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Asthma in Texas Healthcare Workers II

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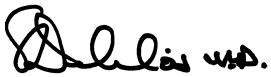

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LIST OF TERMS AND ABBREVIATIONS

ATS	American Thoracic Society
BHR	Bronchial hyperresponsiveness symptoms
BLS	Bureau of Labor Statistics
CNA	Certified Nurse Aide
FDA	Food and Drug Administration
HCP	Healthcare Professionals
JCAHO	Joint Commission on Accreditation of Healthcare Organization
JEM	Job-Exposure Matrix
LVN	Licensed Vocational Nurse
NIOSH	National Institute for Occupational Safety and Health
NOA	New-onset Asthma
NOES	National Occupational Exposure Survey
OA	Occupational Asthma
OSHA	Occupational Safety and Health Administration
PDA	Physician-diagnosed asthma
RN	Registered Nurse
SHIELD	Midland Thoracic Society's Surveillance Scheme of Occupational Asthma
TAS	Texas Asthma in Healthcare Professionals Study 2003
WEA	Work-exacerbated Asthma
WRA	Work-related Asthma
WRFQ	Work Role Function Questionnaire

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Abstract

Healthcare professionals (HCPs) are at risk for work-related asthma (WRA). The 2003 Texas Asthma Study (TAS) found higher odds of new-onset asthma (NOA) associated with medical instrument and building surface cleaning, aerosolized medication administration, and powdered latex glove use in 1992-2000. Subsequent changes in cleaning practices over this time may have affected asthma risk. We assessed changes in WRA prevalence and its risk factors, and examined asthma burden in Texas HCPs about 15 years after the 2003 study.

The project involved two major activities: exposure assessment and administration of a statewide survey. In the exposure assessment phase, the 2003 asthma-specific job-exposure matrix (JEM) was updated, using literature review, focus groups with Houston area HCPs and expert input. Exposures centered on cleaning/disinfection products, procedures and tasks, and latex glove use. JEM coding was conducted by a group of experts and followed the same coding scale used in 2003, to allow comparisons. In the field phase, the 2003 questionnaire was first revised and updated to include new self-reported exposures, components related to occupational history to better characterize WRA in terms of work-exacerbated asthma (WEA) or occupational asthma (OA) and to assess the socioeconomic impact of asthma. It was then administered to a population-based sample of selected groups of healthcare workers in Texas: physicians, nurses, respiratory therapists, occupational therapists, and certified nurse aides (n=9,914).

We examined two asthma outcomes: NOA, i.e. asthma with onset after entering the healthcare field, and bronchial hyperresponsiveness symptoms (BHR), using a previously validated 8-item predictor from the TAS. We used unconditional logistic regression, taking into account survey weights, to estimate associations between exposures and outcomes. Asthma burden was measured by missed workdays and the Work Role Function Questionnaire (WRFQ), a surrogate for presenteeism (i.e., working while ill).

Overall response rate was 34.8% (n=3,444); the final analytical sample was 2,427 participants. The weighted prevalence of NOA was 7.1%, highest among nurses; for BHR, it was 31.0%, highest for occupational therapists. NOA was associated with building surface cleaning (OR 2.03, 95%CI 1.26-3.28), ortho-phthalaldehyde (OR 1.93, 95%CI 1.29-2.88), bleach/quaternary ammonium compounds (OR 1.83, 95%CI 1.14-2.93) and sprays (OR 2.03, 95%CI 1.26-3.28), but not with other exposures. For BHR, there were no statistically significant adverse associations.

Mean missed work days due to health problems among asthmatics and non-asthmatics in the past 12 months were 9.9 and 13.5, respectively ($p>0.05$); however, 76% of these missed work days among asthmatics were due to asthma or breathing problems. Mean WRFQ scores were statistically significantly lower for asthmatics, indicating greater presenteeism.

Compared to the 2003 TAS, NOA and BHR prevalence were unchanged; medical instrument cleaning/disinfection, powdered latex glove use and exposure to a workplace spill were no longer statistically significant risk factors. Cleaning of building surfaces, ortho-phthalaldehyde, bleach, quaternary ammonium compounds, and using sprays to apply cleaners remain a problem. Consequently, HCPs remain at risk for WRA, although there are encouraging trends. Exposure controls, together with optimum clinical management of asthma, would likely result in a decrease in asthma burden in healthcare occupations. In terms of work functioning, asthmatics are more likely than non-asthmatics to work while ill, even though they trend towards missing fewer days of work.

Section 1

Key Findings

The exposure assessment phase of the study produced an updated JEM and study questionnaire. Walkthroughs and focus group sessions were conducted and were preparatory to the updating and recoding of the asthma JEM and questionnaire. Findings and themes from the focus group data informed the validation of the JEM and the updated survey. The new JEM incorporated new categories of instrument cleaning, building surface cleaner products, tasks and procedures to better characterize the exposures in healthcare environment. A new time axis was also added for different exposures to compare the risk of exposures to the 2003 study. The new questionnaire incorporated several new components such as effects on daily activities, unplanned care for asthma, assessment of work-hours and shifts and the WRFQ, along with updates of several components. The study showed an overall prevalence of NOA and BHR symptoms similar to that observed in 2003. The overall weighted prevalence estimates for the analytic sample for physician-diagnosed asthma (PDA), WEA among PDA cases, NOA and BHR-related symptoms were 16.4%, 4.0%, 7.1% and 31%, respectively. For NOA, a nearly two-fold increased odds was observed for sprays used to clean building surfaces, ortho-phthalaldehyde in medical instrument cleaning and disinfection, and bleach and quaternary ammonium compounds used for general surface cleaning.

Key findings were also observed for work-role functioning and presenteeism. Among asthmatics, the average number of days missed in the last 12 months due to overall health issues and asthma or breathing problems were about 10 and 8 days, respectively, i.e., 75% of missed work days were due to respiratory issues. For non-asthmatics, the corresponding values were about 14 and 4. The overall mean score on the WRFQ for asthmatics was lower than for non-asthmatics, indicating asthmatics are more likely to work despite being ill.

Translation of Findings

The overall prevalence of NOA (7.1%) and BHR symptoms (31.0%) among healthcare professionals remains high and similar to 2003, but the associations with some of the risk factors have changed in important ways. Mainly, risk of NOA associated with cleaning and disinfection of medical instruments, such as endoscopes, and exposure to chemical spills at work appears to have decreased. Glutaraldehyde, as a cold disinfectant, appears to be less of an issue than in prior years, probably due to a substantial decrease in its use over the past 15 years. This decrease is encouraging, with more automated cleaning techniques being promoted in the healthcare environment. However, the replacement of glutaraldehyde with ortho-phthalaldehyde was associated with a two-fold increase in risk of NOA. Risks related to use of powdered latex gloves remain controlled, and there were no statistically significant associations with symptoms of BHR. The persistent risk of NOA associated with the cleaning of general building surfaces is concerning. The magnitude of the association is similar to that found in the 2003 study, but the current study also examined risk associated with common tasks and cleaning products, which was not done in the 2003 study.

HCPs who are asthmatics do not miss more days of work than non-asthmatic HCPs, and in fact may take fewer days off due to illness. However, a large proportion of the missed work days in HCPs with asthma are due to asthma or other breathing problems. Further, our results suggest that HCP asthmatics are more likely to work while being ill (i.e., presenteeism) than non-asthmatics, reflecting asthma's effect on work capacity and quality of life in these workers.

Research Outcomes/Impact

The results from this study should be very useful in framing recommendations for reducing continuing exposures to asthmagens in the healthcare environment, while simultaneously showing improvement in other exposures.

Among the improvements:

- Within medical instrument cleaning and disinfection, glutaraldehyde appears to be less of an issue than before, possibly reflecting the greater use of enclosed and automated disinfection procedures for endoscopes, and the decline in use of glutaraldehyde in general. However, we found an increased risk of NOA associated with exposure to ortho-phthalaldehyde, which has largely replaced glutaraldehyde and merits further study.
- Use of powdered latex gloves continues to be under control, insofar as asthma is concerned.
- Overall, the risk of BHR symptoms from workplace exposures appears to have decreased across the board, possibly reflecting a lower likelihood of acute symptoms in the presence of putative exposures to workplace risk factors.

Among the concerns:

- The risk of NOA associated with cleaning of building surfaces remains a concern, reflected by elevated risks associated with general cleaning compounds (bleach and quaternary ammonium compounds) and with spraying as a method of applying cleaning products. This confirms findings in several previous studies, and underscores the persistence of this risk. Alternatives to bleach and less use of sprays may help reduce this risk.
- Having asthma as a HCP impacts work capacity and quality of life. Although asthmatics missed similar or even fewer workdays than non-asthmatics, a large proportion of missed days were due to asthma or breathing problems. Results also point to asthmatics being more likely to work while “ill” than non-asthmatics (i.e., greater presenteeism).

Section 2

Specific Aims

One out of 12 adults in the United States has asthma (1). Among these, approximately 15% to 25% of cases are attributable to work-related factors. Work-related asthma (WRA) is defined as asthma that is exacerbated or induced *de novo* by inhalation exposures in the workplace (2). WRA is a preventable disease associated with adverse health effects and socioeconomic consequences (2). It is estimated that around 2.25 million people in the U.S. age 15-65 years are at risk for WRA (3). In addition, studies have shown that inadequately controlled asthma can lead to work productivity loss, work limitations, and lower quality of life (4, 5).

Healthcare professionals (HCPs), especially nurses, are known to be at risk of WRA (6). Among the various causal factors and triggers of asthma in these professionals are cleaning products, disinfectants, sterilants, pharmaceuticals, sensitizing metals and medications. In particular, exposures to specific highly volatile cleaning agents, both sensitizers and irritants, can adversely affect respiratory health (7). Over the past decade, infection control and general housekeeping practices in healthcare settings have been changing in response to new environmental policies, regulations and trends (8, 9). Whether or not the changes in cleaning products and practices in these settings have modified the risk and impact of WRA among HCPs is, as yet, undetermined (10).

In 2003, we conducted the Texas Asthma in Healthcare Professionals Study (TAS), the first large study of WRA in HCPs, in a statewide representative sample of 5600 Texas HCPs (nurses, physicians, respiratory therapists and occupational therapists). Asthma-related outcomes were measured with a validated survey questionnaire and occupational exposures were determined using a newly developed asthma risk factor job-exposure matrix (JEM), designed for use in healthcare settings. The study found statistically significant associations between occupational exposures and asthma in healthcare workers (6, 11). Specifically, risk of asthma and symptoms of asthma or bronchial hyperresponsiveness (BHR) increased for those whose tasks involved medical instrument cleaning and disinfection, exposure to general cleaning products, use of powdered latex gloves before the year 2000, and administration of aerosolized medications (6). Whereas previous studies had largely consisted of case reports, case series and a few case-control studies, this more rigorously designed, population-based study contributed to confirming HCPs as an at-risk group for asthma. Findings from the TAS also underscored the need for more detailed study of both infection control and prevention practices and HCP groups, in particular nurses as they had the highest asthma risk.

In the more than 10 years since the TAS was published (6), there have been several changes in cleaning and disinfection practices in healthcare (10, 12). There is a greater emphasis on controlling hospital-acquired infections, leading to detailed, strict cleaning and disinfection guidelines (8). However, these guidelines may have had unintended consequences for workers who perform these duties or others who are close bystanders. The use of cleaners and disinfectants related to “green” chemistry and engineering has increased, yet (13, 14) it is not known whether this has affected the magnitude of WRA in healthcare settings (10). But changes are not due only to use of new products. In addition, there have been changes in the nature of the tasks, the frequency of exposures, the general work environment, greater automation of some cleaning practices, and the degree to which personal protective equipment (PPE) is available and used appropriately (13-15). Further research is thus warranted to investigate changes in magnitude of associations between workplace exposures and asthma and asthma-like symptoms in a contemporary population (10). Moreover, our understanding of the impact of asthma on functioning at work and overall quality of life is sparse, justifying more research in this area.

Our specific aims were to:

Aim 1: Estimate the prevalence rate of asthma risk factors and work-related asthma (WRA) in healthcare settings and compare these to rates obtained in the 2003 survey;

Aim 2: Measure associations between occupational exposures and WRA among Texas healthcare workers (HCWs) and compare them to those obtained in 2003;

Aim 3: Measure various indicators of socioeconomic impact of asthma in healthcare workers, comparing them among persons with WRA, non-work-related asthma and nonasthmatics.

All study objectives were achieved for this project.

Background and Significance

Asthma is both a health and economic concern in the United States, with a lifetime prevalence of 8% among adults (16). Nationally, asthma has led to annual costs of more than $56 billion and around 25 million days of restricted activity (17). Work-related factors are implicated in one out of every six cases of asthma in working-aged adults (18-21). Currently, WRA is the most frequently reported work-related occupational respiratory disease in developed nations (22). In 2003, the American Thoracic Society (ATS) projected work-related obstructive airways diseases to be responsible for approximately $7 billion in annual costs (20). Occupation is one of the causative risk factors for new asthma (occupational asthma or OA). Workplace exposures can also worsen pre-existing asthma (i.e. WEA). Collectively, OA and WEA are referred to as work-related asthma (WRA). Healthcare workers are an occupational group at a high risk for WRA compared to other professions (6, 21, 23-25). Current asthma prevalence was highest among workers employed in healthcare (8.8%) (21). It is important to understand the exposures specific to occupations that are responsible for causing or triggering WRA.

OA is defined as NOA characterized by variable airflow limitation and bronchial hyperresponsiveness due to causes and conditions encountered in an occupational environment (26). OA can be caused by either exposure to an allergic sensitizing agent or to high concentrations of respiratory irritant. The prognosis of OA is poor, with only one-third of workers becoming asymptomatic following complete cessation of exposure (27). In addition to OA, exposure to agents common to many workplaces such as chemical irritants, dust, gases, fumes and second hand smoke may also worsen asthma in workers whose disease was pre-existing; this is referred to as WEA (9, 28, 29).

Collectively, both NOA and WEA make up the spectrum of WRA, but traditionally WEA has received less attention than either OA or WRA as a whole (30), with few studies examining its frequency or impact. The definitions of WEA have varied based on their use in epidemiological, clinical or medico-legal settings (28, 29). Among all cases of WRA, WEA conservatively represents around 45% to 50% of cases (28). Distinguishing between OA and WEA is important because of differences in at-risk worker populations, clinical management and impact (31).

In 2011, the ATS published an official statement on WEA (29) that established a case definition useful in both research and clinical contexts. In this definition, WEA requires fulfillment of four criteria: (1) asthma that predates or is concurrent with entering the work environment of interest; (2) the exacerbation, measured as either asthma symptoms and/or increased need for medication, is temporally related to the occupational exposure; (3) there are conditions at work capable of exacerbating asthma; and (4) OA is unlikely. These definitions emphasize the importance of occupational exposures that are responsible for causing WRA (29).

In this study, the focus is on HCPs as an at-risk group for WRA. HCPs comprise up to 8% of the U.S. workforce (32). From 2006 to 2010, despite coinciding with the economic recession, healthcare added more jobs than any other sector, approximately 600,000 (33). Projections for 2010-2020 indicate an addition of another 2 million jobs, or a growth rate of 26% for healthcare professionals and healthcare support (32, 33). Within the HCP group, job growth is greatest among nurses (especially registered nurses), physicians, respiratory therapists, occupational therapists/physical therapists, and home health aides.

In the 1990s, attention began focusing on respiratory hazards among HCPs. This was driven, in part, by

increasing concern over reports of allergic reactions, including asthma, to latex, after passage of the 1992 Occupational Safety & Health Administration (OSHA) Bloodborne Pathogens Standard (6, 34), which resulted in a substantial increase in use of latex-containing personal protective equipment, especially powdered latex gloves (6). As the reports of latex allergic reactions began to appear, both NIOSH and the FDA issued alerts to hospitals recommending a review of their use of latex-containing products, and adoption of hospital-wide latex control policies. In the 2003 TAS, use of latex gloves between 1992 and 2000 was found to be a risk factor for both NOA and symptoms, but this risk disappeared after the year 2000 (6). This suggested that the implementation of control policies was having a beneficial effect.

Work in healthcare settings is associated with a potential for exposures that comprise a full spectrum of workplace hazards, including biological, physical, chemical, and radiation agents, as well as psychosocial factors. Both OA and WEA have been described in the context of these exposures, and mechanisms include both sensitization threshold and irritant exposures. Furthermore, the likelihood of mixed exposures to these agents is high, and may affect allergic sensitization thresholds and irritation potential (20, 27, 29, 35). However, risk of WRA in HCPs is influenced by a number of factors, many of which have been incompletely characterized. This risk can vary by type of professional, their job tasks, the products they use, how they use them, the frequency and intensity of exposure opportunities, and/or the effectiveness of controls to mitigate those exposures.

Nurses are one of the HCP groups at greatest risk of exposure with at least twice the odds of reporting asthma compared to physicians, as was shown in the TAS (6, 11). But there are many subgroups of nurses, and risk is likely to vary according to subgroup (11). In the longitudinal Nurses' Health Study, statistically significant associations were found between working as an operating room nurse and severe, persistent asthma, as compared to administrative nurses (adjusted odds ratio 2.48) (36). In a recent study (37) based on the UK's voluntary reporting Midland Thoracic Society's Surveillance Scheme of Occupational Asthma (SHIELD) program (1991-2011), over 75% of OA cases occurred in nursing, operating theatre, endoscopy and radiology staff. There has been a substantial growth in nursing professions and also more diverse classification of nursing occupations, including nursing assistants and home health aides (38).

Not all nursing professions have been studied separately to assess risk factors for WRA in each sub-profession, considering the diversity in tasks and work roles ranging from a nurse aide to an advanced nurse practitioner. In a separate but concurrent pilot study, this study examined WRA in nurse aides, a growing nursing profession that has been much less studied compared to registered nurses in terms of prevalence and risk factors for WRA. By definition, nurse aides assist other higher nursing professions and physicians by performing other unspecialized services (39). These include providing hands-on care to patients in various settings, cleaning and disinfecting tasks, feeding patients, performing light housekeeping duties in patient rooms, providing skin care, changing linens, and many other duties (40). This raises a reasonable question that, since nurse aides perform more cleaning and disinfecting tasks than LVNs or RNs, might they be at a higher risk of WRA compared to other nursing professions? In 2014, there were 1.5 million jobs related to nursing assistants and orderlies in the US (41). According to the BLS (Bureau of Labor Statistics), this number is projected to increase by 17% by 2024 (41). In Texas alone, there were 124,616 certified nurse aides (CNAs) providing care in 2014 (42). This represents a 2.5% increase since 2009 and a 12% increase since 2004 (42). In addition, nurse aides have an unequal geographic distribution, with non-metropolitan areas having 61.4% more CNAs than metropolitan areas even after controlling for population differences (42). These numbers anticipate consistent growth and geographic variability in this job profession in coming years, and thus a need to specifically study the risk of WRA in nursing sub-occupations.

With respect to tasks and products, several studies of nursing personnel and female hospital workers have found that exposure to cleaning/disinfection is as a risk factor for WRA. The previous literature as well as newer studies have indicated that nurses are at a consistently increased risk of occupational asthma compared to other healthcare professionals. Among healthcare workers, nurses, nurse aids and cleaning workers have been marked as high-risk occupations for WRA (43-45). Among the identified products are bleach,

glutaraldehyde, formaldehyde, and quaternary ammonium compounds (7, 11, 46, 47). However, most of these studies were unable to characterize these various risks in detail, due to small sample size, not gathering sufficiently detailed exposure information, or both (7, 11).

Known factors responsible for WRA are types of task (e.g., cleaning of general building surfaces or medical instrument cold sterilization) (6), product use (e.g., decalcifying agents, toilet cleaners) (7, 48), method of application (e.g., sprays, which can volatilize chemicals that are usually fairly non-volatile) (35, 46, 49), or work environment (e.g., operating rooms, where exposures are among the highest in healthcare settings) (47), along with use of respiratory protection. High level disinfectants (HLDs), such as glutaraldehyde, peracetic acid, or ortho-phthalaldehyde are used on a daily basis in healthcare environments (37, 50). Other disinfectants are alcohol, bleach and sprays (51). Newer studies have indicated the need for determining the role of individual vs. complex agents in the workplace responsible for causing WRA (51, 52). Factors such as frequency of use of certain products also play a role in modifying risk, as was shown in relation to number of days per week on which powdered latex gloves were used by nursing personnel (46). Most important, yet one of the least studied effects, are temporal changes in the prevalence of risk factors related to healthcare practices that may have changed the risk factor profiles of HCP.

Since the 2003 TAS study, new practices have emerged for reasons unrelated to controlling asthma risk. Cleaning and disinfection practices and products in hospitals have changed, including greater use of “green” chemistry and engineering (13, 14). The effects of green products, which contain fewer synthetic chemicals but more nature-derived substances and were designed to minimize environmental impact on WRA is unknown. Studies have also shown there may have been ways to achieve novel assessment decisions such as newer JEMs, to protect against non-allergic sensitization and asthma (53).

To decrease hospital-acquired infections, the emphasis on cleaning and disinfection has increased. In addition to the introduction of the new “green” products, there has been a resurgence in the use of bleach in response to increases in hospital-acquired resistant infections, particularly *Clostridium difficile* (54-56). Bleach is a well-established respiratory irritant (57-60). Whether or not this has resulted in a parallel increase in bleach-related WRA is also not known, and was also explored in this study.

In summary, further research is warranted on details of agents, tasks and occupations associated with asthma in HCPs (10, 53). Specifically, nurse subgroups, given their growing number and multiplicity of roles, and a focus on tasks and work environments related to cleaning and disinfection merit greater attention.

Although several studies have addressed the health and socioeconomic consequences of WRA, to our knowledge none have examined this issue in HCPs. Work disability is common among asthmatic adults, as are missed school days in children; these are collectively referred to as “days of restricted activity” (61). According to the 1983-1985 National Health Interview Survey, approximately 10% of all persons with asthma from age 18 to 44 reported limitation in work ability due to asthma (62). Asthma incidence and severity has increased in recent decades, and it is conceivable that this has translated into increases in work limitations, suggestive of an increase in work disability due to asthma as well (61). However, little is known about how asthma affects work in terms of social, physical or mental demands in HCPs. This indicates the need to study whether work demands and capacity are being affected by WRA, which we addressed by incorporating questions related to missed work days, work-role functioning (a surrogate for presenteeism), and work-related quality of life.

JEMs provide summary estimates for groups of workers sharing similar occupations or job titles, thus allowing group-based estimates to be applied to individuals according to their job titles (63). In large occupational epidemiology studies, JEMs provide researchers with a means to analyze multiple exposure-occupation data across different sub-occupations in one or more industries. Originally, JEMs were most often used in cancer epidemiology studies. However, for the past several years they have been applied to other outcomes, including asthma (64-66).

In the initial stages of this project, a new series of walk-throughs were conducted. Compared to the 2003 study, these walk-throughs included not only hospitals but also outpatient clinic settings and nursing homes. They were also supplemented with focus group sessions involving workers and managers knowledgeable about cleaning and disinfection practices in healthcare settings. In addition, these walkthroughs examined practice changes over the past several years. The walk-throughs and focus groups confirmed the need to study subgroups of HCPs and to include a more detailed approach for assessing cleaning and disinfection exposures that includes not only the products used, but also tasks and settings. These observations were incorporated into the updating and recoding of the 2003 study JEM.

The Work Role Function Questionnaire (WRFQ) is a validated questionnaire that measures self-reported health and self-reported work capacity, by examining work demands in different domains: work scheduling, output, physical, mental and social demands, and then provides a summary score that gives an idea of the relationship between health and work capacity (67). In this sense, the WRFQ can be used as an approximation to measuring presenteeism. To our knowledge, this is the first study to assess work role functioning in HCPs with asthma.

Given the time passed since 2003 TAS, together with changes in cleaning and disinfection practices and subsequent literature on WRA, a repeat study of asthma in Texas HCPs seemed justified. In order for this to be successful, however, the 2003 JEM and study questionnaire needed to be revised and updated.

Methods

The study had two major activities that were conducted in two separate and consecutive stages: exposure assessment/questionnaire revision and administration of a statewide survey.

Exposure Assessment

Year 1 of the funding period was the startup year for the project. The research team was established and project tasks began on schedule.

Year 2 focused primarily on updating the exposure assessment and study questionnaire.

Exposure assessment-related activities consisted of contacting various healthcare settings to set up our walkthroughs and focus group sessions, which were preparatory to the updating and recoding of our asthma job-exposure matrix (JEM). These activities were conducted in three large Houston area hospitals (a general tertiary level hospital (Methodist), a pediatric hospital (Texas Children's) and a cancer center (MD Anderson), two area nursing homes and two outpatient clinics, to reflect smaller healthcare settings. The walkthroughs were conducted by a multidisciplinary team with expertise in occupational medicine, toxicology, pulmonary medicine and hospital safety, focusing on areas where potential at-risk practices may occur, including patient care, operating theaters, procedure rooms and cleaning/disinfection areas. The data gathered from walkthroughs was discussed among the experts and used to update a list of potential respiratory hazards in healthcare settings. Simultaneously, a total of six focus group sessions were also conducted with key healthcare and services personnel at each of the walkthrough locations. The objectives of this focus group study were three-fold: (1) to identify and characterize current practices in cleaning and aerosolized medication administration; (2) to assess changes in practices related to WRA risk factors in health care settings since conducting a previous study of Texas health care workers in 2003; and, (3) to identify factors that could result in varying exposures to these risk factors within job categories of heath care workers. Each focus group session was guided by a facilitator. The discussions centered on location-specific cleaning practices, products, medication administration, use of personal protective equipment and perceived changes in cleaning/disinfection practices over the years. The sessions were audiotaped to maximize capture of discussion content. Each audio file was then transcribed verbatim by a third party company. Focus group data was analyzed using content analysis and open coding to synthesize participant experiences.

The walk-through and focus group observations were contrasted and used to complement each other. The obtained information was summarized, in preparation for a workshop of experts held in October 2015 at the UTHealth School of Public Health. The purpose of the workshop was to generate initial drafts of the new JEM structure and survey questionnaire.

A diverse group of occupational health professionals gathered in the Fall 2015 and discussed and incorporated current cleaning and disinfection practices and products, and administration of newer aerosolized medications to the JEM originally developed in 2003. After finalizing the updated JEM, the cells corresponding to job-practice by exposure categories were coded. The process was conducted by a group of five to seven experts comprised of industrial hygienists, occupational physicians, toxicologists, and occupational health professionals who work in healthcare settings. The panel members assigned codes to each matrix cell based on the probability that a worker in a given cell is exposed to the product or task at least once per week. The same coding scale used in 2003 was used again. A code of '0' was assigned if there was a high probability of no exposure, a '1' or '2' were assigned when the probability of exposure was either low or high, respectively. Disagreements among the experts were resolved by consensus. The coded matrix was then applied to each respondent's current and longest held job as a healthcare professional (HCP), based on the job title and practice setting reported in the questionnaire.

A limited validation of the JEM was conducted after data collection. JEM validation is important but there is limited literature on how a JEM should be validated. To validate our JEM we focused on content validity and construct validation. Content validity is based on expert knowledge, obtained from various information sources, including literature and content experts. To optimize content validity, our JEM was coded by a group of experienced industrial hygienists, occupational epidemiologists and occupational medicine physicians. Construct validity is considered present when a new procedure or test is able to predict a priori-determined associations. In this study, the construct validation was conducted after the JEM was merged with the survey data. For this, exposure to an established respiratory irritant (bleach) and two sensitizers (glutaraldehyde and powdered latex), as defined by the JEM, were tested for associations with NOA and an asthma symptom (wheezing). The expectation was that these exposures should be positively associated (OR>1) with one or both of these outcomes.

The previously validated 2003 survey questionnaire was revised and updated based on more recent literature regarding asthma definitions, together with the knowledge gained through healthcare setting walkthroughs and expert consultations. The new version of the questionnaire contained updated asthma and asthma symptom items, based on more specific and newer updated definitions of asthma, WRA, NOA and WEA, indicators to measure asthma burden and an updated list of self-reported jobs and practice settings that can be linked to the new JEM. The socioeconomic impact of asthma was assessed by the addition of the validated Work Role Function Questionnaire (WRFQ) and already existing questions regarding days absent from work due to asthma. The WRFQ allowed us to measure self-perceived health in relation to work capacity, as a surrogate of presenteeism (i.e., working despite not being well) in this collective. The WRFQ measures self-perceived difficulties in performing a job due to health problems (67). All the versions used until now have shown good psychometric properties (67).

The WRFQ consists of 27 questions on performing work tasks over the previous two weeks (67, 68). As used in literature previously, these 27 items were collapsed into 5 scales: Work Scheduling Demands, Physical Demands, Mental Demands, Social Demands, and Output Demands (67). Responses are scored on a 6-point Likert scale (All of the time, most of the time, half of the time, some of the time, none of the time, and does not apply to my job) that measures how often the respondent is limited in his/her ability to perform tasks. Points were then summed and converted to a 100-point scale, where '0' represents being limited "all the time" and '100' represents not ever being limited (68, 69).

The new version of the questionnaire was pilot tested by administering it to a small convenience sample of 14 local Houston healthcare professionals, both with and without asthma. This pilot assessed ease of use, timing

and comprehensibility of the questionnaire. Based on the respondent's feedback, further refinements were made, leading to the final questionnaire for use in the statewide survey. Time to completion ranged from eight to twenty minutes. The final questionnaire was formatted in two versions: a) on paper and b) an Internet-based version. The paper format was compatible for direct data entry into the HP Teleform (Version 11, Sunnyvale, CA) and the internet-based version were collected and managed using REDCap electronic data capture tools hosted at UTHealth (REDCap 8.1.9, Nashville, TN) (70).

Survey Administration
Year 3 of the project focused on survey administration. As with the 2003 Texas Asthma Study (TAS), four groups of healthcare workers (HCW) with active professional licenses or certification in 2016 were targeted for a cross-sectional confidential mail survey of asthma: physicians (n=61,661), nurses (n=361,719), respiratory therapists (n=13,223) and occupational therapists (n=12,556). In May 2016, a pilot project proposal was awarded by our NIOSH ERC Pilot Projects Research Training Program. This pilot project, which was separate from this grant but with similar aims, expanded our survey population to include certified nurse aides (n=108,718).

Study Population
For physicians, nurses, respiratory and occupational therapists, a stratified random sample was generated from the most current state professional licensing boards. These are the Texas Medical Board for physicians, Texas Board of Nursing for nurses, Executive Council of Physical Therapy and Occupational Therapy Examiners for occupational therapists and Texas Department of Health for respiratory therapists. Lists of licensees and mailing addresses are in the public domain and easily obtainable, in computerized format. The licensing board registries included: name, age, license number, telephone number, address, status of license, and county of residence. The registries are updated continuously and the licenses are renewed yearly. The sampling frame was defined as all members listed on the most current list of active licensees. The sampling unit was defined as individual members on the mailing lists eligible to participate in the study. For the nurse aides, who are not required to have a state license but who may be certified, we used the most recent registry of certified nurse aides (CNAs) from the Texas Department of Aging and Disability Services (71-74)

For the first four groups, based on sample size calculations to assure α=0.05 and β=0.20, adjusted for an expected response rate of at least 50% and an expected proportion of eligible respondents of 90%, the required sample size for each group was calculated as 1,400 each (total = 5,600) (75). For the CNAs, sample size based on α=0.05 and margin of error of 3% was 1,057. The sample size calculations for the first four groups were conducted similar to the original TAS study, while for CNAs, the sample size calculations were done separately based on another method available in literature for a single-group cross-sectional study (76), as the latter was conducted as a separate pilot study later. With 50% expected response rate, a total of 2,114 surveys were to be sent to CNAs. Since nurses may practice in a variety of settings, they have consistently been identified as being at risk for asthma and prior studies have been limited in the extent to which their work habits and environments have been characterized. As a result we oversampled this group, by increasing the number of surveys mailed to them in each subgroups (RNs=1,600, LVNs=800 and APRN=800) (total n=3,200). In addition, given historically low response rates of physicians to mail surveys (77), we also did some limited oversampling of this group to assure a sufficient number of physicians for final analysis (n=400 additional surveys for a total of 1,800). Thus, a total of 9,914 surveys were sent to the target population.

Inclusion criteria for participants were (a) age 18 years and older and (b) working as a nurse, nurse aide, occupational therapist, physician or respiratory therapist with an active license or certification.

Survey Conduct
Data collection took place between October 2016 and February 2017. Based on the approach of Dillman (78), five contact waves with potential study participants were initially planned. However, due to lower response rates than expected, we later modified the approach to include an additional round of postcard mailing, in part

because the mailing period overlapped with the end-of-year holiday season. We also added a token $1 incentive to two of the survey contact waves. This approach was conducted as follows. An initial "warm contact" letter was mailed, which was followed by a hard copy questionnaire, an explanatory cover letter, a $1 token financial incentive, and a business reply envelope. Participants were given the option of returning the hard copy questionnaire by mail or completing it online. Information on how to complete the survey online rather than by hard copy was also included. Follow-up postcard reminders were sent in two rounds (one of which included a holiday seasons greeting), a replacement questionnaire with another $1 incentive and a final reminder letter was mailed subsequently over the next three months.

As surveys were received by mail they were scanned into the HP TeleForm™ system for direct data entry; data from surveys received online were downloaded regularly; each questionnaire was scanned visually for errors, underwent routine range and logic checks and the final dataset was prepared for merging with the JEM dataset.

Study Variables

The main outcome asthma (presence vs. absence) was examined in different ways: (a) physician-diagnosed asthma (PDA), (b) new onset PDA after entry into the health profession (as a surrogate for occupational asthma), (c) work-exacerbated asthma (WEA) and (d) bronchial hyperresponsiveness symptoms. Of these, (a), (b) and (d) allowed comparison to the 2003 results and (c) allowed us to distinguish between new onset and preexisting asthma worsened by the workplace. PDA was defined as a 'Yes' response to the question '*If yes, has your asthma been confirmed by a doctor?*'. New onset asthma among persons with a history of PDA was calculated by comparing the age at which this diagnosis was made to the number of years employed as a healthcare professional; this served as a surrogate for OA. WEA was defined as a 'Yes' response to both the questions '*Have you had an attack/ episode while you were at work in the last 12 months?*' and '*If Yes, do you know what triggered the last attack/ episode of asthma while you were at work?'*. Presence or absence of bronchial hyperresponsiveness symptoms was determined based on a previously validated 8-item symptom predictor of PC_{20} (provocative concentration of methacholine causing a 20% fall in FEV_1), published in 2006 (38). The eight items addressed were trouble breathing, wheezing and/or attacks of shortness of breath in the previous 12 months, nocturnal cough and/or chest tightness in the previous 12 months, and current allergic symptoms when in the presence of animals, feathers, dust, trees, grasses, flowers, or pollen.

The main independent variables were occupational exposures, as defined by the JEM. Exposure to an accidental spill or chemical release was a separate exposure variable, obtained from the questionnaire. All exposure variables were categorical. Covariates in the analysis included from the survey were age, sex, race/ethnicity, type of profession, years as a healthcare professional, smoking status, and obesity (body mass index [kg/m2] $\geqslant$ 30). Atopy was calculated using variables related to exposure to dust and animals.

Data Analysis

We obtained estimates of both counts and prevalence of PDA, NOA, WEA and BHR symptoms as initial descriptive statistics. The mean, median, and frequency distribution of each independent variable were calculated for all variables including exposures and different occupations, *viz.,* nurses, physicians, occupational therapists, respiratory therapists, and nurse aides.

Being a complex survey dataset with samples from various units across the state, weighting adjustments with proportions based on licensing data for healthcare professionals were applied to the data to overcome the problem of under or over-representativeness of the sample. Stata/SE v. 15.0 was used for the statistical analyses (79). Further, Stata's survey data commands were used to appropriately take into account the sample weights (80).

Some participants (n=394) had not answered all the 8-items for the BHR scale. Rather than restricting the analysis to only participants who completed all eight items, we applied the following strategy to be able to use as much of the information provided as possible. BHR scores were calculated if at least 80% of the scale items

were complete, and were coded missing otherwise. For all the one or more missing 8-item responses, we created two scenarios. One was the best-case scenario where all missing items were coded to zero except wheezing, and other being the worst case scenario where all missing items were coded to one except wheezing. If the BHR score for first (best) scenario was equal to one, we kept those values since the score could not be less than or equal to 0.5 despite the number of missing items. For the second (worst) case scenario score was equal to ten, we kept those values since the score could not be greater than 0.5 despite the number of missing items. This helped in imputing 184 further responses. Similarly, for observations with incorrect or missing age, we imputed the age based on the number of years in the healthcare profession and the average number of years at which the profession started (e.g., 26 years for physicians, 22 years for nurses, RTs and OTs, and 16 years for CNAs).

As had been the case in the 2003 TAS, we anticipated a high degree of collinearity between some of the exposure variables (e.g., endoscopy and glutaraldehyde), so collinearity among independent variables was assessed by a correlation matrix, with statistically significant correlations defined as a Pearson coefficient ≥0.70). We knew this would later result in the need to construct individual models for each exposure class. To assure continuity and comparability of the study population across these different models, we reduced the sample to a set consisting only of persons for whom there were no missing data for either independent or outcome variables; this was termed the 'analytical sample'. The sample of participants who had some missing data was termed the 'excluded sample'. Differences in the distribution of variables in the analytical and excluded samples were then tested for significance using chi-square analysis.

After the descriptive statistics, univariate analysis was performed to examine associations between each independent variable and two main outcomes, new onset asthma and bronchial hyperresponsiveness, for this dissertation. For the univariate analysis, unadjusted associations were estimated using logistic regression models for each independent covariate with each outcome. Associations were expressed as the crude odds ratios (OR) and corresponding 95% confidence intervals (CI). Variables with $p \leq 0.25$ with outcomes and/or those identified as important confounders based on the literature were included in the final models. Multivariable regression models were developed for each of the two asthma outcomes using a separate model for each cleaning agent to avoid collinearity due to correlated exposures and accounting for potential confounders.

Results for the final models were expressed as the adjusted ORs with corresponding 95% CIs, with a 95% CI not including the null considered as statistically significant. Goodness-of-fit was assessed using simulated Wald and Hosmer-Lemeshow test, as these are the recommended approaches for survey sample data, with $p<0.05$ considered as indicative of a poor fit (81).

Separate analyses were conducted for assessing presenteeism and burden of asthma in healthcare workers using the WRFQ questionnaire and questions related to missed days at work. The response options for the 27-item WRFQ questionnaire ranged on a five point scale as 0=difficult all the time (100%), 1=difficult most of the time, 2=difficult half of the time (50%), 3=difficult some of the time, and 4=difficult none of the time (0%). Work role functioning for the analytical sample was assessed by deriving weighted percentage score means and standard errors for all the five domains and overall scale by adding the answers in the subscale, dividing by the number of items and then multiplying by 25 to obtain percentage scores between 0 (difficult all the time) and 100 (difficult none of the time). The responses on 'Does not apply to my job' were transformed to missing values. The WRFQ analysis was only conducted for the analytical dataset with no missing values. Weighted 25^{th}, 50^{th}, (median) and 75^{th} percentiles were calculated for each subscale and overall scale. Reliability for all the scales was assessed using Cronbach's alpha. All the mentioned statistics were also calculated by stratifying participants into those with and without a physician diagnosis of asthma (i.e., response 'Yes' or 'No' to the question '*If yes, was your asthma confirmed by a physician?*').

Presenteeism was assessed based on a 'Yes' response to the question "*In the last 12 months, have you had to miss any days of work due to ANY health-related issue (whether asthma or other)?*" and then number of

days entered for days missed due to health-related issues and days missed due to asthma or breathing problems. Weighted mean number of days in the last 12 months for both physician-diagnosed asthmatics and non-asthmatics were calculated. P-values of the differences in the means were calculated by weighted t-test. Weighted 25th, 50th (median) and 75th percentiles were obtained for both these groups separately for missed work days due to overall health issues and missed work days due to asthma or breathing problems.

Results

Exposure Assessment

Focus Group Sessions

A total of 38 individuals participated in six focus group sessions (see Appendix A – Inclusion Enrollment Form). The majority of participants were healthcare providers (76%), with housekeepers/ cleaners comprising the next most populous group (11%). Participants were predominantly female (82%). Approximately one-third of respondents were white, non-Hispanic (35%), another third were black, non-Hispanic (32%), and more than 20 percent were white, Hispanic (22%). Slightly less than half of participants (45.9%) had attained a bachelor's degree. On average, respondents reported working in healthcare for 18.0 years (SD: 11.3 years), with facility administrators reporting the longest tenure (mean: 25.0 years; SD: 0.0 years) and housekeepers/ cleaners reporting the shortest tenure (mean: 12.5 years; SD: 7.9 years). However, no statistically significant differences were seen across job categories in terms of sex, age, education level, race/ ethnicity, workplace, or years in healthcare, which may be partially attributable to small cell sizes.

Participants reported exposure to five broad categories of aerosolized medications (e.g., antibiotics, bronchodilators) and 10 general categories of cleaning products (e.g., glass cleaner, cleaning wipes). Additionally, 12 broad categories of exposure to adhesives, solvents, or other products and procedures were identified (e.g., air fresheners, paint, spray adhesives). Respondents at three of the six facilities also indicated they had access to latex gloves (with and without powder). When asked to specify medications or products that respondents or their co-workers found irritating (i.e., throat, eyes, skin) or offensively odored, they named 15 aerosolized medications, five cleaning products, and five adhesives/ solvents.

Respondents from all facilities reported using cleaning agents, adhesives, and solvents, though the specific brands (when known) varied. Exposure to aerosolized medications, specific medical procedures associated with irritating odors, and latex gloves was limited to fewer sites (four sites, two sites, and three sites, respectively).

Two primary sources of unaddressed variability in exposure were identified: (1) individuals using cleaning products or administering aerosolized medications as part of their job tasks (e.g., nurses, respiratory therapists) were generally well protected from the products (via PPE), but individuals exposed to these agents while performing other tasks were not consistently protected from them; and, (2) the practice of health care providers informally trading patients skewed the levels of exposure substantially toward certain providers and away from others. Related to this latter point, there was no indication that PPE not requiring a close fit to the face (e.g., for men with facial hair) was available, such as a powered air purifying respirator (PAPR).

Additional themes included: (1) lack of knowledge regarding the specific products participants were using; (2) lack of knowledge about why there are restrictions on certain products' use; (3) lack of consistent PPE use, which reflected a lack of knowledge of products' associated risks; and, (4) potential confusion over (centrally-dispensed) products with the same color or number.

Revision of JEM

The complete JEM structure was finalized in early summer 2016. The final version of the revised JEM is presented in Appendix B. Table 1 shows the changes in components of the previous JEM in detail. Instrument

cleaning was subcategorized into four further categories: endoscopy, glutaraldehyde, ortho-phthalaldehyde, and enzymatic cleaners. Building surface cleaners were also subcategorized into four categories: bleach, quaternary compounds, sprays and floor waxing/stripping/buffing for building surface cleaners. The types of procedures were also further subcategorized as patient care cleaning, instrument cleaning, endoscopy, and building surface cleaning that included spraying and floor stripping/waxing and buffing.

To allow comparisons to the 2003 TAS, each major category was also subclassified as pre-2003 and post-2003. The exception was for powdered latex glove use, since this exposure had already been subdivided in the TAS into three time periods (pre-1992, 1992-2000 and post-2000). Instead, two additional time periods were added to reflect changes since the TAS (2001-2006 and 2007 onwards). Year 2006 was when the first study was published. To accurately capture the in-between trends before the first study, during the first study and after the first study, the listed time periods were added.

To ensure that exposures were specifically captured for each different nursing occupation, the nursing category was subcategorized into four subcategories: general/specialized, operating room, administrative and others. Job categories not adequately captured such as dental hygienists and other allied healthcare professionals were removed. Hospitals and health departments were classified into rural (<50,000 population) and urban (≥50,000) to acknowledge possible geographic differences in exposures. Other changes are further detailed in Table 1.

For the JEM construct validation, we evaluated previously established associations between exposure to two sensitizers (glutaraldehyde and powdered latex gloves) and one irritant (bleach) with NOA and one of the symptoms of asthma (wheezing) using exposure data generated from our updated JEM. Glutaraldehyde (OR 1.23, 95% CI 0.80-1.88), powdered latex glove use from 1992-2000 (OR 1.49, 95% CI 0.85-2.63) and bleach (OR 1.60, 95% CI 1.02-2.52) were all positively associated with NOA as would be expected based on the literature (Table 2). Powdered latex glove use from 1992-2000 was also positively associated with wheezing (OR 1.09, 95% CI 0.82 – 1.43) in the expected direction. However, bleach use and glutaraldehyde were inversely associated with wheezing (OR<1), and not in the initially expected direction.

Revision of Survey Study Questionnaire

The components that were added to the questionnaire were WEA questions, effects on daily activities, unplanned care for asthma, assessment of work-hours and shifts and the WRFQ. The components that were updated were asthma symptoms (awakening at night), missed days of work related to WEA, occupational history with an updated list of self-reported exposures to match with the updated JEM, an updated comprehensive list of jobs and practice settings for professions, and time periods (i.e., previous 12 months) for wheezing and shortness of breath. All the changes and new components are mentioned in detail in Table 3. The final version of the survey is presented in Appendix C.

Survey Administration

Of the original 9,914 intended participants, the questionnaire was mailed to 9,893 HCPs in Texas, after removing incorrect addresses identified by the postal service. Table 4 shows the response rates by type of response and healthcare professions. The overall response rate across all professions was 34.8% (n=3,444). The final number of responses, after accounting for bad addresses and refusals, was 3,318. Response rates were highest among occupational therapists (41%, n=573), followed by registered nurses (40.2%, n=1,285), respiratory therapists (37.9%, n=529), physicians (34.1%, n=613) and lowest among certified nurse aides (21.1%, n=444). Of these, the highest percent of complete responses was among occupational therapists (97.4%) and lowest was among physicians (94.8%). In comparison to the 2003 response rate (66%), after excluding CNAs (which were not included in 2003), the overall response rate was 38.5%.

Survey weights were applied to the entire dataset by using the total number of professionals obtained from the

original license or certification registries for each group. Adjustment factors based on population weights were calculated by dividing the percent population of each group in the original registry by the percent population in the study sample. Weights were then assigned based on the adjustment factor for each occupational group for all five professional groups.

The Inclusion Enrollment Form reflects the total enrollment for this study. Table 5 summarizes the descriptive statistics for the final analytic sample with complete responses (n=2,427), and the excluded missing data sample with at least one or more missing values for exposure or outcome (n=899). The missing data sample (i.e., excluded in the main analyses) was considered when one or more covariates for further analysis were missing due to missed responses from the survey. Only the analytical dataset (i.e. complete responses) was considered for main univariate and multivariate analyses.

There were statistically significant differences between the analytical and excluded samples in terms of age, race and profession. Mean age among participants in the analytical sample (49.5 years) compared to the excluded sample (51.8 years). For race/ethnicity, there was a statistically significantly higher prevalence of non-Hispanic whites, and lower prevalence of Hispanics in the analytical sample. Among professions, the percentage of physicians, nurses, RTs and OTs, was statistically significantly higher in the analytical sample ($p<0.001$). There were no differences with respect to gender, atopy, obesity, smoking, and years as healthcare professional.

For occupational exposures, the analytical and excluded groups differed with respect to ortho-phthalaldehyde use and powdered latex gloves use in the period 1992 to 2000.There was a statistically significant lower prevalence of BHR in the analytical sample, but a statistically significant higher prevalence of NOA in the analytical sample.

The overall weighted prevalence estimates for the analytic sample for PDA, WEA among PDA cases, new onset asthma and BHR-related symptoms were 16.4%, 4.0%, 7.1% and 31%, respectively (Table 5). By profession, NOA was 7.7% for nurses, 7.6% for occupational therapists, 5.9% for respiratory therapists, 5.0% for physicians, and 2.6% for CNAs. For BHR symptoms, the corresponding numbers by profession were 34.7% for nurses, 38.3% for occupational therapists, 36.3% for respiratory therapists, 27.6% for physicians, and 30.5% for CNAs.

In the analytical sample, 84% (n=1,861) of respondents were female. The greatest number of women were nurses (39%), followed by OTs (18.5%), physicians (17.4%), RTs (16.5%), and CNAs (8.5%). The weighted prevalence of obesity was 29.2% (n=659). The majority of respondents, i.e. 58.2% (n=414), were Non-Hispanic whites, and 74.5% (n=1,824) respondents were never-smokers. The prevalence of atopy was 15.5% (n=394).

As expected, strong collinearity (>70%) was found among occupational exposures, mainly within instrument cleaning (glutaraldehyde, endoscopy, ortho-phthalaldehyde), building surface cleaning (sprays with quaternary compounds and bleach), and latex glove use (among all time periods.

Table 6 presents the univariate analyses for NOA and BHR symptoms. There were some statistically significant associations between NOA and some of the covariates. For race, a statistically significant inverse association was observed for NOA among non-Hispanic blacks (OR 0.36, 95% CI 0.15-0.86) as compared to non-Hispanic whites. Atopy was associated with NOA (OR 2.50, 95% CI 1.62 – 3.86). For years as healthcare professional, the odds of NOA increased with advancing age across all professional groups, with ORs ranging from 4.47 to 9.37.

For the covariates, there were statistically significant associations between BHR symptoms and male gender (OR 0.62, 95% CI 0.48-0.82) and atopy (OR 6.88, 95% CI 5.10-9.30). Males were less likely to report BHR symptoms compared to females (OR 0.62, 95% CI 0.43 – 0.54). Associations with other covariates with BHR such as race, obesity, smoking and seniority were not statistically significant.

Table 7 shows the crude and adjusted ORs for both NOA and BHR symptoms. For NOA, positive and statistically significant crude associations were found for ortho-phthalaldehyde use (OR 2.04, 95% CI 1.38-3.02), bleach and quaternary compounds (OR 1.60, 95% CI 1.02-2.25 for each), and use of sprays (OR 1.74, 95% CI 1.10-2.76). Negative associations were found for latex glove use from 2001 to 2006 (OR 0.37, 95% CI 0.16-0.84), and after 2007 (OR 0.37, 95% CI 0.16-0.86).

Multivariate models with NOA as the outcome were adjusted for race, atopy, obesity, smoking status and years on the job. There were seven statistically significant associations for tasks and compounds with NOA. For tasks, the adjusted odds for NOA were increased for sprays used in building surface cleaning (OR 2.03, 95% CI 1.26 – 3.27). For compounds, there was a statistically significant adjusted association of NOA with the following: ortho-phthalaldehyde used in instrument cleaning (OR 1.93, 95% CI 1.29-2.88), bleach and quaternary ammonium compounds used to clean building surfaces (OR 1.83, 95% CI 1.14-2.93 for both), and sprays applied to cleaning surfaces (OR 2.03, 95% CI 1.26-3.27). Inverse (i.e., protective) odds were observed for use of latex gloves from years 2001-2006 (OR 0.30, 95% CI 0.13-0.72), and 2007 onwards (OR 0.31, 95% CI 0.13-0.73). Positive, yet nonsignificant associations with NOA were observed for patient care cleaning and disinfection (OR1.82, 95% CI 0.85-3.92), instrument cleaning (OR 1.19 95% CI 0.77-1.85), enzymatic cleaners used in instrument cleaning (OR 1.26, 95% CI 0.71-2.23), latex glove use before 1992 (OR 1.30, 95% CI 0.73-2.32) and latex glove use from 1992-2000 (OR 1.09, 95% CI 0.70-1.69). A history of exposure to a spill at the workplace was positively associated with NOA (OR 1.06, 95% CI 0.48-2.37).

For BHR symptoms, statistically significant inverse crude associations were found for patient care cleaners and disinfection (OR=0.60, 95% CI 0.44-0.83). Similar associations, although not statistically significant, were found for instrument cleaning including endoscopy (OR 0.92, 95% CI 0.72-1.17) and ortho-phthalaldehyde (OR 0.88, 95% CI 0.71-1.09), building surface cleaning including bleach (OR 0.81, 95% CI 0.64-1.02) and sprays (OR 0.82, 95% CI 0.65-1.04). Nonsignificant associations were found for glutaraldehyde (OR 1.01 95% CI 0.79-1.28) and enzymatic cleaners (OR 1.16, 95% CI 0.83-1.60). In the adjusted analysis with BHR symptoms as the outcome, only an inverse association with a self-reported exposure to a chemical spill at work was statistically significant (OR 0.53, 95% CI 0.32 – 0.88). No other associations were found, and most of the point estimates were protective (OR <1.0).

For NOA, model fit was good for all associations except glutaraldehyde and latex use before 1992. Model fit was good for all models that had BHR symptoms as the outcome.

Table 8 shows the mean, standard error and percentile (25th, median and 75th) for each WRFQ subscale (work scheduling, output, physical, mental, social demands) and the overall scale for the weighted sample of 2,427 individuals. Work scheduling and social demand subscales scored the highest mean (85.2 and 84.6, respectively), and the mental demands subscale scored the lowest (82.9). For reliability assessment, Cronbach alpha coefficients were 0.99 for the overall scale and above 0.94 for all the subscales.

Table 9 shows WRFQ scores and missed work days due to health issues and asthma or breathing problems in the last 12 months by PDA status. For PDA cases, the average number of days missed in the last 12 months due to overall health issues and asthma or breathing problems were 9.9 (1.85) and 7.5 (2.12), respectively. For non-asthmatics, the average number of days for health issues and asthma or breathing problems were 13.5 (2.70) and 4.0 (0.79) respectively. The differences among asthmatics and non-asthmatics were not statistically significant. However, 76% percent (7.5 out of 9.9) of the missed days due to health-related issues among asthmatics were due to asthma or breathing problems. For non-asthmatics, that proportion was 30% (4.0 out of 13.5).

Table 9 also shows separate WRFQ subscale and overall scores by PDA status. The overall WRFQ score and three of the domains (work scheduling, output, social) showed statistically significant differences ($p<0.05$) with asthmatics scoring lower than non-asthmatics. The overall mean score for PDA cases was lower (meaning

more difficulty at work due to physical health or emotional problems) compared to non-asthmatics (82.6 *vs.* 84.3). The 25th percentile scale for overall scores showed a statistically significantly lower mean score (74.1) for physician-diagnosed asthmatics compared to non-asthmatics (84.3).

To examine changes since the 2003 TAS, we also compared the main results from this study to those from the earlier study. Since CNAs were not included in 2003, the comparison was based only on nurses, physicians, respiratory therapists and occupational therapists. In contrast to the larger sample, there was no statistically significant difference between the analytical and excluded samples in terms of the prevalence of new onset asthma (7.6% *vs.* 5.9%, respectively), although the difference with respect to BHR symptoms persisted (Table 10). In the multivariable analysis, there was little change in the direction and magnitude of the previously described associations, except that the previously statistically significant inverse association between exposure to a spill at work and BHR symptoms became statistically nonsignificant (Table 11).

Table 12 summarizes the comparison between the 2003 TAS and the current study. For NOA, the odds for patient care cleaners were essentially unchanged (1.82 *vs.* 1.60) and neither was statistically significant. The odds for instrument cleaning was reduced by nearly half compared to the previous study (2.22 *vs.* 1.19). There was no change observed in odds for building surface cleaners (2.03 *vs.* 2.02), both statistically significant. The odds for exposure to spills at workplace also decreased compared to previous study (ORs 1.06 *vs.* 1.23), and both were not statistically significant. The odds for powdered latex glove use for all time periods after the year 2000 remained low and the magnitude was unchanged since the previous study (0.31 *vs.* 0.30). For BHR symptoms, the previously statistically significant higher odds following an exposure to a spill in the workplace (OR 2.02) had become “protective” (OR 0.53). Likewise, the odds for instrument cleaning reduced went from increased to no-risk (ORs 1.00 *vs.* 1.26), and was unchanged for building surface cleaners (ORs 0.84 *vs.* 0.63). The odds for powdered latex glove use remained low and had not changed since the previous study (ORs 0.78 *vs.* 0.77).

Discussion

This study examined the associations between asthma and asthma symptom and cleaning and disinfection products and tasks, and the burden of asthma (i.e. missed work days and presenteeism) in HCW in 2018. We also compared the main results from this study to results from a similar study conducted in 2003.

The overall prevalence of NOA (7.1%) and BHR symptoms (31.0%) among healthcare professionals remains high and similar to 2003, but the associations with some of the risk factors has changed in important ways (6). Mainly, risk of NOA associated with cleaning and disinfection of medical instruments, such as endoscopes, and exposure to chemical spills at work has decreased. Glutaraldehyde, as a cold disinfectant, appears to be less of an issue than in prior years, probably due to a decrease in its use over the past 15 years. However, its replacement, ortho-phthalaldehyde, is associated with a two-fold increase in risk of NOA. Risks related to use of powdered latex gloves remain controlled, and there were no statistically significant associations with symptoms of BHR. In contrast, exposure to cleaning of building surfaces remains an important risk factor for NOA, particularly in association with use of sprays, bleach and quaternary ammonium compounds.

HCPs who are asthmatic do not miss more days of work than those who are non-asthmatics, and in fact the former may take fewer days off due to illness than the latter. However, a large proportion of the missed work days in HCPs with asthma are due to asthma or other breathing problems. Further, our results suggest that HCP asthmatics are more likely to work while being ill (i.e., presenteeism) than non-asthmatics, reflecting asthma’s effect on work capacity and quality of life in these workers.

The decrease in what was previously a greater than two-fold risk for NOA associated with medical instrument cleaning is encouraging. Most likely, this reflects the greater use of enclosed and automated disinfection procedures for endoscopes in recent years, known as Automated Endoscope Reprocessors (AERs) (82). This technique has evolved over the past 10-15 years, incorporating several functions including leak testing,

cleaning, post-cleaning rinse, followed by high-level disinfection (HLD), a second rinse and drying, all of which were previously done manually. Use of these AERs is now widespread (83).

Over this period, glutaraldehyde, the main cold sterilant used to disinfect medical instruments, and which had been repeatedly identified as a sensitizer capable of inducing asthma (84-87), has been steadily replaced by ortho-phthalaldehyde. Ortho-phthalaldehyde, being less volatile than glutaraldehyde, was expected to affect the respiratory system less (88). However, we also observed a two-fold statistically significant increase in odds of NOA associated with ortho-phthalaldehyde. This is consistent with recent reports of acute respiratory symptoms and skin sensitization associated with use of ortho-phthalaldehyde (89, 90). Although it is used primarily for medical instrument disinfection, using the same enclosed system described above, ortho-phthalaldehyde is also used in other situations, some of which may entail a greater risk of direct exposure These include disinfection of other heat-sensitive devices such as electrocardiographic probes or cryosurgical equipment (88). Ortho-phthalaldehyde is also used in tasks related to cleaning the container systems, removing and rinsing soaked instruments, its disposal and while performing other maintenance procedures for AERs (88). More research is needed on the situations in which ortho-phthalaldehyde is used, as a precursor to limiting the opportunities it presents for direct exposure of workers.

The persistent risk of NOA associated with the cleaning of general building surfaces is concerning. The magnitude of the association is similar to that found in the TAS, but the current study also examined risk associated with common tasks and cleaning products, which was not done in the 2003 TAS). Specifically, use of both bleach and quaternary ammonium compounds have been increasingly identified as risk factors for asthma, as has application of cleaners by spraying, in studies of nurses and housekeeping personnel (12, 37). The risk associated with bleach may be due to a resurgence in the use of bleach in the U.S. as part of intensified attempts to control hospital-acquired infections, particularly those associated with *Clostridium difficile* (57-60). In Europe, use of bleach remains widespread, in both healthcare and domestic environments, and has long been recognized as a risk factor for asthma (60). Quaternary ammonium compounds are used on a daily basis in hospitals for cleaning of floors, countertops and patient rooms as disinfectant sprays and wipes (91). Reports of asthma associated with exposure to quaternary ammonium compounds surfaced over 18 years ago (92), and have continued to appear (37, 93-95). Spraying a cleaning product increases the chance of aerosolization and subsequent inhalation of the chemical. Previous studies have described frequent use of cleaning sprays as a relevant and important risk factor for causing asthma (49, 96). In our walk-throughs (data not shown) we observed less use of sprays than cleaning wipes for general surface cleaning, but there were some instances, such as when cleaning wheelchairs and physical therapy equipment where a cleaner was first sprayed onto the equipment and then wiped down with a cloth. It is obvious that hospital-acquired infections must be controlled, but consideration of methods that simultaneously reduce opportunities for direct or bystander worker exposure are imperative (90).

The disappearance of risk of NOA associated with powdered latex glove use observed in the TAS was further confirmed by our results. This suggests that current latex control policies, from limiting the availability of these types of gloves, mainly to improvements in the manufacturing of less allergenic lightly powdered or non-powdered latex gloves, to their substitution with non-latex gloves remains an effective approach. Similar findings have been found by other authors (97-101).

Another encouraging finding was the absence of statistically significant association of BHR symptoms with any of the occupational exposures. In the 2003 TAS, both exposure to surface cleaners and to a chemical spill at the workplace were associated with BHR symptoms; these no longer appear to be as prominent. In the case of chemical spills, this may be due to more standardized procedures for detecting, alerting and controlling a chemical spill, together with better training of personnel and use of appropriate personal protective equipment, in accordance with newer OSHA guidelines (102).

For building surface cleaning, there was no increased risk associated with BHR symptoms, despite an increased risk of NOA. The apparent discrepancy between risks associated with NOA but not with BHR

symptoms deserves further examination and explanation, some of which is speculative. Asthma is a chronic disease; hence, once present, it is lifelong, as reflected by the accumulating prevalence of NOA with increasing age groups that we observed. In contrast, BHR symptoms may be more a reflection of acute or recent symptoms that can come and go. As an example, asthma may be present, but well controlled and asymptomatic. If this hypothesis is true, then the absence of associations with BHR symptoms is encouraging, suggesting that current controls are doing a better job of preventing acute symptoms than in the past. This should not be taken as reason for not continuing to chip away at the risk factors we identified in this study. The past successes in controlling asthma risk factors should serve to continue along the same path of finding safer ways to control healthcare-associated infections.

Finally, an important finding in this study is that asthma takes its toll on affected workers, in terms of missed work days and presenteeism. To our knowledge, this study is the first to assess the impact of asthma on work capacity, sickness absence and presenteeism, all of which are important aspects of quality of life. The large proportion of days missed due to asthma identifies an area for intervention, with better clinical management of asthma in combination with continued improvement in exposure control. Yet, even while they do not miss work, asthmatics appear to be more likely to continue working despite not being completely well. Our results showed consistently lower WRFQ scores, both overall as well as by domain, for asthmatics compared to non-asthmatics. Healthcare workers, as a whole, are reluctant to miss work. Whereas this certainly reflects great commitment to their job, it is not necessarily healthy. Supervisors and managers have an important role to play in encouraging employees to report when they are not well, and to develop contingency measures for covering patient needs while protecting their employees.

This study has several strengths. The sampling and weighting strategy produced a statewide representative sample of five groups of HCPs, making results generalizable to similar workers in the U.S. Results may also be generalizable to other countries, particularly industrialized nations, but should be done cautiously. Cleaning and disinfection products may vary by country, or even in healthcare environments within a same country. In the U.S., accreditation of hospitals and other healthcare settings by the Joint Commission is common, and criteria and standards are uniform. The same may not be true in other countries. Likewise, the job duties ascribed to certain groups of HCPs, for example nurses or therapists, may be different than in the U.S. These considerations can limit the generalizability of our findings.

Another strength is that exposure classifications were based on a detailed and updated JEM that contained more exposure categories, subclasses, and some content and construct validation. JEM validation is not straightforward (and rarely performed); as such, it should be considered incomplete in our study. Nevertheless, the fact that for NOA all associations, and one for BHR symptoms, were in the expected direction provides some level of assurance of reasonably good functioning of the JEM. Using externally derived exposures decreases the chance of recall bias. The use of an updated questionnaire that incorporates more definitions of asthma, more symptoms in relation to work, and measures of asthma burden allowed for more detailed examination of asthma-exposure relationships and for additional analyses that go beyond the scope of this dissertation. The addition of CNAs, a previously unstudied group, is also a strength, allowing comparison to other nursing professionals. In addition, we prepared a stand-alone manuscript that describes asthma and BHR risks associated with working as a CNA, which has been added to this dissertation (see Journal Article in Appendix B). Finally, by preserving the same study design, sampling strategy and execution as the 2003 TAS, we were able to comment on changes in associations that have transpired since the original study, with findings of improvement in the control of some risks and persistence of others.

The study also has several limitations; among these are a lower response rate than in 2003 and the presence of missing data for some of the variables. The overall response rate for this study was 34.8% (~39% for the four main occupational groups), compared to a response of 66% in the TAS, 10 years ago. In part, this reflects a general trend towards declining response rates in epidemiological surveys that has been widely described (103-105). Many reasons are suggested, including internal company policies limiting participation in research, an increase in security measures in new housing communities, and more rigorous filtering of mail to avoid

spam and phishing, or ability to delete or ignore the emails or surveys due to high volumes. However, we did undertake measures to limit the effect of this lower response rate as the final number of responses in the analytical sample (n=2,427) was comparable to the TAS (n=2,738). This would likely be addressed by obtaining knowledge about representativeness of the sample to the census population. The weighting technique used in the dissertation assumes the sample to be a simple random sample from the population, however questionable to a certain extent due to low response rate.

There was missing data for some key variables for our analysis. The BHR symptom variable was constructed based on responses to eight questions. Missing data in more than two variables out of eight, or missing any of the key covariates would lead to a missing count and a smaller analytical sample; this was a similar issue in the TAS. If missing, and restricting the level of acceptable uncertainty, we only imputed up to two of the eight items if at least 80% of the items (i.e., six) were nonmissing. Additional analyses with the use of advanced statistical techniques (e.g., regression-based multiple imputations) (106) is ongoing and will be completed within the next year.

Conclusion and Next Steps

Based on the results in this study, the prevalence of NOA and BHR symptoms is similar to that observed in 2003. For those categories that are comparable between the two studies, the risks for NOA remain unchanged for building surface cleaning, have decreased for instrument cleaning, and continue to be well controlled for powdered latex glove use. Within medical instrument cleaning and disinfection, associations with endoscopy and exposure to glutaraldehyde with either NOA or BHR symptoms were not statistically significant, possibly reflecting the greater use of enclosed and automated disinfection procedures for endoscopes, and the decline in use of glutaraldehyde in general. Instead, there is a newly identified risk of NOA, as compared to 2003, in association with exposure to ortho-phthalaldehyde, which has largely replaced glutaraldehyde and merits further study.

The continued risk of NOA associated with cleaning of building surfaces is supported in this study by elevated risks associated with general cleaning compounds (bleach and quaternary ammonium compounds) and with spraying as a method of applying cleaning products. Alternatives to bleach and less use of aerosolizing procedures may help reduce this risk. Overall, the risk of BHR symptoms from workplace exposures appears to have decreased across the board, possibly reflecting a lower likelihood of acute symptoms in the presence of putative exposures to workplace risk factors. Having asthma as a healthcare professional creates an impact on work capacity and quality of life. Although asthmatics missed similar or even fewer workdays than non-asthmatics, a large proportion of missed days were due to asthma or breathing problems. Results also point to asthmatics being more likely to work while “ill” than non-asthmatics, an indication of presenteeism.

The next steps for the project include conducting multiple imputations to increase the size of the analytic sample, and performing more detailed analyses. In particular, examination of asthma risk by professions, especially within nursing categories is needed. Also, we will estimate associations for other asthma outcomes, in particular WEA as well as analysis of other quality of life indicators. Several papers are planned for the coming year to reflect all of these analyses.

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LIST OF TABLES

Table 1. Job-Exposure Matrix update (2014): summary of changes made to the original 2003 job-exposure matrix, and rationale.

Axis	Old Component	New Component	Comments
Exposure			
Cleaning Agents/ Disinfectants	Instrument cleaning and disinfection	Subcategorized into 1. Endoscopy 2. Glutaraldehyde 3. Ortho-phthalaldehyde 4. Enzymatic cleaners	Subcategorized to better capture the procedure type and chemical products used, and identified in the literature as risk factors.
	Building surfaces cleaning and disinfection	Subcategorized into 1. Bleach 2. Quaternary ammonium compounds 3. Sprays 4. Floor stripping/ waxing/ buffing	Subcategorized to better capture exposure to specific compounds, and methods of application known to be risk factors
Powdered latex gloves	Powdered latex gloves	Added a newer time axis (Current), and changed previous axis from 2000-current to 2000-TAS.	This is to capture changes in use of latex gloves over the period of time, and update to the present.
Adhesives/ Solvents/ Gases	Patient care, surface cleaning and miscellaneous	Removed Miscellaneous categories	This category did not capture useful information in the 2003 study and was removed.
Time Axis	All categories	A Pre-2003 and Post-2003 time axes were added to each category excluding powdered latex, which has pre-existing time axes as mentioned in powdered latex gloves category.	This allowed comparability between the original and newer versions of the JEM
Job			
Nurses (RN, LVN, and CNA)	All nursing categories	Subcategorized into 4 maim categories: a. Generalized Medicine/ Surgery/ Specialized b. Operating room nurses c. Administrative nurses d. Others	This was included to recognize the various levels of nursing roles.
Other Dental, Dental Hygienists and Other Allied Health Professionals	Miscellaneous job categories	These categories were deleted.	These categories were deleted, either because they were not adequately captured, or separate detailed studies were conducted on these populations.
Practice Setting			
Hospitals and Health Departments	Hospitals and health departments	Added Rural and Urban subcategories to all hospitals and health departments.	To capture possible differences in exposures in rural and urban settings.

Table 2. Job-exposure matrix construct validation: Association[a] of sensitizers and irritant with NOA[b] and wheezing for JEM Validation (n=2427 from analytical dataset).

Outcome	Exposure Type	Exposure	Odds Ratio (95% CI)
NOA	Sensitizer	Glutaraldehyde	1.23 (0.80 – 1.88)
		Powdered Latex(1992-2000)	1.27 (0.82 – 1.96)
	Irritant	Bleach	1.60 (1.02 – 2.52)
Wheezing	Sensitizer	Glutaraldehyde	0.77 (0.57 – 1.03)
		Powdered Latex1992-2000)	1.09 (0.82 – 1.43)
	Irritant	Bleach	0.86 (0.65 – 1.12)

[a] From weighted logistic regression models. [b] New-onset asthma

Table 3. Questionnaire update (2004): summary of changes made to the original 2003 survey instrument, and rationale.

Questionnaire Section	Type of change	New Indicators/ Change in old Indicators
Asthma Symptoms	As is, along with new addition	Added item on awakening at night, based on Sunyer et al (116)
Work-exacerbated asthma (WEA)	New addition	Added question assessing episode of asthma at work in past 12 months, and trigger associated with it if known.
Wheezing/ whistling/ shortness of breath	As is, with changes	Changed time axis for symptoms from 'all the time' to 'past 12 months', for consistency with other studies.
Effects on daily activities	New addition	This new section is derived from mini-AQLQ questionnaire to measure the quality of daily life affected due to work-related asthma.(117)
Unplanned care for asthma	New addition	The unplanned care of asthma is a new section added to better capture work exacerbated asthma, based on newer published indicators.
Occupational history	Changes	Updated list of exposures, jobs and practice settings based on new update of the JEM (As described in Table 1), to allow comparison of self-reported exposures to JEM-derived exposures. Added a question to assess the number of work-hours and days (type of shift at workplace) Added a new question to know the history of past 4 jobs and the most recent and longest held job of those.
Work Role Functioning Questionnaire (WRFQ)	New addition	Added a new 27-item WRFQ questionnaire to measure the impact of WRA on work-related quality of life and functioning.
Updated comprehensive list of jobs and practice settings	Changes	Jobs were further classified for each occupation such as general/special, operating room, administrative and other categories for all nursing professionals including registered nurse, licensed vocational nurses and nurse aides. Practice settings were also further classified to incorporate both urban and rural facilities for hospitals and health departments.

Table 4. Summary of responses by occupation among Texas healthcare workers (n=9,914)

Occupation	Initial Sample	Population Sent to (Final)	Total Responses by type			Total Responses	Non-blank Responses	% Non-blank Responses	% Response Rate
			Paper	Online	Refusal				
MD	1800	1799	470	111	32	613	581	94.8	34.1
OT	1400	1397	444	114	15	573	558	97.4	41.0
RN	3200	3197	1017	228	40	1285	1245	96.9	40.2
RT	1400	1396	419	96	14	529	515	97.4	37.9
Total HCWs	7800	7789	2350	549	101	3000	2899	96.6	38.5
CNAs	2114	2104	366	53	25	444	419	94.4	21.1
All Combined	9914	9893	2716	602	126	3444	3318	96.3	34.8

MD= Physicians, OT=Occupational Therapists, RN=Registered Nurses, RT=Respiratory Therapists, HCW=Healthcare Workers, CNAs=Certified Nurse Aides

Table 5. Descriptive characteristics[a] of the analytical sample (n=2,427) and the excluded sample (n=899) of Texas healthcare workers.

Characteristics	Analytical sample (n = 2427)	Excluded sample (n=899)	p-value[b]
Age (years) (mean ± SE)	49.5 ± 0.35	51.8 ± 0.65	0.002
Gender [n (%)]			0.07
Women	1861 (83.7)	648 (6.6)	
Men	563 (16.3)	153 (13.4)	
Race [n (%)]			<0.001
Non-Hispanic white	1414 (58.2)	398 (44.0)	
Hispanic	448 (18.0)	154 (21.6)	
Non-Hispanic black	246 (11.8)	119 (17.3)	
Others	316 (12.0)	146 (17.1)	
Atopy [n (%)]	394 (15.5)	140 (18.0)	0.17
Obesity			0.66
(BMI ≥ 30 kg/m^2) [n (%)]	659 (29.2)	204 (30.2)	
Smoking [n (%)]			0.17
Never smokers	1824 (74.5)	619 (75.3)	
Current smokers	114 (5.7)	51 (7.5)	
Former smokers	486 (19.8)	142 (17.2)	
Job seniority [n (%)]			0.28
0-10 years	621 (25.7)	220 (29.8)	
11-20 years	674 (26.9)	203 (25.3)	
21-30 years	531 (20.8)	183 (20.2)	
≥31 years	598 (26.6)	196 (24.7)	
Profession [n (%)]			<0.001
Physicians	423 (11.6)	146 (9.7)	
Nurses	945 (69.6)	300 (53.4)	
Respiratory Therapists	401 (2.5)	131 (2.0)	
Occupational Therapists	449 (2.5)	112 (1.5)	
Certified Nurse Aides	206 (13.7)	208 (33.4)	
Physician-Diagnosed Asthma (PDA)	416 (16.4)	113 (13.0)	0.04
Work-Exacerbated Asthma (among PDA)	19 (4.0)	5 (3.1)	0.45
NOA [n (%)]	167 (7.1)	32 (4.2)	0.02
BHR Symptoms [n (%)][c]	778 (31.0)	276 (40.2)	<0.001
Cleaning agents (>2003 for all)			
Patient cleaning & disinfection	2095 (88.2)	525 (87.1)	0.55
Instrument cleaning			
Endoscopy	724 (29.4)	174 (26.7)	0.28
Glutaraldehyde	713 (28.6)	172 (26.4)	0.38
Ortho-phthalaldehyde	960 (46.4)	222 (39.3)	0.01
Enzymatic cleaners	483 (10.6)	110 (10.1)	0.75
Building surface cleaning			
Bleach	1775 (75.8)	449 (76.5)	0.73
Quaternary ammonium compounds	1775 (75.8)	449 (76.5)	0.73
Sprays	1791 (77.1)	451 (77.2)	0.93
Stripping/waxing/buffing	0	0	--
Powdered latex gloves			
Pre 1992	1761 (84.2)	464 (84.7)	0.79
1992 – 2000	1509 (72.0)	367 (64.9)	0.00
2001 – 2006	211 (5.8)	57 (5.6)	0.82
2007 onwards	210 (5.8)	57 (5.6)	0.89
Aerosolized medications (>2003)	1134 (58.3)	257 (48.7)	0.05
Adhesives/Removers/Glues/Solvents/Gases/ Vapors (< & >2003)			
Patient Care	1850 (71.6)	413 (59.2)	<0.001
Surface	362 (2.1)	73 (1.5)	0.02
Spill at work [n (%)]	114 (5.1)	28 (4.3)	0.47

[a] From weighted sample; [b] P-values of chi-squared test for differences in proportions and of *t* test for mean differences.

Table 6. Unadjusted associations (n=2,427) of sample demographic and job-related characteristics with asthma-related outcomes among Texas healthcare workers.

	New onset asthma	BHR Symptoms[b]
Characteristics[c]	**OR (95% CI)**	**OR (95% CI)**
Age (continuous)	**1.03 (1.02 – 1.04)***	1.00 (0.99 – 1.01)
Sex		
Female	1.00	1.00
Male	0.62 (0.36 – 1.06)*	**0.62 (0.48 – 0.82)***
Race (Non-Hispanic White)	1.00	1.00
Hispanic	0.61 (0.35 – 1.07)*	0.83 (0.62 – 1.11)*
Non-Hispanic Black	**0.36 (0.15 – 0.86)***	0.71 (0.49 – 1.02)*
Others	0.74 (0.40 – 1.38)	1.05 (0.76 – 1.46)
Atopy	**2.50 (1.62 – 3.86)***	**6.88 (5.10 – 9.30)***
Obesity	1.39 (0.92 – 2.09)*	1.36 (1.07 – 1.71)*
Smoking (Non-Smokers)	1.00	1.00
Current Smokers	0.91 (0.36 – 2.32)	1.33 (0.83 – 2.11)*
Former Smokers	1.19 (0.74 – 1.92)	1.29 (0.99 – 1.69)*
Job seniority (0-9 years)	1.00	1.00
10-16 years	**4.47 (1.84 – 10.87)***	1.18 (0.88 – 1.60)
17-26 years	**6.80 (2.82 – 16.36)***	1.22 (0.88 – 1.67)*
>= 27 years	**9.36 (4.02 – 21.80)***	1.04 (0.77 – 1.41)
Spill at Work	0.71 (0.33 – 1.52)	0.44 (0.28 – 0.70)*

[a] New-onset asthma; [b] Bronchial hyperresponsiveness; [c] All from self-reported questionnaire.
*Note: Bold indicates p<0.05 and * indicates p-value≤0.25.*

Table 7. Adjusted associations (n=2427) of cleaning tasks and compounds with asthma-related outcomes among Texas healthcare workers.

	NOA	NOA	BHR Symptoms[b]	
Cleaning-related tasks	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Patient care cleaning & disinfection	1.89 (0.91 – 3.92)	1.82 (0.85 – 3.93)	**0.60 (0.44 – 0.83)**	**0.63 (0.45 – 0.89)**
Instrument cleaning				
Endoscopy	1.18 (0.77 – 1.80)	1.19 (0.77 – 1.85)	0.92 (0.72 – 1.17)	1.00 (0.77 – 1.30)
Building surface cleaning				
Sprays	**1.74 (1.10 – 2.76)**	**2.03 (1.26 – 3.28)**	0.82 (0.6 – 1.04)	0.84 (0.66 – 1.08)
Cleaning compounds				
Instrument cleaning				
Glutaraldehyde	1.23 (0.80 – 1.88)	1.22 (0.79 – 1.88)	1.01 (0.79 – 1.28)	1.03 (0.79 – 1.34)
Ortho-phthalaldehyde	**2.04 (1.38 – 3.02)**	**1.93 (1.29 – 2.88)**	0.88 (0.71 – 1.09)	0.87 (0.69 – 1.09)
Enzymatic cleaners	1.34 (0.76 – 2.36)	1.26 (0.71 – 2.23)	1.16 (0.83 – 1.60)	1.14 (0.79 – 1.64)
Building surface cleaning				
Bleach	**1.60 (1.02 – 2.52)**	**1.83 (1.14 – 2.93)**	0.81 (0.64 – 1.02)	0.81 (0.63 – 1.03)
Quaternary ammonium compounds	**1.60 (1.02 – 2.52)**	**1.83 (1.14 – 2.93)**	0.81 (0.64 – 1.02)	0.81 (0.63 – 1.03)
Sprays	**1.74 (1.10 – 2.76)**	**2.03 (1.26 – 3.27)**	0.82 (0.65 – 1.04)	0.84 (0.66 – 1.08)
Powdered Latex Glove Use				
Pre-1992	1.49 (0.85 – 2.63)	1.30 (0.73 – 2.32)	0.85 (0.64 – 1.13)	0.85 (0.63 – 1.17)
1992 – 2000	1.27 (0.82 – 1.96)	1.09 (0.70 – 1.69)	0.99 (0.78 – 1.25)	0.94 (0.73 – 1.21)
2001 – 2006	**0.37 (0.16 – 0.84)**	**0.30 (0.13 – 0.72)**	0.74 (0.53 – 1.03)	0.77 (0.55 – 1.07)
2007 onwards	**0.37 (0.16 – 0.86)**	**0.31 (0.13 – 0.73**)	0.76 (0.54 – 1.05)	0.78 (0.56 – 1.09)
Spill at workplace	0.71 (0.33 – 1.52)	1.06 (0.48 – 2.37)	0.44 (0.28 – 0.70)*	**0.53 (0.32 – 0.88)**

[a] New-onset asthma; [b] Bronchial hyperresponsiveness; [c] From weighted logistic regression models adjusted for race, atopy, obesity, smoking and job seniority; [d] All from self-reported questionnaire, except cleaning agents and latex use, which were assessed with the job-exposure matrix.

*Note: Bold indicates p<0.05 * indicates p-value≤0.25.*

Table 8. Descriptive statistics[a] of the 27-item Work-Role Functioning Questionnaire (WRFQ) among Texas healthcare workers (n=2,427).

		Percentile			
WRFQ scales	**Mean (SE)**	**25th**	**50th (median)**	**75th**	**Cronbach's Alpha**
Work Scheduling	85.2 (0.70)	80.0	100	100	0.94
Output demands	83.7 (0.79)	82.1	100	100	0.98
Physical demands	84.1 (0.75)	83.3	100	100	0.97
Mental demands	82.9 (0.80)	79.2	100	100	0.99
Social demands	84.6 (0.80)	92.0	100	100	0.97
Overall scale	84.0 (0.73)	82.4	98.1	100	0.99

[a] All from weighted sample except Cronbach's alpha*;* scale scoring ranges from 0 "Difficult meeting work demands all of the time" to 100 "Difficult meeting work demands none of the time".

Table 9. Work-role function (WRF) scores[a] and missed work days due to health in the last 12 months[a] by physician-diagnosed asthma in Texas healthcare workers (n=2,427).

	Physician- diagnosed asthma								
	Yes				No				
		Percentile				Percentile			
Measures	Mean (SE)	25th	50th (median)	75th	Mean (SE)	25th	50th (median)	75th	p-value[b]
WRF scales									
Work Scheduling	84.1 (1.66)	75	100	100	85.4 (0.77)	80.0	100	100	0.02
Output demands	82.4 (1.95)	75	100	100	83.9 (0.86)	85.7	100	100	0.01
Physical demands	82.5 (1.90)	75	100	100	84.4 (0.82)	83.3	100	100	0.41
Mental demands	81.1 (2.04)	75	100	100	83.2 (0.88)	83.3	100	100	0.11
Social demands	84.1 (1.92)	83.3	100	100	84.7 (0.88)	91.7	100	100	0.03
Overall scale	82.6 (1.78)	74.1	96.3	100	84.2 (0.80)	84.3	98.1	100	0.02
Missed work days in last 12 months (n=649)[c]									
Due to health-related issues (n=648)[d]	9.9 (1.85) *n=169*	2.0	5.0	10.0	13.5 (2.70) *n=479*	2.0	3.0	5.0	0.26
Due to asthma or breathing problems (n=159)[e]	7.5 (2.12) *n=86*	2.0	5.0	8.0	4.0 (0.79) *n=73*	1.0	3.0	4.0	0.12

[a] From weighted sample; [b] P-values of *t* test for mean differences. [c] Among participants reporting at least one missed day; [d] One reported "zero" missed days; [e] Missed days due to asthma or breathing problems out of missed days due to health-related issues.

Table 10. Comparison of prevalence estimates for NOA[a] and BHR[b] symptoms among healthcare professionals based on inclusion and exclusion of CNAs.

	Analytical Sample[a]	**Excluded Sample[b]**	
	n (%)	**n (%)**	p-value[c]
NOA [n(%)]			
Among all professionals	167 (7.1)	32 (4.2)	0.02
All professionals without CNAs	159(7.6)	30 (5.9)	0.29
BHR Symptoms [n(%)]			
Among all professionals	778 (31.0)	276 (40.2)	<0.001
All professionals without CNAs	718(31.4)	225(44.1)	<0.001

[a] New-onset asthma; [b] Bronchial hyperresponsiveness; [c] *n=2427* including CNAs*, n=2221* excluding CNAs; [d] *n=899* including CNAs*, n=691* excluding *CNA*; [e] p-values of chi-squared test for differences in proportions.

Table 11. Comparison of adjusted multivariate odds ratios for NOA[a] and BHR[b] symptoms among healthcare professionals based on inclusion and exclusion of CNAs[c].

	Adjusted NOA		Adjusted BHR Symptoms[a]	
	Among all healthcare professionals	**All professionals without CNAs**	**Among all healthcare professionals**	**All professionals without CNAs**
Cleaning-related tasks	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**
Patient care cleaning & disinfection	1.82 (0.85 – 3.93)	1.89 (0.87-4.09)	**0.63 (0.45 – 0.89)**	**0.56(0.39-0.81)**
Instrument cleaning Endoscopy	1.19 (0.77 – 1.85)	1.13 (0.71-1.79)	1.00 (0.77 – 1.30)	**0.97(0.73-1.29)**
Building surface cleaning Sprays	**2.03 (1.26 – 3.28)**	**1.99(1.23-3.21)**	0.84 (0.66 – 1.08)	**0.77 (0.59-0.99)**
Cleaning compounds				
Instrument cleaning				
Glutaraldehyde	1.22 (0.79 – 1.88)	1.15 (0.73-1.80)	1.03 (0.79 – 1.34)	0.01(0.76-1.34)
Ortho-phthalaldehyde	**1.93 (1.29 – 2.88)**	**1.93 (1.27-2.93)**	0.87 (0.69 – 1.09)	0.83(0.65-1.07)
Enzymatic cleaners	1.26 (0.71 – 2.23)	1.27 (0.72-2.27)	1.14 (0.79 – 1.64)	1.24 (0.84-1.83)
Building surface cleaning				
Bleach	**1.83 (1.14 – 2.93)**	**1.99(1.23-3.21)**	0.81 (0.63 – 1.03)	**0.77 (0.59-0.99)**
Quaternary ammonium compounds	**1.83 (1.14 – 2.93)**	**1.99(1.23-3.21)**	0.81 (0.63 – 1.03)	**0.77 (0.59-0.99)**
Sprays	**2.03 (1.26 – 3.27)**	**2.07 (1.27-3.36)**	0.84 (0.66 – 1.08)	0.79 (0.61-1.03)
Powdered Latex Glove Use				
Pre-1992	1.30 (0.73 – 2.32)	1.39 (0.77-2.52)	0.85 (0.63 – 1.17)	0.79 (0.57-1.11)
1992 – 2000	1.09 (0.70 – 1.69)	1.10 (0.69-1.74)	0.94 (0.73 – 1.21)	0.88 (0.66-1.17)
2001 – 2006	**0.30 (0.13 – 0.72)**	**0.31 (0.13-0.73)**	0.77 (0.55 – 1.07)	0.77 (0.55-1.08)
2007 onwards	**0.31 (0.13 – 0.73**)	**0.32 (0.14-0.75)**	0.78 (0.56 – 1.09)	0.78 (0.56-1.10)
Spill at workplace	1.06 .48 – 2.37)	0.96 (0.44-2.12)	**0.53 (0.32 – 0.88)**	0.60 (0.35-1.01)

[a] New-onset asthma; [b] Bronchial hyperresponsiveness; [c] Certified Nurse Aides.

Table 12. Comparison of prevalence estimates and adjusted multivariate odds ratios for current study with Texas Asthma Study conducted in 2003 for NOA[a] and BHR[b] symptoms.

	NOA		BHR[a] Symptoms	
	2003 Study[b]	**2018 Study[c]**	**2003 Study**	**2018 Study**
Prevalence (%)	6.6%	7.1%	27.4%	31.0%
Cleaning Agents	**OR 95%CI**	**OR 95%CI**	**OR 95%CI**	**OR 95%CI**
Patient Care Cleaners	1.60 (0.18-14.16)	1.82 (0.85-3.93)	0.79 (0.35-1.78)	0.63 (0.45-0.89)
Instrument Cleaning	2.22 (1.34-3.67)	1.19 (0.77-1.85)	1.26 (0.95-1.67)	1.00 (0.77-1.30)
Surface Cleaners	2.02 (1.20-3.40)	2.03 (1.26-3.28)	1.63 (1.21-2.19)	0.84 (0.66-1.08)
Latex 2000-2006	0.42 (0.13-1.29)	0.30 (0.13-0.72)	0.61 (0.34-1.11)	0.77 (0.55-1.07)
Latex 2007 and later	--	0.31 (0.13-0.73)	--	0.78 (0.56-1.09)
Spill at Workplace	1.23 (0.53-2.87)	1.06 (0.48-2.37)	2.02 (1.28-3.21)	0.53 (0.32-0.88)

[a] New-onset asthma; [b] *Bronchial* h*yperresponsiveness*; [c] *n=2738 in analytical sample*; [d] *n=2427 in analytical sample*

Publications

Dissertation
Patel J. (2018). The Association of Cleaning Products and Practices with Asthma among Texas Healthcare Professionals (Doctoral Dissertation). The University of Texas Health Science Center at Houston.

Inclusion of Children

The study population included only adult licensed healthcare professionals and did not involve children.

Materials Available for other Investigators

Copies of the Job Exposure Matrix and validated 2016 questionnaire (included as Appendix A and B) are available through the Contact Principal Investigator at the following address:

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APPENDICES

Appendix A: PHS Inclusion Enrollment Reports

Appendix B: Job Exposure Matrix

Appendix C: A Survey of Asthma in Health Professionals

Appendix A

PHS Inclusion Enrollment Reports

PHS Inclusion Enrollment Report

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

This report format should NOT be used for collecting data from study participants.

***Study Title (must be unique):** Asthma in Texas Healthcare Workers II - Focus Group Sessions

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type ☒ Planned ☐ Cumulative (Actual)

Using an Existing Dataset or Resource ☐ Yes ☒ No

Enrollment Location ☒ Domestic ☐ Foreign

Clinical Trial ☐ Yes ☒ No **NIH-Defined Phase III Clinical Trial** ☐ Yes ☐ No

Comments: Total enrolled is N=38. The discrepancy in the number reported below is because information was not reported by the participants (n=20).

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			**Total**
	Female	**Male**	**Unknown/ Not Reported**	**Female**	**Male**	**Unknown/ Not Reported**	**Female**	**Male**	**Unknown/ Not Reported**	
American Indian/ Alaska Native	0	0		1	0					1
Asian	1	2		0	0					3
Native Hawaiian or Other Pacific Islander	0	0		0	0					0
Black or African American	6	0		0	0					6
White	5	2		1	0					8
More than One Race	0	0		0	0					0
Unknown or Not Reported										
Total	12	4		2	0					18

Report 1 of 2

To ensure proper performance, please save frequently.

PHS Inclusion Enrollment Report

***Study Title (must be unique):** Asthma in Texas Healthcare Workers II - Survey Administration

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type ☒ Planned ☐ Cumulative (Actual)

Using an Existing Dataset or Resource ☐ Yes ☒ No

Enrollment Location ☒ Domestic ☐ Foreign

Clinical Trial ☐ Yes ☒ No **NIH-Defined Phase III Clinical Trial** ☐ Yes ☐ No

Comments:

Total enrolled is n=3,326. The discrepancy in the number reported below is because information was not reported by the participants (n=360).
Please note that we cannot separate the numbers for Asian and Native Hawaiian or Pacific Islander categories because the two categories were merged in our study questionnaire. The numbers reported under "Asian" include the numbers of "Native Hawaiian/Pacific Islander".

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			Total
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	8	4		3	2					17
Asian	207	68		7	3					285
Native Hawaiian or Other Pacific Islander	0	0		0	0					0
Black or African American	300	61		8	1					370
White	1,397	408		352	98					2,255
More than One Race	21	5		9	4					39
Unknown or Not Reported										
Total	1,933	546		379	108					2,966

Report 2 of 2

To ensure proper performance, please save frequently.

Appendix B

Job Exposure Matrix

JEM (Rows (Exposures) – Top, Columns (Job x Practice Settings)

Exposures

Code	LEVEL Description (Major chemical class)	Cleaning agents/disinfectants										
	LEVEL Description (Chemical subclass) (Original 2003 Exposure Categories)	Patient-care cleaning and disinfection-PT		Instrument cleaning and disinfection-IN								
	Original 2003 Exposure Categories C	As 2003 CLPT		As 2003 CLIN								
		CLPT		CLIN	Endoscopy		Glutaraldehyde		Orthophtaldehyde		Enzymatic cleaners	
		CLPCPE	CLPCPO	CLIN	CLINEPE	CLINEPO	CLINGPE	CLINGPO	CLINOPE	CLINOPO	CLINEZPE	CLINEZPO
	Time-dependent consideration	<=2003	Post 2003		<=2003	Post 2003	<=2003	Post 2003	<=2003	Post 2003	<=2003	Post 2003

Code	LEVEL Description (Major chemical class)									
	LEVEL Description (Chemical subclass) (Original 2003 Exposure Categories)	Building surfaces cleaning & disinfection-BD								
	Original 2003 Exposure Categories C	As 2003 CLBD								
		CLBD	Bleach		Quaternary Ammonium Compounds		Sprays		Stripping/ Waxing/ Buffing	
		CLBD	CLBDBPE	CLBDBPO	CLBDQPE	CLBDQPO	CLBDSPE	CLBDSPO	CLBDXPE	CLBDXPO
	Time-dependent consideration		<=2003	Post 2003	<=2003	Post 2003	<=2003	Post 2003	<=2003	Post 2003

Code	LEVEL Description (Major chemical class)	Powdered latex gloves				Aerosolized medications		Adhesives/removers/glues			
	LEVEL Description (Chemical subclass) (Original 2003 Exposure Categories)	Powdered latex gloves-LX				Aerosolized medications-AM		Adhesives/removers/glues-AD			
	Original 2003 Exposure Categories C	As 2003	As 2003	As 2003		As 2003		2003 ADPT		2003ADBD	
		As 2003	As 2003	As 2003		AM		Patient Care		Surface	
		LX1992	LX2000	LX2001	LXC	AMPE	AMPO	ADPTPE	ADPTPO	ADBDPE	ADBDPO
	Time-dependent consideration	Pre 1992	1992-2000	2000-NAG1	Current	<=2003	Post 2003	<=2003	Post 2003	<=2003	Post 2003

Job-Practice Settings

OCCUPATION X PRACTICE SETTING
MD-ALL (Physicians)
MD-Urban Hospital - Surgical Specialty
MD-Urban Hospital - Other Specialties
MD-Rural Hospital - Surgical Specialty
MD-Rural Hospital - Other Specialties
MD-Private practice
MD-Outpatient clinic - Surgical Specialty
MD-Outpatient clinic - Other Specialties
MD-Nursing home
MD-Health department (Urban)
MD-Health department (Rural)
MD-Health insurance agency
MD-Research
MD-Academia
RN-ALL (Registered Nurses)
I- General Medicine/Surgery/Specializ
RN-Hospital (Urban-Floor-Intensive Care)
RN-Hospital (Urban-Floor-Nonsurgical)
RN-Hospital (Urban-Floor-Surgical)
RN-Hospital (Urban-Special Endoscopy/ B
RN-Hospital (Urban-Special Infusion/Inject
RN-Hospital (Rural-Floor-Intensive Care)
RN-Hospital (Rural-Floor-Nonsurgical)
RN-Hospital (Rural-Floor-Surgical)
RN-Hospital (Rural-General Floor)
RN-Hospital (Rural-Special Endoscopy)
RN-Hospital (Rural-Special Bronchoscopy
RN-Hospital (Rural-Special Infusion/Injectio
RN-Private practice
RN-Outpatient clinic
RN-Nursing home

RN-Operating Room Nurses
RN-Hospital (Urban)
RN-Hospital (Rural)
RN-Private practice
RN-Outpatient clinic
RN-Administrative Nurses
RN-Hospital (Urban)
RN-Hospital (Rural)
RN-Private practice
RN-Outpatient clinic
RN-Nursing home
RN-Health department
RN-Others
RN-Public school
RN-Health insurance agency
RN-Research
RN-Medical sales
RN-Academia
RN-Home health
RN-Dental office
LVN-ALL (Licensed Vocational Nurses)
LVN- General Medicine/Surgery/Specialized)
LVN-Hospital (Urban-Floor-Intensive Care)
LVN-Hospital (Urban-Floor-Nonsurgical)
LVN-Hospital (Urban-Floor-Surgical)
LVN-Hospital (Urban-Special Endoscopy/ Broncho
LVN-Hospital (Urban-Special Infusion/Injection/Oth
LVN-Hospital (Rural-Floor-Intensive Care)
LVN-Hospital (Rural-Floor-Nonsurgical)
LVN-Hospital (Rural-Floor-Surgical)
LVN-Hospital (Rural-General Floor)
LVN-Hospital (Rural-Special Endoscopy)
LVN-Hospital (Rural-Special Bronchoscopy)
LVN-Hospital (Rural-Special Infusion/Injection/Othe
LVN-Private practice
LVN-Outpatient clinic
LVN-Nursing home

LVN-Operating Room Nurses
LVN-Hospital (Urban)
LVN-Hospital (Rural)
LVN-Private practice
LVN-Outpatient clinic
LVN-Administrative Nurses
LVN-Hospital (Urban)
LVN-Hospital (Rural)
LVN-Private practice
LVN-Outpatient clinic
LVN-Nursing home
LVN-Health department
LVN-Others
LVN-Public school
LVN-Health insurance agency
LVN-Research
LVN-Medical sales
LVN-Academia
LVN-Home health
LVN-Dental office
NP-ALL (Nurse Practitioners)
NP-Hospital (Urban)
NP-Hospital (Rural)
NP-Private practice
NP-Outpatient clinic
NP-Nursing home
NP-Health department (Urban)
NP-Health department (Rural)
NP-Public school
NP-Health insurance agency
NP-Research
NP-Medical sales
NP-Academia
NP-Home health
NP-Dental office

RT-ALL (Respiratory therapists)
RT-Hospital (Urban)
RT-Hospital (Rural)
RT-Private practice
RT-Outpatient clinic
RT-Nursing home
RT-Public school
RT-Health insurance agency
RT-Research
RT-Medical sales
RT-Academia
RT-Home health
OT-ALL (Occupational therapists)
OT-Hospital (Urban)
OT-Hospital (Rural)
OT-Private practice
OT-Outpatient clinic
OT-Nursing home
OT-Health department (Urban)
OT-Health department (Rural)
OT-Public school
OT-Health insurance agency
OT-Research
OT-Medical sales
OT-Academia
OT-Home health
OT-Dental office

PA-ALL (Physician Assistant)
PA-Hospital (Urban)
PA-Hospital (Rural)
PA-Private practice
PA-Outpatient clinic
PA-Nursing home
PA-Health department (Urban)
PA-Health department (Rural)
PA-Public school
PA-Health insurance agency
PA-Research
PA-Academia
PA-Home Health
PT-ALL (Physical therapists)
PT-Hospital (Urban)
PT-Hospital (Rural)
PT-Private practice
PT-Outpatient clinic
PT-Nursing home
PT-Health department (Urban)
PT-Health department (Rural)
PT-Public School
PT-Health insurance agency
PT-Research
PT-Medical sales
PT-Academia
PT-Home health
PT-Dental office

Appendix C

A Survey of Asthma in Health Professionals

The University of Texas
Health Science Center at Houston

School of Public Health

A Survey of Asthma in Health Professionals

A study funded by the US Centers for Disease Control and Prevention and the National Institute for Occupational Safety and Health (CDC-NIOSH)

A Survey of Asthma in Health Professionals

START HERE

You have been randomly selected from among your licensed Texas colleagues. All answers are confidential.

Trouble Breathing

Questions 1 through 3 ask you about trouble breathing EVER IN YOUR LIFE

1. **Have you ever had trouble with your breathing?** ***(Mark an X for the single best answer)***
   - ☐ Yes → ***Go to Questions 1.1 and 1.2***
   - ☐ No
   - ☐ Don't Know
   → ***Go to Question 2***

   1.1 **If YES, what kind of troubled breathing did you have?**
   - ☐ Continuously, as if breathing is not quite right
   - ☐ Repeatedly, however gets completely better
   - ☐ Only rarely

   1.2 **Was your troubled breathing brought on by your work environment?**
   - ☐ Yes
   - ☐ No
   - ☐ Don't Know

2. **Have you ever had COPD or emphysema confirmed by a doctor?**
   - ☐ Yes
   - ☐ No
   - ☐ Don't Know

3. **Have you ever had asthma?** ***(Mark an X for the single best answer)***
   - ☐ Yes
   - ☐ No
   - ☐ Don't Know
   → ***Go to Question 7***

   3.1 ***If YES,*** **has your asthma been confirmed by a doctor?**
   - ☐ Yes
   - ☐ No
   - ☐ Don't Know
   → ***Go to Question 7***

   3.1.1 ***If YES,*** **at what age was your asthma confirmed by a doctor?**

   ____ YEARS OLD

   3.1.2 ***If YES,*** **when your asthma was confirmed by a doctor, were you...?**
   - ☐ Not working
   - ☐ Working as a healthcare professional
   - ☐ Working, but not as a healthcare professional

   Please specify your job:

   _____

For Office use Only

For Office use Only

Asthma

Questions 4 and 5 ask you about asthma in THE LAST 12 MONTHS

4. Have you had an attack/episode of asthma in the last 12 months? ***(Mark an X for the single best answer)***

☐ Yes
☐ No
☐ Don't Know → ***Go to Question 5***

4.1 ***If YES,*** **<u>how many attacks/episodes</u> of asthma have you had in the last 12 months?** ***(Enter approximate number of asthma attacks)***

_____ ATTACKS

4.2 Have you had an attack/episode of asthma while you were <u>at work</u> in the last 12 months?

☐ Yes
☐ No
☐ Don't Know → ***Go to Question 5***

4.2.1 ***If YES,*** **do you know what triggered the <u>last</u> attack/episode of asthma while you were at work?**

☐ Yes
☐ No → ***Go to Question 5***

4.2.1.a ***If YES,*** **what was the trigger?**

_____

5. On average, how often do/did you take <u>any medications for asthma</u>, including inhalers, aerosols or tablets in the last 12 months?

☐ Daily
☐ Weekly
☐ Monthly
☐ Rarely (less than once a month)
☐ Never

Unplanned Care for Asthma

Question 6 asks you about unplanned care for your asthma in THE LAST 12 MONTHS

6.1 Have you increased your use of fast-acting (or rescue) bronchodilators or inhaled steroids on a short-term basis for two consecutive days or longer?
☐ Yes ☐ No

6.2 Have you increased your use of oral steroids on a short-term basis for two consecutive days or longer?
☐ Yes ☐ No

6.3 Have you been treated with any oral or IV steroids (e.g., prednisone, 7-day steroid pack)?
☐ Yes ☐ No

6.4 Have you had any urgent treatment at your doctor's office?
☐ Yes ☐ No

6.5 Have you had any treatment in an emergency room?
☐ Yes ☐ No

6.6 Have you been hospitalized (e.g., overnight or longer)?
☐ Yes ☐ No

Wheezing, Whistling or Shortness of Breath

Questions 7 through 9 ask you about your breathing in THE LAST 12 MONTHS

7. Have you had <u>wheezing or whistling</u> in your chest in the last 12 months? ***(Mark an X for the single best answer)***

- ☐ Yes → ***Continue on THIS page***
- ☐ No
- ☐ Don't Know → ***Go to Next Page***

7.1 Have you been at all breathless <u>when the wheezing noise was present</u> in the last 12 months?

- ☐ Yes
- ☐ No

7.2 Have you had wheezing or whistling in your chest <u>when you did not have a cold</u> in the last 12 months?

- ☐ Yes
- ☐ No

7.3 Have you had wheezing or whistling in your chest while you were <u>at home</u> (indoors or outdoors) in the last 12 months?

- ☐ Yes
- ☐ No

7.4 Have you had wheezing or whistling in your chest while you were <u>at work</u> in the last 12 months?

- ☐ Yes
- ☐ No

7.5 While you were <u>away from work</u> in the last 12 months, was your wheezing or whistling: worse, better or unchanged?

- ☐ Worse
- ☐ Better
- ☐ Unchanged

7.6 <u>After returning to your work</u> in the last 12 months, was your wheezing or whistling: worse, better or unchanged?

- ☐ Worse
- ☐ Better
- ☐ Unchanged

7.7 If you were <u>away from work for 5 or more consecutive days of absence</u> in the last 12 months, was your wheezing or whistling: worse, better or unchanged?

- ☐ Worse
- ☐ Better
- ☐ Unchanged
- ☐ Not applicable

7.8 When you <u>returned to your work after 5 or more consecutive days of absence</u> in the last 12 months, was your wheezing or whistling: worse, better or unchanged?

- ☐ Worse
- ☐ Better
- ☐ Unchanged
- ☐ Not applicable

8. **Have you had an attack/episode of <u>shortness of breath</u> in the last 12 months?** ***(Mark an X for the single best answer)***

☐ Yes
☐ No
☐ Don't Know

→ ***Go to Question 9 at the BOTTOM of this page***

8.1 **Have you had an attack/episode of shortness of breath after <u>strenuous activity or exercise</u> in the last 12 months?**

☐ Yes
☐ No

8.2 **Have you had a daytime attack/episode of shortness of breath <u>at rest</u> in the last 12 months?**

☐ Yes
☐ No

8.3 **Have you been <u>awakened</u> (at night or while sleeping) by an attack/episode of shortness of breath in the last 12 months?**

☐ Yes
☐ No

8.4 **Have you had an attack/episode of shortness of breath while you were <u>at home</u> (indoors or outdoors) in the last 12 months?**

☐ Yes
☐ No

8.5 **Have you had an attack/episode of shortness of breath while you were <u>at work</u> in the last 12 months?**

☐ Yes
☐ No

8.6 **While you were <u>away from work</u> in the last 12 months, was your shortness of breath: worse, better or unchanged?**

☐ Worse
☐ Better
☐ Unchanged

8.7 **<u>After returning to your work</u> in the last 12 months, was your shortness of breath: worse, better or unchanged?**

☐ Worse
☐ Better
☐ Unchanged

8.8 **If you were <u>away from work for 5 or more consecutive days of absence</u> in the last 12 months, was your shortness of breath: worse, better or unchanged?**

☐ Worse
☐ Better
☐ Unchanged
☐ Not applicable

8.9 **When you <u>returned to your work after 5 or more consecutive days of absence</u> in the last 12 months, was your shortness of breath: worse, better or unchanged?**

☐ Worse
☐ Better
☐ Unchanged
☐ Not applicable

9. **Have you been <u>awakened</u> (at night or while sleeping) by an attack/episode of any of these symptoms in the last 12 months?** ***(Indicate Yes or No for each symptom)***

	Yes	No
Cough	☐	☐
Chest tightness	☐	☐

Participation in Activities

Questions 10 through 13 (next page) ask you about your health and how much it impacts your participation in activities

10. In the last 2 weeks, how much of the time did asthma or breathing problems limit any of the following activities?

	All of the time (100%)	Most of the time	Half of the time (50%)	Some of the time	None of the time (0%)
10.1 Strenuous activities (such as hurrying, exercising, running up stairs, sports)	☐	☐	☐	☐	☐
10.2 Moderate activities (such as walking, housework, gardening, shopping, climbing stairs)	☐	☐	☐	☐	☐
10.3 Social activities (such as talking, playing with pets/children, visiting friends/relatives)	☐	☐	☐	☐	☐
10.4 Activities or tasks you have to do at work	☐	☐	☐	☐	☐

11. Have you EVER had to change your job tasks or leave a job position because of asthma or breathing problems?

☐ Yes
☐ No

12. In the last 12 months, have you had to miss any days of work due to ANY health-related issue (whether asthma or other)?

☐ Yes
☐ No
☐ Don't Know → ***Go to Question 13***

12.1 *If YES,* how many days of work did you have to miss due to health-related issues? *(Enter approximate number of days)*

_____ DAYS

12.1.1 Of the days indicated above, how many days did you miss due to asthma or breathing problems? *(Enter approximate number of days)*

_____ DAYS

13. In the LAST 4 WEEKS, how much of the time did your physical health or emotional problems make it difficult for you to do the following? ***(Mark an X for the single best answer for each item)***

	All of the time (100%)	Most of the time	Half of the time (50%)	Some of the time	None of the time (0%)	Does not apply to my job
13.1 Work the required number of hours	☐	☐	☐	☐	☐	☐
13.2 Get going easily at the beginning of the workday	☐	☐	☐	☐	☐	☐
13.3 Start on your job as soon as you arrive at work	☐	☐	☐	☐	☐	☐
13.4 Do your work without stopping to take extra breaks or rests	☐	☐	☐	☐	☐	☐
13.5 Stick to a routine or schedule	☐	☐	☐	☐	☐	☐
13.6 Handle the workload	☐	☐	☐	☐	☐	☐
13.7 Work fast enough	☐	☐	☐	☐	☐	☐
13.8 Finish work on time	☐	☐	☐	☐	☐	☐
13.9 Do your work without making mistakes	☐	☐	☐	☐	☐	☐
13.10 Satisfy the people who judge your work	☐	☐	☐	☐	☐	☐
13.11 Feel a sense of accomplishment in your work	☐	☐	☐	☐	☐	☐
13.12 Feel you have done what you are capable of doing	☐	☐	☐	☐	☐	☐
13.13 Walk or move around different work locations (for example, going to meetings)	☐	☐	☐	☐	☐	☐
13.14 Lift, carry, or move objects at work weighing more than 10 pounds	☐	☐	☐	☐	☐	☐
13.15 Sit, stand, or stay in one position for longer than 15 minutes while working	☐	☐	☐	☐	☐	☐
13.16 Repeat the same motions over and over again while working	☐	☐	☐	☐	☐	☐
13.17 Bend, twist, or reach while working	☐	☐	☐	☐	☐	☐
13.18 Use hand-held tools or equipment (for example, a phone, pen, keyboard, computer mouse, drill, hairdryer or sander)	☐	☐	☐	☐	☐	☐
13.19 Keep your mind on your work	☐	☐	☐	☐	☐	☐
13.20 Think clearly when working	☐	☐	☐	☐	☐	☐
13.21 Do work carefully	☐	☐	☐	☐	☐	☐
13.22 Concentrate on your work	☐	☐	☐	☐	☐	☐
13.23 Work without losing your train of thought	☐	☐	☐	☐	☐	☐
13.24 Easily read or use your eyes when working	☐	☐	☐	☐	☐	☐
13.25 Speak with people in person, in meetings or on the phone	☐	☐	☐	☐	☐	☐
13.26 Control your temper around people when working	☐	☐	☐	☐	☐	☐
13.27 Help other people to get work done	☐	☐	☐	☐	☐	☐

Allergies

Questions 14 through 17 ask you about allergies and family medical history

14. Have you ever had any of the following conditions? *(Indicate Yes or No for each condition)*

Yes	No	
☐	☐	Nasal or sinus allergies, including hay fever
☐	☐	Eczema or any kind of skin allergy
☐	☐	Frequent heartburn
☐	☐	More than 6 respiratory infections in one year
☐	☐	Allergies to chemicals
☐	☐	Allergies to medicines
☐	☐	Allergies to animals
☐	☐	Allergies to dust or dust mites
☐	☐	Allergies to latex or latex-containing products *(ace bandages/adhesive tape/condoms/gloves)*

15. When you are near <u>animals</u> (cats/dogs/horses), <u>feathers</u> (pillows/quilts/duvet), or in a <u>dusty</u> part of the house, do you ever: *(Indicate Yes or No for each symptom)*

Yes	No	
☐	☐	Get itchy or watery eyes?
☐	☐	Get a feeling of tightness in your chest?

16. When you are near <u>trees, grass, or flowers</u>, or when there is a lot of <u>pollen</u> around, do you ever:

Yes	No	
☐	☐	Get itchy or watery eyes?

17. Have any of your parents, siblings or children had any of the following conditions? *(Indicate Yes, No or Don't Know for each condition)*

Yes	No	Don't Know	
☐	☐	☐	Asthma
☐	☐	☐	Hay fever, eczema, or skin allergies

House or Apartment

Questions 18 and 19 ask you to describe the house or apartment you currently live in

18. In your house or apartment, are there visible areas of mold, mildew or water damage?

☐ Yes
☐ No → ***Go to Question 19***

18.1 *If YES,* how long have they been there? *(Circle Days, Months or Years)*

Days
Months
Years

19. In your house or apartment, are there any unusual odors?

☐ Yes
☐ No → ***Go to Next Page***

19.1 *If YES,* how long have they been there? *(Circle Days, Months or Years)*

Days
Months
Years

Occupational History

Questions 20 through 27 ask you about your CURRENT or MOST RECENT Job

20. In which month and year did you begin your current or most recent job?

____/_____
Month Year

21. In which month and year did you stop working at this job?

____/_____ ☐ Not applicable
Month Year

22. How many hours per week did/do you usually work on this job, including overtime?

_____ HOURS PER WEEK

23. During this time, were/are you a student in this job? ***(Mark an X for the single best answer)*** ☐ Yes ☐ No

24. Which of the following best describes the hours you usually work in this job? ***(Mark an X for the single best answer)***

☐ Regular daytime shift ☐ Rotating shift
☐ Regular evening shift ☐ Other
☐ Regular night shift

25. While working at this job, indicate how often, on average, you handled or were exposed to any of the following products? ***(Select the single best answer for each item)***

	At least once a month	At least once a week	Never
Disinfectants/sterilants	☐	☐	☐
Cleaning agents	☐	☐	☐
Latex gloves/products	☐	☐	☐
Aerosolized medications	☐	☐	☐
Adhesives/adhesive removers/ glues	☐	☐	☐
Gases/vapors	☐	☐	☐
Glutaraldehyde (Cidex®) or ortho-Phtalaldehyde (Cidex OPA®) or enzymatic cleaners	☐	☐	☐
Floor strippers/wax/buffers	☐	☐	☐
Chlorinated bleach/bleach (hypochlorite)	☐	☐	☐
Quaternary Ammonium Compounds (QACs/Quats)	☐	☐	☐

26. What kind of business or industry is/was this? ***(Mark an X for the single best answer)***

☐ Hospital (Urban)
☐ Hospital (Rural)
☐ Private Practice
☐ Outpatient Clinic (Surgical)
☐ Outpatient Clinic (Other)
☐ Health Department (Urban)
☐ Health Department (Rural)
☐ Health Insurance Agency
☐ Public School
☐ Nursing Home
☐ Research
☐ Medical Sales
☐ Academia
☐ Home Health
☐ Dental Office
☐ Other (Specify) ↓

27. What is/was your job title? ***(Mark an X for the single best answer)***

☐ LVN-General/Specialty
☐ LVN-Operating Room
☐ LVN-Administrative
☐ LVN-Other
☐ RN-General/Specialty
☐ RN-Operating Room
☐ RN-Administrative
☐ RN-Other
☐ CNA-General/Specialty
☐ CNA-Operating Room
☐ CNA-Administrative
☐ CNA-Other
☐ Nurse Practitioner
☐ Physician
☐ Respiratory Therapist
☐ Occupational Therapist
☐ Physical Therapist
☐ Physician's Assistant
☐ Other (Specify) ↓

27.1 IF WORKING AS GENERAL/ SPECIALTY RN/LVN/CNA, which of these best fits your workplace?

☐ Floor-ICU
☐ Floor-Non Surgical
☐ Floor-Surgical
☐ Endoscopy/Bronchoscopy
☐ Special Infusion/Injection
☐ Other (Specify) ↓

Occupational History

Questions 28 through 35 ask you about your LONGEST HELD Job

28. Is your current or most recent job also your longest job?

☐ Yes → *Go to Next Page*
☐ No

29. In which month and year did you begin your longest held job?

Month / Year

30. In which month and year did you stop working at this job?

Month / Year

31. How many hours per week did you usually work on this job, including overtime?

HOURS PER WEEK

32. During this time, were you a student in this job? *(Mark an X for the single best answer)*

☐ Yes
☐ No

33. While working at this job, indicate how often, on average, you handled or were exposed to any of the following products? *(Select the single best answer for each item)*

	At least once a month	At least once a week	Never
Disinfectants/sterilants	☐	☐	☐
Cleaning agents	☐	☐	☐
Latex gloves/products	☐	☐	☐
Aerosolized medications	☐	☐	☐
Adhesives/adhesive removers/ glues	☐	☐	☐
Gases/vapors	☐	☐	☐
Glutaraldehyde (Cidex®) or ortho-Phtalaldehyde (Cidex OPA®) or enzymatic cleaners	☐	☐	☐
Floor strippers/wax/buffers	☐	☐	☐
Chlorinated bleach/bleach (hypochlorite)	☐	☐	☐
Quaternary Ammonium Compounds (QACs/Quats)	☐	☐	☐

34. What kind of business or industry was this? *(Mark an X for the single best answer)*

☐ Hospital (Urban)
☐ Hospital (Rural)
☐ Private Practice
☐ Outpatient Clinic (Surgical)
☐ Outpatient Clinic (Other)
☐ Health Department (Urban)
☐ Health Department (Rural)
☐ Health Insurance Agency
☐ Public School
☐ Nursing Home
☐ Research
☐ Medical Sales
☐ Academia
☐ Home Health
☐ Dental Office
☐ Other (Specify) ↓

35. What was your job title? *(Mark an X for the single best answer)*

☐ LVN-General/Specialty
☐ LVN-Operating Room
☐ LVN-Administrative
☐ LVN-Other
☐ RN-General/Specialty
☐ RN-Operating Room
☐ RN-Administrative
☐ RN-Other
☐ CNA-General/Specialty
☐ CNA-Operating Room
☐ CNA-Administrative
☐ CNA-Other
☐ Nurse Practitioner
☐ Physician
☐ Respiratory Therapist
☐ Occupational Therapist
☐ Physical Therapist
☐ Physician's Assistant
☐ Other (Specify) ↓

35.1 IF WORKING AS GENERAL/ SPECIALTY RN/LVN/CNA, which of these best fits your workplace?

☐ Floor-ICU
☐ Floor-Non Surgical
☐ Floor-Surgical
☐ Endoscopy/Bronchoscopy
☐ Special Infusion/Injection
☐ Other (Specify) ↓

Jobs *(continued)*

Questions 36 asks you about jobs that you have EVER had

36. Think about <u>all of the jobs</u> you have ever had. To the best of your knowledge have you ever used or been in contact with any of the following materials at least <u>once a week</u>? *(Indicate Yes or No for each one)*

Yes	No	
☐	☐	Bleach
☐	☐	Cleaners/abrasives for room/counter top
☐	☐	Cleaners/abrasives for restroom/toilets
☐	☐	Detergents
☐	☐	Disinfectants
☐	☐	Floor strippers/wax/buffers
☐	☐	Sprays

Yes	No	
☐	☐	Ammonia
☐	☐	Pesticide
☐	☐	Paints (acrylics, stains/varnishes)
☐	☐	Tobacco smoke (including passive)
☐	☐	Solvents (toluene, xylene, benzene, hexane, mineral spirits, paint thinners)
☐	☐	Toner for copiers or printers
☐	☐	Talc

Yes	No	
☐	☐	Glutaraldehyde (Cidex®)
☐	☐	ortho-Phtalaldehyde (Cidex OPA®)
☐	☐	Enzymatic cleaners
☐	☐	Adhesives or glues
☐	☐	Quaternary Ammonium Compounds (QACs/Quats)

Yes	No	
☐	☐	Anesthetics
☐	☐	Antibiotics
☐	☐	Antiseptics
☐	☐	Bronchodilators
☐	☐	Iodine (Povidone iodine, Betadine®)
☐	☐	Nebulized drugs (pentamidine or ribavirin)

Yes	No	
☐	☐	Acetaldehyde
☐	☐	Alkalis
☐	☐	Ethylene oxide
☐	☐	Formalin/formaldehyde
☐	☐	Nitric oxide

Accidental Chemical/Powder Spill or Gas Release

Questions 37 asks you about exposure to an accidental chemical/powder spill or gas release

37. Were you ever involved in an accidental chemical spill or gas release?

☐ Yes
☐ No
☐ Don't Know

→ *Go to Next Page*

37.1 Did this accidental chemical spill or gas release occur at work? *(Mark an X for the single best answer)*

☐ Yes
☐ No

37.2 In the first 24 hours following this accident, did you experience any of the following symptoms? *(Indicate Yes or No for each symptom)*

Yes	No	
☐	☐	Wheezing
☐	☐	Shortness of breath
☐	☐	Cough
☐	☐	Chest tightness

37.3 Did you have to receive medical attention because of this accident? *(Mark an X for the single best answer)*

☐ Yes
☐ No
☐ Don't Know/Don't Remember

37.4 When did this accident occur?

Month ____/____ Year ____ ____ ____ ____

Demographics

38. What is your date of birth?

Month / Day / Year

39. What is your gender?

- ☐ Male
- ☐ Female

40. Do you consider yourself Spanish/ Hispanic/Latino? ***(Mark an X for the single best answer)***

- ☐ No, not Spanish/Hispanic/Latino
- ☐ Yes, Mexican, Mexican American, Chicano
- ☐ Yes, Puerto Rican
- ☐ Yes, Cuban
- ☐ Yes, other Spanish/Hispanic/Latino (specify):

_____

41. What is your race? ***(Mark an X for the single best answer)***

- ☐ White
- ☐ Black
- ☐ Asian, Asian-American or Pacific Islander
- ☐ American Indian or Alaska Native
- ☐ Another race (specify):

_____

42. What is your standing height?

Feet / Inches

43. How much do you weigh?

Pounds

44. What is the highest grade or level of education that you have completed? ***(Mark an X for the single best answer)***

- ☐ High school graduate or GED
- ☐ Some college or vocational/technical school
- ☐ 4-year college graduate (Bachelor's Degree)
- ☐ Graduate/Medical/Law school

45. How many years have you worked as a health care professional? ***(Include years as a healthcare student)***

YEARS

46. Have you smoked at least 100 cigarettes during your life?

- ☐ Yes
- ☐ No

47. Do you smoke cigarettes now?

- ☐ Yes
- ☐ No → ***Go to Question 48***

47.1 If YES, how many cigarettes do you smoke per day?

- ☐ Less than 1/2 pack each day
- ☐ 1/2 to 1 pack a day
- ☐ > 1 to 2 packs a day
- ☐ > 2 to 3 packs a day
- ☐ More than 3 packs a day

48. Do you use e-cigarettes? ☐ Yes ☐ No

49. Would you say your health in general is...?

- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

Thank you for completing this survey.

Please return this survey in the envelope provided to:
PO Box 20186
Houston, Texas 77225-9901

UTHealth®

The University of Texas
Health Science Center at Houston

School of Public Health

Thank you for completing
A Survey of Asthma in Health Professionals
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