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Associations between distress tolerance and asthma symptoms and quality of life

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Abstract

Objective—Given the robust associations between anxiety and asthma, the purpose of the current study was to explore associations between asthma outcomes and tolerance for negative affective states (i.e. distress tolerance) as well as tolerance for the specific negative emotional states of anxiety and fear.

Methods—Participants were 61 nonsmoking adults with asthma (61.9% female, 54.8% African-American, M_{age} = 34.72, SD = 13.58) who underwent spirometry and completed self-report measures.

Results—After controlling for the effects of age, race and the physical concerns domain of anxiety sensitivity, poorer global distress tolerance and tolerance for fear and anxiety each significantly predicted poorer lung function (8.7–13.8% variance), asthma control (4.9–8.8% variance) and asthma-related quality of life (6.7–8.9%).

Conclusions—These findings suggest that targeting distress tolerance, specifically tolerance of fear and anxiety, may be helpful in improving asthma outcomes.

Keywords

Anxiety; asthma control; distress tolerance; lung function

It has been well established that anxiety disorders are not only more common among individuals with asthma [1–3], but also are associated with more severe asthma (e.g. greater bronchodilator use, shortness of breath, wheezing, doctor's office visits), and frequency of asthma attacks [4–6], poorer quality of life and increased functional impairments [4,5,7–13]. Recent work on anxiety and asthma has begun to explore the role of anxiety-related cognitive-affective risk factors, defined as negative beliefs or ways of attending to and interpreting negative or ambiguous anxiety-related symptoms, as one potential mechanism

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for understanding associations between anxiety and asthma. This work has primarily focused on anxiety sensitivity, defined as the fear of arousal-related sensations due to their perceived negative physical, cognitive and social consequences [14,15]. Results from this emerging body of literature indicate that greater anxiety sensitivity, particularly the physical concerns domain, is associated with poorer asthma control and asthma-related quality of life [16,17] and greater physical and emotional reactivity and decreased lung function in response to asthma-like symptoms [18].

Given the important role that anxiety sensitivity plays in asthma, an important next step in this area of work is to explore associations between asthma and other anxiety-related cognitive-affective risk factors. One such factor to consider in this regard is distress tolerance, defined as an individual's perceived or actual capacity to withstand or endure negative emotional states [19,20]. Extant research indicates that individuals with anxiety psychopathology have lower levels of distress tolerance compared to the general population [21]. Further, low distress tolerance is associated with increased symptoms of worry, generalized anxiety disorder, obsessive-compulsive disorder, panic psychopathology and social anxiety [22–30]. Moreover, distress tolerance demonstrates unique associations with anxiety psychopathology above and beyond the effects of anxiety sensitivity [27].

Despite robust associations between anxiety psychopathology and distress tolerance among individuals without asthma, no research, to date, has examined the role of this cognitive-affective risk factor in asthma. Theoretically, an individual low in distress tolerance who experiences anxiety as a result of shortness of breath related to asthma, for example, would likely be unable to withstand or endure this anxiety and might take steps to immediately reduce these symptoms by using short-acting beta agonist (SABA) medication without determining whether such an action is truly necessary. Such a scenario could result in overuse of asthma medications or even the perception that the person's asthma is worse than it objectively is given the frequency of SABA use. Moreover, SABAs themselves can also produce anxiety-like symptoms, which could lead to a vicious cycle of increasing anxiety and medication use.

As a first attempt to test this theory, the purpose of the current study was to examine the unique predictive ability of distress tolerance in terms of lung function, asthma control and asthma-related quality of life among nonsmoking adults with current asthma. It was hypothesized that after controlling for the effects of race, gender and the physical concerns domain of anxiety sensitivity, lower distress tolerance would be predictive of poorer lung function (FEV_1), asthma control and asthma-related quality of life. However, it is possible that an individual might score high on distress tolerance as a global construct, but actually have difficulty tolerating one or two specific negative emotions. For example, an individual may be able to tolerate certain negative emotions (e.g. sadness, anger, disgust), but not others (e.g. fear anxiety). Therefore, in addition to examining associations between asthma and global distress tolerance, a secondary aim of this study was to examine associations with the tolerance of fear and anxiety, specifically. These anxiety-related emotions were chosen because of the high rate of co-occurring anxiety and asthma and to build on existing work examining other anxiety-related cognitive risk factors in asthma. It was hypothesized that lower levels of tolerance of fear and anxiety would be predictive of poorer asthma outcomes.

Methods

Participants

Participants were 61 nonsmoking adults with current asthma (61.9% female; M_{age} = 34.72, SD = 13.58, Range = 18–65 years). For inclusion in the study, participants had to (a) be between the age of 18–65; (b) meet biochemical cutoff values for being a nonsmoker, as indexed by expired carbon monoxide levels below 5 ppm [31]; (c) have received a physician diagnosis of asthma; (d) not have a diagnosis of another chronic lung disease; (e) have experienced asthma symptoms in the past six months; (f) have a prescription for an inhaled corticosteroid or similar medication (i.e. more than just a short-acting bronchodilator used on an as-needed basis); (g) meet the cutoff score for an asthma diagnosis on the Asthma Screening Questionnaire (ASQ; i.e. score ≥4) [32]. Due to the well-established relationship between smoking and both asthma and distress tolerance, current smokers were excluded from the current study [33–35].

In terms of the racial composition of the sample, 54.8% self-identified as African-American, 39.7% as Caucasian and 1.8% of the sample reported Hispanic ethnicity. Participants were, on average, 16.48 years (SD = 14.13) years of age when diagnosed with asthma. 14.3% of the sample reported daily rescue inhaler use, 76.2% had experienced at least one asthma attack in the past six months and 45.9% had had at least one emergency department visit due to asthma in the past six months. Participants reported a mean Asthma Control Test (ACT) [36] score of 15.98 (SD = 4.54), indicating poorly controlled asthma.

Measures

Expired carbon monoxide—Biochemical verification of smoking status was completed by carbon monoxide (CO) analysis of breath samples assessed using a Bedfont Micro 4 Smokerlyzer CO Monitor (Model EC50; coVita, Haddonfield, NJ). Past research has shown that a cutoff score of 5 parts per million (ppm) reliably discriminates nonsmoking status [31].

Asthma screening questionnaire—The ASQ [32] is a six-item measure that assesses four dimensions of asthma symptoms (i.e. coughing, wheezing, chest tightness, shortness of breath) in four situations that commonly elicit asthma symptoms (i.e. lying down, after exercising, after laughing/crying). Research indicates that a score greater than four on the ASQ reliably discriminates between those with and without asthma (96% sensitivity, 100% specificity; 32). The ASQ showed good internal consistency (α = 0.81) in the current sample. The mean ASQ score for the current sample was 12.13 (SD = 4.38).

Anxiety sensitivity index-3—The anxiety sensitivity index-3 (ASI-3) [37] is an 18-item self-report measure that assesses the degree to which participants fear the negative consequences associated with anxiety symptoms. Items are rated on a 5-point Likert scale. The ASI-3 has three lower--order factors: (a) physical concerns, (b) social concerns and (c) cognitive concerns. For the purpose of this study, only the physical concerns subscale was used. The ASI-3 has demonstrated strong psychometric properties [37]. Internal consistency for the physical concerns subscale in the current sample was good (α = 0.84).

Tolerance of negative affective states scale—The tolerance of negative affective states scale (TNASS) [38] is a 25-item self-report measure that assesses the degree to which individuals can withstand or endure specific negative affective states. Participants are given a definition of tolerance and intolerance at the beginning of the measure and then asked to rate how tolerant they are of eight specific emotions using a 5-point Likert-type scale (1 = *very intolerant* to 5 = *very tolerant)*. Higher scores reflect higher levels of affective tolerance. The TNASS is comprised of one higher-order affective tolerance factor and six lower order factors: (a) Fear; (b) Sadness; (c) Anger; (d) Disgust; (e) Anxiety; (f) Negative Social Emotions. Only the total, fear, and anxiety scales were used in the current study. In the initial validation study [38], the TNASS demonstrated discriminant validity, such that an individual's perceived tolerance of an emotion was not related to the frequency of experiencing the emotion, nor to the degree of awareness or attention of the emotion. In the current study, internal consistency was excellent for the total score ($\alpha = 0.96$), good for the anxiety subscale ($\alpha = 0.79$), and acceptable for the fear ($\alpha = 0.70$) subscale. The TNASS was chosen over more commonly used self-report measures of distress tolerance (i.e. Distress Tolerance Scale; DTS [19]) because it provides an explicit definition of tolerance to participants and assesses both global distress tolerance as well as tolerance of specific negative emotions, providing an opportunity to determine whether there are differential effects for specific emotions. Moreover, the DTS has been criticized because it only asks about tolerance of emotions indirectly. That is, the DTS does not specifically ask whether or not emotions are tolerable, but rather uses words that may not be truly synonymous with tolerance (e.g. "My feelings of distress or being upset are not acceptable"). Further, the DTS appears to be measuring emotion regulation (e.g. When I feel distressed or upset I must do something about it immediately) rather than the perceived ability to tolerate emotional distress.

Lung function—Lung function was assessed using a KoKo Legend portable office spirometer (nSpire Health, Inc., Longmont, CO). Forced expiratory volume in one second (FEV_1) was used as the main outcome variable indicative of lung function.

Asthma control test—The ACT [36] is a five-item self-report measure that assesses level of asthma control over the past four weeks. Research has shown that the ACT has good reliability and is able to differentiate between different levels of asthma control [36]. Internal consistency for the ACT in the current sample was good ($\alpha = 0.86$)

Asthma quality of life questionnaire—The asthma quality of life questionnaire (AQLQ) [39] is a 32-item self-report measure that assesses asthma-related quality of life across four factors: (a) asthma symptoms; (b) activity limitation; (c) emotional function; (d) environmental stimuli. Participants rate each item on a 7-point Likert-type scale (1 = *totally limited, 7 = not limited at all*). The AQLQ has demonstrated good internal consistency and discriminant validity [40]. The AQLQ showed excellent internal consistency in the current sample ($\alpha = 0.97$)

Procedure

Participants were recruited from the community via advertisements placed in public areas, healthcare provider waiting rooms, in local newspapers and on community-oriented websites (e.g. Craigslist). Interested individuals were first screened for eligibility by phone (i.e. age, smoking status, ASQ). Potentially eligible participants were then scheduled for an individual appointment by a trained research assistant. Upon arrival to the study session, participants first provided informed, written consent. Nonsmoking status was then biochemically verified via CO analysis. Eligible participants then completed spirometry to assess lung function and completed the self-report measures described above. Following completion of the study, participants were compensated $25 for their time and effort. The University Institutional Review Board approved all study materials and procedures prior to the collection of data.

Data analytic plan

First, descriptive statistics and zero-order correlations were examined for all study variables. Then, the main effect of distress tolerance for the primary dependent variables (asthma control, asthma quality of life, lung function) was evaluated using a hierarchical multiple regression procedure [41]. Three sets of regressions were conducted: one using the TNASS-Total score as the measure of distress tolerance, one using the TNASS-Fear subscale and one using the TNASS-Anxiety subscale. For each set of regression analyses, separate models were constructed for predicting asthma control (ACT), quality of life (AQLQ) and lung function (FEV_1). In each model, race (coded as 0 = African-American and 1 = Caucasian), age and anxiety sensitivity-physical concerns were entered simultaneously as covariates in step one in order to control for these theoretically relevant factors. Given the conceptual similarity between anxiety sensitivity and distress tolerance as well as research demonstrating that anxiety sensitivity, particularly the physical concerns domain, is associated with poorer asthma outcomes [16–17], anxiety sensitivity-physical concerns was chosen as a covariate on an *a priori* basis to ensure that any significant findings are due to the intolerance of negative affective states rather than the fear of symptoms associated with anxiety. Race and age were chosen as covariates due to their significant associations with lung function, asthma control and asthma-related quality of life. At the second step of the model, the measure of distress tolerance (TNASS-Total, TNASS-Fear or TNASS-Anxiety) was entered. All assumptions for conducting linear regression analyses were met.

Results

Zero-order correlations

Associations between all study variables are presented in Table 1. Race was significantly associated with age, lung function, asthma control and asthma-related quality of life (range: 0.26–0.54). Age was positively associated with anxiety sensitivity-physical concerns ($r = 0.27$, $p < 0.01$), and negatively associated with asthma control ($r = -0.51$, $p < 0.01$) and asthma-related quality of life ($r = -0.53$, $p < 0.01$). Anxiety sensitivity-physical concerns was negatively associated with asthma control ($r = -0.47$, $p < 0.01$) and asthma-related quality of life ($r = -0.54$, $p < 0.01$). The TNASS-Total, Fear and Anxiety scores were positively associated with asthma control (range: 0.26–0.41) and asthma-related quality of

life (range: 0.35–0.42). TNASS-Total and TNASS-Anxiety, but not TNASS-Fear, were also significantly associated with lung function (range: 0.32–0.40).

Regression analyses

Results for the first set of regressions, using the TNASS total score as the measure of distress tolerance, are presented in Table 2. In terms of FEV_1, Step 1 of the model was not significant. Step 2 of the model accounted for 13.8% unique variance, and poorer distress tolerance was a significant predictor of poorer lung function ($\beta = 0.39$, $t = 2.80$, $p < 0.01$). For asthma control, the first step accounted for 42.2% of the variance, and age ($\beta = -0.36$, $t = -2.94$, $p < 0.01$) and anxiety sensitivity-physical concerns ($\beta = -0.35$, $t = -2.86$ $p < 0.01$) were significant predictors at this step. At Step 2, poorer distress tolerance predicted poorer asthma control ($\beta = 0.31$, $t = 2.77$, $p < 0.01$), accounting for 8.8% unique variance. In terms of asthma-related quality of life, step one of the model accounted for 55.8% of the variance, and race ($\beta = 0.35$, $t = 2.92$, $p < 0.01$), age ($\beta = -0.29$ $t = -2.48$, $p < 0.05$), and anxiety sensitivity-physical concerns ($\beta = -0.36$, $t = -3.03$, $p < 0.01$) were all significant predictors. Specifically, those who were Caucasian, younger, and lower in anxiety sensitivity physical concerns reported a better quality of life. Step 2 accounted for 6.7% unique variance, and poorer distress tolerance significantly predicted poorer asthma-related quality of life ($\beta = 0.27$, $t = 2.53$, $p < 0.05$).

Results of the regression analyses using the TNASS-Fear subscale as the measure of distress tolerance are presented in Table 3. In terms of FEV_1, Step 1 of the model was not significant. Step 2 of the model accounted for 8.7% unique variance, and TNASS-Fear was a significant predictor ($\beta = 0.30$, $t = 2.28$, $p < 0.05$). For asthma control, the first step accounted for 41.6% of the variance, and age ($\beta = -0.35$, $t = -3.03$, $p < 0.01$) and anxiety sensitivity-physical concerns ($\beta = -0.34$, $t = -2.97$ $p < 0.01$) were significant predictors. At Step 2, TNASS-Fear was a significant predictor ($\beta = 0.28$, $t = 2.70$, $p < 0.01$), accounting for 7.4% unique variance. In terms of asthma-related quality of life, Step 1 of the model accounted for 56.4% of the variance, and race ($\beta = 0.32$, $t = 2.82$, $p < 0.01$), age ($\beta = -0.31$ $t = -2.74$, $p < 0.01$), and anxiety sensitivity-physical concerns ($\beta = -0.38$, $t = -3.50$, $p < 0.01$) were all significant predictors. Specifically, younger, Caucasian participants with lower levels of anxiety sensitivity physical concerns reported better quality of life. Step 2 accounted for 8.9% unique variance, and TNASS-Fear was a significant predictor ($\beta = 0.30$, $t = 3.23$, $p < 0.01$).

Results of the regression analyses using the TNASS-Anxiety subscale as the measure of distress tolerance are presented in Table 4. In terms of FEV_1, Step 1 of the model was not significant. Step 2 of the model accounted for 10.9% unique variance, and TNASS-Anxiety was a significant predictor ($\beta = 0.33$, $t = 2.55$, $p < 0.01$). For asthma control, the first step accounted for 40.2% of the variance, and age ($\beta = -0.33$, $t = -2.78$, $p < 0.01$) and anxiety sensitivity-physical concerns ($\beta = -0.36$, $t = -3.03$ $p < 0.01$) were significant predictors at this step. At Step 2, TNASS-Anxiety was a significant predictor ($\beta = 0.23$, $t = 2.08$, $p < 0.05$), accounting for 4.9% unique variance. In terms of asthma-related quality of life, Step 1 of the model accounted for 54.7% of the variance, and race ($\beta = 0.30$, $t = 2.58$, $p < 0.01$), age ($\beta = -0.27$ $t = -2.34$, $p < 0.05$), and anxiety sensitivity-physical concerns ($\beta = -0.41$, $t =$

−3.57, $p < 0.01$) were all significant predictors. Specifically, younger, Caucasian participants with lower levels of anxiety sensitivity-physical concerns had better quality of life. Step 2 accounted for 7.9% unique variance, and TNASS-Anxiety was a significant predictor ($\beta = 0.28$, $t = 2.88$, $p < 0.01$).

Discussion

The current study sought to examine the role of the cognitive-based anxiety-related risk factor of distress tolerance in terms of asthma outcomes (i.e. lung function, asthma control and asthma-related quality of life) among adults with asthma recruited from the community. Results indicated that, as hypothesized, lower levels of global distress tolerance, as well as tolerance of fear and anxiety specifically, were significantly predictive of poorer lung function, asthma control and asthma-related quality of life. It should be noted that these effects were above and beyond the variance accounted for by age, race and the physical concerns domain of anxiety sensitivity.

These results suggest that individuals with asthma who believe that they are unable to tolerate emotional distress, particularly distress related to anxiety and fear, have more severe asthma and more functional impairment due to their asthma. It may be that the inability to tolerate the increased anxiety, fear and distress often experienced during asthma exacerbations directly impacts asthma through the effects of such distress on inflammatory processes. Indeed, previous research has found that stress can lead to asthma exacerbations through its effects on proinflammatory cytokines [42,43]. An inability to tolerate distress may also impact asthma outcomes indirectly. Individuals with lower levels of distress tolerance may be less able to tolerate even small increases in anxiety associated with their asthma symptoms, which might result in increased anxiety and fear and likely an increase in asthma symptoms and attempts to decrease them through the use of SABAs.

There are, however, several limitations to the current study that warrant further consideration. First, this study was cross-sectional in nature so no causal inferences can be made. Longitudinal studies are needed to better understand how distress tolerance impacts asthma over time. Second, self-report measures were utilized as the primary assessment methodology for many of the key constructs. The utilization of self-report methods does not fully protect against reporting errors and may be influenced by shared method variance. Thus, future studies could build on the present work by utilizing a multi-method assessment approach to address this concern. For example, objective measures of medication use and inflammation could help further our understanding of these processes. Finally, this study used a relatively small, non-clinical sample. It will be important for future studies to use larger samples to determine whether these findings generalize to clinical populations. Despite these limitations, the results of the current study highlight the importance of distress tolerance in asthma and the potential utility for improving asthma outcomes through targeted interventions to improve distress tolerance, particularly for anxiety and fear.

Conclusions

In conclusion, the present findings suggest that global distress tolerance significantly predicted poorer lung function, asthma control and asthma-related quality of life. Further, the tolerance of anxiety and fear, specifically, also predicted poorer lung function, asthma control and asthma-related quality of life. The primary implication of these findings is the identification of modifiable factors that may be helpful in improving asthma outcomes.

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References

1. Goodwin RD, Pagura J, Cox B, Sareen J. Asthma and mental disorders in Canada: impact on functional impairment and mental health service use. J Psychosom Res 2010;68:165–173. [PubMed: 20105699]
2. Opolski M, Wilson I. Asthma and depression: a pragmatic review of the literature and recommendations for future research. Clin Pract Epidemiol Ment Health 2005;1:18. [PubMed: 16185365]
3. Zielinski TA, Brown ES, Nejtek VA, Khan DA, Moore JJ, Rush AJ. Depression in asthma: prevalence and clinical implications. Prim Care Companion J Clin Psychiatry 2000;2:153–158. [PubMed: 15014636]
4. Lavoie KL, Cartier A, Labrecque M, Bacon SL, Lemière C, Malo J-L, Lacoste G. Are psychiatric disorders associated with worse asthma control and quality of life in asthma patients? Respir Med 2005;99: 1249–1257. [PubMed: 16140225]
5. Goldney RD, Ruffin R, Fisher LJ, Wilson DH. Asthma symptoms associated with depression and lower quality of life: a population survey. Med J Aust 2003; 178:437–441. [PubMed: 12720509]
6. Strine TW, Mokdad AH, Balluz LS, Berry JT, Gonzalez O. Impact of depression and anxiety on quality of life, health behaviors, and asthma control among adults in the United States with asthma, 2006. J Asthma 2008;45:123–133. [PubMed: 18350404]
7. Lavoie KL, Bacon SL, Barone S, Cartier A, Ditto B, Labrecque M. What is worse for asthma control and quality of life: depressive disorders, anxiety disorders, or both? Chest 2006;130:1039–1047. [PubMed: 17035436]
8. Mancuso CA, Peterson MG, Charlson ME. Effects of depressive symptoms on health-related quality of life in asthma patients. J Gen Intern Med 2000;15: 301–310. [PubMed: 10840265]
9. Eisner MD, Katz PP, Lactao G, Iribarren C. Impact of depressive symptoms on adult asthma outcomes. Ann Allergy Asthma Immunol 2005;94:566–574. [PubMed: 15948301]
10. Fernandes L, Fonseca J, Martins S, Delgado L, Costa Pereira A, Vaz M, Branco G, et al. Association of anxiety with asthma: subjective and objective outcome measures. Psychosom J Consult Liaison Psychiatry 2010;51:39–46.
11. Feldman JM, Lehrer PM, Borson S, Hallstrand TS, Siddique MI. Health care use and quality of life among patients with asthma and panic disorder. J Asthma 2005;42:179–184. [PubMed: 15962874]
12. Kullowatz A, Kanniess F, Dahme B, Magnussen H, Ritz T. Association of depression and anxiety with health care use and quality of life in asthma patients. Respir Med 2007;101:638–644. [PubMed: 16891108]
13. McCauley E, Katon W, Russo J, Richardson L, Lozano P. Impact of anxiety and depression on functional impairment in adolescents with asthma. Gen Hosp Psychiatry 2007;29:214–222. [PubMed: 17484938]
14. McNally RJ. Anxiety sensitivity and panic disorder. Biol Psychiatry 2002;52:938–946. [PubMed: 12437935]

15. Reiss S, McNally RJ, Expectancy model of fear In: Reiss S, Bootzin RR, ed. Theoretical issues in behavior therapy. San Diego (CA): Academic Press; 1985: 107–121
16. Avallone KM, Mcleish AC, Luberto CM, Bernstein JA. Anxiety sensitivity, asthma control, and quality of life in adults with asthma. J Asthma 2012;49:57–62. [PubMed: 22176702]
17. McLeish AC, Zvolensky MJ, Luberto CM. The role of anxiety sensitivity in terms of asthma control: a pilot test among young adult asthmatics. J Health Psychol 2011;16:439–444. [PubMed: 20978153]
18. McLeish AC, Luberto CM, O'Bryan EM. Anxiety sensitivity and reactivity to asthma-like sensations among young adults with asthma. Behav Modif 2016; 40:164–177. [PubMed: 26405256]
19. Simons JS, Gaher RM. The distress tolerance scale: development and validation of a self-report measure. Motiv Emot 2005;29:83–102.
20. Zvolensky MJ, Marshall EC, Johnson K, Hogan J, Bernstein A, Bonn-Miller M. Relations between anxiety sensitivity, distress tolerance, and fear reactivity to bodily sensations to coping and conformity marijuana use motives among young adult marijuana users. Exp Clin Psychopharmacol 2009;17:31–42. [PubMed: 19186932]
21. Mitchell MA, Riccardi CJ, Keough ME, Timpano KR, Schmidt NB. Understanding the associations among anxiety sensitivity, distress tolerance, and discomfort intolerance: a comparison of three models. J Anxiety Disord 2013;27:147–154. [PubMed: 23376602]
22. Allan NP, Macatee RJ, Norr AM, Raines AM, Schmidt NB. Relations between common and specific factors of anxiety sensitivity and distress tolerance and fear, distress, and alcohol and substance use disorders. J Anxiety Disord 2015;33:81–89. [PubMed: 26037492]
23. Cougle JR, Timpano KR, Goetz AR. Exploring the unique and interactive roles of distress tolerance and negative urgency in obsessions. Pers Individ Dif 2012; 52:515–520.
24. Cougle JR, Timpano KR, Fitch KE, Hawkins KA. Distress tolerance and obsessions: an integrative analysis. Depress Anxiety (1091–4269) 2011;28:906–914. [PubMed: 21681873]
25. Huang K, Szabó M, Han J. The relationship of low distress tolerance to excessive worrying and cognitive avoidance. Behav Change 2009;26:223–234.
26. Laposa JM, Collimore KC, Hawley LL, Rector NA. Distress tolerance in OCD and anxiety disorders, and its relationship with anxiety sensitivity and intolerance of uncertainty. J Anxiety Disord 2015;33:8–14. [PubMed: 25956557]
27. Keough ME, Riccardi CJ, Timpano KR, Mitchell MA, Schmidt NB. Anxiety symptomatology: the association with distress tolerance and anxiety sensitivity. Behavior Therapy 2010;41:567–574. [PubMed: 21035619]
28. Kertz SJ, Stevens KT, McHugh RK, Björgvinsson T. Distress intolerance and worry: the mediating role of cognitive variables. Anxiety Stress Coping Int J 2015; 28:408–424.
29. Marshall EC, Zvolensky MJ, Vujanovic AA, Gregor K, Gibson LE, Leyro TM. Panic reactivity to voluntary hyperventilation challenge predicts distress tolerance to bodily sensations among daily cigarette smokers. Exp Clin Psychopharmacol 2008;16:313–321. [PubMed: 18729685]
30. Norr AM, Oglesby ME, Capron DW, Raines AM, Korte KJ, Schmidt NB. Evaluating the unique contribution of intolerance of uncertainty relative to other cognitive vulnerability factors in anxiety psychopathology. J Affect Disord 2013;151:136–142. [PubMed: 23778202]
31. Perkins KA, Karelitz JL, Jao NC. Optimal carbon monoxide criteria to confirm 24-hr smoking abstinence. Nicotine Tob Res 2013;15:978–982. [PubMed: 22990219]
32. Shin B, Cole SL, Park S, Ledford DK, Lockey RF. A new symptom-based questionnaire for predicting the presence of asthma. J Investig Allergol Clin Immunol 2010;20:27.
33. Brown RA, Lejuez CW, Kahler CW, Strong DR. Distress tolerance and duration of past smoking cessation attempts. J Abnorm Psychol 2002;111:180–185. [PubMed: 11866171]
34. Brown RA, Lejuez CW, Kahler CW, Strong DR, Zvolensky MJ. Distress tolerance and early smoking lapse. Clin Psychol Rev 2005;25:713–733. [PubMed: 16023275]
35. McLeish AC, Zvolensky MJ. Asthma and cigarette smoking: a review of the empirical literature. J Asthma 2010;47:345 [PubMed: 20528586]

36. Nathan RA, Sorkness CA, Kosinski M, Schatz M, Li JT, Marcus P, Murray JJ, Pendergraft TB. Development of the asthma control test: a survey for assessing asthma control. J Allergy Clin Immunol 2004;113:59–65. [PubMed: 14713908]

37. Taylor S, Zvolensky MJ, Cox BJ, Deacon B, Heimberg RG, Ledley DR, Abramowitz JS, et al. Robust dimensions of anxiety sensitivity: development and initial validation of the Anxiety Sensitivity Index-3. Psychol Assess 2007;19:176–188. [PubMed: 17563199]

38. Bernstein A, Brantz H. Tolerance of Negative Affective States (TNAS): development and evaluation of a novel construct and measure. Cognit Ther Res 2013;37:421–433.

39. Juniper EF, Guyatt GH, Epstein RS, Ferrie PJ, Jaeschke R, Hiller TK. Evaluation of impairment of health-related quality of life in asthma: development of a questionnaire for use in clinical trials. Thorax 1992;47:76–83. [PubMed: 1549827]

40. Juniper EF, Guyatt GH, Ferrie PJ, Griffith LE. Measuring quality of life in asthma. Am Rev Respir Dis 1993;147:832 [PubMed: 8466117]

41. Cohen J, Applied multiple regression/correlation analysis for the behavioral sciences. 3rd ed. Mahwah (NJ): L. Erlbaum Associates; 2003.

42. Glaser R Stress-associated immune dysregulation and its importance for human health: a personal history of psychoneuroimmunology. Brain Behav Immun 2005;19:3–11. [PubMed: 15581732]

43. Tsigos C, Chrousos GP. Hypothalamic– pituitary–adrenal axis, neuroendocrine factors and stress. J Psychosom Res 2002;53:865–871. [PubMed: 12377295]

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Table 1.

Descriptive statistics and zero-order correlations among all study variables.

	1	2	3	4	5	6	7	8	9	*M*	*SD*	Observed range
1. Race	–	−0.29*	−0.24	0.20	0.11	0.11	0.26*	0.35**	0.54**	–	–	–
2. Age	–	–	0.27*	−0.25	−0.14	−0.17	−0.16	−0.51**	−0.53**	34.72	13.58	18–65
3. ASI-PC	–	–	–	−0.11	−0.14	−0.06	0.01	−0.47**	−0.54**	20.43	7.47	10–44
4. TNASS-Total	–	–	–	–	0.86**	0.86**	0.40**	0.41**	0.42**	61.26	17.47	22–105
5. TNASS-Fear	–	–	–	–	–	0.77**	0.23	0.28*	0.41**	11.30	3.23	4–18
6. TNASS-Anxiety	–	–	–	–	–	–	0.32*	0.26*	0.35*	11.62	3.54	4–19
7. FEV_1	–	–	–	–	–	–	–	0.36**	0.25	84.44	20.63	43–131
8. ACT	–	–	–	–	–	–	–	–	0.85**	15.98	4.54	6–25
9. AQLQ	–	–	–	–	–	–	–	–	–	4.49	1.30	1.28–6.97

* $p < 0.05$.

** $p < 0.01$.

Note. Race: 0 = African-American, 1 = Caucasian; ASI-PC: Anxiety Sensitivity Index-3- Physical Concerns subscale [37]; TNASS-Total: Tolerance of Affective States Scale Total Score [38]; TNASS-Fear: Tolerance of Negative Affective States Scale Fear-Distress Subscale [38]; TNASS Anxiety: Tolerance of Negative Affective States Scale-Anxious Apprehension Subscale [38]; FEV_1: Forced expiratory volum in one second; ACT: Asthma Control Test [36]; AQLQ: Asthma Quality of Life Questionnaire [39].

Table 2.

TNASS-Total Predicting asthma outcomes.

	ΔR^2	*t*	β	sr^2	*p*
Criterion variable: FEV_1					
Step 1	0.11				0.18
Race		2.06	0.31	0.09	0.05*
Age		−0.58	−0.09	0.01	0.57
ASI-PC		0.95	0.14	0.02	0.35
Step 2	0.14				0.01**
TNASS-Total		2.80	0.39	0.14	0.01**
Criterion variable: asthma control					
Step 1	0.42				0.00**
Race		1.63	0.20	0.03	0.11
Age		−2.94	−0.36	0.11	0.01**
ASI-PC		−2.86	−0.35	0.11	0.01**
Step 2	0.09				0.01**
TNASS-Total		2.77	0.31	0.09	0.01**
Criterion variable: asthma-related quality of life					
Step 1	0.56				0.00**
Race		2.92	0.35	0.10	0.01**
Age		−2.48	−0.29	0.07	0.02*
ASI-PC		−3.03	−0.36	0.11	0.00**
Step 2	0.07				0.02*
TNASS-Total		2.53	0.27	0.07	0.02*

*$p < 0.05$.

**$p < 0.01$.

Note. β = standardized beta weight; sr^2 = squared semi-partial correlation.

Table 3.

TNASS-Fear Predicting asthma outcomes.

	ΔR^2	*t*	β	sr^2	*p*
Criterion variable: FEV_1					
Step 1	0.08				0.25
Race		1.91	0.27	0.07	0.06
Age		−0.32	−0.05	0.00	0.75
ASI-PC		0.57	0.08	0.01	0.57
Step 2	0.09				0.03 *
TNASS-Fear		2.28	0.30	0.09	0.03 *
Criterion variable: asthma control					
Step 1	0.42				0.00 **
Race		1.84	0.21	0.04	0.07
Age		−3.03	−0.35	0.10	0.00 **
ASI-PC		−2.97	−0.34	0.10	0.01 **
Step 2	0.07				0.01 **
TNASS-Fear		2.70	0.28	0.07	0.01 **
Criterion variable: asthma-related quality of life					
Step 1	0.56				0.00 **
Race		2.82	0.32	0.02	0.01 **
Age		−2.74	−0.31	0.08	0.01 **
ASI-PC		−3.50	−0.38	0.13	0.00 **
Step 2	0.09				.00 **
TNASS-Fear		3.23	0.30	0.09	0.00 **

* $p < 0.05$.

** $p < 0.01$.

Note. β = standardized beta weight; sr^2 = squared semi-partial correlation.

Table 4.

TNASS-Anxiety predicting asthma outcomes.

	ΔR^2	*t*	β	sr^2	*p*
Criterion variable: FEV_1					
Step 1	0.09				0.19
Race		2.03	0.29	0.09	0.05 *
Age		−0.53	−0.08	0.01	0.60
ASI-PC		0.69	0.10	0.01	0.50
Step 2	0.11				0.01 *
TNASS-Anxiety		2.55	0.33	0.11	0.01 *
Criterion variable: asthma control					
Step 1	0.40				0.00 **
Race		1.58	0.18	0.03	0.12
Age		−2.78	−0.33	0.09	0.01 **
ASI-PC		−3.03	−0.36	0.11	0.00 **
Step 2	.05				0.04 *
TNASS-Anxiety		2.08	0.23	0.05	0.04 *
Criterion variable: asthma-related quality of life					
Step 1	0.55				0.00 **
Race		2.58	0.30	0.08	0.00 **
Age		−2.34	−0.27	0.06	0.02 *
ASI-PC		−3.57	−0.41	0.14	0.00 **
Step 2	0.08				0.01 **
TNASS-Anxiety		2.88	0.28	0.08	0.01 **

* $p < 0.05$.

** $p < 0.01$.

Note. β = standardized beta weight; sr^2 = squared semi-partial correlation.