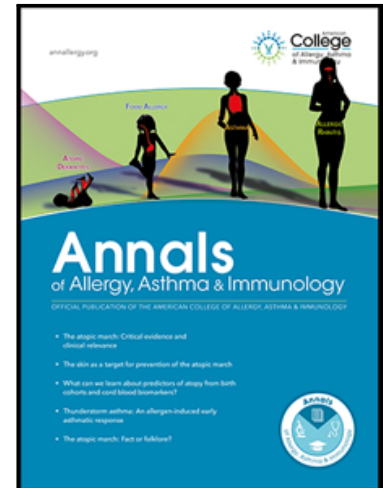


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Eleanor R. Turi BSN, RN, CCRN , Laura C. Reigada PhD ,
Jianfang Liu PhD , Sarah I. Leonard MSN, RN ,
Jean-Marie Bruzzese PhD

PII: S1081-1206(21)01033-4
DOI: <https://doi.org/10.1016/j.anai.2021.09.010>
Reference: ANAI 3712



To appear in: *Annals of Allergy, Asthma Immunology*

Received date: 10 July 2021
Revised date: 17 August 2021
Accepted date: 11 September 2021

Please cite this article as: Eleanor R. Turi BSN, RN, CCRN , Laura C. Reigada PhD , Jianfang Liu PhD , Sarah I. Leonard MSN, RN , Jean-Marie Bruzzese PhD , Associations Between Anxiety, Self-efficacy, and Self-care in Rural Adolescents with Poorly Controlled Asthma, *Annals of Allergy, Asthma Immunology* (2021), doi: <https://doi.org/10.1016/j.anai.2021.09.010>

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Associations Between Anxiety, Self-efficacy, and Self-care in Rural Adolescents with Poorly Controlled Asthma

Eleanor R. Turi, BSN, RN, CCRN^a; Laura C. Reigada, PhD^b; Jianfang Liu, PhD^a; Sarah I. Leonard, MSN, RN^a; Jean-Marie Bruzzese, PhD^a

^a = Columbia University School of Nursing; ^b = Brooklyn College & The Graduate Center, The City University of New York

Corresponding Author:

Jean-Marie Bruzzese, PhD
Professor of Applied Developmental Psychology (in Nursing)
Columbia University School of Nursing
560 West 168th Street
New York, NY 10032
Phone: 917-376-3048
Email: jb3958@cumc.columbia.edu

Conflicts of interest: None

Funding source: NIH (R01 HL136753 PI=Bruzzese)

Abbreviations: YAAS = Youth Asthma-Related Anxiety Scale; SCARED = Screen for Child Anxiety and Emotional Disorders; SAS = statistical analysis system; SD = standard deviation; CI=confidence interval; No = number

Word count: 3368

Figures: 1

Tables: 2

Abstract

Background: Rural adolescents are vulnerable to asthma; good self-care can reduce morbidity. Sub-types of anxiety (e.g., asthma-related, generalized) may have differential associations with asthma self-care. Low self-efficacy, a determinant of behavior, is associated with increased anxiety. Little is known about these relationships in rural adolescents.

Objective: To evaluate whether anxiety symptoms are associated with asthma symptom prevention and management among rural adolescents and whether self-efficacy mediates these relationships.

Methods: We used baseline data from 197 rural adolescents (M age =16 years; 69% female; 62% Black) who were part of a trial testing the effectiveness of a school-based asthma intervention. Adolescents completed the Youth Asthma-related Anxiety Scale, Screen for Child Anxiety and Emotional Disorders, Asthma Management Self-efficacy Index, and Asthma Prevention and Management Indices. Linear regression tested whether 1) asthma-related and generalized anxiety had curvilinear relationships with self-care, 2) social and separation anxiety had linear relationships with self-care, and 3) self-efficacy mediated significant relationships.

Results: Asthma-related anxiety had a significant curvilinear relationship with prevention, and a linear association with management. Generalized anxiety had a significant curvilinear association with management; social anxiety had a significant linear relationship with prevention. Self-efficacy partially or fully mediated these relationships.

Conclusion: Anxiety symptoms were associated with asthma self-care among this sample of rural adolescents, with differing roles for prevention and management. Self-efficacy may be a mechanism to improve asthma self-care among rural adolescents with anxiety. In the absence of self-efficacy, asthma-related, generalized, or social anxiety may motivate adolescents to take steps to care for their asthma.

Keywords: anxiety, self-efficacy, self-care, asthma, rural, adolescence

Introduction

Despite advances in the clinical management of asthma, asthma continues to have relatively high prevalence and morbidity among adolescents.¹⁻³ Accordingly, appropriate asthma self-care, which consists of behaviors one may take to either prevent the onset of symptoms (e.g., taking medicine daily or avoiding triggers), or to manage existing symptoms (taking prescribed medication to relieve symptoms, remaining calm), can dramatically reduce asthma morbidity.⁴ Yet, adolescents do not take adequate steps to care for their asthma.⁵⁻⁷ Little is known about factors that contribute to asthma self-care in rural adolescents, representing a critical gap in the literature given that rural adolescents are vulnerable to asthma,⁸ with some studies documenting similar asthma prevalence and morbidity among rural youth compared to urban youth.⁹⁻¹¹

One factor that may impact asthma self-care is anxiety, which is highly comorbid and associated with worse asthma severity¹²⁻¹⁴ and poor asthma control in youths.^{15,16} Studies that examine the relationship between anxiety and asthma are limited as most examine anxiety as a global construct.¹³ While types of anxiety (e.g., generalized, social and separation anxiety) have overlapping transdiagnostic features,^{17,18} each sub-type also has distinctive features (e.g., eliciting stimuli, cognitive misinterpretations, coping responses) which may have differential associations with asthma self-care and may require specific approaches to optimize asthma self-care. In addition, some adolescents with asthma may experience asthma-related anxiety, defined as worry or fears around the illness, including asthma symptoms, medication and consequences.¹⁹ While the literature is nascent, this type of anxiety seems to have a distinct relationship with asthma self-care,^{19,20} but requires further examination.

Elucidating how different levels of generalized anxiety and asthma-related anxiety impact asthma self-care in rural adolescents is needed to help them better manage their asthma. Research suggests that among adults, moderate levels of asthma-related anxiety and generalized anxiety may optimize asthma self-care, while low and high levels may hinder self-care.²¹⁻²³ Similarly, when urban adolescents reported low asthma-related anxiety, they took fewer steps to prevent asthma symptoms, while moderate levels of asthma-related anxiety were associated with taking more preventive steps to care for asthma.²⁴

The mechanism by which anxiety impacts asthma self-care is still under investigation. Social cognitive theory posits that self-efficacy, or one's confidence in their ability to execute a behavior, is essential to implementing behaviors.²⁵ Previous studies have demonstrated a positive association between self-efficacy and asthma self-care.^{26,27} A person's emotional state may impact their self-efficacy,²⁸ with some studies showing that high levels of anxiety are associated

with low levels of self-efficacy.^{29,30} Thus, it has been theorized that anxiety may exert its effect on asthma self-care by undermining self-efficacy, which in turn can decrease asthma-related self-care.³¹ However, this mediational relationship has not been evaluated in adolescents with asthma, or in rural settings.

To address these gaps, using data from a sample of rural adolescents, we examined whether different types of anxiety symptoms are associated with asthma self-care (i.e., symptom prevention and management), and whether self-efficacy mediates these relationships. We hypothesized that moderate levels of asthma-related and generalized anxiety, compared to low or high levels, would be associated with the most self-care, and that more symptoms of social and separation anxiety would be associated with less prevention and management steps. We also hypothesized that self-efficacy would mediate any significant relationships between anxiety types and self-care.

Methods

Participants

We performed a secondary data analysis of baseline data collected from a randomized trial testing the effectiveness of a school-based asthma intervention for adolescents from eight high schools serving rural students. Rurality was classified by Rural-Urban Commuting Area codes.³² To identify eligible adolescents for the clinical trial, all adolescents in a participating school were asked to complete a screening form. Eligible participants reported being diagnosed with asthma by a medical provider, being 13.0 years or older, and having uncontrolled asthma, which we defined as: (1) in the last month: daytime symptoms at least once a week; activity limitations at least once a week; night wakening at least two nights a month; or rescue inhaler use when symptomatic at least once a week, or (2) in the last 12 months: one or more asthma-

related urgent visits to a medical provider, emergency room visit or hospitalization; use of systemic corticosteroids for asthma; or four or more asthma-related school absences.

Procedures

The Institutional Review Boards of Columbia University and the Medical University of South Carolina approved study procedures. Parents/guardians provided written consent and adolescents provided written assent. During the winter of 2019 and 2020, adolescents completed surveys during the school day, administered by trained study personnel. Demographic information was collected during screening for the larger clinical trial; the remaining measures were completed after written caregiver consent and adolescent assent were obtained.

Measures

Demographics and Asthma Characteristics

Adolescents reported their date of birth (which was used to calculate baseline age), sex, and race/ethnicity (Black, White, or another). They also reported if in the prior three months they had immediate or urgent asthma-related treatment (i.e., doctor's office or clinic visit, emergency room visit, or hospitalization) and/or took steroid pills for 5-7 days for asthma symptoms. We classified those who endorsed either item as having a recent exacerbation of asthma.

Anxiety. To assess asthma-related anxiety, the *Youth Asthma-Related Anxiety Scale* (YAAS)¹⁹ was used. This self-report measure assesses the adolescent's nervousness or worry about their asthma over the last two weeks. The scale has 9-items and is on a 6-point Likert scale (0 = never, 5 = always). Reliability and validity of the YAAS have been established,¹⁹ and factor analysis confirmed the factor structure in this sample.

Adolescents completed the generalized, social, and separation anxiety subscales of the *Screen for Child Anxiety and Emotional Disorders* (SCARED).³³ Using a 3-point Likert scale (0

= not true or hardly ever true, 2 = very true or often true), adolescents indicated how much each of 24 statements described them. The generalized anxiety subscale (nine items) assesses the extent to which the adolescent reports overall worry and nervousness. The social anxiety subscale (seven items) measures adolescent fears of negative evaluation in social or performance situations, and the separation anxiety subscale (eight items) evaluates adolescent distress when temporarily leaving home or otherwise separating from a specific attachment figure. The SCARED has well-established psychometric properties.³³

Asthma Self-care

Adolescents completed two indices to assess asthma self-care. The *Asthma Prevention Index* is a 9-item tool where adolescents indicate on a 3-point Likert scale the extent to which they take (yes, on a regular basis; yes, but not on a regular basis; not taken) each of nine steps to prevent the onset of symptoms (e.g., avoiding triggers, taking prescribed medication as directed). A count of the total number of steps taken was computed collapsing across the two positive responses. To measure what adolescents do to manage asthma symptoms once they begin, adolescents completed the *Asthma Management Index*, which includes assessment of seven management steps (e.g., resting, took asthma medicine that the doctor gave them). The total number of steps taken was computed. Both indices have demonstrated good internal consistency ($\alpha = 0.67$ and 0.70 , respectively) and test-retest reliability ($r = 0.71$ for both indices).³⁴

Asthma Management Self-efficacy

The *Asthma Management Self-efficacy Index*³⁴ was used to measure adolescents' confidence in implementing asthma self-care behaviors. This index, which includes 14-items, uses a 6-point Likert scale (1 = very sure you could NOT, 6 = very sure you could), has

demonstrated internal consistency ($\alpha = 0.84$), test-retest reliability ($r = 0.46$)³⁴ and has been shown to be treatment sensitive.³⁵

Data Analysis

Analyses were conducted using SAS version 9.4. Linear regression was used to test whether there was a significant relationship between each predictor (asthma-related, generalized, social, and separation anxieties) and outcome (prevention steps and management steps). To control for the known associations of demographic factors and asthma,¹ as well as the known association between asthma exacerbations and self-care and anxiety symptoms,³⁶⁻³⁹ all models controlled for age, sex, race/ethnicity, and if the adolescent had an asthma exacerbation in the prior three months. We also included school in the model to control for potential between-subject correlations due to adolescents attending the same school. Assumption of normality of linear regression models was assessed and confirmed by examining the distribution of the residuals of linear regression models.

To test for a curvilinear relationship between asthma-related and generalized anxiety and asthma self-care, both linear (i.e., first order) and curvilinear (i.e., second order) terms of the predictor were included in these models. If the curvilinear term was significant, the association was deemed curvilinear. If only the linear term was significant, the model was re-fit with just the linear term included, and if it remained significant, the association was determined to be linear. We calculated the vertex of the curve (peak of the line) to further describe the curvilinear associations.

Next, to assess whether self-efficacy mediated significant associations between anxiety and self-care, we included self-efficacy in the model. If self-efficacy was significant, mediation was established.⁴⁰ If the association between the predictor and outcome continued to be

significant, there was a partial mediation effect; otherwise, there was a full mediation effect.⁴⁰ To determine the extent to which self-efficacy mediates curvilinear relationships, we evaluated the movement of the vertex of the curve, which was expressed as percentage of movement accounted for by the mediator. To further describe the mediation of the linear associations, we calculated the percentage of the total effect (indirect effect) that was accounted for by self-efficacy. Additional details on how these calculations are performed, as well as our specific calculations of them, are detailed in the eSupplement.

Results

Sample Characteristics

The larger clinical trial, from which we drew our sample, was comprised of 201 participants. Four did not complete one or more of the measures used in this study and were excluded from this study. Our final sample ($N = 197$) included adolescents ranging in age from 14.47 to 19.92 ($M = 16.32$, $SD = 1.19$) years; 68.53% identified their sex as female, and the majority (62.44%) identified their race/ethnicity as Black. As detailed in Table 1, 30.96% reported having an asthma exacerbation.

Descriptive statistics for the predictor and outcome variables are listed in Table 2. On average, the students took 5.39 of 9 steps to prevent the onset of symptoms, and 4.80 of 7 steps to manage existing symptoms. The mean asthma management self-efficacy score was 4.33, indicating that adolescents reported on average that they “probably could” to “most likely could” care for their asthma. The median asthma-related anxiety score was 1.56, which is in the lower-third of the 5-point scale. The median generalized anxiety score was 9.00 of 18, and 50.75% of the sample fell at or above the cutoff of 9 for possible generalized anxiety disorder. Similarly, the median social anxiety score was 8.00 of 14, and 50.25% of the sample fell at or above the cutoff

of 8 for possible social anxiety disorder. The median separation anxiety score was 4.00 of 16, and 49.75% fell at or above the cutoff of 5 for possible separation anxiety disorder.

Association of Anxiety and Asthma Self-care

Asthma-related Anxiety

Both the linear (adjusted beta [95% Confidence Interval (CI)]: 0.94 [0.58, 1.30]) and curvilinear (-0.45 [-0.71, -0.18]) asthma-related anxiety terms were significantly associated with prevention steps, indicating that there is a significant curvilinear association between asthma-related anxiety and prevention. See Figure 1A.

The linear asthma-related anxiety term was the only significant predictor of management steps (linear: 0.30 [0.07, 0.53]; curvilinear: -0.09 [-0.26, 0.08]). To obtain a more parsimonious model, we re-fit the model with just the linear term (0.26 [0.04, 0.47]). Thus, there is a significant linear association between asthma-related anxiety and management.

Generalized Anxiety

When both the linear and quadratic generalized anxiety terms were included in the model with prevention, only the linear term was significant (0.07 [0.001, 0.15]; curvilinear: -0.01 [-0.03, 0.003]). We re-fit the model with just the linear term included, and the relationship was no longer significant (0.07 [-0.003, 0.15]). Thus, the relationship between generalized anxiety and prevention steps was not significant.

The linear generalized anxiety term was not a significant predictor of management steps (0.004 [-0.04, 0.05]), but the curvilinear term was significant (-0.01 [-0.02, -0.002]), indicating that there is a significant curvilinear relationship between generalized anxiety and management steps. See Figure 1B.

Social Anxiety

The linear association between social anxiety and prevention steps was significant (0.09 [0.003, 0.17]); a significant association between social anxiety and management steps was not found (0.04 [-0.009, 0.09]).

Separation Anxiety

There were no significant linear relationships between separation anxiety and prevention steps (-0.01 [-0.12, 0.10]) or management steps (-0.02 [-0.08, 0.05]).

Mediation Analyses

Asthma-related Anxiety

The quadratic asthma-related anxiety term (-0.42 [-0.68, -0.16]) remained significant in the final multivariable regression model with prevention steps, which means that self-efficacy (0.50 [0.11, 0.88]) partially mediated the curvilinear relationship between asthma-related anxiety and symptom prevention. Self-efficacy decreased the value of asthma-related anxiety associated with the vertex by less than 1% (please see the eSupplement for details on how this percentage was calculated).

The linear asthma-related anxiety term remained significant in the final regression model with management steps (0.21 [0.001, 0.41]), indicating that self-efficacy (0.44 [0.20, 0.68]) partially mediated the linear relationship between asthma-related anxiety and symptom management. About 18% of the association between asthma-related anxiety and management steps was mediated by self-efficacy; see the eSupplement for calculation details.

Generalized Anxiety

The quadratic generalized anxiety term (-0.01 [-0.02, -0.002]) remained significant in the final regression model with symptom management, indicating that self-efficacy (0.48 [0.24, 0.72]) partially mediated the curvilinear relationship between generalized anxiety and

management steps. Self-efficacy decreased the value of generalized anxiety associated with the vertex by about 66% (see eSupplement for calculation details).

Social Anxiety

The linear social anxiety term was no longer significant (0.08 [-0.002, 0.16]) when self-efficacy (0.63 [0.23, 1.03]) was included in the model with prevention steps. This indicates that self-efficacy fully mediates the linear relationship between social anxiety and prevention steps.

Discussion

This study is among the first to examine the relationship between various anxiety types and asthma self-care among adolescents, and the first that we are aware of to test this in a rural sample. We found anxiety types have differential relationships with asthma self-care among rural adolescents, and that self-efficacy plays a mediating role in these relationships. In particular, asthma-related anxiety was the only anxiety type associated with prevention as well as management behaviors. Consistent with a study of younger urban adolescents,²⁴ a moderate level of asthma-related anxiety (compared to high or low levels) was associated with the most steps taken to prevent the onset of asthma symptoms in the current sample. While increased asthma-related anxiety was associated with less symptom prevention, higher levels of asthma-related anxiety were associated with adolescents engaging in more steps to manage existing asthma symptoms. These findings suggest that the relationship between asthma-related anxiety and asthma self-care may vary depending on whether the target is symptom prevention versus management. For instance, higher asthma-related anxiety may be adaptive in the context of disease symptom exacerbation in that it encourages timely management of asthma symptoms in the moment,²⁰ but for prevention, which requires a more anticipatory study for initiating action, only moderate asthma-related anxiety is optimal.

Congruent with research among adults showing differential associations between anxiety and specific asthma self-care behaviors,⁴¹ we found that generalized anxiety symptoms were not associated with the prevention of asthma symptoms, but were associated with the management of existing symptoms. More specifically, moderate levels of generalized anxiety (compared to high or low levels) were associated with the most steps to manage existing asthma symptoms. This potentially suggests some generalized anxiety symptoms, coinciding with the urgent nature of current asthma symptoms, may help to increase threat detection to enhance management of exacerbations,⁴² while relatively more generalized anxiety symptoms may impair the adolescent from taking action.

This study also found that self-efficacy mediated the relationships between anxiety types and self-care behaviors. Indeed, self-efficacy played a significant role, either fully mediating (i.e., social anxiety) or partially mediating (i.e., asthma-related, generalized anxiety) relationships. Thus, findings expand on research with adults that found self-efficacy mediated the association between generalized anxiety disorder and asthma control and quality of life.⁴³ Perceived self-efficacy, defined as judgments of personal capabilities to perform certain actions, can reduce the impact of anxiety by supporting effective modes of behavior that cognitively restructure events perceived as threatening into safe ones.²⁸ Self-efficacy may help adolescents realize that they are capable of caring for their asthma, thus able to manage fear because they embody a sense of control.^{28,31} For adolescents who reported higher self-efficacy, less asthma-related, generalized, and social anxiety were each associated with optimal asthma self-care behaviors; although the influence of self-efficacy appeared to differ among anxiety types. Self-efficacy seemed to have the most influence on the relationships between social anxiety and generalized anxiety on asthma self-care behavior, but a less impactful role for asthma-related

anxiety and self-care behaviors. Thus, the impact of self-efficacy may vary depending on context. While anxiety types may have overlapping transdiagnostic features, there was differential associations between self-efficacy and asthma self-care in this study, which requires further empirical examination.

Overall, this study found that different types of anxiety symptoms are associated with asthma self-care. Broadly, anxiety is an anticipation of future real or perceived threats,⁴⁴ however, it is important to note that models of emotional disorders have suggested that there may actually be two distinct categories of anxiety disorders: distress related anxiety (e.g., generalized anxiety disorder) and fear related anxiety (e.g., social anxiety and separation anxiety).^{45,46} It is unknown whether asthma-related anxiety is a distinct construct or a sub-type anxiety condition. Nonetheless, theoretical models have highlighted the importance of recognizing asthma symptoms as threatening and then mobilizing attentional resources towards addressing the threat.⁴⁷ Thus, some types of anxiety in relation to asthma may encourage an individual to carry out appropriate self-care behaviors.²⁰ More research is needed in other settings and with larger samples to further understand these complex relationships.

Study findings point to the possible importance of proactively assessing self-efficacy and anxiety when treating rural adolescents with asthma, as these factors seem to be related with optimal self-care. Clinicians could specifically focus on helping young people develop high levels of self-efficacy, as this can meaningfully impact asthma self-care. Self-efficacy educational or peer modeling sessions may be particularly useful when aiming to enhance asthma-related confidence among adolescents.⁴⁸ In the absence of self-efficacy, varying levels of asthma-related anxiety, generalized anxiety, and social anxiety may potentially be protective as individuals more prone to anxiety may be more risk averse and attentive to their asthma.⁴⁹

Cautiously, this may signal the importance of asthma vigilance which may encourage adolescents take their asthma seriously and perform self-care behaviors.⁴⁹

The study is not without limitations. As a secondary data analysis, we were unable to include other variables that may have impacted the relationships examined, such as income, insurance status, access to primary or specialty care, prior use of management tools (e.g., asthma action plans), and comorbid conditions that may impact anxiety. Additionally, data was cross-sectional, precluding our ability to establish temporality or causality. For example, it is plausible that those who are self-efficacious may experience fewer anxiety symptoms. Our convenient sample, which was collected in rural South Carolina public schools and included students with poorly controlled asthma, was comprised mostly of Black participants (62%). This is not reflective of the counties we drew from or the U.S. rural population, where on average 39.3% (range 17.9 – 62.1%) and 7.8% of the population identify as Black, respectively.^{50,51} Thus, we are unable to conclude that our findings are applicable in other settings or to those with well controlled asthma. Moreover, adolescents with high functional impairment from either anxiety or asthma may not have been captured in our study, as these students may not have been able to attend school regularly enough to participate in the larger clinical trial.

This study was novel in examining how certain levels of anxiety types associate with self-efficacy and self-care among rural adolescents, a vulnerable population underrepresented in asthma research. Our findings lay the framework for future research examining the complex roles anxiety types and self-efficacy play in asthma self-care among rural adolescents. Health care providers working with this population are encouraged to assess self-care behaviors and consider the differential role that anxiety and self-efficacy may be playing, as these adolescents may have varied self-care needs.

Acknowledgments:

We thank Dr. Yihong Zhao (Columbia University School of Nursing) for consulting on our data analysis section.

Additional Information Regarding Data Analysis

To further describe significant curvilinear relationships, we calculated the vertex of the curve using the formula $-b/2a$, where a is the regression coefficient of the second order predictor and b is the regression coefficient of the first order predictor.¹ We evaluated the movement of the vertex of the curve to determine the extent to which self-efficacy mediates curvilinear relationships. This was done by calculating $(\text{Vertex 1} - \text{Vertex 2}) / \text{Vertex 1}$, where Vertex 1 is the vertex of the curve in Model 1 (mediator not included) and Vertex 2 is the vertex of the curve in Model 2 (mediator included).

To further describe the mediation of the linear associations, we calculated the ratio of the indirect/mediated effect as $(\beta_1 - \beta_2) / \beta_1$, where β_1 is the regression coefficient of the predictor in Model 1 (i.e., without mediator) and β_2 is the regression coefficient of the predictor in Model 2 (i.e., final regression model with mediator).²

Relevant Calculations to Understand the Mediation Analyses***Asthma-related Anxiety***

Prevention: Self-efficacy decreased the value of asthma-related anxiety associated with the vertex by less than 1%. The vertex of the curve shifted from 1.048 in Model 1 to 1.045 in Model 2. $[(1.048 - 1.045) / 1.048]$.

Management: The linear term in Model 1 was 0.255 and was 0.208 in Model 2; therefore, about 18% $[(0.255 - 0.208) / 0.255]$ of the association between asthma-related anxiety and management steps was mediated by self-efficacy.

Generalized Anxiety

Management: The vertex of the curve in Model 1 was approximately 0.62, and the vertex of the curve in model 2 was approximately 0.21; as such, self-efficacy decreased the value of generalized anxiety associated with the vertex by about 66% $[(0.62-0.21) / 0.62]$.

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Table 1. Participant Characteristics (n = 197)

Characteristic	n (%)
Age (Mean (SD))	16.32 (1.19)
Sex	
Female	135 (68.53)
Male	54 (27.41)
Not reported	8 (4.06)
Race/Ethnicity	

Black	123 (62.44)
White	39 (19.80)
Another or Unknown	35 (17.77)
Asthma exacerbation in prior 3 months	61 (30.96)

Asthma exacerbation = At least 1 urgent medical visit or steroid prescription for asthma in prior 3 months (self-report)

Table 2. Distribution of Predictor, Mediator, and Outcome Variables (n = 197)

	Mean (SD)	Median	Range	25 th Percentile	50 th Percentile	75 th Percentile
No. Prevention Steps	5.39 (2.53)	5.00	0 – 9.00	3.00	5.00	8.00
No. Management Steps	4.80 (1.44)	5.00	0 – 7.00	4.00	5.00	6.00
Asthma Management Self-efficacy	4.33 (0.78)	4.38	1.00 – 6.00	3.86	4.38	4.86
Asthma-related Anxiety	1.62 (0.92)	1.56	0.22 – 4.22	1.00	1.56	2.11
Generalized Anxiety	8.87 (4.34)	9.00	0 – 18.00	6.00	9.00	12.00
Social Anxiety	7.68 (3.81)	8.00	0 – 14.00	5.00	8.00	10.00
Separation Anxiety	4.81 (3.04)	4.00	0 – 15.00	2.00	4.00	7.00

Abbreviations: No = number; SD = standard deviation

Figure 1. Curvilinear Associations Between Anxiety Types and Self Care. (A) Asthma-related Anxiety and Prevention (B) Generalized Anxiety and Management (n = 197)

A

B

