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RESEARCH ARTICLE

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The role of positive affect in asthma control and symptom severity in adolescents

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Abstract

Introduction: We test the effects of positive affect and its arousal subscale components of calm, wellbeing, and vigor on asthma control and symptom severity in adolescents with moderate to severe asthma. Additionally, we test whether positive affect (and its arousal components) moderate how stress impacts asthma control and symptom severity.

Methods: Adolescents with asthma ($N = 66$, ages 12–17) completed brief surveys 4 times a day for 7 days reporting on their positive affect, stress, and asthma symptom severity and conducted a morning peak expiratory flow assessment each day. Asthma control and psychological asthma triggers were assessed at the end of the 7 days.

Results: Positive affect moderated the association between stress and asthma control ($b = -0.33$, $p = 0.009$) as well as the association between psychological triggers and asthma control ($b = -0.74$, $p = 0.007$). When assessing the positive affect arousal components, calm and wellbeing seemed to be driving these effects. Additionally, calm moderated the association between stress and asthma symptom severity ($b = -0.33$, $p = 0.036$) as well as the association between psychological triggers and asthma symptom severity ($b = -0.75$, $p = 0.021$).

Conclusions: When considering patient stress (e.g., general stress, psychological asthma triggers), positive affect and its arousal components of calm and wellbeing may be helpful for patients with higher levels of stress and/or for patients experiencing greater numbers of psychological triggers.

KEYWORDS

asthma control, asthma symptoms, positive affect, stress

1 | INTRODUCTION

Of the 25 million adolescents living in the United States, 2 million suffer from Asthma (Centers for Disease Control and Prevention, 2022). This disease can be life-threatening and is associated with adverse outcomes such as respiratory symptoms, emergency department visits and hospitalizations, school absences, and restriction of daily physical activity as well as long-term negative implications for general health status (Ahmed & Turner, 2019; Fletcher et al., 2010; Kaplan & Price, 2020). Although guideline-recommended medical care, (National Asthma Education Prevention Program NAEPP, 2007) including the use of daily inhaled corticosteroids, has greatly improved the treatment of asthma, the ability of adolescents to control their asthma and reduce daily asthma symptom severity still remains a large health concern (Centers for Disease Control and Prevention, 2022). Therefore, it is important to better understand psychosocial factors that may improve asthma control and symptom severity in the context of adolescent asthma.

Positive affect, encompassing emotions such as joy and happiness, is an important psychosocial factor that has been shown to improve health in the context of many diseases (Pressman & Cohen, 2005) (e.g., cardiovascular disease, diabetes). Additionally, in adults, positive affect has been associated with better pulmonary function, fewer asthma symptoms, (Affleck et al., 2000) and fewer respiratory tract infections (Richman et al., 2005). Further, one feature of positive affect that is necessary to consider when studying the impact of positive affect on health is that positive affect may be subdivided based on arousal level: high arousal (e.g., vigor) versus mid-arousal (e.g., wellbeing) versus low arousal (e.g., calm). Vigor includes high arousal positive affect feelings such as energetic and lively; well-being includes mid arousal positive affect feelings such as happy and pleased; calm includes low arousal positive affect feelings such as calm and relaxed.

These arousal level components have differing physiological and psychological profiles. For example, individuals feeling vigor have higher energy, greater sympathetic activity, and more approach motivation compared to those feeling calm (McManus et al., 2024). In contrast, feeling calm is associated with lower blood pressure, higher heart rate variability, and a broader attentional scope (McManus et al., 2024). Theoretical (Larsen & Diener, 1992) and measurement (Jenkins et al., 2021) models pose that well-being is a middle ground between the two and associated with greater sympathetic activity (Kreibig, 2010). Further, initial research suggests that different arousal levels of positive affect may have differential implications for health (Acevedo et al., 2020; Pressman et al., 2017). For example, vigor but not calm is associated with better sleep quality (Pressman et al., 2017). Individuals feel less pain and exhibit less sympathetic activity to pain when induced to feel calm, but not when induced to feel vigor (Acevedo et al., 2020). Additionally, feeling calm, but not vigor has been associated with better cardiovascular indicators of health (Armon et al., 2014). These findings are examples that affirm that the relationships between positive affect and health can only be fully understood if we assess whether the relationship is due to valence alone (i.e., feeling positive affect in general) or a combination of valence and arousal (i.e., positive affect components). In the context of asthma control and symptom severity specifically, it is possible that more high arousal positive affect could be detrimental in some cases (e.g., laughter (Liangas et al., 2003)) while low arousal positive affect (e.g., calm) may be more beneficial.

Additionally, positive affect has been shown to be health promoting because of its stress buffering capabilities (Pressman & Cohen, 2005; Pressman et al., 2019). Given stress is one prominent factor associated with increased asthma attacks, symptom frequency, and severity, (Chen & Miller, 2007) applying the stress buffering hypothesis of positive affect to the context of asthma would predict that positive affect may mitigate the negative effects of stress on asthma control and symptom severity (Pressman & Cohen, 2005).

Finally, in children, hope (a type of positive emotion) has been associated with better medication adherence, (Berg et al., 2007) and positive life events (i.e., events that induce positive affect) have been associated with fewer asthma exacerbations (Sandberg et al., 2002). That said, no study has examined how positive affect in the daily lives of adolescents relates to daily asthma control and symptom severity. Questions remain as to whether positive affect has health enhancing effects in the context of adolescent asthma, if positive affect is most beneficial during times of stress (e.g., general stress, psychological asthma triggers), and how the moderating role of positive affect differs based on arousal level of positive affect.

Thus, in the present investigation, we test the effects of positive affect and its arousal components on asthma control and symptom severity in adolescents with moderate to severe asthma and additionally test whether positive affect (and its arousal components) moderate how stress impacts asthma control and symptom severity.

2 | MATERIALS AND METHODS

2.1 | Participants and procedure

Participants were adolescents with asthma recruited from the Severe Asthma Clinic in a tertiary care pediatric hospital in Southern California. Participants were between the ages of 12–17 years and diagnosed with asthma; could speak, read, and write in English; and had access to a smartphone or tablet along with internet access for the at-home portion of the study. Exclusion criteria included the presence of comorbidities that could affect lung function assessment (including but not limited to gastroesophageal reflux disease, cystic fibrosis, and any form of chronic lung disease) or the presence of significant developmental disabilities that would preclude comprehension of the questionnaires or other components of the study protocol. Adolescents who agreed to participate completed assent as appropriate. All protocol and study materials were approved by the hospital's Institutional Review Board.

Adolescents first completed a baseline survey assessing demographic variables either in the clinic or via zoom. During their baseline visit, participants were provided a handheld Microlife Digital Peak Flow Meter to take home. A trained research assistant instructed participants on how to use the device. Research assistants: 1. demonstrated how to use the device with their personal peak flow meter; 2. had participants practice using the peak flow meter we provided them; and 3. gave participants a concise instruction sheet covering the three buttons on the device as well as the 5 easy steps to use the device and report peak flow values. Next, adolescents completed the ecological momentary assessment (EMA) portion of the study which included answering brief surveys four times a day for 7 days. Participants received text messages at each of the 28 time points which included a link to a survey. The EMA surveys assessed positive affect (including its arousal components), negative affect, stress, and asthma symptom severity. The morning EMA also instructed participants to complete their peak flow meter assessment before taking any asthma medications and record their peak expiratory flow rate score from the best of three blows. On day 8 of the study, adolescents completed a follow up survey which assessed asthma control and psychological triggers related to asthma. Adolescents received a $50 gift card and the peak flow meter as compensation.

2.2 | Predictive measures

2.2.1 | Affect

Overall positive affect, its three arousal components (calm, wellbeing, and vigor), and overall negative affect were assessed using the Subcomponents of Affect Scale (SAS) (Cohen et al., 2003; Jenkins et al., 2021) during the EMAs. The SAS is composed of 18 items, nine positive and nine negative affect adjectives. Participants were asked to rate the extent to which they felt each adjective (e.g., happy, calm) in the current moment. The nine positive affect adjectives were averaged to represent a total positive affect score while the nine negative affect adjectives were averaged to represent a total negative affect score. Additionally, the positive affect items have three subscales (calm, wellbeing, and vigor) each with three items that are averaged (calm subscale items reflecting low arousal positive affect include: calm, at ease, relaxed; wellbeing subscale items reflecting mid-arousal positive affect include: happy, cheerful, pleased; vigor subscale items reflecting high arousal positive affect include: full of pep, lively, energetic). The SAS is valid and reliable and has been previously used in EMAs and longitudinal studies (Cohen et al., 2003; Jenkins et al., 2021). Additionally, adjectives from the SAS have been validated in adolescent samples (Terry et al., 1999). Positive affect, the positive affect arousal subscales, and negative affect were each averaged over the EMA week for analysis purposes. Cronbach's alphas were high for each of these measures across the four time points over the 7 days: positive affect $\alpha_{mean} = 0.91$ (range = 0.86 to 0.94), calm $\alpha_{mean} = 0.81$ (range = 0.70 to 0.91), wellbeing $\alpha_{mean} = 0.84$ (range = 0.66 to 0.92), vigor α_{mean} 0.88 = (range = 0.81 to 0.93), and negative affect $\alpha_{mean} = 0.89$ (range = 0.86 to 0.92).

2.2.2 | Stress

Participants rated how "stressed" and "overwhelmed" they felt on a Likert type scale at each EMA assessment. These items are from the Adjective Rating Questionnaire and have been successfully used reliably in other EMA studies to track momentary levels of stress (Pressman et al., 2017). Stress was averaged over the EMA week for analysis purposes. The Cronbach's alpha for this measure had a mean of 0.90 and a range of 0.73–0.96 across the four time points over the 7 days.

2.2.3 | Psychological triggers

Psychological triggers were assessed using the valid and reliable psychological triggers subscale of the Asthma Trigger Inventory (Ritz et al., 2006; Wood et al., 2006) completed at the follow up survey. Participants were asked to rate in general on a five-point scale how often (never to always) each of ten psychological triggers (e.g., feeling tense, depressed mood) are involved when they experience symptoms of asthma. Ratings over the 10 triggers were summed together such that larger values reflected a greater presence of psychological asthma triggers during symptoms of asthma. The Cronbach's alpha for this measure was 0.89.

2.3 | Outcome measures

2.3.1 | Asthma control

Asthma control was assessed with the Asthma Control Test which is a valid and reliable five-item measure that asks about symptoms, medication usage, and limitations in daily activity to reflect asthma control over the past 4 weeks (Schatz et al., 2006; Wallenstein et al., 2007). After reverse scoring four items, ratings of each item are such that higher values reflect better asthma control. A total score is created by summing the five items. The Cronbach's alpha for this measure was 0.78.

2.3.2 | Asthma symptom severity

Symptom severity was assessed by the Asthma Control Diary which has been previously validated (Juniper et al., 2000) and is scored using six items assessing symptom severity throughout the day and a morning peak expiratory flow assessment. The morning items included: "How often were you woken by your asthma symptoms during the night?" and "How bad were your asthma symptoms when you woke up this morning?" Four items assessed symptoms throughout the day: "How limited were you in your activities today because of your asthma?," "How much shortness of breath did you experience today?," "How much of the time did you wheeze today?," and "Please score how many puffs of bronchodilator (Ventolin) you have used in the past 24 h". The Cronbach's alpha for the six self-reported items had a mean of 0.87 and a range of 0.80–0.90 over the 7 days.

For scoring, the highest morning peak expiratory flow rate score was used to calculate the peak expiratory flow percent predicted value and then was converted to a 0–6 scale with higher values reflecting worse asthma symptoms. This score for each morning was then mean averaged with the self-reported items (all scored on a 0–6 scale with higher values reflecting worse asthma symptoms). Thus, the Asthma Control Diary results in one average score over the week with higher values reflecting greater asthma symptom severity.

2.4 | Statistical analysis

Descriptive statistics were used to describe means, standard deviations, and ranges. Linear regressions with listwise deletion were used to predict asthma control and asthma symptom severity from positive affect and its arousal components as well as test whether positive affect and its arousal components moderated stress and psychological triggers. We tested main effects first followed by interaction effects and tested arousal components in separate models given sample size limitations (but please see our Supplemental Analyses in which all arousal components are entered simultaneously). Significant moderation effects were explored with simple slopes at the 15th and 85th percentiles on the moderators. All regression models adjust for adolescent age, sex, race/ethnicity, and negative affect as well as yearly household income. Our outcome variables (asthma control and asthma symptom severity) had substantial skewness and thus were log transformed resolving all issues of skewness. Of importance, the log transformation sometimes results in a transformed variable that is the inverse of the untransformed variable (i.e., it should be interpreted in the opposite direction as the original variable). This was the case for the asthma control variable but not for the asthma symptom severity variable. For ease of interpreting results, in our tables and figures, we label our outcomes as "worse asthma control" (i.e., higher values are reflective of worse asthma control) and "greater asthma symptom severity" (i.e., higher values are reflective of greater symptom severity).

3 | RESULTS

3.1 | Descriptive and bivariate analyses

The final sample included 60 adolescents ages 12–17 with asthma (after removing five participants who were lost to follow up and one sibling). Please see Table 1 for baseline characteristics. The average EMA response rate was 83% (i.e., on average 23.24 of 28 possible EMA entries were completed per participant). The average peak flow meter adherence rate was 89% (i.e., on average 6.23 of 7 possible peak flow meter assessments were completed per participant). Table 2 presents bivariate correlations between our predictor and outcome variables.

3.2 | Main effects of positive affect on asthma outcomes

We did not detect main effects of positive affect on asthma control or asthma symptom severity, nor did calm, wellbeing, or vigor directly associate with asthma control or asthma symptom severity (see Table 3 Models 1, 1a, 1b, and 1c).

3.3 | Positive affect moderating the association between stress and asthma outcomes

3.3.1 | Asthma control

Positive affect significantly moderated the association between stress and asthma control ($b = -0.33$, $t = -2.76$, $p = .009$, 95% CI [−0.57, −0.09], see Table 3 Model 2 and Figure 1). At high levels of positive affect, as stress increased, asthma control

TABLE 1 Demographic characteristics.

Demographic characteristics	
Age	M = 14.17 (SD = 1.66)
Female	58%
Race/Ethnicity	
Latino/a	41%
Non-Hispanic White	32%
Asian	20%
African American	3%
Another Race/Ethnicity	3%
Yearly Household Income	M = $144,943.50 (SD = $164,998.5) Range $3,200–$1,200,000

Abbreviations: M, mean; SD, standard deviation.

TABLE 2 Correlations among positive affect, stress, psychological triggers, and asthma outcomes.

	M (SD)	2.	3.	4.	5.	6.	7.	8.
1. Positive affect	3.40 (0.75)	0.85*	0.96*	0.93*	−0.51*	−0.28*	−0.06	−0.15
2. Calm	3.46 (0.70)		0.76*	0.64*	−0.62*	−0.31*	0.01	−0.09
3. Wellbeing	3.54 (0.81)			0.88*	−0.50*	−0.27	−0.09	−0.15
4. Vigor	3.20 (0.95)				−0.33*	−0.22	−0.07	−0.16
5. Stress	2.58 (1.06)					0.44*	−0.12	−0.05
6. Psychological triggers	0.64 (0.64)						0.23	0.20
7. Worse asthma control	1.83 (0.52)							0.66*
8. Greater asthma symptom severity	−0.58 (0.69)							

*$p < 0.05$.

TABLE 3 Positive affect main effects and interactions with stress and psychological triggers predicting asthma outcomes.

		Dependent variables	
Model	Independent variable(s)	Worse asthma control *b* [95% CI]	Greater asthma symptom severity *b* [95% CI]
1.	Positive affect	−0.09 [−0.34, 0.16]	−0.22 [−0.54, 0.09]
1a.	Calm	−0.02 [−0.30, 0.26]	−0.15 [−0.50, 0.21]
1b.	Wellbeing	−0.11 [−0.35, 0.13]	−0.22 [−0.52, 0.08]
1c.	Vigor	−0.07 [−0.26, 0.12]	−0.16 [−0.40, 0.07]
2.	Positive affect stress*	−0.33* [−0.57, −0.09]	−0.26 [−0.58, 0.06]
2a.	Calm Stress*	−0.37* [−0.60, −0.13]	−0.33* [−0.63, −0.02]
2b.	Wellbeing Stress*	−0.28* [−0.52, −0.04]	−0.23 [−0.54, 0.08]
2c.	Vigor Stress*	−0.18 [−0.38, 0.03]	−0.06 [−0.33, 0.20]
3.	Positive Affect Triggers*	−0.74* [−1.27, −0.21]	−0.63 [−1.40, 0.14]
3a.	Calm Triggers*	−0.60* [−1.05, −0.15]	−0.75* [−1.38, −0.12]
3b.	Wellbeing Triggers*	−0.56* [−1.04, −0.07]	−0.49 [−1.19, 0.21]
3c.	Vigor Triggers*	−0.35 [−0.77, 0.07]	−0.09 [−0.70, 0.52]

Note: Values represent regression coefficients (*b*) and their corresponding 95% confidence intervals ([95% CI]); all models adjust for adolescent age, sex, race/ethnicity, and negative affect as well as yearly household income.

*$p < 0.05$.

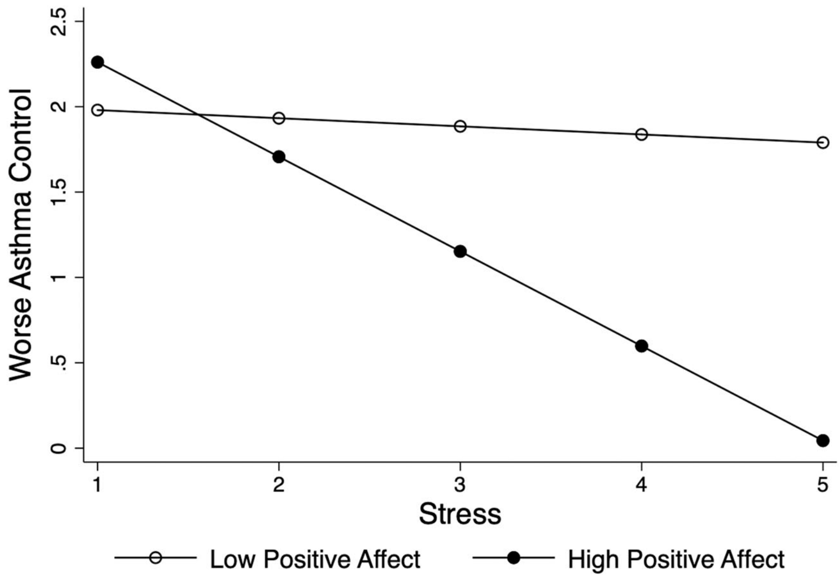

FIGURE 1 Positive affect moderates the association between stress and asthma control. At high levels of positive affect, as stress increased, asthma control improved. At low levels of positive affect, there was no association between stress and asthma control.

improved (simple slope: $b = -0.55$, $t = -2.99$, $p = .005$, 95% CI [−0.93, −0.18]). At low levels of positive affect, there was no association between stress and asthma control (simple slope: $b = 0.05$, $t = -0.26$, $p = 0.792$, 95% CI [−0.41, 0.32]). When assessing the arousal components of positive affect, calm and wellbeing seemed to be driving the effect such that calm ($b = -0.37$, $t = -3.15$, $p = 0.003$, 95% CI [−0.60, −0.13]) and wellbeing ($b = -0.28$, $t = -2.32$, $p = 0.026$, 95% CI [−0.52, −0.04]) significantly moderated the association between stress and asthma control (see Table 3 Models 2a and 2b) to produce the same pattern of effects as seen with overall positive affect (i.e., Figure 1).

3.3.2 | Asthma symptom severity

While positive affect did not significantly moderate the association between stress and asthma symptom severity ($b = -0.26$, $t = -1.65$, $p = 0.106$, 95% CI [−0.58, 0.06], see Table 3 Model 2), the arousal component of calm did moderate the association between stress and asthma symptom severity ($b = -0.33$, $t = -2.17$, $p = 0.036$, 95% CI [−0.63, −0.02], see Table 3 Model 2a and Figure 2). At high levels of calm, as stress increased, asthma symptom severity decreased (simple slope: $b = -0.59$, $t = -2.60$, $p = 0.013$, 95% CI [−1.05, −0.13]). At low levels of calm, there was no association between stress and asthma symptom severity (simple slope: $b = -0.18$, $t = -0.87$, $p = 0.387$, 95% CI [−0.61, 0.24]).

3.4 | Positive affect moderating the association between psychological triggers and asthma outcomes

3.4.1 | Asthma control

Positive affect significantly moderated the association between psychological triggers and asthma control ($b = -0.74$, $t = -2.84$, $p = .007$, 95% CI [−1.27, −0.21], see Table 3 Model 3 and Figure 3). At low levels of positive affect, as psychological triggers increased asthma control became worse (simple slope: $b = 0.57$, $t = 3.16$, $p = 0.003$, 95% CI [0.20, 0.93]). At high levels of positive affect, there was no association between psychological triggers and asthma control (simple slope: $b = -0.57$, $t = -1.83$, $p = 0.075$, 95% CI [−1.21, 0.06]). When assessing the arousal components of positive affect, calm and wellbeing seemed to be driving the effect such that calm ($b = -0.60$, $t = -2.68$, $p = 0.011$, 95% CI [−1.05, −0.15]) and wellbeing ($b = -0.56$, $t = -2.31$, $p = 0.027$, 95% CI [−1.04, −0.07]) significantly moderated the association between psychological triggers and asthma control (see Table 3 Models 3a and 3b) to produce the same pattern of effects as seen with overall positive affect (i.e., Figure 3).

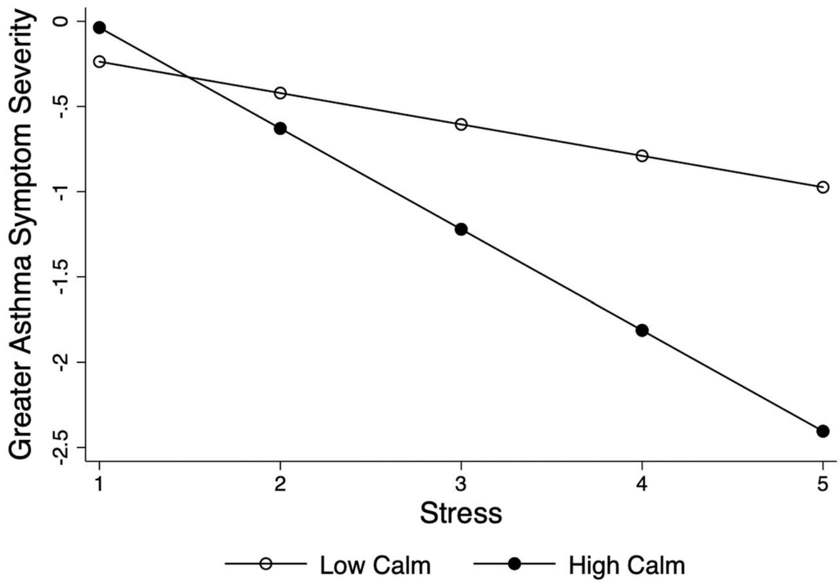

FIGURE 2 Calm moderates the association between stress and asthma symptom severity. At high levels of calm, as stress increased, symptom severity decreased. At low levels of calm, there was no association between stress and asthma symptom severity.

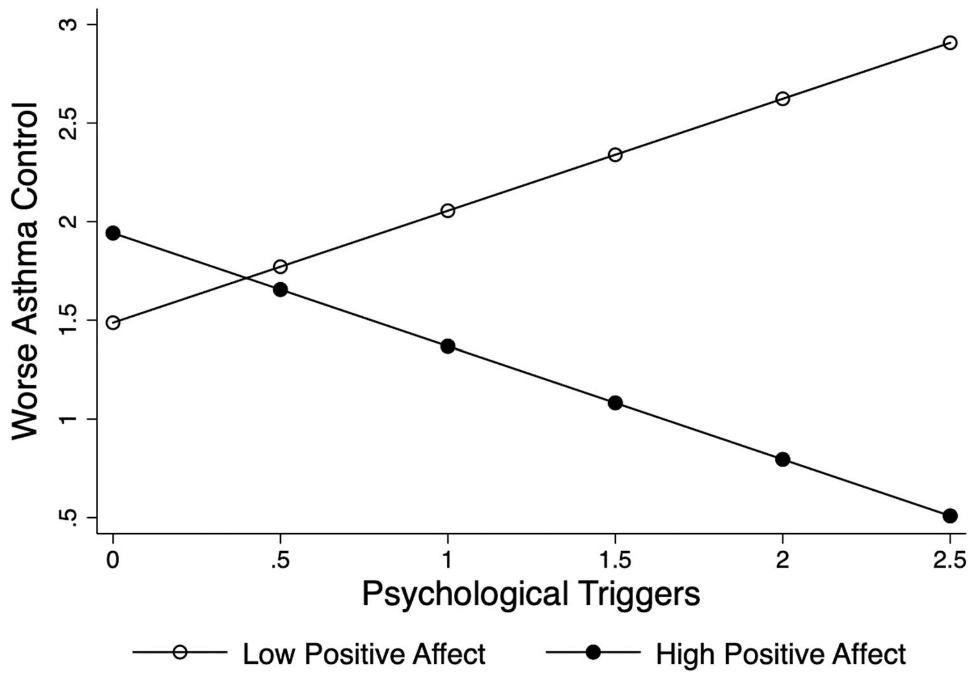

FIGURE 3 Positive affect moderates the association between psychological triggers and asthma control. At low levels of positive affect, as psychological triggers increased, asthma control became worse. At high levels of positive affect, there was no association between psychological triggers and asthma control.

3.4.2 | Asthma symptom severity

While positive affect did not significantly moderate the association between psychological triggers and asthma symptom severity ($b = -0.63$, $t = -1.66$, $p = 0.105$, 95% CI [−1.40, 0.14], see Table 3 Model 3), the arousal component of calm did moderate the association between psychological triggers and asthma symptom severity ($b = -0.75$, $t = -2.41$, $p = 0.021$, 95% CI [−1.38, −0.12], see Table 3 Model 3a and Figure 4). At low levels of calm, as psychological triggers increased, asthma symptom severity became worse (simple slope: $b = 0.46$, $t = 2.24$, $p = 0.031$, 95% CI [−0.04, 0.88]). At high levels of calm, there

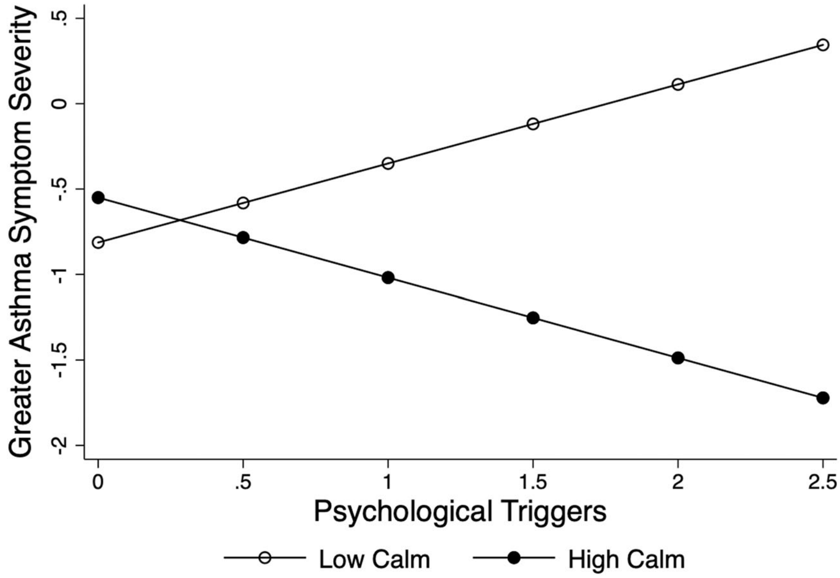

FIGURE 4 Calm moderates the association between psychological triggers and asthma symptom severity. At low levels of calm, as psychological triggers increased, asthma symptom severity became worse. At high levels of calm, there was no association between psychological triggers and asthma symptom severity.

was no association between psychological triggers and asthma symptom severity (simple slope: $b = -0.47$, $t = -1.31$, $p = 0.198$, 95% CI [−1.19, 0.26]).

4 | DISCUSSION

In this study, we tested the effects of positive affect and its arousal components on asthma control and symptom severity in adolescents with moderate to severe asthma and whether positive affect (and its arousal components) moderate how stress impacts asthma control and symptom severity. We did not find evidence that positive affect had direct effects on asthma control or symptom severity. However, when considering patient stress (e.g., general stress, psychological asthma triggers), we did demonstrate that positive affect and its arousal components of calm and wellbeing may be helpful for patients with higher levels of stress and/or for patients experiencing greater numbers of psychological triggers.

Positive affect and some of its arousal components significantly moderated the association between general stress and asthma outcomes. At high levels of positive affect, as stress increased, asthma control improved and at low levels of positive affect, stress was not associated with asthma control. When assessing the arousal components of positive affect, low arousal positive affect (calm) and mid-arousal positive affect (wellbeing) matched this general positive affect by stress finding. In other words, it was the adolescents with high positive affect/calm/wellbeing but also high stress who seemed to be doing best. However, for asthma severity, only low arousal positive affect (calm) interacted with stress to predict asthma symptom severity. Here, it was those adolescents with greater calm and high stress who had less asthma symptom severity.

Although the positive affect/arousal component interactions with stress do not align with the typical stress buffering model of positive affect predictions, (Pressman & Cohen, 2005; Pressman et al., 2019) this 'high-positive affect, high-stress benefit' is consistent with literature examining the moderating role of positive affect on stress in predicting other health (e.g., recovery from skin abrasion (Robles et al., 2009)), physiological (e.g., inflammation (Blevins et al., 2017)), and health behavior (e.g., sleep (Pressman et al., 2017)) outcomes. There could be a few explanations for findings such as these. First, individuals with higher positive affect and more stress could be those who intentionally put themselves in more stressful situations (Chang et al., 2017) because they have psychosocial resources, such as positive affect, to cope with such stress (e.g., similar to high achievers). Second, individuals experiencing high positive affect and high stress could be individuals who articulate, pay attention to, attend to, and regulate their emotions with better clarity and granularity. Indeed, many emotion regulation scales often encompass such processes (Gross & John, 2003). Third, those with more stress might have to be more deliberate about mitigating negative health outcomes and thus it is those with high stress, who also have high positive affect, that have psychosocial resources (Cohn et al., 2009) to help them succeed in this health protective endeavor. Nevertheless, given this work and the work of others (Blevins et al., 2017; Pressman et al., 2017; Robles et al., 2009) demonstrating a 'high positive affect, high stress benefit,' more research in this area is needed to understand the potential mechanisms behind such effects.

When testing the moderating role of positive affect and its arousal components on the association between psychological triggers and asthma outcomes, we saw effects consistent with the classic stress buffering model of positive affect (Pressman & Cohen, 2005; Pressman et al., 2019). For those with low positive affect, when psychological triggers increased, asthma control became worse. And, for those with high positive affect, as triggers increased, asthma control remained the same. When assessing the arousal components of positive affect, low arousal positive affect (calm) and mid-arousal positive affect (wellbeing) matched this general positive affect by psychological triggers finding. In other words, positive affect/calm/wellbeing buffered against the detrimental impact of triggers on health. However, for asthma symptom severity, only low arousal positive affect (calm) interacted with psychological triggers to predict asthma symptom severity. Here, it was those adolescents with greater triggers but less calm who had greater asthma symptom severity. Adolescents who must deal with more psychological triggers, and who also don't have the psychosocial resource of positive affect/calm/wellbeing, are the ones experiencing worse asthma outcomes while those with the resource of positive affect and/or some of its components are protected.

This study had strengths and limitations. First, to our knowledge, our study is the first to investigate the differential effects of positive affect components in adolescents with asthma. In general, these lower-arousal positive affect components (calm and wellbeing for asthma control and calm for asthma symptom severity) may be health promoting during stress/triggers because they are related to parasympathetic control of smooth muscle in airways and the expression of Th2 cytokines (Chen & Miller, 2007). Thus, positive affect components may be a promising and underexplored target for intervention in adolescent asthma care. Second, the EMA design of this study was an ideal method to estimate the relationship between positive affect, stress, and asthma control and symptoms in everyday life in adolescents. EMAs provide a more granular experience of stress/affect/symptoms and when individuals can report their experience in the moment (in EMAs) it is often more accurate as opposed to one-time assessments that may be subject to recall bias. Third, along with the subjective portions of the asthma control test and asthma diaries, the adolescents also completed objective lung function tests using peak flow assessments. Fourth, our sample contained a high proportion of adolescents with moderate to severe asthma which may be the most important population to study because of their disproportionate needs for care. Nevertheless, future studies may recruit more patients than our relatively small sample to obtain more precise estimates of the statistical relationships between affect, stress, and asthma. While we mostly included arguably the most important group of patients with regard to controlling asthma, future studies may also recruit more patients with mild asthma to have a more balanced sample. Another strength was the breadth of analyses across two asthma health outcomes and evaluating main effects before interaction terms as well as subcomponents separately, aligning with established practices in this research domain (e.g., (Koval et al., 2013); Jenkins et al., 2020; Pressman et al., 2017). We chose not to apply a stricter alpha to our multiple tests of significance because we had pre-specified reasons for our model building strategy and a stricter alpha increases the risk of false negatives (Perneger, 1998).

The correlations among the positive affect components were high. Thus, it is possible that certain adolescents scored relatively high/low on two or more components. This makes cleanly distinguishing between the arousal effects more difficult because scores on arousal components are not mutually exclusive. However, allowing our participants to respond with any combination of reported intensities of felt arousal components more accurately reflects how emotions are felt and may affect health (Moore & Martin, 2022). Further, although our sample was somewhat diverse in that we recruited both Latino/a (41%) and Non-Hispanic White (32%) adolescents, our results may not necessarily be identical in other populations (e.g., other race/ethnic identities, non-English speakers, youth at other developmental stages). There are cultural and linguistic differences in felt emotion and which emotions are most desirable (Tsai, 2017). For example, European Americans tend to feel happier and desire feeling different components of positive affect compared to Chinese Americans (Tsai, 2017). Researchers seeking to generalize our results should replicate our study in their intended population.

Given the costs associated with asthma control and symptoms, understanding positive affect as a potential tool to promote health may provide opportunities for future intervention work to complement guideline recommended medical care. If positive affect and/or low to mid-arousal positive affect provides health benefits on asthma control and symptom severity, especially at high stress, interventions to boost these affect types in the daily life of adolescents may be fruitful. Positive affect interventions often encompass teaching skills to promote positive affect (e.g., savoring positive events, expressing gratitude, being kind, reappraising negative events in a positive light) (Moskowitz et al., 2017). Indeed, enhancing positive affect has improved other clinically relevant outcomes (Ogedegbe, 2012; Pressman et al., 2019) (e.g., medication use, vagal tone, blood pressure), including those in adolescent populations (Jaser et al., 2019; Schache et al., 2019). Thus, future randomized controlled trial studies will be needed to assess the efficacy of positive affect interventions for adolescents with asthma.

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CONFLICT OF INTEREST STATEMENT

Dr. Zeev N. Kain serves as a consultant for Medtronic and Pacira and is the President of the American College of Perioperative Medicine. The remaining authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS APPROVAL STATEMENT

All protocol and study materials were approved by the hospital's Institutional Review Board.

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