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Self-management behaviors in World Trade Center rescue and recovery workers with asthma

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Abstract

Background: Asthma is a major source of morbidity among World Trade Center (WTC) rescue and recovery workers. While physical and mental health comorbidities have been associated with poor asthma control, the potential role and determinants of adherence to self-management behaviors (SMB) among WTC rescue and recovery workers is unknown.

Objectives: To identify modifiable determinants of adherence to asthma self-management behaviors in WTC rescue and recovery worker that could be potential targets for future interventions.

Methods: We enrolled a cohort of 381 WTC rescue and recovery workers with asthma. Sociodemographic data and asthma history were collected during in-person interviews. Based on the framework of the Model of Self-regulation, we measured beliefs about asthma and controller

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Notes on contributor

Dr. Wisnivesky had full access to the data in the study and takes responsibility for the integrity and accuracy of the data analysis. Dr. Wisnivesky contributed to the study design, data analysis and interpretation, manuscript writing, and manuscript submission and revisions. Dr. Rojano, West, and Goodman contributed substantially to data analysis and interpretation, and the writing of the manuscript. Dr. Weiss, Dr. de la Hoz, Dr. Crane, Dr. Crowley, Dr. Harrison, and Dr. Markowitz contributed to the study design, recruitment of participants, review of literature, and critical revision of the article.

Conflicts of interest

Dr. Wisnivesky is a member of the Research Board of EHE International, has received consultant honorarium from Merck, Astra Zeneca, and Quintiles, and research grants from Sanofi and Quorum. Other authors have no conflict of interest to report.

medications. Outcomes included medication adherence, inhaler technique, use of action plans, and trigger avoidance.

Results: Medication adherence, adequate inhaler technique, use of action plans, and trigger avoidance were reported by 44%, 78%, 83%, and 47% of participants, respectively. Adjusted analyses showed that WTC rescue and recovery workers who believe that they had asthma all the time (odds ratio [OR]: 2.37; 95% confidence interval [CI]: 1.38–4.08), that WTC-related asthma is more severe (OR: 1.73; 95% CI: 1.02–2.93), that medications are important (OR: 12.76; 95% CI: 5.51–29.53), and that present health depends on medications (OR: 2.39; 95% CI: 1.39–4.13) were more likely to be adherent to their asthma medications. Illness beliefs were also associated with higher adherence to other SMB.

Conclusions: Low adherence to SMB likely contributes to uncontrolled asthma in WTC rescue and recovery workers. Specific modifiable beliefs about asthma chronicity, the importance of controller medications, and the severity of WTC-related asthma are independent predictors of SMB in this population. Cognitive behavioral interventions targeting these beliefs may improve asthma self-management and outcomes in WTC rescue and recovery workers.

Capsule summary:

Improving World Trade Center-related asthma outcomes will require multifactorial approaches such as supporting adherence to controller medications and other self-management behaviors. This study identified several modifiable beliefs that may be the target of future efforts to support self-management in this patient population.

Keywords

Medication adherence; WTC-related asthma; specific modifiable beliefs; beliefs about medications questionnaire; model of self-regulation; trigger avoidance

Background

It is estimated that >50,000 rescue, recovery workers, and volunteers were involved in the recovery effort following the attack on the World Trade Center (WTC) [1]. While many physical and mental health conditions have been identified, pulmonary diseases are among the most prevalent problems in WTC rescue and recovery workers. Asthma, in particular, commonly affects WTC rescue and recovery workers, with a cumulative incidence of nearly 30% 9-years after the attack [2]. Asthma also remains a major source of morbidity and reduced quality of life in WTC-exposed populations [2]. Ten years after the attacks, more than two-thirds of WTC Health Registry enrollees with asthma reported uncontrolled symptoms [3]. Multiple factors likely contribute to asthma morbidity in WTC-exposed individuals including mental health conditions such as post-traumatic stress disorder (PTSD) and physical conditions such as gastroesophageal reflux, obstructive sleep apnea, and chronic sinusitis [2, 4].

International guidelines highlight the importance of self-management behaviors (SMB) as critical determinants of asthma control [5]. Asthma self-management encompasses several complex behaviors, such as adherence to medication, correct inhaler technique, use of action

plans, and trigger avoidance. Unfortunately, studies show that up to 50% of patients with asthma in the general population do not adhere to their SMB [6, 7]. Thus, low adherence to SMB may also be an unidentified contributor to asthma morbidity in WTC rescue and recovery workers. While research in patients with asthma in the general population has established the role of illness and medication beliefs as strong determinants of SMB [8, 9], less is known about the factors influencing self-management in WTC rescue and recovery workers. WTC rescue and recovery workers may hold different beliefs about asthma etiology, timeline, and likelihood of control due to the unique relationship with WTC exposure. Thus, a better understanding of the factors influencing adherence to SMB in this population is needed to maximize asthma control.

In this study, we assessed SMB in a prospective cohort of WTC rescue and recovery workers with asthma. We used the theoretical framework of the Model of Self-regulation (SRM) [10] to identify potentially modifiable beliefs associated with adherence to asthma SMB that could be the target of future interventions.

Methods

Study population

Between December 2012 and July 2016, we collected data from WTC rescue and recovery workers with asthma who were enrolled in the Mount Sinai Hospital, North-well Health System, or New York University WTC Health Programs (WTCHP). This program includes people who volunteered or worked in the lower Manhattan, barge-loading piers or Staten Island landfill for >4 h from 9/11 to September 14, 2001, >24 h during September 2001, or >80 h from September 2001 to December 2001. Also were eligible workers from the Port Authority Trans Hudson Corporation and personnel of the Office of the Chief Medical Examiner [11, 12]. Lower Manhattan residents, schoolchildren, building occupants, and passers-by were not included in this registry. Members of the Fire Department of the City of New York are followed in a parallel program.

Inclusion criteria in the current study were age ≥18 years, diagnosis of asthma made by a health-care provider, and being English or Spanish speaker. We excluded WTC rescue and recovery workers with a prior diagnosis of chronic obstructive lung disease (COPD) or other chronic respiratory illnesses. Additionally, due to the possibility of undiagnosed COPD, asthma patients were excluded if they had history of >15 pack-years of smoking.

Study variables

Following informed consent, participants completed a standardized in person interview. We collected sociodemographic information and data regarding asthma history including onset in relation to 9/11 exposure, medication regimen, chronic use of oral steroids, and resource utilization. We used the Asthma Control Questionnaire to assess level of asthma control [13]. Sensitization to indoor and outdoor allergens was assessed using serum immunoglobulin E levels. Using criteria established in previous studies, participants were assigned to four different groups of WTC exposure: low, intermediate, high, and very high

based on the total amount of time spent at the WTC site, the level of the exposure to the WTC cloud, and work on the pile (Table 1) [2].

Disease and medication beliefs

The underpinnings of our study to understand the potential contribution of illness and medications beliefs to asthma SMB are based on Leventhal's SRM model. The fundamental premise of the model is that patients develop a common-sense mental model for solving health problems [10]. These mental models consist of cognitive representations and emotional meanings of asthma that activate SMB. The outcomes of these actions are then appraised for efficacy (reducing asthma symptoms) and these feedback loops in turn can reinforce or modify self-management actions. The SRM posits that there are five domains of cognitive illness representations: (1) identity refers to the labels that patients have for their asthma symptoms; (2) cause refers to the patient's understanding of the etiology of asthma and its triggers; (3) timeline relates to beliefs about the condition's chronicity; (4) consequences are the real and perceived impact of the symptoms and illness; and (5) the control domain encompasses beliefs that asthma can be controlled. The SRM hypothesizes that WTC rescue and recovery workers that correctly attribute asthma symptoms and that believe that asthma is a chronic condition associated with potentially severe complications that can be controlled with daily medications are more likely to be adherent to SMB. Conversely, a dysfunctional acute mental model "no symptoms, no asthma" (asthma is only present during symptomatic periods) has been associated with low adherence [9]. Similarly, emotional responses to asthma (e.g., worries, sadness, anxiety, etc.) may also influence SBM, which may be especially important WTC rescue and recovery workers due to the relative high prevalence of mental health conditions.

The SRM also proposes that asthma patients hold beliefs about the necessity of controller medications as well about concerns regarding potential side effects [14, 15]. WTC rescue and recovery [14] workers weigh the potential benefits vs. concerns about asthma medications and the balance of these factors may determine their adherence to controller medication.

We used the Brief Illness Perception Questionnaire to assess asthma beliefs in WTC rescue and recovery workers [16, 17]. This is a validated scale available in English and Spanish that includes items assessing beliefs along the five domains of the SRM as well as emotional responses to asthma [16]. WTC rescue and recovery workers are likely to hold other illness beliefs given the unique nature of their asthma in relationship with WTC exposures. Thus, we included additional items assessing whether WTC rescue and recovery workers misattributed symptoms of asthma to other WTC-related comorbidities (labels), whether they attributed their asthma to WTC exposure or lack of respiratory protection during WTC work (cause), believe that WTC-associated asthma has a different chronicity (timeline) or may be more difficult to control with medications (controllability). We also included an item assessing whether participants believed that doctors have less knowledge about how to treat WTC-related asthma.

We used the Beliefs about Medications Questionnaire (BMQ) to measure asthma medication beliefs along two domains: necessity and concerns [18, 19]. The BMQ has been validated in

English and Spanish and shown to have adequate psychometric properties. Finally, we included an item assessing the belief that inhaled corticosteroids may not work in WTC-related asthma and an item assessing participant's confidence (self-efficacy) controlling their asthma.

Outcomes

We assessed adherence to several SMB recommended by current asthma management guidelines [20]. Adherence to asthma controller medications is considered the cornerstone of asthma management and a major determinant of disease control. We used the Medication Adherence Rating Scale (MARS) [18, 21] to assess self-reported adherence to asthma controller medications. The MARS is a 10-item tool that has good psychometric properties. It has been validated in English and Spanish, is worded specifically to avoid social desirability bias [14], and correlates strongly with objective measurements of daily use of asthma controller medications [14, 22]. Consistent with prior research, WTC rescue and recovery workers with a score of ≥4.5 were considered adherent [14].

Asthma controller medications are typically delivered via a metered dose inhaler (MDI) or a dry powder inhaler (DPI) device. Effective drug deliver requires that patients correctly perform several steps prior to and during actuation of these devices. Then, participants were asked to demonstrate use of the MDI or DPI during the interview; inhaler technique was assessed using validated scales (participants correctly performing >75% of steps were coded as having a good technique) [23].

We collected data on the use of asthma action plans with items from prior studies [8, 24]. Avoidance of triggers is also important for attaining good asthma control. Thus, we used validated questions from the National Asthma Survey [25] to collect data about trigger avoidance behaviors including: use of pillow and mattress covers, washing sheets in hot water, keeping windows closed, and using an air conditioner during the allergy season, smoking avoidance, avoiding house pets, removal of carpets, curtains and drapes, and elimination of cockroaches. WTC rescue and recovery workers who reported performing ≥5 of these behaviors were classified as adherent [26].

Statistical analysis

Means, standard deviations, and frequencies were used to report the baseline characteristics of study participants. The proportion of WTC rescue and recovery workers that were classified as adherent to each SMB were reported with 95% confidence intervals (CI) based on the binomial distribution.

Differences in illness and medication beliefs among WTC rescue and recovery workers with vs. without adherence to each asthma SMB was assessed using a chis-quare test. Multiple logistic regression was used to assess the adjusted association between illness and medication beliefs and each SMB after controlling for age, sex, race, income, education, intubation history, and chronic oral steroid use. Associations were estimated using odds ratios (OR) with 95% CIs. All statistical tests were performed with SAS 9.3 statistical software (SAS Institute Inc., Cary, North Carolina) using two-tailed tests and a 0.05 significance level. The study was approved by the Institutional Review Boards of the Icahn

School of Medicine at Mount Sinai, Queens College and New York University School of Medicine.

Results

Between December 2012 and July 2016, we contacted 2,101 potentially eligible WTC rescue and recovery workers. Of these, 1,037 declined, 694 were deemed ineligible for participation, and 403 agreed to participate in the study. Of these, 19 were found to be ineligible after enrollment and 3 did not complete the baseline interview. Thus, our final cohort included 381 WTC rescue and recovery workers with asthma.

The mean (SD) age of participants at the time of enrollment in this study was 52.4 (8.9), 71% were male, 35% white, 14% Black, and 43% Hispanic (Table 2). Most WTC rescue and recovery workers (73%) reported onset of disease after 9/11, and 15% and 4% had a history of emergency room visit or hospitalization due to asthma in the prior year, respectively. The proportion of WTC rescue and recovery workers with well-controlled, uncontrolled, and very poorly controlled asthma was 27%, 26%, and 48%, respectively. Overall, 66% were prescribed a controller medication.

Adherence to asthma controller medications was 44% (95% confidence interval [CI]: 38%–50%). Most participants (77%, 95% CI: 71%–81% and 85%, 95% CI: 73%–93%) showed a correct MDI and DPI technique, respectively. Overall, 29% of participants reported having received an action plan from their health care provider, 83% (95% CI: 75%–89%) of them use the action plans to manage their asthma. Only, 47% (95% CI: 42%–52%) were adherent to trigger avoidance behaviors, adherence was 27% vs. 21% among participants with and without allergy sensitization, respectively ($p = 0.92$).

Unadjusted associations between illness and medication beliefs and adherence to asthma SMB

The prevalence of illness and medication beliefs among study participants are reported in Table 3. Unadjusted analyses showed that WTC rescue and recovery workers that believe that they have asthma all the time, not just when experiencing symptoms had higher odds of being adherent to asthma controller medications (odds ratio [OR]: 2.20; 95% CI: 1.36–3.57). Similarly, WTC rescue and recovery workers who believe that medications were important when not having symptoms (OR: 10.93; 95% CI: 4.97–24.1), who reported feeling the effects of inhaled corticosteroids (OR: 1.87; 95% CI: 1.10–3.16) or who believed that their present health depends on medicine (OR: 2.04; 95% CI: 1.23–3.37) were more likely to be adherent to their controller medication. Conversely, WTC rescue and recovery workers who held the belief that they only need short acting medications for treating their asthma were less likely to be adherent to their controller treatment (OR: 0.48; 95% CI: 0.29–0.78). None of the WTC-specific illness beliefs was associated with medication adherence.

WTC rescue and recovery workers who were confident in their ability to control their asthma were more likely to demonstrate a correct MDI technique (OR: 2.65; 95% CI: 1.37–5.14); none of the beliefs were significantly associated with DPI technique. WTC rescue and recovery workers that believe that medications are needed to maintain their present health

(OR: 3.51, 95% CI: 1.05–11.76) were significantly more likely to use their asthma action plans. Finally, beliefs associated with higher adherence to trigger avoidance included properly identifying wheezing as being related to asthma (OR: 2.07, 95% CI: 1.14–3.75) and reporting that asthma was due to WTC exposure (OR: 3.27, 95% CI: 1.05–10.12). Additionally, WTC rescue and recovery workers that believe that asthma affected their life (OR: 1.65, 95% CI: 1.08–2.51), who were highly concerned about their asthma (OR: 1.63, 95% CI: 1.07–2.49), that reported increased emotional responses to asthma (OR: 1.94, 95% CI: 1.24–3.03), or were worried about corticosteroids weakening their immunity (OR: 1.57, 95% CI: 1.01–2.44) were more likely to be adherent to trigger avoidance behaviors.

Adjusted associations between beliefs and asthma SMB

Adjusted analyses controlling for baseline sociodemographic characteristics and asthma history (Table 4) showed that WTC rescue and recovery workers who believe that they had asthma all the time, and not only when they were having symptoms (OR: 2.37; 95% CI: 1.38–4.08), WTC-related asthma is more severe (OR: 1.73; 95% CI: 1.02–2.93), asthma medications are important even when not having symptoms (OR: 12.76; 95% CI: 5.51–29.53), their present health depends on their asthma medicine (OR: 2.39; 95% CI: 1.39–4.13) and who feel the effects of inhaled corticosteroids (OR: 1.93; 95% CI: 1.08–3.43) were more adherent to their controller medications. Similarly, WTC rescue and recovery workers who were more confident in their ability to control their asthma (OR: 2.1; 95% CI: 1.01–4.16) were more likely to have an adequate MDI technique in adjusted analyses; there were no beliefs significantly associated with DPI technique. WTC rescue and recovery workers who believe that they have asthma all the time (OR: 4.33; 95% CI: 1.08–17.28) were significantly more likely to use actions plans. Conversely, those who held the belief that they only need short acting medication for treating their asthma were less likely to be adherent to their controller treatment (OR: 0.45; 95% CI: 0.26–0.77). Finally, WTC rescue and recovery workers were more likely to be adherent to trigger avoidance if they believe that their asthma was due to WTC exposure (OR: 3.89; 95% CI: 1.11–13.5), that asthma affects their life (OR: 1.78, 95% CI: 1.09–2.93), or had strong emotional responses to asthma symptoms (OR: 1.94, 95% CI: 1.12–3.36).

Discussion

Asthma is one the most common chronic conditions affecting WTC rescue and recovery workers [2]. As in prior studies of WTC-exposed populations, most of patients in our cohort had poorly controlled disease and relatively high rates of acute asthma-related resource utilization [2, 3, 27]. Importantly, we found that a considerable proportion of these patients had low adherence to controller medications and other asthma SMB. We identified several modifiable illness and medication beliefs that were associated with non-adherence to asthma self-management which may be the target of behavioral and/or educational interventions. These results suggest that efforts to better self-management may lead to improved asthma outcomes of WTC rescue and recovery workers.

Improving control among WTC rescue and recovery workers with asthma is a major priority given the high burden of disease experienced by this population [2, 3]. Addressing physical

and mental health comorbidities, PTSD in particular, may lead to better asthma outcomes. However, adequate asthma control also requires good adherence to SMB and issue that has not been well studied in WTC asthma populations. Adherence to daily controller medications is one of the most important components of asthma self-management. A clinical trial in adults with uncontrolled asthma demonstrated that adherence to a combination of an inhaled corticosteroid and a long-acting bronchodilator resulted in the virtual elimination of exacerbations and near-normal quality of life in most patients [28]. Consistent with studies in the general population, we found relatively high rates of non-adherence to SMB among WTC patients with asthma suggesting potential targets for management efforts [9, 22, 29, 30].

Previous studies have found that patients' attitudes and adherence to recommended treatments are linked to their understanding of and beliefs about their illness and its treatment [31–33]. A study of patients hospitalized due to an asthma exacerbation and prospectively followed for 6 months post discharge showed that the belief that asthma was present only when experiencing symptoms were significantly less likely to lower adherence to controller medications [9]. Concerns about addiction to and potential side effects related to chronic use of inhaled corticosteroids has been also associated with decreased adherence in patients with asthma and COPD [34]. Our findings suggest that the acute mental model of asthma (the no symptoms, no asthma belief) is also associated with decreased adherence to controller medications among WTC rescue and recovery workers with asthma. Similarly, the belief that controller medications were important during asymptomatic periods was also related to improved adherence. Interestingly, almost 50% patients agreed to the statement that WTC-related asthma was more severe and those holding this belief were more likely to be adherent to controller medications.

Identifying non-adherence among WTC rescue and recovery workers with uncontrolled asthma is important to avoid unnecessary step up controller medications. However, asthma patients tend to over report their level of adherence due to social desirability bias and health care professionals are relatively inaccurate identifying non-adherence [34, 35]. Electronic monitoring devices can provide objective measure of adherence and detailed information about medication patterns; however, they are costly and impractical for clinical settings [34, 36]. Routine used of self-reported tools like the MARS may be useful for systematically identifying WTC rescue and recovery workers with low adherence, particularly among those with persistent symptoms despite medium or high doses of controller medications. Similarly, health care providers may use some of the beliefs associated with non-adherence in this study to identify patients at higher risk of non-adherence offering an opportunity to simultaneously address misconceptions about asthma or its treatment.

Drug studies have demonstrated that the effectiveness of asthma therapy is highly dependent on inhaler technique [37, 38]. Unfortunately, inadequate use of inhaler devices for asthma is common among asthma patients, leading to decreased drug delivery and worse asthma control [37–42]. While we found that the majority of WTC rescue and recovery workers with asthma had good MDI and/or DPI technique, delivery of inhaled medications may be suboptimal in up to 25% of patients, potentially contributing to poor asthma control. Several studies have shown that choice of inhaler device, improved inhaler designs, and use of

spacers have the potential to facilitate use, increase adherence, and drug delivery, leading to a better control of asthma [43, 44]. Brief training interventions based on standardized checklists have also shown to improve inhaler technique and asthma outcomes [45]. Thus, periodic assessment by direct observation of inhaler technique and ensuring adequate skills in WTC rescue and recovery workers with asthma may be important [46].

Avoidance of environmental triggers is a key SMB that could contribute to improved control in >50% of WTC rescue and recovery workers with asthma that are sensitized to indoor or outdoor allergens. The effectiveness of home-based environmental and multi-trigger interventions in reducing asthma morbidity is now well-established [47–49]. This approach has been effective at reducing the presence of asthma triggers, improvements in self-management outcomes, and reductions in asthma morbidity, improving also the adherence to other SMB such as use of medications and asthma action plans [50–52]. Consistent with previous studies, our results also showed that many WTC rescue and recovery workers did not consistently practiced SMB that decrease exposure to aeroallergens and identified several beliefs that may underlie their behaviors.

There is consistent evidence that educational and/or behavioral interventions can lead to better asthma control [53–55]. A Cochrane systematic review including 36 trials which compared self-management education with usual care showed that educational interventions led to reduced asthma-related emergency rooms visits and hospitalizations due to asthma, lower number of unscheduled physician visits, and improved asthma-related quality of life, and nocturnal symptoms of asthma [56]. The SRM has been used to as the theoretical framework to develop successful self-management interventions in patients with chronic disease [10]. Thus, targeting misbeliefs held by WTC rescue and recovery workers with asthma may help achieving improved rates of control in this population.

The study has several strengths and limitations that are worth discussing. Despite enrolling a relatively large cohort of WTC rescue and recovery workers with asthma, we included only rescue and recovery workers participating in the WTCHP. Thus, our sample did not represent other populations exposed to the WTC disaster such as firefighters, local residents, schoolchildren, and passer-by and consequently, our results cannot be generalized to these individuals, many of whom are also affected by asthma. Adherence to asthma controller medications and other SMB were assessed by self-report and thus, could be subject to bias. However, many WTC patients with asthma reported low adherence rates and we used previously validated instruments that are word in a way to avoid social desirability bias [14]. Additionally, physicians must rely on self-report information when making asthma treatment decisions in routine practice. Some of the trigger avoidance behaviors assessed in our study would only apply to WTC rescue and recovery workers who are sensitized to specific allergens. Additionally, health care providers may not discuss these behaviors with all their patients. Thus, our study may have overestimated the extent of non-adherence to trigger avoidance among WTC rescue and recovery workers. We observed high rates of adherence among 29% of the WTC rescue and recovery workers who were offered an asthma action plan by their provider. It is possible that health care providers differentially discussed actions plans with WTC rescue and recovery workers that were more engaged with their care, potentially explaining the high rates of reported adherence in the study. Our cross-sectional

design does not allow us to make conclusions regarding a causal association between beliefs and asthma SBM. However, we used a well-established theoretical framework to guide our assessments of the relationship between beliefs and behaviors which will help translating our results into actionable components of future interventions.

Our study did not include a control group of non-WTC exposed asthmatics. WTC rescue and recovery workers are a special asthma population given the relationship with WTC exposures, specific occupational exposures prior and after 9/11, selection of healthy workers (prior to 9/11) into the cohort, and high prevalence of physical and mental health comorbidities. Thus, it is very difficult to find an appropriate control group to perform valid comparisons of asthma beliefs and SMB. While a lack of a control group did not allow us to make side by side comparisons, a review of the literature shows that similarly to our findings in WTC rescue and recovery workers, beliefs that asthma is a chronic disease, that medications are needed even when free of asthma symptoms (“necessity”), and lack of concerns about medication side effects are also associated with higher adherence to SMB among inner-city patients with asthma [9, 22, 24, 57]. However, our study showed a relationship between adherence to SMB and emotional responses as well as disease consequences that were not described in the previous studies [22, 57, 58].

Conclusions

In summary, we found that many WTC rescue and recovery with asthma have low adherence to important SMB, a factor that may explain some of the increased rates of morbidity in this population. Our findings help elucidate some of the potential mechanisms leading to low adherence to effective asthma self-management in this population and offers potential targets for future interventions.

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Abbreviations

WTC	World Trade Center
SMB	Self-management behaviors
OR	Odds ratio
CI	Confidence interval
PTSD	Post-traumatic stress disorder
SRM	Self-regulation Model
WTCHP	WTC Health Programs
COPD	Chronic obstructive pulmonary disease

MARS	Medication Adherence Rating Scale
MDI	Metered dose inhaler
DPI	Dry powder inhaler

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Key message:

This study identified modifiable beliefs associated with low adherence to self-management behaviors among World Trade Center rescue and recovery rescue and recovery workers with asthma which could be the target for future interventions.

Table 1.

Definitions of exposure levels among World Trade Center Workers.

Group	Definition
Low	Exposed for less than 40 days, not exposed to the cloud and did not work on the pile
Intermediate	Not exposed to the initial cloud, worked between 40 and 90 days or did not work on the pile
High	Exposed to the dust cloud but either worked less than 90 days or did not work on the pile
Very high	Worked more than 90 days, exposed to the dust cloud, and worked in the pile

Table 2.

Baseline characteristics of World Trade Center rescue and recovery workers with asthma enrolled in the study.

Characteristic	Value
Age, years, mean (SD)	53 (8)
<45	54 (14)
45–60	260 (69)
>60	64 (17)
Male, No. (%)	264 (70)
Race/Ethnicity, No. (%)	
White	131 (35)
Black	53 (14)
Hispanic	157 (42)
Other/refused	40 (9)
Married or living with a partner, No. (%)	233 (62)
English as Primary Language, No. (%)	281 (77)
Education, No. (%)	
Did not graduate high school	38 (10)
High School or GED	64 (17)
Some college	149 (39)
College graduate or higher degree	128 (34)
Monthly income, No. (%)	
<$3,000	206 (54)
>$3,000	146 (39)
Refused/Unknown	29 (7)
Occupation no. (%)	
Employed full time	157 (42)
Employed part time	38 (10)
Unemployed	22 (6)
On disability	47 (12)
Retired	79 (21)
Not working	19 (5)
Student/Other	19 (5)
Smoking status no. (%)	
Current/former smoker	112 (31)
Never smoked	253 (69)
WTC exposure no. (%)	
Low	56 (15)
Intermediate	156 (42)
High	131 (35)
Very high	30 (8)
Asthma onset post 9/11, No. (%)	282 (74)
Sensitized to indoor allergens no. (%)	186 (56)

Characteristic	Value
History of intubation, No. (%)	12 (3)
Hospitalization for asthma in the past year, No. (%)	16 (4)
Emergency room visit for asthma in the past year, No. (%)	56 (15)
Oral corticosteroid use in past 12 months no. (%)	97 (27)
Asthma control no. (%)	
Well controlled	98 (26)
Uncontrolled	99 (26)
Very poorly controlled	183 (48)
On asthma controller medication, No. (%)	245 (66)
Comorbiditiesno. (%)	
Gastric esophageal reflux disorder	250 (66)
Sinusitis	237 (63)
Major depression	101 (27)
Posttraumatic stress disorder	96 (25)

SD: standard deviation; No: Number; WTC: World Trade Center.

Table 3.

Unadjusted relationship between illness and medication beliefs with self-management behaviors of World Trade Center rescue and recovery workers with asthma.

Belief	Participants holding belief No. (%)	Medication adherence OR (95% CI)	Correct MDI technique OR (95% CI)	Correct DPI technique OR (95% CI)	Action plan OR use (95% CI)	Trigger avoidance OR (95% CI)
Illness beliefs						
Asthma labels						
Wheezing due to asthma	299 (84.0)	1.08 (0.53–2.17)	1.29 (0.56–2.94)	0.97 (0.10–9.57)	1.21 (0.31–4.79)	2.07 (1.14,3–75)
Tiredness due to asthma	161 (44.6)	1.01 (0.63–1.63)	1.21 (0.69–2.13)	4.70 (0.52–42.59)	2.06 (0.76–5.60)	1.42 (0.93,2.15)
WTC-related asthma is different from non-WTC-related asthma	146 (52.1)	1.21 (0.76–1.95)	0.91 (0.52–1.59)	0.83 (0.16–4.19)	2.39 (0.89–6.40)	1.01 (0.67–1.52)
Cause						
Asthma due to WTC exposure	348 (95.1)	1.88 (0.56–6.25)	0.60 (0.13–2.78)	1.03 (0.04–23.6)	5.05 (0.30–84.36)	3.27 (1.05–10.12)
Asthma due to inadequate respiratory protection at WTC site	265 (95.7)	1.37 (0.48–3.87)	0.65 (0.14–3.07)	*	2.53 (0.43–14.86)	1.84 (0.73–4.68)
Timeline						
Have asthma all the time, not just when experiencing symptoms	133 (36.0)	2.20 (1.36–3.57)	1.42 (0.79–2.54)	1.27 (0.25–6.40)	2.88 (0.90–9.24)	1.06 (0.69–1.63)
Control						
WTC-related asthma is more severe	182 (49.7)	1.31 (0.81–2.10)	0.93 (0.53–1.63)	0.49 (0.08–2.83)	1.77 (0.67–4.67)	1.27 (0.84–1.92)
Doctors do not know how to treat WTC-related asthma	67 (18.6)	0.83 (0.46–1.49)	0.74 (0.37–1.48)	1.24 (0.13–11.93)	1.51 (0.40–5.69)	0.88 (0.52–1.50)
Consequences						
Asthma affects my life	139 (37.3)	1.10 (0.69–1.76)	0.79 (0.45–1.38)	0.48 (0.27–0.86)	2.48 (0.88–6.99)	1.65 (1.08–2.51)
Experience lot of asthma symptoms	93 (24.9)	0.82 (0.48–1.39)	1.66 (0.83–3.33)	1.96 (0.34–11.28)	1.88 (0.58–6.09)	0.81 (0.51–1.30)
Emotional Responses						
Concerned about asthma	231 (61.9)	1.08 (0.65–1.79)	0.74 (0.41–1.33)	0.94 (0.19–4.78)	1.33 (0.48–3.67)	1.63 (1.07–2.49)
Asthma affects emotionally	115 (30.8)	1.21 (0.74–1.97)	0.48 (0.27–0.86)	1.06 (0.21–5.35)	1.71 (0.61–4.82)	1.94 (1.24–3.03)
Worried asthma may get worse	103 (28.1)	1.07 (0.64–1.76)	0.52 (0.29–0.96)	1.35 (0.23–7.85)	1.69 (0.57–5.06)	1.54 (0.98–2.44)
Medication beliefs						
Necessity						
Important to use medications when not having symptoms	191 (71.3)	10.93 (4.97–24.1)	1.56 (0.80–3.03)	1.38 (0.23–8.33)	0.96 (0.24–3.83)	1.47 (0.86–2.50)

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Belief	Participants holding belief No. (%)	Medication adherence OR (95% CI)	Correct MDI technique OR (95% CI)	Correct DPI technique OR (95% CI)	Action plan OR use (95% CI)	Trigger avoidance OR (95% CI)
Feel effects of inhaled corticosteroids	228 (64.0)	1.87 (1.10–3.16)	1.05 (0.58–1.89)	1.09 (0.18–6.47)	0.49 (0.15–1.61)	1.37 (0.89–2.12)
Only need SABA to treat asthma	196 (59.0)	0.48 (0.29–0.78)	1.12 (0.63–1.99)	0.36 (0.06–2.09)	0.92 (0.33–2.55)	0.70 (0.45–1.09)
Present health depends on medicine	147 (55.1)	2.04 (1.23–3.37)	1.33 (0.73–2.46)	2.48 (0.48–12.66)	3.51 (1.05–11.76)	1.15 (0.71–1.87)
Concerns						
Inhaled steroids weaken immunity	122 (35.1)	1.28 (0.78–2.12)	0.68 (0.38–1.22)	1.09 (0.16–7.31)	1.65 (0.57–4.76)	1.57 (1.01–2.44)
Medications do not work as well for WTC asthma	60 (16.6)	0.72 (0.38–1.34)	0.77 (0.36–1.65)	0.61 (0.10–3.71)	1.21 (0.37–3.98)	0.91 (0.52–1.59)
Self-efficacy						
Confident in ability to control asthma	298 (81.0)	1.48 (0.83–2.64)	2.65 (1.37–5.14)	1.94 (0.31–12.12)	0.73 (0.22–2.39)	0.75 (0.44–1.26)

OR: Odds ratio for adherence to asthma self-management behavior for those with vs. without the belief; CI: confidence interval; MDI: Metered Dose Inhaler; DPI: Dry Powder Inhaler; WTC: World Trade Center; SABA: Short-Acting Beta-Agonist.

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Table 4.

Adjusted associations of illness and medication beliefs with self-management behaviors of World Trade Center rescue and recovery workers with asthma.

Belief	Medication adherence OR (95% CI)	Correct MDI technique OR (95% CI)	Correct DPI technique OR (95% CI)	Action plan use OR (95% CI)	Trigger avoidance OR (95% CI)
Asthma labels					
Wheezing due to asthma	1.16 (0.52–2.58)	1.3 (0.54–3.14)	0.41 (0.02–7.75)	3.83 (0.66–22.11)	1.96 (0.99–3.89)
Tiredness due to asthma	1.11 (0.65–1.91)	1.28 (0.67–2.44)	__*	1.83 (0.57–5.92)	1.4 (0.86–2.27)
WTC-related asthma is different from non-WTC-related asthma	1.39 (0.84–2.31)	0.85 (0.47–1.54)	0.94 (0.13–6.85)	2.78 (0.89–8.69)	1.09 (0.69–1.73)
Cause					
Timeline					
Asthma due to WTC exposure	1.82 (0.52–6.36)	0.61 (0.12–3.04)	__*	1.91 (0.08–44.41)	3.89 (1.11–13.58)
Asthma due to inadequate respiratory protection at WTC site	2.37 (1.38–4.08)	1.17 (0.62–2.21)	1.44 (0.18–11.22)	4.33 (1.08–17.28)	1.27 (0.77–2.08)
Control					
WTC-related asthma is more severe	1.73 (1.02–2.93)	0.93 (0.51–1.73)	0.39 (0.04–3.57)	1.64 (0.5–5.37)	1.25 (0.78–2.01)
Doctors do not know how to treat WTC asthma	0.81 (0.43–1.53)	0.77 (0.36–1.67)	2.29 (0.1–53.39)	1.68 (0.37–7.61)	0.8 (0.43–1.46)
Consequences					
Asthma affects my life	1.3 (0.77–2.19)	0.88 (0.47–1.65)	2.42 (0.26–22.89)	2.38 (0.73–7.74)	1.78 (1.09–2.93)
Experience lot of asthma symptoms	0.7 (0.4–1.24)	1.77 (0.82–3.82)	__*	1.92 (0.51–7.16)	0.88 (0.51–1.5)
Emotional responses					
Concerned about asthma	1.26 (0.72–2.21)	0.93 (0.49–1.77)	0.93 (0.1–8.45)	1.2 (0.33–4.37)	1.45 (0.89,2.36)
Asthma affects emotionally	1.54 (0.84–2.83)	0.5 (0.25–0.98)	4.74 (0.15–145.52)	1.27 (0.38–4.23)	1.94 (1.12–3.36)
Worried asthma may get worse	1.45 (0.78–2.7)	0.6 (0.29–1.24)	1.55 (0.14–17.24)	2.2 (0.55–8.89)	1.31 (0.75–2.29)
Medication beliefs					
Necessity					
Important to use medications when not having symptoms	12.76 (5.51–29.53)	1.5 (0.74–3.07)	0.94 (0.06–14.15)	0.62 (0.11–3.44)	1.72 (0.93–3.18)
Feel effects of inhaled corticosteroids	1.93 (1.08–3.43)	0.92 (0.48–1.76)	0.66 (0.06–7.76)	0.32 (0.08–1.33)	1.42 (0.87–2.33)
Only need SABA to treat asthma	0.45 (0.26–0.77)	1.07 (0.57–2.02)	0.39 (0.04–3.42)	1.33 (0.38–4.64)	0.56 (0.33–0.93)
Present health depends on medicine	2.39 (1.39–4.13)	1.45 (0.73–2.88)	4.82 (0.35–67.01)	2.88 (0.64–12.87)	1.17 (0.67–2.05)
Concerns					
Inhaled steroids weaken immunity	1.35 (0.76–2.38)	0.74 (0.39–1.4)	0.75 (0.04–15.51)	2.9 (0.72,11.63)	1.18 (0.7–1.98)

Belief	Medication adherence OR (95% CI)	Correct MDI technique OR (95% CI)	Correct DPI technique OR (95% CI)	Action plan use OR (95% CI)	Trigger avoidance OR (95% CI)
Medications do not work as well for WTC asthma	0.8 (0.4–1.6)	1.09 (0.46–2.56)	0.49 (0.03–8.72)	1.27 (0.29–5.47)	1.05 (0.56–1.99)
Self-efficacy					
Confident in ability to control asthma	1.36 (0.72–2.61)	2.1 (1.01–4.36)	2.47 (0.24–25.37)	0.47 (0.09–2.34)	0.95 (0.51–1.76)

OR: Odds ratio for adherence to asthma self-management behavior for those with vs. without the belief; CI: confidence interval; MDI: Metered Dose Inhaler; DPI: Dry Powder Inhaler; WTC: World Trade Center; SABA: Short-Acting Beta-Agonist.

* Unable to fit model due to complete separation of data.