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Pulmonary Function Among Latino Thoroughbred Workers - A Pilot Study

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PULMONARY FUNCTION AMONG LATINO THOROUGHBRED WORKERS - A PILOT STUDY

CAPSTONE PROJECT PAPER

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By

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Disclosure Statement

The author certifies that he will take public responsibility for the content and provide any relevant data upon request. The author also certifies that he has contributed substantially to conception, design or analysis, and interpretation of the data, drafting or revision of content, and approval of the final version. The author also confirms that the content has not been published elsewhere and does not overlap or duplicate their previously published work.

Abstract

Background/Objectives

Evidence suggests working in horse barns is associated with adverse respiratory effects among Latino thoroughbred workers, yet no studies to date have measured pulmonary function. We examined the prevalence of self-reported respiratory symptoms, abnormal pulmonary function, and associated occupational factors among Latino thoroughbred farmworkers.

Methods

Participants were recruited via a community-based, purposive sampling strategy and participated in an interview-administered survey and spirometer test. Surveys and spirometry tests were administered to 80 participants by two trained health promoters (*Promotoras*) in July-September 2014. Pulmonary function (abnormal/normal) was classified by a pulmonologist. Demographic and occupational factors were assessed for associations with respiratory outcomes by multivariate logistic regression.

Results

Participants were primarily male (74%) and of Mexican nationality (76%), while 21% were current smokers, 18% were former smokers, and 61% had never smoked. On average, participants were 37 years old, had lived in the U.S. for 17 years, and were employed for 5 years at a current horse farm. Participants reported working in a barn an average of 21 hours/week and working in dusty conditions an average of 22 hours/week. Few participants reported wearing a dust mask in the barn (27%), and among all participants, 94% reported infrequent dust mask utilization. A large proportion (79%) of participants reported experiencing upper and/or lower respiratory symptoms in the past

12 months. The prevalence of physician or nurse diagnosed asthma was 18% and the prevalence of abnormal pulmonary function was 27%. Among those with abnormal pulmonary function, one participant had obstructed spirometry, while the remainder had restricted spirometry. Multivariate logistic regression indicates that a shorter duration of horse farm employment (≤5 versus >5 years) and a shorter time living in the U.S. (≤10 versus >10 years) increased the odds of abnormal pulmonary function (Years of current horse farm employment: OR = 6.3, 95% CI = 1.15-34.35; Years living in the U.S.: OR = 5.2, 95% CI = 1.3-20.6).

Conclusions

Latino thoroughbred workers may be at risk for adverse respiratory conditions due to chronic exposure to dusty barn environments and limited use of dust masks. Future research will further clarify the occupational and social factors affecting the respiratory health of this worker group. Promoting safety education regarding occupational respiratory risks and the use of dusk masks may help to improve the respiratory health of this vulnerable worker group.

Introduction

Latino agriculture workers are a vulnerable population with a heightened risk for occupational illness and injury. The risk of a Latino agriculture worker being injured on the job is seven times that of non-Latino workers (BLS 2006). Accordingly, the National Institute of Occupational Safety and Health (NIOSH) considers the Latino workforce a priority population for lessening occupational safety risks (NORA AgFF Sector Council, 2008). Livestock production is an especially dangerous segment of agriculture (Meyers and Chapman, 2001) and one livestock subgroup with little attention to date is the thoroughbred breeding industry. There are approximately 460,000 employees in the thoroughbred industry and nearly two-thirds of those workers are Latino or foreign born (AHC, 2005), thereby necessitating investigation of the factors impacting the occupational health of Latino thoroughbred workers.

Based on the limited number of studies investigating the occupation hazards of thoroughbred work, evidence suggests that Latinos may be more susceptible than non-Latinos to occupational hazards. For example, Swanberg et al. (2013) found Latinos working on horse farms in the southeast U.S. were more likely to be struck or kicked by horses than non-Latinos and that the most frequent injuries acquired by Latino workers were kicks from horses and musculoskeletal discomfort. Thus, it is likely that Latinos may also be at a heightened risk for other occupational injuries commonly associated with thoroughbred farm work, such as bites and falls from the horse (Douphrate et al., 2009; Langley and Morris, 2009; Lofqvist et al., 2009; Iba et al., 2001), and adverse pulmonary effects related to chronic occupational exposure to dust containing various

respiratory toxins found in or near the horse barn (Cho et al., 2010; Elfman et al., 2009, Samadi et al., 2009; Curtis et al., 1996; Mackiewitcz et al., 1996).

The risk of respiratory exposures and subsequent adverse respiratory effects may be increased for Latino thoroughbred workers due to chronic occupational exposure to organic and inorganic dust. Work tasks that tend to be associated with high levels of dust exposure include those that increase airborne dust concentrations in the workers' breathing zone, such as mucking, sweeping, and feeding horses (Curtis et al., 1996; Samadi et al., 2009). Working near to livestock has also been shown to increase exposure to respiratory toxins (O'Shaughnessy et al., 2010). In addition, horse bedding type (e.g. straw versus paper), level of barn air ventilation, and time of year may also impact the concentration of respirable dust found in horse barns (Wålinder et al., 2011; Elfman et al., 2009; Curtis et al., 1996). Furthermore, in one of the few studies to conduct dust sampling on U.S. horse farms, Cho et al. (2010) found that potential exposures to high levels of dust may also occur in areas surrounding the horse barn.

Dust found in horse barns contains a variety of respiratory toxins, which may adversely impact worker health. For example, dust samples from horse barns have yielded high concentrations of organic dust containing endotoxins (Samadi et al., 2009; Mackiewicz et al., 1996), Beta 1-3 Glucans (Elfman et al., 2009; Samadi et al., 2009), horse hair and dander (Tutluoglu et al., 2002), ammonia (Curtis et al., 1996), hydrogen sulfide (Elfman et al., 2009), in addition to sawdust, metal, and silica particles (Mazan and Hoffman, 2006). Subsequently, respiratory conditions have been reported for horse worker populations including: high rates of asthma (Kimball-Dunn et al., 1999), bronchial obstruction (Elfman et al., 2009), dyspnea (Kimball-Dunn et al., 1999), chronic

bronchitis (Gallagher et al., 2007; Melbostad et al., 1997), upper and lower respiratory symptoms (Swanberg et al., 2015) and allergic reactions to horse dander and hair (Tutluoglu et al., 2002). Furthermore, Mazan et al. (2009) found New England equine workers reported significantly higher rates of self-reported respiratory symptoms relative to a reference population not exposed to barns or horses.

Spirometry is an important tool in assessing the impacts of occupational exposures upon pulmonary function. Objective measures of pulmonary function, such as spirometry, provide a less biased perspective on lung health than self-reported symptoms alone, as decreased pulmonary function may not always be accompanied by upper or lower respiratory symptoms (Iversen and Dahl, 2000) and self-reported symptoms may be subject to recall bias. In addition, spirometry may also be helpful in detecting early stages of respiratory disease prior to symptomology onset (Petty, 2000).

Spirometry has been used previously to establish associations between acute and chronic agriculture respiratory exposures and pulmonary function. For example, Eastman et al. (2013) found that dairy workers experienced a within-worker cross-shift decrease in pulmonary function, while Donham et al. (2000) found poultry workers exhibited a within worker cross-shift decline in pulmonary function, both presumably due to respiratory exposures. Duration of employment may also impact pulmonary function, as Rodriguez et al. (2014) found evidence of restrictive lung function associated with a greater number of years in agriculture work among Latino workers and Donham et al. (1995) found swine workers exhibited decreased pulmonary function after six years of employment. Finally, associations have also been detected between decreased pulmonary function and exposure to endotoxins encountered in dairy work. For example, dairy

farmers may experience a decrease in pulmonary function associated with increasing shift duration and subsequent endotoxin exposure levels (Eastman et al., 2013; Mitchell et al., 2015). As endotoxins are likely one of the respiratory irritants frequently encountered by Latino thoroughbred workers in the horse barn, it is possible that reduced pulmonary function may be prevalent in this worker group.

The only study to date that has assessed the respiratory health of Latino thoroughbred workers suggests that there is a potential association between occupational exposures and adverse respiratory health outcomes in Latino thoroughbred workers. Swanberg et al. (2015) found that 62% of Latino thoroughbred workers reported respiratory symptoms and that 44% reported a cough in the last year. Furthermore, infrequent dust mask use was associated with increased odds of reporting upper respiratory symptoms. These results suggest that the horse barn contains respiratory toxins that may adversely impact worker respiratory health and that more frequent use of dusk masts may decrease respiratory toxin exposures.

No studies to date have assessed pulmonary function among Latino thoroughbred workers. In this study we examined two questions regarding Latino thoroughbred workers: 1) What is the prevalence of abnormal pulmonary function and self-reported respiratory symptoms?; and 2) What occupational and demographic factors are associated with pulmonary function and self-reported respiratory symptoms? We hypothesized that Latino thoroughbred workers may experience a high prevalence of abnormal pulmonary function (and respiratory symptoms), potentially associated with high levels of chronic exposure to dust on the horse farm. Furthermore, we hypothesized that dusk masks may provide protection from respiratory hazards such that high levels of self-reported dust

exposure and frequent use of dust masks may be associated with a lower prevalence of abnormal pulmonary function (and respiratory symptoms), whereas infrequent dusk mask usage may be associated with a high prevalence of abnormal pulmonary function (and respiratory symptoms).

Methods

We conducted a cross-sectional study investigating self-reported respiratory symptoms and pulmonary function among 80 male and female Latino thoroughbred workers. Eligibility criteria required participants to be eighteen years or older and employed in the thoroughbred industry for at least nine of the past twelve months. Those with surgery in the past three months were excluded. Participants were recruited by two Spanish-speaking community health promoters (*Promotoras*) through a community-based purposive sampling approach (e.g, local parks, Latino cultural events, and via social connections). Surveys and pulmonary function tests were conducted between July and September of 2014. Approval for the study was granted by the University of Kentucky Institutional Review Board.

Training

Promotoras were trained in questionnaire administration, human subjects' protection, and research ethics by study personnel and spirometry training was conducted by a pulmonary physician. Quality control of survey administration and data occurred via weekly meetings between *Promotoras* and study personnel to obtain feedback on survey administration and recruitment methodologies as well as a review of data quality. The quality of spirometry tests were evaluated by the pulmonary physician (DM) to ensure

high quality spirograms and reproducible results. Those surveys with missing information and spirometry tests of low quality were re-administered to participants, when possible.

Participation and study results

Participants received a $15.00 Wal-Mart gift card for participation in the study as well as information about various community resources. Results of the pulmonary function tests were reported in writing to participants in October 2014. The location and contact information for local clinics with Spanish-speaking health care providers were also included with participants' results in order to provide further review of the pulmonary function tests, if desired.

Measures

Participants were given a 40-item questionnaire that was administered in either Spanish or English. The questionnaire was developed through integrating items from National Agricultural Workers Survey (NAWS), the Burden of Lung Disease Survey (BOLD), clinical diagnostic questions used to ascertain the presence or absence of pulmonary disease, as well as questions used in previous studies with this population (Swanberg et al. 2013, 2015).

Demographics

Demographic questions were taken from the National Agricultural Workers Survey (NAWS). Gender was recorded as male or female and age was measured as the number of years since birth. Age was later condensed to three levels (≤30, 31-40, and >40) for statistical analysis. Nationality was measured as Mexican, Mexican American, Guatemalan, Honduran, or other. Length of time living in the U.S. was recorded in years and was collapsed to ≤ 10 years and > 10 years for statistical analysis. Participants'

smoking status was recorded as: current, former, or never smoker. Educational attainment was assessed on an ordinal scale, including grade school, high school/GED, some college, associate, bachelors, and master's degree or higher, with participants noting the highest level of education completed. Educational attainment was later condensed to low (high school or less) or high (greater than high school education) for statistical analysis.

Occupational Exposure Factors

Length of time working at the current horse farm was recorded in years. This was later collapsed to ≤ 5 years and > 5 years. Participants were asked if they worked in a barn and this response was recorded as "yes" or "no". Length of time working in barns per week was measured in hours and was later condensed to ≤ 20 hours/week and > 20 hours/week. Length of time working in dusty environments per week was measured in hours and this was collapsed to ≤ 20 hours/week and > 20 hours/week for statistical analysis. The frequency of dust mask use in the barn was ascertained via a Likert scale comprised of never, seldom, sometimes, often, or always/almost always. This was later condensed to infrequent (never, seldom, and/or sometimes) and frequent (often, or always/almost always) dust mask usage. Presence or absence of dusk mask use was calculated with "never" coded as "absence" and "seldom, sometimes often, or always/almost always" coded as "presence".

Respiratory Symptoms

Respiratory symptoms were assessed by examining self-reported upper and lower respiratory symptoms via questions taken from the Burden of Lung Disease Survey (BOLD). Upper respiratory symptoms included nasal irritation, throat irritation, and sinus trouble, while lower respiratory symptoms included cough, wheezing, chest tightness,

shortness of breath, and difficulty breathing. These symptoms were condensed to upper (any or all upper respiratory symptoms), lower (any or all lower respiratory symptoms), and any respiratory symptoms (any upper and/or lower respiratory symptoms). Participants were also asked whether respiratory symptoms improved when away from the barn for greater than one day. Pre-existing respiratory conditions including physician or nurse-diagnosed asthma and chronic obstructive pulmonary disease (COPD) were assessed by asking whether a physician or nurse has told the participant they have the condition (yes/no). The presence of allergies to house dust and animal dander, as well as skin irritation and hay fever was determined with yes/no response options.

Pulmonary Function

Participant respiratory health was measured by *Promotoras* with the Easyone spirometer (ndd Medical Technologies, Zurich, Switzerland). Pulmonary function tests were reviewed for diagnostic quality by the pulmonary physician and those tests of low quality were re-administered at a later date. The highest quality trial among three or more trials was used for pulmonary function classification. Participant spirograms were reviewed by a pulmonary physician at the University of Kentucky and were recorded as normal or abnormal. Abnormal pulmonary function was further categorized as restrictive or obstructive lung function. Abnormal pulmonary function was defined based on predictive pulmonary function comparison values for Mexican-Americans regarding gender and age versus forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) obtained from the National Health and Nutrition Exam Survey (NHANES III) by Hankinson et al. (1999). Abnormal pulmonary function was defined as FEV1 / FVC < 0.70 and FEV1 < 0.80, while normal pulmonary function was defined as

FEV1/FVC ≥0.70 and FEV1 ≥ 0.80 of predicted by NHANES III data. Restrictive lung function was defined as FEV1 < 0.80 and FVC < 0.80, while obstructive lung function was defined as FEV1 / FVC < 0.70 as predicted by NHANES III.

Statistical Analyses

SPSS version 22 (IBM Corp, Armonk, NY) was used to calculate basic descriptive statistics (mean, standard deviation, minimum and maximum values), chi-square tests, and multivariate logistic regressions. Bi-variate analyses of association between demographic and occupational factors and respiratory symptoms were assessed for statistical significance via Chi-square with an alpha value of 0.05. Continuous variables to be used in statistical analyses as dichotomous variables were generated by condensing quartiles and investigating frequency histograms for break points in the distribution.

A multivariate logistic regression was calculated to ascertain the adjusted odds of respiratory symptoms and abnormal pulmonary function occurring as a function of specific occupational and non-occupational factors. Covariates included in the model were selected based on factors found to impact pulmonary function and respiratory symptoms in past studies as well as those factors with significant bi-variate associations with the presence abnormal pulmonary function and respiratory symptomology. Collinearity and multicollinearity of covariates were assessed via correlation matrices and variance inflation factor (VIF) values to ensure reliable regression coefficients. Collinearity and multicollinearity were considered present with a significant Pearson correlation coefficient greater than 0.4 and a VIF value greater than 10 (O'Brien 2007).

Results

Demographics

A total of 80 participants were recruited to participate in the study. Participants were primarily male (74%) and, on average, 37.7 years old (SD = 10.9, Range = 18-65). When condensed into age categories, 25% of participants were ≤30, 40% were 31-40, and 35% were >40. Participants were primarily of Mexican nationality (76%), while 16% were Mexican-American, 5% were Guatemalan, and 2.5% were Honduran. Among participants, 21% were current smokers, 18% were former smokers, and 61% had never smoked. Participants had lived in the U.S. for an average of 16.7 years (SD = 9.8, Range = 1.2-39). When condensed to two categories, 29% of the participants had resided in the U.S. for ≤10 years and 71% for >10 years. Approximately half of the participants had high educational attainment (57%), while 43% had low educational attainment. (Table 1)

Occupational Exposure Factors

Participants were employed on average for 5.4 years at the current horse farm (SD = 4.5, Range = 1-30). When time on current farm was condensed to two levels, 56% of participants had worked on the current horse farm for ≤5 years and 44% had worked on the current horse farm for >5 years. Most participants (96%) reported working in a barn with an average of 21 hours/week spent working in the barn (SD = 13.6, Range = 0-60). Participants reported working in dusty conditions an average of 22 hours/week (SD = 13.4, Range = 2-52). When condensed to two levels of dust exposure, 56% reported working in dusty conditions for ≤ 20 hours per week and 44% reported working in dusty conditions for > 20 hours per week. Among participants, 28% reported wearing a dust

mask when working in the barn and 94% of the total sample infrequently (never, seldom, and/or sometimes) wore dust masks in the barn. (Table 1)

Respiratory Symptoms

A large proportion of participants (79%) reported experiencing upper and/or lower respiratory symptoms in the past 12 months. Furthermore, among participants, 51% reported upper respiratory symptoms and 69% reported lower respiratory symptoms in the past 12 months. The prevalence of individual respiratory symptoms ranged from 19% to 56%: 56% reported a cough, 24% reported wheezing, 24% reported chest tightness, 30% reported shortness of breath, 19% reported difficulty breathing, 30% reported nasal irritation, 30% reported throat trouble, and 19% reported sinus trouble. A large proportion of participants (70%) reported that respiratory symptoms improved when they were away from the barn for greater than one day. The prevalence of physician or nurse diagnosed asthma was 18%. One participant reported COPD (1.3% prevalence), while the prevalence of allergy to house dust was 16.3% and the prevalence of allergy to animal hair or dander was 2.5%. Skin irritation was reported by 10% of participants and 3.8% reported having been told they that have hay fever by a doctor or nurse.

The number of years living in the U.S. was significantly associated with upper respiratory symptoms and was marginally correlated with lower or any respiratory symptoms. The number of years working on the current horse farms was significantly associated with lower and any respiratory symptoms. The proportion of those participants ≤30 years of age who reported lower respiratory symptoms (90%) was greater than the proportion in the 31-40 and >40 age groups. All other age categories, dust exposure, barn

work, and use of dust masks were not significantly associated with self-reported respiratory symptoms. (Table 2)

Pulmonary Function

We administered 80 spirometry tests and used 79 in our analyses. One participant's pulmonary function test was not used due to poor quality and an inability to re-contact the participant for re-testing. The prevalence of abnormal pulmonary function was 27%. Among those with abnormal pulmonary function, one participant showed signs of obstructive lung function, while the remaining twenty showed signs of restrictive lung function. Those workers with less time working on the current horse farm and those who lived in the U.S. for a shorter duration had significant bi-variate associations with abnormal pulmonary function. Gender, age, job type, dust exposure, barn work, and use of dust masks were not significantly associated with pulmonary function, although a general trend existed such that increased exposure to dust and the barn, never wearing a dust mask, and infrequent use of a dust mask were associated with an increased prevalence of abnormal pulmonary function. (Table 2)

Multivariate Associations

A full multivariate model was analyzed for associations between occupational and demographic factors and the odds of abnormal pulmonary function and of upper, lower, or any respiratory symptoms (Table 3). Correlation matrices revealed years in U.S. and years on current farm were significantly correlated (Pearson correlation = 0.226, $p = 0.04$), yet this was below the level of 0.4 correlation for suggested multicollinearity and/or collinearity. Furthermore, collinearity diagnostics revealed no VIF levels that would suggest multicollinearity or collinearity among covariates (VIF ≥ 10) in any of the

models, as all VIF values for covariates included in the model were <1.6. To further validate the rationale of inclusion, the elimination and inclusion of either years on current farm or years in the U.S. had no significant impact on overall model significance, adjusted odds ratios, or variance estimates. Thus, years on current farm and years in U.S. were included in the models to estimate the association of both occupational factors (years on current farm) and non-occupational factors associated (years in U.S.) with pulmonary function and symptomology.

The multivariate logistic regression model was significant for abnormal pulmonary function (Omnibus Chi-square test of model coefficients = 18.222, 9 df, p=0.030, Magelkerke R^2=0.312). The model indicates that a shorter duration of current horse farm employment (≤5 versus >5 years) increased the adjusted odds of abnormal pulmonary function (OR = 6.3, 95% CI = 1.15-34.35) and a shorter duration of time living in the U.S. (≤10 versus >10 years) increased the adjusted odds of abnormal pulmonary function (OR = 5.2, 95% CI = 1.3-20.6). The model also demonstrated that participants ≤30 of age years had a decreased odds of abnormal pulmonary function relative to those >40 years of age (OR=0.12, 95% CI = 0.02-0.80) and that those participants aged 31 – 40 years also had a decreased odds of abnormal pulmonary function relative to those participants greater than 40 years of age (OR=0.10, 95% CI =0.02-0.56). All other covariates in the model were non-significant for predicting abnormal pulmonary function.

The multivariate logistic regression model was not significant for self-reported upper respiratory symptoms (Omnibus Chi-square test of model coefficients = 12.02, 9 df, P=0.212, Magelkerke R^2=0.20). The only significant covariate in the model was years

living in the U.S.: A shorter duration of time living in the U.S. (≤10 versus >10 years) increased the adjusted odds of participants reporting upper respiratory symptoms (OR = 4.0, 95% CI = 1.17-13.3).

The multivariate logistic regression model was significant for self-reported lower respiratory symptoms (Omnibus Chi-square test of model coefficients = 19.93, 9 df, P=0.018, Magelkerke R^2=0.321). The model indicates that a shorter duration of current horse farm employment (≤5 versus >5 years) increased the adjusted odds of self-reported lower respiratory symptoms (OR = 4.5, 95% CI = 1.2-16.8). All other covariates were not significant in the model for predicting lower respiratory symptoms.

The multivariate logistic regression model was not significant for upper and/or lower self-reported respiratory symptoms (Omnibus Chi-square test of model coefficients = 14.4, 9 df, P=0.11, Magelkerke R^2=0.262). No covariates were found to be significant in the model for predicting the presence of any upper and/or lower respiratory symptoms.

Discussion

This is the first study to measure pulmonary function among Latino thoroughbred workers. We found that Latino thoroughbred workers experience a prevalence of abnormal and restrictive pulmonary function that is much higher than the general Mexican-American population, suggesting differing exposures may be present for Latino thoroughbred workers than the general Mexican-American population. For example, NHANES III data (2007-2010) showed that Mexican-Americans had an overall 12.5% prevalence of abnormal pulmonary function, with 6.2% showing signs of restrictive lung function and 6.3% showing signs of obstructive lung function (Ford et al. 2013). By

comparison, participants in this study had an overall prevalence of 27% for abnormal lung function with 25% showing signs of restrictive lung function and 2% showing signs of obstructive lung function. These comparisons raise concern about the potential for the thoroughbred farm work environment to adversely impact Latino thoroughbred worker respiratory health.

Decreased pulmonary function, specifically restrictive patterns, related to occupational exposures have been described among grape workers (Gamsky et al.,1992), dairy workers (Eastman et al., 2013), poultry workers (Donham et al., 2000), and swine workers (Donham et al., 1995; Rodriguez et al., 2014), yet this is the first of reported restrictive lung function in Latino thoroughbred workers. We found the majority (20/21 cases) of those participants with abnormal pulmonary function had evidence of restrictive lung function, which is a consistent with exposure to respiratory toxins found in organic dust, such as endotoxins and mold. Similar restrictive lung function results have been found among compost workers (Bünger et al., 2007) and pig farmers (Vogelzang et al., 1998) exposed to organic dust and related respiratory toxins. Thus, in conjunction with past agriculture studies with similar respiratory exposures, our results suggest that the thoroughbred farm occupational environment may adversely impact the pulmonary function of Latino thoroughbred workers.

Our results also demonstrate a high prevalence of self-reported respiratory symptoms (79%) in Latino thoroughbred workers, which may be associated with occupational exposure to respiratory toxins. For example, 56% of participants in this study reported a cough, which is relatively consistent with the prevalence of cough (44%) found in this study population previously by Swanberg at al. (2015) and is suggestive of

lower respiratory irritation generated, in part, by occupational exposure. Furthermore, our detected prevalence of cough is much greater than the 5% prevalence of chronic cough found for Mexican-Americans in the NHANES III study (Arif et al. 2003). Although we did not measure chronic cough in this study, in conjunction with a high prevalence of abnormal pulmonary function and respiratory symptoms, these results further suggest Latino thoroughbred workers may be exposed to respiratory toxins in the occupational environment, which may result in respiratory irritation.

Occupational respiratory exposures, including organic dust, are believed to contribute significantly to the prevalence of asthma in adults (Sigsgaard and Schlünssen, 2004). The development of occupational asthma may be a risk for Latino thoroughbred workers due to the potential for chronic exposure to organic dust and associated respiratory toxins encountered on thoroughbred farms. Although we did not diagnose occupational asthma, we found an 18% prevalence of professionally diagnosed asthma in our sample of Latino thoroughbred workers. This prevalence is higher than the 10% prevalence found in Latino poultry workers (Mirabelli et al. 2010), as well as the 12% prevalence reported for Hispanic non-white livestock workers (Schenker et al., 2005), and also the 3% prevalence reported for Mexican-Americans in NHANES III (Arif et al. 2003). These results suggest that the thoroughbred farm occupational environment may be associated with the development of asthma in this worker group.

A large proportion (70%) of participants in our study reported an improvement in respiratory symptoms when they were away from the work environment for more than one day. This improvement of respiratory symptoms when removed from the occupational environment is a clinical diagnostic indicator for the presence of

occupational lung disease (Hughson, 2005). Thus, in conjunction with a high prevalence of self-reported respiratory symptoms and abnormal pulmonary function, these results further point towards the presence of occupational respiratory irritants associated with the thoroughbred work environment.

Our results highlight the importance of evaluating previous respiratory exposures that may contribute to occupational-related pulmonary function. We found that recent arrival in the U.S. increased the odds of abnormal pulmonary function by 5 times. Although not an explicit measure or prior exposure, one plausible explanation for our findings is that those new to the U.S. may have previous respiratory exposures, in their country of origin, which may have adversely impacted their pulmonary function prior to horse farm exposures. For example, exposure to air pollutants have been documented to reduce lung growth in children from southern California and Mexico City, and such pollutants may also accelerate lung aging in adults (Götschi et al., 2007). However, among children, relocation to an area of lower air pollution levels may help to improve pulmonary function (Avol et al., 2001), yet it is not known whether such improved function also occurs for adults when relocated. It is also possible that exposures to respiratory toxins, such as endotoxins and Beta 1-3 Glucans, found in low quality housing in participant's country of origin, may also contribute to lower pulmonary function in those newer to the U.S. than those who have lived in the U.S. for a longer duration.

Counter to our hypotheses, we did not find a significant association between self-reported respiratory symptoms and infrequent use of dust masks, as was previously detected in this worker group by Swanberg et al. (2015). One plausible explanation for

this difference is the fact that few of the workers in our study used dust masks in the barn (29%), and 94% of our sample population used them infrequently (never, seldom, and/or sometimes), making any protective benefit of dust mask usage difficult to detect in our relatively small sample size and subsequent limited statistical power. In addition, despite a similarly low frequency of dust mask utilization to our study, Swanberg et al. (2015) collected data during the winter months, whereas our study collected data during warmer months. Relative to the winter, in the summer barn ventilation may be higher and workers may be exposed to lower levels of dust and respiratory toxins, thus the benefit of dusk mask utilization may be less detectable in our study population than that of Swanberg et al. (2015).

Although we hypothesized that increased exposure to dust would be associated with decreased respiratory health among Latino thoroughbred workers, we did not detect such a relationship. In contrast to our hypotheses, we found that those new to work on the current horse farm experienced 6 times the odds of abnormal pulmonary function compared to those workers who had worked on the current horse farm for a longer duration. Several potential non-mutually exclusive explanations for these findings are plausible. First, these results may suggest that workers newer to thoroughbred work may perform jobs that are more risky for respiratory health than jobs of more senior employees. Also, as described above, newer thoroughbred workers who are new to the U.S. may potentially have pre-existing (prior to employment) abnormal pulmonary function. Another interpretation is that workers may develop a tolerance to respiratory toxins over a longer duration of employment and therefore report fewer symptoms and exhibit higher levels of pulmonary function than workers that are less tolerant with a

shorter duration of employment. Finally, these results may also indicate a healthy worker survivor population, such that those workers who experience adverse symptoms early in their thoroughbred worker career may leave the workforce, while those who are resistant to adverse effects may remain in the occupation (Arrighi and Picciotto 1994). Future longitudinal cohort studies with this worker population may help to elucidate why a shorter duration of employment may be associated with decreased respiratory health.

Study Limitations

Our results indicate the need for further studies to help to identify occupational factors that may influence the pulmonary function and respiratory health of this worker group, beginning with more precise estimates of worker dust exposure and more accurate job type and job task classifications. One of our major limitations is that we did not measure dust exposure on horse farms via dust sampling. We also did not ascertain length of horse farm employment overall, which may be an important indicator of career occupational exposure and associated respiratory health. Our measure of horse farm exposure (i.e. years on current farm) does not distinguish between a long-term worker at various farms and a short term thoroughbred worker, making it difficult to determine total career occupational exposure. We also did not measure the frequency of respiratory symptoms, which, if chronic, may help to indicate a consistent response to the occupational environment. Finally, due to the potential for non-random sampling errors as a function of our convenience sampling methodology, we may have sampled an unhealthy sub-group of this worker population and therefore overestimated the general level of abnormal pulmonary function. However, this seems unlikely as the prevalence of

self-reported respiratory symptoms, demographics, and level of dust exposure closely matches that of Swanberg et al. (2015).

Conclusions

Latino thoroughbred workers may be at risk for adverse respiratory conditions due to chronic exposure to dusty barn environments, limited use of dust masks, and a high prevalence of abnormal pulmonary function and respiratory symptoms. Our results also indicate that recent arrival in the U.S. was associated with decreased pulmonary function, which may be exacerbated by respiratory exposures encountered on the horse farm. Although we were unable to detect specific occupation factors associated with decreased pulmonary function in this worker group, in conjunction with a high prevalence of respiratory symptomology relative to a Mexican-American reference population, it is likely that the occupational environment contributes to the high prevalence of abnormal pulmonary function noted in this worker group. As a result, promoting safety education regarding occupational respiratory risks and the use of dusk masks may help to improve the respiratory health of this vulnerable worker group. Further investigation is necessary to identify and quantify respiratory exposures on the thoroughbred farm, to identify specific job tasks that may pose respiratory risks, and to assess the potential for a causal relationship between the thoroughbred farm work environment and associated respiratory conditions.

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Tables

Table 1. Demographic Characteristics of Latino Thoroughbred Workers and Risk Factors for Occupational Exposure

Variable	Mean/ %	N	Min	Max	Std. Dev.
Demographic/Non-Occupational Factors					
Age	**37.7**	80	18.0	65.0	10.9
Race (White)	**98.8**	80			
Gender (Male)	**73.8**	80			
Nationality					
Mexican	**76.3**	80			
Mexican-American	**16.3**	80			
Guatemalan	**5.0**	80			
Honduran	**2.5**	80			
Years living in the U.S.	**16.7**	80	1.25	39.0	9.8
Current Smoker (yes)	**21.3**	80			
Former smoker (yes)	**17.5**	80			
Never smoker (yes)	**61.3**	80			
High educational attainment (≥high school)	**42.5**	80			
Low educational attainment (<high school)	**57.5**	80			
Job Related Risk Factors					
Hours per week breathing dust or dirt	**22.4**	80	2.0	52.0	13.4
Hours per week working in the barn	**21.0**	77	0	60.0	14.0
Years working at current farm	**5.4**	80	1.0	30.0	4.50
Work in barn (yes)	**96.3**	77			
Wear dust mask in barn (yes)	**28.6**	77			
Never/Seldom/Sometimes use dust mask	**93.5**	77			
Often/Always use dust mask	**6.5**	77			

Table 2. Bivariate Associations between Demographic, Occupational Factors, and Respiratory Conditions

	Overall	Upper Respiratory Symptoms (Presence)				Lower Respiratory Symptoms (Presence)				All Respiratory Symptoms (Presence)				Abnormal Pulmonary Function (Presence)			
	%	N	χ^2	Sig.	%	N	χ^2	Sig.	%	N	χ^2	Sig.	%	N	χ^2	Sig.	%
Gender		80	1.294	0.189		80	0.058	0.507		80	0.825	0.282		80	0.058	0.510	
Male	74	59			47.5	59			69.5	59			76.3	58			25.9
Female	26	21			61.9	21			66.7	21			85.7	21			26.6
Age		80	4.438	0.109		80	6.541	**0.038**		80	3.617	0.164		79	4.285	0.117	
≤30	25	20			70	20			**90**	20			90	19			26.3
31-40	40	32			50	32			56	32			68.8	22			15.6
>40	35	28			39.3	28			67	28			82.1	28			39.3
Smoking		80	5.099	0.078		80	3.466	0.177		80	1.201	0.548		78	1.775	0.412	
Current	21	16			62.5	16			87.5	16			87.5	15			13.3
Former	17	18			27.8	18			61.1	18			72.2	18			33.3
Never	61	45			55.6	45			64.4	45			77.8	45			26.7
Education		80	2.617	0.082		80	0.629	0.293		80	3.179	0.064		79	0.159	0.447	
<High School	58	46			43.5	46			65.2	46			71.7	46			28.3
≥High School	42	34			61.8	34			73.5	34			88.2	33			24.2
Years in U.S.			4.334	**0.032**			2.886	0.073			3.040	0.069			4.746	**0.031**	
≤10	29	23			**69.6**	23			82.6				91.3	23			**43.5**
>10	71	57			43.9	57			63.2				73.7	56			**19.6**
Years at current farm		80	0.001	0.58		80	6.06	**0.014**		80	3.85	**0.046**		79	4.314	**0.038**	
≤5	56	45			51.1	45			**80**	45			**86.7**	45			**35.6**
>5	44	35			51.4	35			54.3	35			68.6	34			**14.7**
Barn Work (hours/week)		77	2.201	0.105		77	0.000	0.591		77	2.678	0.088		77	0.093	0.481	
≤20	60	48			57.8	48			68.9	48			84.4	47			25.0
>20	40	32			40.6	32			68.8	32			68.8	32			28.1
Dust Exposure (hours/week)		80	0.001	0.578		80	0.208	0.417		80	0.741	0.278		79	0.127	0.458	
≤20	56	45			51.1	45			66.7	45			82.2	44			25
>20	44	35			51.4	35			71.4	35			74.3	35			28.6
Wear Dust Mask in Barn		77	0.005	0.57		77	1.02	0.230		77	1.27	0.20		76	0.48	0.33	
Yes	29	22			50	55			65.5	55			74.5	54			24.1
No	71	55			50.9	22			77.3	22			86.4	22			31.8
Dust Mask Use		77	1.843	0.187		77	2.421	0.145		77	1.515	0.276		76	0.110	0.604	
Infrequent	93.5	72			48.6	72			66.7	72			76.4	71			26.8
Frequent	6.5	5			80	5			100	5			100	5			20

Table 3. Multivariate Logistic Regression Models: Demographic, Occupational, and Non-Occupational Factors

		Abnormal Pulmonary Function			Upper Respiratory (presence)			Lower Respiratory (presence)			Any Respiratory (presence)		
			95% C.I.			95% C.I.			95% C.I.			95% C.I.	
		OR (adj.)	Lower	Upper	OR (adj.)	Lower	Upper	OR (adj.)	Lower	Upper	OR (adj.)	Lower	Upper
Gender	Male	1			1			1			1		
	Female	2.76	0.62	12.32	1.83	0.54	6.21	1.12	0.26	4.79	2.90	0.57	14.78
Age	>40 years	1			1			1			1		
	≤30 years	**0.12**	**0.02**	**0.81**	3.25	0.71	14.86	1.19	0.16	8.47	0.76	0.09	5.96
	31 – 40 years	**0.10**	**0.02**	**0.56**	1.66	0.48	5.71	0.26	0.06	1.02	0.27	0.06	1.22
Smoke status	Never	1			1			1			1		
	Current	1.64	0.27	10.05	1.49	0.38	5.86	6.60	0.95	45.77	4.89	0.70	33.86
	Former	2.18	0.49	9.67	0.62	0.15	2.46	0.51	0.12	2.09	0.84	0.18	4.00
Years in U.S.	>10	1			1			1			1		
	≤10	**5.16**	**1.29**	**20.64**	**3.95**	**1.17**	**13.33**	2.17	0.52	8.95	3.91	0.69	21.94
Years on current farm	>5	1			1			1			1		
	≤5	**6.29**	**1.15**	**34.34**	0.71	0.23	2.15	**4.45**	**1.18**	**16.75**	2.98	0.76	11.64
Dust exposure	≤20 hrs/wk	1			1			1			1		
	>20 hrs/wk	1.63	0.46	5.74	0.96	0.35	2.63	1.63	0.50	5.27	0.65	0.19	2.27
Wear dust mask in barn	Yes	1			1			1			1		
	No	1.59	0.40	6.30	1.28	0.40	4.04	1.04	0.26	4.08	0.79	0.17	3.59

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