore, parental consent and child assent were collected before the study began. Participants were also videotaped for offline behavioral coding and physiology was collected for both parents and children throughout the study.

Disappointing Gift Task

Early in the visit children ranked six small prizes from their most to least favorite: a light-up ring, bouncy ball, glow-in-the-dark lizard, stretchy frog, parachute alien, and teething ring. The children were then told they would receive their favorite prize later in the study. After completing most of the other tasks (approximately 3 hours later), children were given a colorful gift box and told their prize was inside. In order to evoke distress, when children opened the box they found their least favorite prize, which had also been broken (e.g., the teething ring was broken in half). The child received the disappointing gift from the experimenter and they sat together for one minute while the experimenter pretended to be distracted by paperwork and child behavior was videotaped and later coded for distress.

Physiological Data Acquisition

Physiological data was collected using an electrocardiogram (ECG) throughout the visit. The ECG signal was collected by MindWare Technologies ambulatory cardiography equipment. Seven self-adhesive electrodes were applied to children's torsos immediately after the informed consent procedures were completed. Three electrodes were placed on the distal right collarbone, and on the right and left floating ribs for cardiac data acquisition and four additional electrodes were placed on the upper and lower sternum, the back of the neck, and the mid-back for impedance data acquisition. Electrode placement was based on the lead II configuration which

has been shown to produce a strong ECG signal (Meek & Morris, 2002) and the ambulatory monitor for recording cardiac data was placed in a backpack so the child could move freely for the duration of the study. Physiological data was also collected for the parents in the same way, although the current study is not using it.

Measures

Health and Behavior Questionnaire

During the study, parents were asked to fill out the MacArthur Health and Behavior Questionnaire (HBQ) for their child in order to gauge respiratory health (Essex et al., 2002). The HBQ is comprised of multiple scales that measure children's symptoms of mental health (e.g., internalizing and externalizing symptoms of mental health and their subscales), physical health (e.g., chronic medical conditions, global physical health), social functioning (e.g., peer acceptance and rejection, prosocial behaviors), and school functioning (e.g., academic competence, school engagement). The measure also assesses children's health care utilization in the mental, physical, and school domains. The present study used a subset of items in the chronic medical conditions scale, wherein parents indicated 'yes' or 'no' to whether or not their child had experienced any of the listed chronic conditions. The parameters from the HBQ used to evaluate children's respiratory health in this study include 1) asthma, 2) repeated, persistent respiratory infections such as colds, bronchitis, or croup, and 3) bad allergies requiring doctor visits and frequent medications. The HBQ data was dichotomized to indicate the presence or absence of each of the respiratory conditions. A composite score was derived for respiratory health, 0 indicating no respiratory issues and 1 indicating that the child had at least one of the respiratory conditions.

Emotion Regulation Checklist

Parents completed the Emotion Regulation Checklist (ERC) which is a 24-question instrument for the hetero-evaluation of the level of emotion regulation of children by means of two scales, Emotion Regulation (ER) and Emotional Lability/Negativity (L/N). ER assesses the expression of emotions, empathy, and emotional self-awareness, while L/N assesses the lack of flexibility, anger dysregulation, and mood lability (Shields & Cicchetti, 2008). Parents rated their children's emotion regulation using a 4-point scale to indicate how often a child displays affective behaviors (1= never, 2 = sometimes, 3 = often, 4 = almost always). The ER subscale contains eight items, such as "is a cheerful child" or "responds positively to neutral or friendly overtures by peers". Six items are rated positively (1, 3, 7, 14, 21 and 23), and two are inversely rated (16 and 18). Scores were obtained by adding the scores of all of the items, making allowances for the items that required reverse scoring. High scores indicate a greater capacity for ER. The maximum score in this subscale is 32, and the minimum is 8. The L/N subscale has eleven items that are scored positively (2, 6, 8, 10, 13, 14, 17, 19, 20, 22 and 24) and four are reversely scored (4, 5, 9 and 11). The maximum score is 60, while the minimum is 15. Higher scores indicate greater emotion dysregulation. Item 12 does not score for either of the scales as it is not loaded on either factor, following ERC authors' instructions. The ERC has shown a high reliability of $\alpha = 0.85$ (Shields & Cicchetti, 2008).

Data Reduction and Coding

Behavioral Distress

Child behavioral distress during the disappointing gift task was coded after the study on a global scale by trained research assistants on a 1 to 5 scale (1 = no distress, 5 = high distress). Distress was defined as verbal complaints, (e.g., "I didn't pick this prize!; "It's broken!"), facial expressions and body language (e.g., frowning, crossing arms), and less commonly expressed

behaviors like crying, yelling, and throwing things. Coders evaluated differences in intensity and duration of displayed distress; a score of 1 indicated no distress (e.g., child looking bored, playing with toy, genuinely laughing/smiling), a score of 2 indicated low intensity, short-lasting distress (e.g., brief complaints, some frowning/pouting), a score of 3 indicated low intensity, longer-lasting distress (e.g., consistently complaining/whining, long nervous laughter, looking upset most of the time), a score of 4 indicated high intensity but short lasting distress (e.g., crying for some of the time, throwing or hitting once), and a score of 5 indicated high intensity distress that lasted for a longer duration (crying, screaming for most of the time, hitting or throwing more than once). Inter-rater reliability was calculated for 80% of the files and percent agreement was above 88% for all task phases.

Physiological Data

The ECG data were processed after the study using MindWare HRV Version 3.0.21 software. Respiratory sinus arrhythmia (RSA) was derived from ECG using the software's algorithm. RSA spectral power was integrated in the 0.15-0.80 Hz frequency band for children and calculated in 30 second epochs. Percent agreement between coders for 30% of all epochs was 91%. Throughout the visit, participants completed cardiac baseline measurements in between tasks during which participants were asked to sit quietly at a table for 2 minutes to record resting cardiac data. The three cardiac baseline averages previous to the disappointing gift task were averaged to serve as a composite baseline RSA measurement.

RESULTS

Overview

The results are organized into four sections. First, issues concerning missing data are explored. For the next three sections, I present the associations between each of the respiratory

diseases as well as the general presence or absence of any respiratory disease with child behavioral distress, parent-reported emotion regulation and RSA. For the last section, I present the correlations between respiratory diseases (individual and composite) and emotion regulation as a whole, accounting for all the variables.

Missing Data

The missing data for all the variables were a low percentage (.5-1.6%) of the overall sample and no significant patterns of missingness were found. As such, the multiple imputations method was used to generate ten iterations, which were then pooled together for the data analysis to account for the missing data.

Associations between respiratory health and child behavioral distress

Using an independent sample t-test, we found a marginally significant difference (p = 0.055) in distress between children with asthma (M = 2.01, SD = 0.63) and children without asthma (M = 1.78, SD = .67). Similarly, there was a significant difference (p = 0.004) in distress amongst children with allergies (M = 2.00 , SD = .55) and children without allergies (M = 1.80, SD = 0.69). However, there was no significant difference (p = 0.288) in child distress for the presence of respiratory infections (M = 1.78, SD = 0.55) compared to absence of respiratory infections (M = 1.83, SD = .68). Overall, accounting for all three respiratory illness variables together in a composite score, children with respiratory illnesses experienced significantly more distress (M = 2.02, SD = .57) compared to children without respiratory illness (M = 1.75, SD = .684), $t(182) = -2.643$, p = .008. Interestingly, there was also a negative correlation between child age and distress, suggesting that younger children exhibited greater distress (r = -0.200, p = 0.008).

Associations between respiratory health and parent-reported emotion regulation

Using an independent sample t-test, we found that children with respiratory illnesses (M = 27.83, SD = 6.49) and children without respiratory illnesses (M = 25.98, SD = 6.961) did not significantly differ in their emotion regulation skills, $t(182) = -1.497$, $p > .05$. Specifically, there was no difference (p = 0.518) between children with (M = 23.80, SD = 2.20) and without (M = 23.45, SD = 2.50) asthma for parent-reported emotion regulation. There was also no difference (p = 0.584) in emotion regulation for children with respiratory infections (M = 24.56, SD = 2.31) compared to without respiratory infections (M = 23.40, SD = 2.44), as well as no difference (p = .68) in emotion regulation for presence of allergies (M = 24.43, SD = 2.33) and absence of allergies (M = 23.40, SD = 2.45).

Similarly, there was no difference (p = 0.618) between children with (M = 27.32, SD = 6.50) and without (M = 26.30, SD = 6.97) asthma for parent-reported emotion dysregulation. There was also no difference (p = 0.65) in emotion regulation for children with respiratory infections (M = 28.94, SD = 6.36) compared to without respiratory infections (M = 26.23, SD = 6.89), as well as no difference (p = .81) in emotion regulation for presence of allergies (M = 29.45, SD = 6.71) and absence of allergies (M = 26.12, SD = 6.79).

Consequently, there was no correlation between the presence of respiratory disease (asthma, infections, and/or allergies) and parent-reported emotion regulation (r = 0.112, p = 0.140) nor parent-reported emotion dysregulation (r = 0.119, p = 0.137). (nor parent-reported dysregulation (p = 0.618)

Associations between respiratory health and baseline RSA

Using an independent sample t-test, we found that there was no difference in baseline RSA (p = 0.920) between children with asthma (M = 6.80, SD = 0.15) and children without

asthma (M = 6.78, SD = 0.10). Additionally, there was no significant difference in baseline RSA (p = .64) for children with respiratory infections (M = 6.96, SD = .95) and children without respiratory infections (M = 6.76, SD = 1.13). Likewise, no difference was found in baseline RSA (p = .63) in children with allergies (M = 6.77, SD = 1.32) and children without allergies (M = 6.78, SD = 1.09). Consequently, there was no difference in baseline RSA (t(182) = -.137, r = 0.010, p = 0.891) in children with (M = 6.80, SD = 1.06) and without (M = 6.77, SD = 1.13) respiratory disease (asthma, infections, and/or allergies) as calculated by the respiratory illness composite score.

Convergence of biobehavioral indices of emotion regulation

The convergence of biobehavioral indices of emotion regulation was also analyzed. There was a negative correlation between baseline RSA and distress (r = -0.200, p = 0.016) and the rest of the correlations were not statistically significant.

DISCUSSION

Overview

The goal of this study was to investigate the relationship between respiratory health (e.g., the presence or absence of asthma and other respiratory diseases such as allergies and respiratory infections) and biobehavioral dimensions of emotion regulation in childhood by examining the observed, reported, and physiological aspects of emotion regulation individually as well as in combination to identify the aspects of emotion regulation that may be most strongly associated with respiratory issues. I hypothesized that presence of respiratory disease would be correlated with poorer emotion regulation in each way it was assessed in this study. Specifically, I hypothesized that the presence of respiratory disease in children would relate to higher levels of observed distress in children during a stressful task, lower parent-reported emotion regulation

skill, and lower baseline RSA.

Preliminary analyses indicated a significant negative correlation between child age and distress, where younger children exhibited higher levels of distress during a stressful task. These results are consistent with previous studies on developmental emotion regulation. Children of different ages utilize different emotion regulation strategies, and this study supports the general trend that older children utilize more adaptive emotion regulation skills and exhibit less behavioral distress in a challenging situation than do younger children. These results provide insight into developmental implications of children's emotion regulation, specifically through observing children's behavioral distress in the face of a stressful situation in a laboratory setting.

Furthermore, results indicated that there was a significant positive correlation between the presence of respiratory illness in children and observed behavioral distress, supporting the hypotheses. Previous studies primarily focused on the behavioral index of emotion regulation in children in terms of displaying negative affect due to respiratory illness. This study assesses behavioral distress in children in an affective context independent of respiratory illness, giving further insight on differences in expression of distress between children with and without asthma in stressful situations. Additionally, children with other respiratory illnesses, accounted for by the respiratory problems composite score, were also revealed to have significantly more distress compared to children without any respiratory illness. However, individually for respiratory infections and allergies, there was no significant difference in distress. To my knowledge, this is the first study that accounted for other respiratory illnesses such as infections and allergies, and the inconsistency of the results between different types of respiratory illness provides a more specific lens into the associations between respiratory health and emotion regulation.

Contrary to the hypotheses, there was no significant correlation between respiratory

illness and baseline RSA. Firstly, investigations between baseline RSA and asthma in previous studies have shown several inconsistencies as some adults with asthma experience bronchoconstriction while others do not. Moreover, most of the prior research focuses on baseline RSA in adults with asthma. The lack of a significant difference in RSA baselines between the two groups in this study adds to the inconsistencies in previous literature. Additionally, this study presents an important methodological contribution by measuring baseline RSA in children. There was no significant difference in baseline RSA in children with other respiratory illnesses indicated by individual respiratory infections and allergies scores as well as the respiratory illness composite score. Hence, this study presents new insight into the relationship between baseline RSA and respiratory illnesses other than asthma.

Similarly, there was no difference in parent-reported emotion regulation (and dysregulation) in children with and without respiratory illness. Although this study proposed a unique methodology, the 'Disappointing Gift Task', as a supplement to parent-reported emotion regulation, the inconsistencies between the results from the gift task and parent-reports further strengthens the context-dependent nature of emotion regulation. The distress experienced by children with respiratory illness in response to a stressful situation in a laboratory setting varied from the parent-reported emotion regulation. In addition to the unique methodological contribution, these results illustrate the importance of considering multiple indices while drawing conclusions about emotion regulation.

Limitations and Future Research

Some limitations of this study include the small sample size of children with respiratory illnesses other than asthma (such as respiratory infections such as bronchitis, cold and croup, and allergies) and the possibility that parent report of children's emotion regulation abilities was

influenced by social desirability effects. But, respiratory infections and allergies are generally less common in children than asthma, and the sample of children in this study is representative of the population, thereby having little effect on the generalizability of this study. Second, this study employed a multi-dimensional, biobehavioral approach to emotion regulation, so although the parent-report measure may have been influenced by social desirability effects, there were other indices of emotion regulation assessed to address this limitation. Future research can focus on possible mechanisms or moderators that help explain the association between respiratory illness and behavioral distress (e.g., cognitive or physiological indicators of emotion regulation).

Conclusion

Because respiratory health and emotion regulation are two very important aspects of child development, studying the links between them can help guide caregivers, teachers, health professionals, and policy makers on how best to support children's healthy development. This study contributed to the field of developmental psychobiology by presenting important links between respiratory illness and behavioral distress in children, as well as developmental patterns in children exhibiting behavioral distress. Moreover, the multi-method biobehavioral approach in this study examined the observed, reported, and physiological aspects of emotion regulation individually as well as in combination to draw conclusions on which aspects of emotion regulation are most strongly associated with respiratory issues. All in all, this research aids in highlighting the possible emotional consequences of poor respiratory health, in addition to contributing to an important avenue of work in the Inland Empire community where rates of pediatric asthma and allergies are notoriously high.

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