

PHENOTYPES AND DIAGNOSIS

Bronchial Hyperresponsiveness, Word Descriptors, and Ethnicity: Women with Mild Asthma

GRACE E. HARDIE, PH.D.,^{1,2,*} JAMES K. BROWN, M.D.,^{2,3,4} AND WARREN M. GOLD, M.D.^{2,5}

¹San Francisco State University (SFSU), Nursing, San Francisco, CA, USA.

²University of California, San Francisco (UCSF), Pulmonary Department, San Francisco, CA, USA.

³Pulmonary and Critical Care Division, University of California, San Francisco (UCSF), San Francisco, CA, USA.

⁴Veterans Administration Medical Center (VAMC), San Francisco, CA, USA.

⁵Cardiovascular Research Institute (CVRI), University of California, San Francisco (UCSF), San Francisco, CA, USA.

Background. Few studies have examined the ethnic differences in symptom reporting and airway hyperresponsiveness (AHR) for women with mild asthma during a methacholine (McH) challenge. **Objective.** The purpose of this sub-analysis was to determine: (1) whether AHR to McH varied by the ethnicity of women with mild asthma and (2) whether ethnic word descriptors (EWDs) varied by the ethnicity during induced bronchoconstriction. **Methods.** Specific inclusion criteria included the following: FEV₁ (forced expiratory volume in 1 second) $\geq$ 70% predicted normal, PC₃₀ $\leq$ 8 mg/McH, β_2 inhaler only, and self-reported ethnicity of African American (AFAM), Mexican American–Hispanic–Latino (MexAMLat), Asian-Pacific Islander (Asian PI), or white. Serial pulmonary function testing (PFT) and Borg, visual analogue scale (VAS), and EWDs were collected. **Results.** A total of 44 women, mean age of 31.3 years old, with a mean baseline FEV₁ of 2.85 L comprised this sub-analysis. Ethnic–racial diversity included: 12 AFAMs, 5 MexAMLat, 13 Asian-PIs, and 14 whites. All had atopy $\geq$ 2 pinprick responses of 3 mm. At PC₃₀, Asian-PI women required a significantly ($p < .05$) smaller mean dose of McH 1.9 mg/mL. MexAMLat women required an McH dose of 1.6 mg/mL. At PC₃₀, McH dose was 2.9 mg/mL for AFAMs and 3.0 mg/mL for whites, respectively. Asian-PIs who used only upper airway EWDs at PC₃₀ were *itchy throat*, *itchy chin*, and *constricted throat* ($p < .001$). AFAMs significant EWDs were *itchy throat*, *itchy chin/face*, and *tight throat* ($p < .01$). Lower airway EWD was used by both MexAMLat and whites. Significant EWD for Whites were *tight chest* ($p < .01$) and *hard to inhale/lungs tight* ($p < .001$). **Conclusion.** Asian-PI women required a significantly smaller dose ($p < .05$) of McH to induce a PC₃₀. AFAM and whites required a comparable dose of McH at PC₃₀. Asian-PI and AFAM women used only upper airway EWD. Asian-PI women may be at a greater risk for acute asthma episodes that are not recognized or treated due to their upper airway symptom reporting.

Keywords ethnicity, asthma, women, word descriptors, bronchial hyperresponsiveness

BRONCHIAL HYPERRESPONSIVENESS, WORD DESCRIPTORS, AND ETHNICITY: WOMEN WITH MILD ASTHMA

Under- or overperception of symptoms during induced bronchoconstriction is a well-accepted phenomenon (1–4). However, few research studies in this area have examined the relationships between symptom reporting on the one hand and ethnicity and gender on the other (4–6). Under- or overperception of asthma symptoms by women, in particular, has been attributed to several physiological mechanisms (or factors) including hormonal influence, smaller airway caliber, increased airway responsiveness to methacholine (McH) (dose related), exposure to smoking, and increased reporting of symptoms compared to their male counterparts (2, 3). As a result, documenting, let alone understanding, bronchial hyperresponsiveness (BHR) in women is difficult due to the complexity of the physiological and environmental variables.

What has not been clearly defined is how we should determine whether hormonal modulation influences BHR

because controlling for variability within one individual would be a highly complex process (2, 3, 6). Manfreda et al. (7) were unable to confirm or explain geographical, country of origin, and gender determinants for increased BHR. Leynaert et al. (2) reported that BHR was greater in women than men based on the anatomical premise that women have a smaller airway caliber (3–5). They confirmed a higher responsiveness (PD₂₀) of BHR even after adjusting, by gender, for height–weight and predicted forced expiratory volume in 1 second (FEV₁). Potential risk factors they identified contributing to an increase in BHR was greater atopy and susceptibility to environmental contaminants (2).

However, correlating a smaller airway caliber as a determinant of gender differences in BHR remains controversial (2–8). Several McH challenge studies that assessed gender, and symptom perception reported differences in both airway reactivity (BHR) and symptom reporting (5, 6, 8, 9). Whether ethnicity and being female influences BHR and symptom presentation has rarely been studied (2, 7–12). Many times, research results are presented as aggregate data resulting in an inability to isolate differences in the group specific to ethnicity or gender (7–11). Among patients with asthma considerable differences especially in regards to BHR, symptoms, and environmental factors are accepted (4–6, 9–13).

*Corresponding author: Grace E. Hardie, Ph.D., Associate Professor, Nursing, San Francisco State University, 1600 Holloway Avenue, Burk Hall 387, San Francisco, CA 94132, USA; Tel: (415) 405 0484; Mobile: (510) 682 7172; Fax: (415) 338 0555; E-mail: ghardie@sfsu.edu

Understanding the independent gender effect on BHR and symptom reporting may lead to improved ability of health professionals to recognize asthma exacerbations and this may lead to earlier interventions (1, 8–10).

The objective of this study was to examine whether differences in the ethnicity of women with asthma influenced BHR and word descriptors during McH-induced bronchoconstriction.

METHODS

Study Site and Subjects

Data for 44 women were collected as part of a larger bronchoconstrictor study of African Americans (AFAM), MexAMLat, Asian-Pacific Islanders (Asian-PIs), and whites with mild asthma. The research laboratory setting was the Adult Pulmonary Function Laboratory, Moffitt Hospital, at the University of California, San Francisco, CA, USA. Subjects were recruited by multiple recruitment strategies that included physician referrals, advertisements, databases, electronic resources, and flyers.

Inclusion criteria for the larger study included: $FEV_1 \geq 70\%$; ethnicity (AFAM, Hispanic, MexAMLat, Asian-PI, or white) by self-report; provocative concentration of McH causing a 30% fall in FEV_1 (PC_{30}); physician-confirmed diagnosis of asthma; 18–60 years; only using a β -adrenergic-agonist inhaler-intermittently; demonstrated atopy by two or more positive skin prick reactions (wheal ≥ 3 mm) to 12 extracts of aero-allergens common to Northern California; no caffeine or caffeine products within 8 h of scheduled visit; no URI or flu-like symptoms in the prior 6 weeks; and English speaking. The exclusion criteria are described in a prior publication (10).

METHODS/MEASURES

Human subjects consent for this protocol was obtained from both the Committee on Human Research at the University of California (H8803-2219) and San Francisco State University (H3-702). Informed consent was obtained according to those guidelines and all subjects received a copy of their written consent.

Breathlessness Measurement

Breathlessness was measured during the McH challenge by use of the modified Borg (14, 15) and Visual Analog Scale (VAS) (14, 15). Each subject completed a new form at baseline, at 2 min after each dose of MCH, and at 2 min post-bronchodilator. Complete details about this procedure are fully described in another publication (10). To limit bias, subjects were not allowed to see their previous BORG or VAS scale.

Ethnic Word Descriptor Questionnaire

The ethnic word descriptor questionnaire (EWDQ) is a validated open-ended questionnaire that allows subjects to describe, in their own words, the sensations or symptoms

they experience during the McH challenge (10, 16). At baseline, 2 min after an McH dose, and then again 2 min after bronchodilator, all subjects were asked to complete a new EWDQ. Prior to the administration of EWDQ, subjects were informed that there were not any correct words and that they could not look at what words they had previously written. English was an inclusion criterion. Subjects were asked to write out their word descriptors in English to limit any researcher bias in the back translation that may occur with non-English word descriptors.

Pulmonary Function Testing

Baseline pulmonary function testing (PFT) was performed using a KoKo spirometer (17, 18) and pneumotach (Ferraris-PDS CardioRespiratory, Louisville, CO, USA). PFT results are expressed as percentage of the predicted normal value ($PPFEV_1$) and as a mean FEV_1 . At least three maneuvers were performed until three results within 5% were obtained. A complete list of all the PFT measures collected (8) are noted in a prior publication. All the PFT results were reported and corrected for ethnicity and body size, were built into the Koko program, and met the National Health and Nutrition Examination Survey III (NHANES) standards (17, 18). PFT reference values for whites were used for Asian-PIs because, at present, predicted reference values are lacking (17, 18).

Methacholine Challenge

A DSM-2 Micro-Dosimeter (S & M Instruments, Doylestown, PA, USA) was used to administer McH chloride by a standardized procedure (17–19). Aerosols were nebulized using a Devillbiss 646 nebulizer (Devillbiss Healthcare, Somerset, PA, USA) with oxygen regulated to generate 20-lbs/square inch (PSI) with an output of 0.13 mL/min. The complete protocol and procedures for the McH challenge are described elsewhere (10, 16, 19). We used a PC_{30} to better replicate the symptoms that an asthmatic subject experiences during an acute episode rather than the standard provocation concentration that causes a 20% fall in FEV_1 . All subjects received either 2 puffs of albuterol or Atrovent bronchodilator (BD) by a spacer after completion of the McH challenge; they had to reach at least 90% of their baseline FEV_1 (positive BD response) before leaving the research laboratory.

Procedures

Eight hours prior to testing all subjects were asked to withhold any inhaled (β_2) bronchodilators, caffeine, or alcohol. The visit was re-scheduled if they had to use their bronchodilator 8 h before the study procedures. An explanation of all the study procedures (skin and PFT testing, McH challenge, breathlessness measures, and EWDQ) was provided before consent was obtained. All subjects had a screening chest physical exam with vital signs prior to PFT testing; if any wheezing or other abnormal respiratory symptoms were present, the visit was rescheduled. Demographic data and allergen skin testing was performed prior to PFT testing.

Statistical Analysis

Results are reported as mean $\pm$ standard deviation (SD) of the mean, and the ethnic word descriptors (EWDs) were analyzed using cluster analysis, chi square, and expressed by p-values. Group differences by race, ethnicity, and change in FEV₁ over time, Borg and VAS scores at PC₃₀ were analyzed by ANOVA. A repeated measures ANOVA was applied to evaluate the effect of race and gender on FEV₁ and Borg and VAS scores. A sub-analysis of the primary data set specific to women was analyzed using comparable statistical approaches. A p-value $< .05$ was considered significant.

RESULTS

In this sub-analysis, the mean age of the 44 female subjects was 31.3 years with a mean FEV₁ at baseline of 2.85 L (Table 1). The ethnic diversity included 12 AFAMs, 5 Hispanic, MexAMLat, 13 Asian-PIs, and 14 whites (Table 1). The following were the ethnic heritage of the subjects: all the MexAMLat subjects were US born; all the Asians identified themselves as Chinese—eight were born outside of the United States and five were US born. English was the language of choice for all the subjects. Most were nonsmokers or had never smoked except for 6% of the white females (Table 1). Atopy, defined as ≥ 2 pinprick responses of 3 mm, was documented across all ethnic groups (Figure 1). A negative correlation between increased atopy and nocturnal awakenings for African Americans (Pearson: $p < -.016$) was present but not with the degree of BHR. Figure 2 compares nocturnal awakenings with skin prick responsiveness to aeroallergen by ethnicity. Nocturnal awakenings refer to episodes of difficulty breathing that woke up a subject from their sleep and that occurred between 12 am and 4 am. Correlations between nocturnal awakenings, skin prick responses, and ethnicity provided only trend data because of the limited sample size.

The baseline FEV₁ and FEV₁ percent predicted values were not significantly different between African Americans, MexAMLat and whites (Figure 3). The baseline FEV₁ percent predicted and baseline FEV₁

values by ethnicity are presented in Figure 3. A significant difference in baseline FEV₁ percent predicted values between Asian-Pacific Islanders (Asian PI) and Whites ($p < .002$) was present and is discussed below.

Asian PI females required a significantly smaller ($p < .05$) dose of McH, 1.9 mg/mL to induce a PC₃₀ (Figure 4). MexAMLat females also required a smaller dose, 1.6 mg/mL, of McH at PC₃₀; the small sample size ($n = 5$) limited statistical analysis but the dose of McH suggests that a higher degree of BHR for Mexican American-Hispanic women may exist (Figure 5). Conversely, African American and white females required a comparable dose of McH, 2.9 mg/mL, and 3.0 mg/mL, respectively, to achieve a PC₃₀ (Figures 4 and 5).

EWD collected at PC₃₀ were compared between groups and only those word descriptors used by 75% (chi square; χ^2) of the members of each group will be discussed. Each of the word descriptors represents that individual's written response on the EWDQ and these terms reflect their own words used to describe their symptoms of airflow obstruction at PC₃₀ (Figure 6). The three significant, $p < .001$, upper airway EWD at PC₃₀ for Asian-PI women were *itchy throat*, *itchy chin*, and *constricted throat* (Figure 6). Stated differently, 72% of the Asian-PI women used only upper airway EWD at PC₃₀. AFAM women also had three significant, $p < .01$, upper airway word descriptors at PC₃₀ and they were *itchy throat*, *itchy chin/face*, and *tight throat* (Figure 6). Significant lower airway EWD used by white women at PC₃₀ included *tight chest* ($p < .01$), *hard to inhale*, *wheeze*, and *lungs tight* ($p < .001$) (Figure 6). Mexican American women used several EWD that suggested lower airway symptoms but the sample size again limited any interpretation or analysis. The Borg and VAS measurements did not correlate with EWD nor was a significant difference, baseline to PC₃₀, between ethnic groups documented.

DISCUSSION

As we reported Asian-PIs required a significantly smaller dose (1.9 mg/mL) of McH to achieve a PC₃₀

TABLE 1.—Study sample characteristics of women by their ethnicity.

Women*	African American	MexAMLat and Hispanic	Asian-Pacific Islander	White	Mean
<i>N</i> = 44	12	5	13	14	
Age (years) (mean)	30.2 $\pm$ 9.0	34.0 $\pm$ 10.0	28.5 $\pm$ 9.0	32.4 $\pm$ 12.0	31.3
Atopy (≥ 2 responses)	All positive	All positive	All positive	All positive	
Smoking Hx (% nonsmokers)	100	100	100	94	98.5
FEV ₁ (baseline: L)	2.69 $\pm$.30	2.90 $\pm$.14	2.70 $\pm$.21	2.96 $\pm$.36	2.85
FEV ₁ (predicted)	95.1 $\pm$.59	92.3 $\pm$.58	78.2 $\pm$.82	91.5 $\pm$.70	88.8 % predicted
*Methacholine PC ₃₀ mean dose (mg/mL)	2.9	1.6	1.9	3.0	2.35

Notes: AFAM, African American; MexAMLat, Mexican American-Latino, and Hispanic; PI, Pacific Islander; FEV₁, forced expiratory volume in (second).

*% Change in FEV₁ at PC₃₀ per group: AFAM = 33.8%; MexAMLat = 39%; Asian-PI = 33.1%; Whites = 34.1% (overall mean = 35% change in FEV₁ at PC₃₀).

*MCH-Methacholine-PC₃₀ = provocative concentration causing a 30% drop in FEV₁.

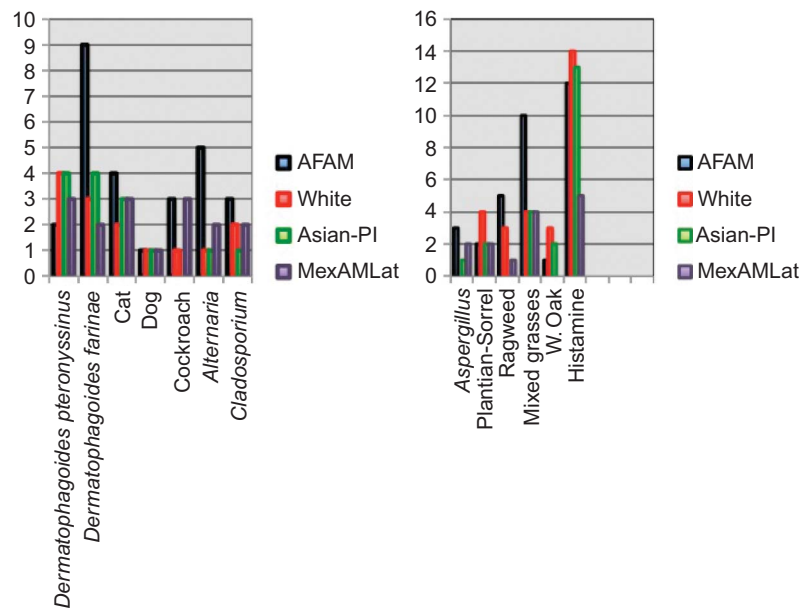


FIGURE 1.—Results of skin testing ≥ 2 mm and at least three skin prick responses: women by ethnicity ($N = 44$).

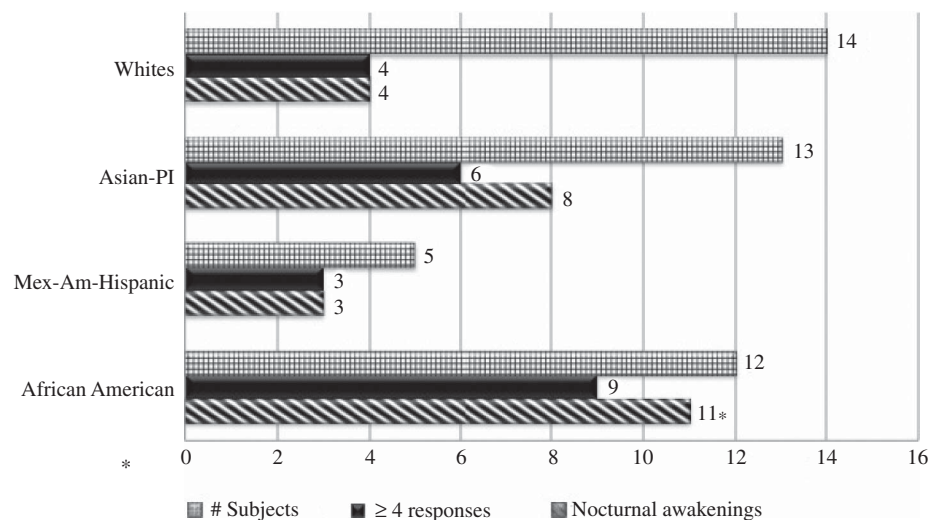


FIGURE 2.—Frequencies: skin prick responsiveness (atopy) and nocturnal awakenings $N = 44$.

Notes: Nocturnal awakening refers to episodes that occurred in the early am, or 12–4 am, and at least twice weekly.

$\delta = p < -.016$ /negative correlation: atopy/nocturnal awakenings for AFAM.

*Skin prick testing included: Negative control, *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, cat, dog, cockroach, *Alternaria*, *Cladosporium*, *Aspergillus*, plantain-sorrel, ragwood, mixed grasses, W. Oak, histamine (all common aero-allergens to Northern California).

(Figures 4 and 5). The four groups were fairly comparable in age, atopy, and smoking history. Baseline FEV₁ for the Asian-PIs did vary but we believe that the increased BHR is directly related to the fact that predicted PFT reference values for Asian-PIs are presently lacking. Because of this fact, PFT reference values for whites were used for Asian-PIs. Until predicted PFT reference values specific for Asian-PIs are validated, it is difficult to determine whether the observed absolute values of FEV₁ represent an over- or underestimation of lung function among the Asian-PI subjects. The baseline FEV₁ percent predicted differences (Table 1) between Asian-PIs (78.2%) and whites (91.5%) that we reported

imply that lung volumes for Asians may differ from whites. We were concerned that the 78.2% FEV₁ percent predicted values might represent more moderate airway disease. However, our demographic questionnaire included several questions on both oral and inhaled corticosteroids use, including dosage, in the last year (10). All the Asian American women reported zero use of either oral or inhaled in the last year strongly suggesting that their asthma was adequately controlled. With moderate asthma, corticosteroids are frequently prescribed for exacerbations (4, 5, 20). Once correction factors for PFT reference values are confirmed, as they have been for AFAM and Mexican Americans (17, 18),

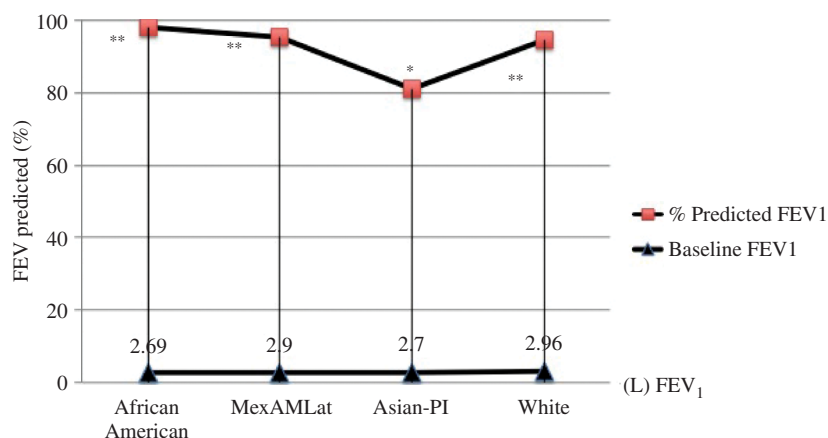


FIGURE 3.—FEV₁ percent predicted and baseline FEV₁ by ethnicity: $N = 44$.

Note: * $p < 0.002$, Asian-PI, **NS.

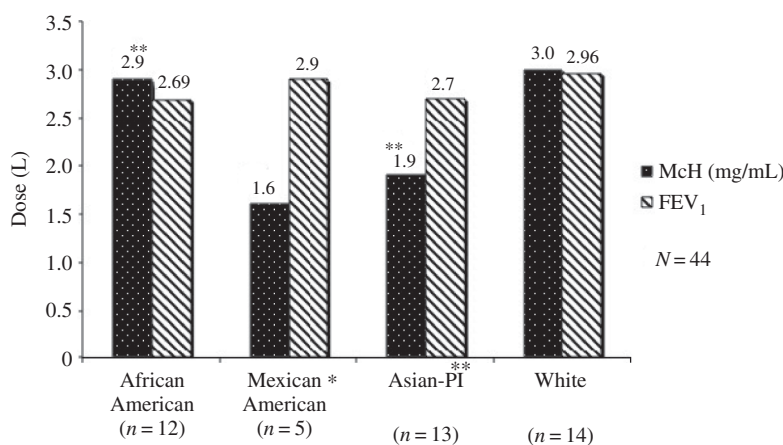


FIGURE 4.—Baseline FEV₁: maximal doses of methacholine at PC₃₀ by ethnic group.

Note: *Includes Latino & Hispanics, ** $p < .05$ dose McH at PC₃₀, ***dose (mg/mL) of methacholine at PC₃₀.

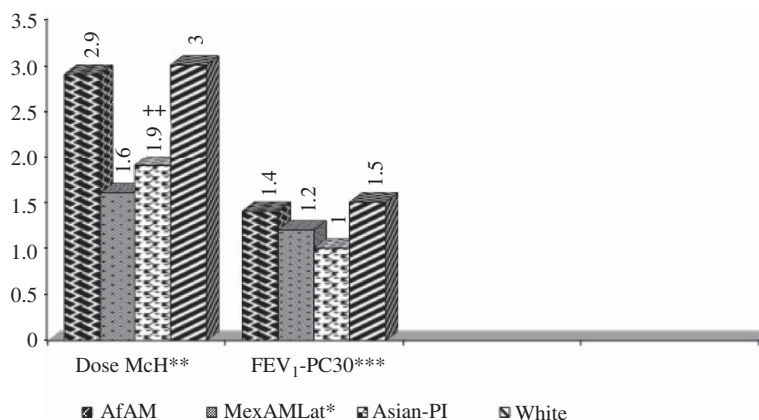


FIGURE 5.—At PC₃₀: mean doses of methacholine and mean FEV₁ by ethnicity: $N = 44$.

Notes: *MexAMLat & Hispanic, ** $p < .05$ Asian-PI: all other doses.

McH = NS, **mg/mL, ***reported in liters.

then accuracy in determining the exact differences in baseline FEV₁ percent predicted values between these two ethnic groups is possible. Irrespectively, being female and an Asian-PI may pose a risk factor for increased BHR and thus increased airflow obstruction during acute asthma episodes.

The presence of both increased atopy and nocturnal awakenings for Asian-PI women warrants further exploration (Figures 1 and 2) (21–24). Several researchers have reported both increased asthma symptoms and moderate atopic skin responsiveness in immigrant pediatric Asian populations (23–26). Levin et al. examined

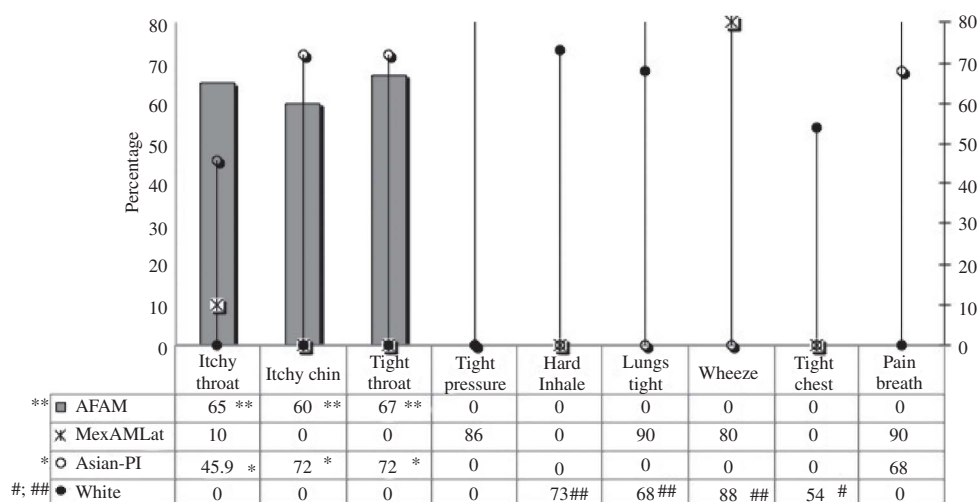


FIGURE 6.—Word descriptors at PC₃₀ by ethnicity and frequency ($N = 44$).

Notes: Significant word descriptors: *Asian PI: $p < 0.001$ (itchy throat, itchy chin, constricted throat), **AFAM = $p < .01$ (itchy throat, itchy chin/face, tight throat), ***Whites: $p < .01$ (tight chest), **** $p < .001$ (hard to inhale, lungs tight, wheeze).

the degree of atopy with BHR in AFAM teenagers (27) and noted an association between allergic rhinitis and BHR. However, studies of adult asthmatics that examine the relationship between atopy and dose of McH are lacking. However, the complex relationship between family histories, allergies, and environmental factors must be elucidated if risk factors for Asian populations are to be identified (24–26). Worth noting is that three of the five Mexican-American-Hispanic women reported weekly nocturnal awakenings and these same individuals had more than four pin-prick responses to aeroallergens (3, 26, 28).

We confirmed a mean PC₃₀ dose of McH of 1.6 mg/ML for MexAMLat women that strongly suggested the presence of BHR (29) (Figures 4 and 5). Although the small sample size for the MexAMLat women limits generalization, these findings illustrate the importance of recruitment of minorities into research studies in order to understand and explain ethnic airway variability and airway hyperresponsiveness (AHR) (5–7, 10, 29). In a prior study (16) that included both males and females, we documented a significant difference at PC₃₀ in McH dose between AFAM and whites, but when comparing only females this difference was lacking.

We noted significant differences at PC₃₀ in EWD or symptom reporting based on ethnicity (Figure 6). To avoid the possibility of researcher bias in the translation of word descriptors (EWDQ), only English-speaking subjects were included with English as the written language for all the subjects. We reported that Asian-PI and AFAM women used upper airway word descriptors compared to the lower airway word descriptors used by Mexican-American-Hispanic and white women (4, 10, 28, 30, 31). It was essential to rule out if vocal cord disorder (VCD) was a factor for the upper airway word descriptors (20). The director of the pulmonary function laboratory, a pulmonologist, examined all the flow-volume loops of subjects for VCD and all the flow-volume curves showed no evidence

of a plateau. Laryngoscopy was not preformed to rule out VCD. One explanation for these unique EWD is that linguistic and qualitative differences in how symptoms caused by bronchoconstriction are described may represent different pathophysiological pathways compared to dyspnea thereby resulting in different qualities of verbal descriptors (25, 28, 30). In examining why asthma prevalence was greater in US born Asian Americans compared to foreign born, Greenfield et al. (26) suggested that language translation of asthma systems was a factor. They reported that “wheeze” when translated into Cantonese meant “a sound from the throat.” Studies that examine linguistic interpretations of asthma symptoms for adult Asian Americans are rare. If asthma management for ethnic groups is to improve then integration of EWDs for symptom reporting is a must. Whether cultural differences influence how symptoms are described also requires validation. Ethnic differences in airway pathophysiological pathways or adrenergic responsiveness are documented but, at present, very few bronchoconstrictor studies of asthmatic Asian-PIs are available (3, 13, 23, 28).

Han et al. (30) collected and translated from the Chinese patients experiencing bronchoconstriction the effort aspect of symptom descriptions using factor-loading analysis to categorize spontaneously elicited symptom descriptors. They wanted to determine whether cultural/ethnic and language descriptors correlated with the traditional medical terms of dyspnea or effort of breathing. It is common in Chinese culture that bodily symptoms are expressed as emotional experiences (30) and they reported that respiratory complaints for Chinese patients reflected this cultural linguistic domain. Han et al. noted that several of the linguistic Chinese word descriptors, *blocked chi* and *blocked chi in the throat*, correlated moderately with the dyspnea-affective factor (30). In other words the linguistic descriptor *blocked chi* was associated with breathing effort that is a westernized

word descriptor. Interestingly, the linguistic term *blocked chi*, and as we have reported *tight throat*, may represent a comparable physiological symptom besides being linguistically unique (10, 12, 13, 23–25). Han et al. supported the need to expand linguistically the current word descriptors, language of breathlessness (10, 31), but how to incorporate both ethnic and minority diversity will be challenging.

Several factors may explain gender-specific differences (female) in bronchoconstrictor responsiveness and symptom reporting (2–9, 12, 13). First, hormonal factors or monthly variability of these hormones has been correlated with severity of asthma symptoms (4–7, 9). A link has been demonstrated between increased levels of endogenous estrogen as an inflammatory marker for airway inflammation in premenstrual women with asthma and BHR (32–36). Second, the role of estrogen receptor (ER) isoforms, ER α & ER β , in modulating signaling pathways of airway smooth muscles with inhibition of intracellular Ca²⁺ may explain increased premenstrual asthma symptoms (37). Unfortunately, data that included menstrual cycle, estrogen level, or birth control usage were not collected. However, collecting this sex-specific data for females is essential to determine the link between BHR and hormonal factors (32–37). Equating hormonal changes as the only major factor for BHR in women is shortsighted since other physiological mechanisms are likely involved (13).

Another concern was whether a lack of asthma control or overreporting of symptoms contributed to the difference in airway responsiveness (BHR) for the Asian-PIs especially compared to whites. We assessed for asthma control in all the subjects prior to study participation. Our demographic questionnaire included questions about the use of inhaled or oral corticosteroids, number of urgent visits to an emergency room (ER) or physician, use of antibiotics, hospitalizations, and symptom frequency in the last year (10). None of the Asian-PI subjects reported any urgent care visits (ER or a physician), any use of corticosteroids, or any significant changes in their asthma. These data strongly suggest adequate asthma control, but to elucidate the relationship between BHR and upper airway word descriptors for Asian-PIs requires further research.

Several studies have examined how gender influences symptom reporting and whether women overreport their asthma symptoms compared to men (2, 4, 7, 9, 21) since this may or may not indicate increased severity or responsiveness. A more reasonable assumption is that women are more likely to report respiratory complaints since symptom verbalization is more socially acceptable (6, 21), whereas for men, it is socially less acceptable to go into a great depth when explaining their physical complaints (7, 21). Other possible explanations for gender differences include environmental influences, work settings, and immunological factors (5, 7, 13, 33–37, 39). How country of origin or childhood exposure to smoking influences BHR across ethnic groups requires further studies. Not only are gender differences difficult to

confirm but when including ethnicity into the mix further clouds this very complex issue.

One of the limitations of our study was the sample size ($N = 44$) especially for Mexican-American, Latino women. In an earlier publication (38), we reported the barriers to the recruitment of ethnic minorities into research studies particularly for Mexican-American (29), Latino, and Asian-PI subjects. The fear for Mexican-American, Latino subjects, or their family members is if they lack legal status as a US citizen this hinders their participation in research. Although, this was a sub-analysis of a larger study sample, we considered the findings to be invaluable in guiding future studies to examine how ethnic differences in women influence symptom reporting and, in turn, clinical management. We collected data on whether the subjects were US or foreign born but we did not analyze whether the length of time (residency) in the United States influenced how they described their asthma symptoms. All of our subjects used English (spoken and written) to avoid researcher bias in back translation with non-English written word descriptors. The lack of predicted PFT reference values specific to Asian-PIs was a major limitation and based on research by Hankinson (18) it is likely that Asians have reduced PFT reference values compared to whites.

CONCLUSION

Definitive conclusions are difficult to assert due to the lack of asthma studies that have examined or even reported data on the effects of ethnicity in women. Defining the relationship between BHR, ethnicity, female gender, and word descriptors remains in its infancy. In addition, even less is known about Mexican-American-Hispanic and Asian-PI women in regard to their asthma symptoms, BHR, and treatment outcomes (24, 25, 29). If both gender and ethnicity were reported as nonaggregate data then differentiating the inter-relationships between gender, ethnicity, word descriptors, and airway responsiveness would be possible. This is one of the first studies to report BHR during induced bronchoconstriction for Asian-PI women. However, until predicted PFT reference values for Asian-PIs are confirmed then the reliability of PFT and McH data will be questioned (10, 12, 18). To assume that Asian-PIs and whites share a comparable level of lung function requires validation. Because Asian-PI and AFAM women shared a common language of upper airway word descriptors, this strongly suggests that both ethnic groups may share a risk for more acute or severe asthma episodes. Another risk is undertreatment of their asthma symptoms for both ethnic groups because of their linguistically unique upper airway word descriptors since these words are not traditionally associated with acute asthma episodes (10, 30). These differences in ethnicity and symptom reporting have significant implications for asthma management that incorporates culturally and ethnically sensitive education and symptom assessment. The independent effects of ethnicity, atopy, and AHR in females must be established to determine those

individuals who are at risk for acute asthma episodes. Asthma management must be tailored to meet the cultural and ethnic diversity of asthma patients since the belief that one asthma management plan meets the needs for all asthma patients no longer applies.

ACKNOWLEDGMENTS

G. E. Hardie, Ph.D., authored this manuscript. Warren M. Gold, M.D., and James K. Brown, M.D., provided editorial comments. The authors gratefully acknowledge the participants in this study for their willingness to participate. The author thanks G. Managapant for the statistical assistance.

This study was funded by a Research in Minority Institutions award (5 P2-RR11805) from the Center of Resources for funding from the office of Minority Health, National Institutes of Health (NIH), Bethesda, MA, USA.

DECLARATION OF INTEREST

Grace E. Hardie, Ph.D., Warren M. Gold, M.D. and James K. Brown, M.D. report no conflicts of interest.

STATEMENT OF PUBLICATION

This is to confirm that this manuscript has not been published elsewhere nor has it been submitted simultaneously for publication elsewhere (Grace Hardie, PhD).

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