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Latino Worker Reported Respiratory Symptoms and Stall Bedding on Thoroughbred Horse Farms

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Capstone Project Paper

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ABSTRACT

Objective: The purpose of this study is to assess the association between self-reported respiratory symptoms in Latino workers and bedding type used in stalls on thoroughbred horse farms.

Methods: Self-reported community-based questionnaire data from 225 Latino horse farm workers in the southeastern US collected from October 2013-April 2014 were used to investigate associations between upper and lower respiratory symptom prevalence and the type of bedding used in stalls (straw, sawdust, or straw plus wood shavings or sawdust). Analysis was performed by chi-square to compare frequencies of symptoms and demographic and exposure risk factors. Logistic regression was used to adjust comparisons of symptoms with bedding type to control for potential confounders. A p-value less than 0.05 was considered statistically significant.

Results: Upper or lower respiratory symptoms were reported in over half the subjects. 86% of the sample was male. A small percent were current smokers (17%) and over half stated they never smoked (57%). More than two-thirds stated they never, seldom, or only sometimes wore a dust mask. Over two-thirds only used straw in horse stalls (68%), 24% used straw mixed with wood shavings or sawdust, and 8% used sawdust alone. One-third of sawdust workers reported upper respiratory symptoms and 28% lower respiratory symptoms. Half of the straw only subjects reported upper or lower respiratory symptoms. Nearly two-thirds (65%) of straw plus wood shavings or sawdust subjects reported upper respiratory symptoms and more than half reported lower respiratory symptoms (59%). Males had decreased odds for both upper (OR: 0.41 CI: 0.17-0.97) and lower respiratory symptoms (OR: 0.2 CI: 0.08-0.53). Former smokers had increased odds for both upper (OR: 2.78 CI: 1.09-7.08) and lower respiratory symptoms (OR: 2.96 CI: 1.15-7.59). Never, seldom or sometimes use of dust masks had increased odds of upper (OR: 2.76 CI: 1.44-5.29) and lower respiratory symptoms (OR: 1.99 CI: 1.03-3.85). Workers in barns using sawdust had lower odds for lower respiratory symptoms, but this did not reach the level of significance.

Conclusion: Many Latino horse farm workers reported experiencing upper or lower respiratory symptoms. The findings in this analysis suggest that sawdust as a bedding type may be protective in development of respiratory symptoms, but small sample size was a limitation in this analysis.

INTRODUCTION

Work in the horse industry is associated with exposure to airborne dust, toxins and allergens (1). Chronic exposure to these irritants are suggested to cause or worsen symptoms of pulmonary disease in workers (1, 2). The horse industry as a whole directly contributes approximately $50 billion to the US economy and nationwide employs approximately 988,000 people (3). Among thoroughbred breeding farms in the southeastern US, Latino workers make up over half of the workforce (4). Previous studies have shown Latino workers in the thoroughbred industry have a high prevalence of abnormal pulmonary function and respiratory symptoms, including nasal and throat irritation, sinus trouble, cough, difficulty breathing, and COPD, which may be caused by workplace particulate and respiratory toxin exposure (4, 5).

Compared to workers in swine, chicken, dairy and beef, thoroughbred breeding farm workers have been little studied concerning exposure to adverse air quality and potential health effects. One factor that may promote exposures to organic dusts and gases and impact respiratory health that has yet to be examined is exposure to bedding materials which may be a source for airborne fungal and bacterial particles during stall mucking and barn cleaning activities (6).

Three common types of bedding used in horse stalls in the US are wood shavings, sawdust and straw. In addition to inhalable and respirable dusts including bacteria, fungal spores and mold, endotoxins and organic materials, bedding materials also emit gases such as ammonia during agitation and cleaning (7). Ammonia can injure the respiratory tract and eyes, and high values have been measured during stall activities, such as mucking (8). These

components of stable air are likely important risk factors for airway inflammation and respiratory health in horse workers (9).

This study investigated the relationship between bedding type used on thoroughbred horse breeding farms and self-reported respiratory symptoms. The hypothesis was that the bedding type used on a thoroughbred horse farm had a significant association with worker reported respiratory symptoms. We hypothesized that use of straw by itself was associated with higher rates of respiratory symptoms because it served as a greater substrate for growth of organisms and production of ammonia. Data from the Thoroughbred Worker Health and Safety Study which comprised self-reported questionnaire data collected between 2013-2014 from 225 Latino horse farm workers was used for this study.

The specific aim for this study is:

1. To assess the association between self-reported worker respiratory symptoms and bedding type used in horse stalls.

The results of this study may be beneficial in determining if bedding type used in horse stalls impacts respiratory symptoms reported by Latino farm workers. If a significant difference in type is identified, results may indicate that subsequent research into bedding types, use of personal protective equipment PPE such as respirators, cleaning and storage regimens, and air sampling is warranted to reduce respiratory health risks.

LITERATURE REVIEW

Much research has been done over the past few decades to determine why agricultural workers are at increased risk of respiratory problems. Agricultural work is a dusty occupation, with workers at constant risk of exposure to varying levels of dust and its components as well as other types of air pollution. It has been suggested that being exposed to a barn environment for more than 10 hrs per week is a significant predictor of self-reported respiratory symptoms within the past year (10). In horses, respiratory problems are as a whole the second biggest cause of days of lost training in the thoroughbred industry, a finding that may be replicated in human workers (11). The Occupational Safety and Health Administration (OSHA) does not regulate air quality on horse farms, and as such worker exposure data is not well documented nor is it regulated (5).

The air in a horse stable contains a wide variety of gases and organic dust from microbial, plant, and animal sources (9). The organic dust may contain pathogenic or nonpathogenic bacteria, fungi, high molecular weight allergens, bacterial endotoxins, β(1-3)-glucans, pollen, and plant fibers (9). It has been well documented that the components of organic dust can cause chronic airway disease in humans and horses (5, 6, 9, 12, 13). Cases of illness have been observed among workers exposed to mycotoxins, a toxic chemical produced by mold, whose presence in the air decreases the activity of the alveolar macrophages in the lungs (14). Stable air can also contain varying levels of gases such as ammonia, a water soluble toxic gas which can irritate the eyes and mucous membranes of the upper respiratory tract and exacerbating infectious respiratory disease (8, 15).

Types of Bedding and Stable Air Components

Certain activities and materials used in the barn have been identified as generating more dust and air contaminants, and thus generating more risk to respiratory health during those times (6). The type of feed, bedding and sanitary procedures can have complex and varying effects on size of stable air quality, and can be the principle source of dust in stables (9, 11. 16). The size and quantity of particulates, and ultimately the rate of deposition in the lungs, can also be affected by feed and bedding choices (15).

The primary functions of bedding are to absorb moisture, keep the stall floor dry, and produce a healthy microclimate in the stable (1, 8, 16). The release rates of contaminants in horse stables vary significantly throughout the day, and peaks of those rates are associated with mucking (15). Curtis et al found that while stalls were being mucked, bedding type was a significant source of the variation in number of particles, especially in the 1-2µm and 2-5µm range (15). Various factors can also influence how long those contaminants are sustained it the air and presumed risk to respiratory health (17).

Review of the literature found mixed results as to the contamination of air quality by different bedding types. A study led by Vandenput et al. that investigated multiple bedding materials including wheat straw, flax straw and wood shavings found that of all the bedding types wood shavings liberated significantly more respirable particles than the other materials, but found no significant difference between the two straw types (18). Fleming et al. found that straw generated the highest concentration of gaseous ammonia over the study period, followed by paper cuttings, wood shavings, hemp, linen, and straw pellets (8). Concentrations up to 20mg/m3 were found in the stable during mucking (8). Curtis et al. found that mean number of particles in the 1-5µm size range was significantly higher when straw was used as a

bedding material compared to paper (15). Straw bedding also contained higher levels of dust mite excreta and spores (15). In another study, straw was the only material which mold was found prior to the start (13). In another study, Auger et al. found that dust-extracted wood shavings were lower in dust and cleaner than straw (11). Raymond et al. found that even the cleanest of straw contains significantly more small, respirable fungal spores than other bedding types, such as wood shavings, paper, and peat (17). However, Elfman et al. (9) and Bøe et al. (19) found no significant difference of dust concentration between bedding materials.

The amount of time a worker spends doing mucking activities varies. In a study by Samadi et al., it was found the median time for cleaning out the stables was 125 minutes (6). He states that higher dust, endotoxin, β(1-3)-glucans and microbial exposures were observed during morning shifts, when stall mucking and sweeping of the stable floor occurred and were lower in the evening when these tasks were absent (6). This finding was supported by Fleming (13). A German study of equestrian stables found that mucking out increased the airborne particulate matter concentration (PM.1-5) by a factor of 19 in the stall and a factor of 9 in the neighboring stall (7). In another study, 81% of the maximum respirable dust concentrations were recorded within 35 minutes of peak stable activity, such as removing the horse from the stall and mucking out (20).

Effects of Bedding Choice to Horse Workers

Little research has been done specifically investigating the occupational health effects of workers in horse stables using various bedding materials. In a study of Latino Horse Farm workers Swanberg et al. found that over half of the workers reported experiencing respiratory

symptoms (5). In another study of Latino horse farm workers, Flunker et. al found that 27% of the workers sampled had abnormal pulmonary function and 24% experienced restrictive lung function (4). These rates are double the abnormal pulmonary function of the general Mexican-American population (12%) and four times greater than the prevalence of restrictive pulmonary function (6.2%) (4).

The literature indicates an increased rate of respiratory symptoms and morbidities in workers who tend horses. Stable air contains a varied amount of gases and organic dust which have been shown to be associated with elevated rates of respiratory symptoms. The concentration of organic dust and gases have been noted to peak during activities such as mucking horse stalls. Several studies found significant differences in air quality between stalls using different types of bedding, and straw bedding was associated with higher dust and gas concentrations in a number of studies (8, 13, 15, 16, 20).

METHODS

Data Used

This study was conducted using data from the Thoroughbred Worker Health and Safety Study, collected between October 2013 and April 2014, and described by Swanberg et al in 2015 (5). The Thoroughbred Worker Health and Safety Study collected self-reported questionnaire data from 225 Latino thoroughbred farm workers in the southeastern US on their general health and employment history. Horse farm workers were selected within the community using a purposive sampling strategy and interview questionnaires were performed

in person by a lay health promoter (5). Waiver of informed consent and research procedures were approved by UK IRB (5).

Respiratory Symptoms and Conditions

This study focused on respiratory symptoms and conditions reported by Latino horse farm workers. Respiratory symptoms included upper respiratory symptoms (nasal irritation, throat irritation, and sinus trouble) and lower respiratory symptoms (dry cough, productive cough, wheezing, chest tightness, shortness of breath, and difficulty breathing) consistent with pervious literature (5). Respondents either answered 'yes' or 'no' when asked if they had ever experienced these symptoms.

Potential Exposure Factors

The exposure variables examined in this study were the type of bedding used in the horse stalls. The main types of bedding materials identified in this study were straw, wood shavings, and sawdust. For the analysis, the respondents were coded as being part of one of the following exposure groups: straw only; straw plus sawdust or wood shavings; and sawdust only.

Other Factors

Other potential risk factors included in the study were age, sex, smoking status, years working on horse farms in general, years working on the current farm, hours per week working in the barn, and dust mask usage frequency. Risk factors were separated into the following categories: age- under 30, 31-40, over 40 years; smoking status- (current, former, never

smoker); years working on horse farms- less than 9, more than 9; years working on current farm- (less than 4, more than 4); hours per week working in the barn- (less than 20, more than 20); dust mask usage- (often/always, never/seldom/sometimes).

Statistical Analysis

Risk factors of interest were analyzed using chi-square to compare the frequencies of those with upper and lower respiratory symptoms in relation to the demographic and exposure risk factors. A p-value was calculated to determine statistical significant difference between groups, with a p-value less than 5% considered significant. In the analysis, continuous variables of age, job duties, years working on horse farms, years working on current farm, and hours per week working in barn were recoded as binary categorical variables above and below the median. Specific respiratory symptoms were compared to bedding type used. Multiple logistic regression analysis was used to adjust comparisons of symptoms with bedding type to control for potential confounders. All analyses were done using SAS 9.4.

RESULTS

A total of 225 Latino horse farm workers participated study. Over half the subjects reported either having upper respiratory symptoms (53%) or lower respiratory symptoms (52%) and over 60% reported having any respiratory symptom. The frequency of symptoms by characteristics of the participants is provided in Table 1. The mean age of respondents was 35 years (SD 9.8 years) with an age range of 18-65 years. The respondents were predominately male (86%) and most had jobs tasks working with horses at least part of the time (90%). Slightly over half of the respondents claimed to never have been a smoker (57%), and only a

small percentage were current smokers (17%). The mean number of years working on horse farms was 10.5 years (SD 7.3 years) and the mean years working in their current position was 5.4 years (SD 4.6 years). Nearly half of the respondents worked at least 20 hours per week in the barn (49%) with a range from 0 hours to 56 hours per week. More than two-thirds of respondents answered that they never, seldom or only sometimes wore a dust mask at some point during the work day. A little over two-thirds of the respondents said that only straw was used as the bedding type used in horse stalls (68%) while almost a quarter claimed to use a mix of straw and either shavings or sawdust (24%) and the remainder using sawdust exclusively as bedding (8%). Not quite two-thirds of respondents stated that hay was stored in an overhead hay loft (64%) with the remainder claiming it was stored in a separate room, building, or simply none in the barn (20%, 14% and 2%, respectively).

The younger workers, females, non-smokers, workers primarily working with horses, workers rarely wearing dust masks, and workers in barns which used straw as bedding tended to have a greater frequency of respiratory symptoms. Although only 18 participants worked in barns that used sawdust only for bedding, one third of those workers reported upper respiratory symptoms, while 51% of workers in barns which used straw only and 65% of the workers in barns which used straw plus wood shavings or sawdust reported respiratory symptoms. A similar pattern was seen with lower respiratory symptoms with only 28% of the workers in barns using only sawdust reported symptoms while over half of the workers in barns using straw only (52%) or straw plus wood shavings or sawdust (59%) reported symptoms.

Table 2 shows the bivariate analysis of specific respiratory symptoms by bedding type. Over half of respondents said they had at least one upper respiratory or lower respiratory

symptom (53 and 52%, respectively). Out of respondents with upper respiratory symptoms nasal irritation (41%) and throat irritation (45%) were the most common; 24% of the participants reported sinus trouble. Out of respondents with lower respiratory symptoms dry cough (33%) and productive cough (26%) were the most common; 8% of the participants reported difficulty breathing, 6% wheezing, 9% chest tightness, and less than 1% shortness of breath. Workers in barns that only used sawdust consistently reported lower frequencies of specific upper and lower respiratory symptoms.

Table 3a shows the results of the adjusted logistic regression for upper respiratory symptoms. Variables in the model included age (30 years and younger, 31-40, and over 40) sex, smoking status (never, current and former), dust mask usage (never/seldom/sometimes and often/always), and types of bedding in stalls (straw only, sawdust only, and straw plus shavings/sawdust). The following variables had significant associations with symptoms: workers with symptoms had 0.4 times the odds of being male (CI: 0.17-0.97), 2.8 times the odds of being former smokers (CI: 1.1-7.08), and 2.8 times the odds of never/seldom/sometimes using a dust mask (CI: 1.44-5.29). With only 18 workers employed in barns using sawdust only, the odds ratio was not quite significant; but workers with symptoms had only 0.35 times the odds of working barns that used sawdust only compared to workers in barns that used straw as bedding.

Table 3b shows the results of the adjusted logistic regression for lower respiratory symptoms with the same variables in the model with similar results. The following variables had significant associations with symptoms: workers with lower respiratory symptoms had 2.3 times the odds of being less than 30 years old (CI: 1.11-4.68), 0.2 times the odds of being male

(CI: 0.08-0.53), 3 times the odds of being former smokers (CI: 1.15-7.59), and 2 times the odds of never/seldom/sometimes wearing a dust mask (CI: 1.03-3.85). Workers with lower respiratory symptoms had 0.3 times the odds of working in barns that used sawdust only in stalls compared to barns that used just straw (CI: 0.1-1.0).

DISCUSSION

Currently, no published studies have been found investigating specifically the association between exposure to horse bedding type and the respiratory health of Latino horse farm workers. A study by Samadi et al. found that horse workers are exposed to high levels of inhalable dust, which were similar to cowsheds and animal feed operations (6). Increased risk of respiratory conditions such as chronic bronchitis, chronic obstructive pulmonary disease (COPD) and reduced lung function have been associated with livestock farming (12). Review of the literature suggested that the type of bedding used in horse stalls may have differing effects on the levels of dust, growth of organisms, and generation of ammonia, and in turn may have an effect on the respiratory health of workers and horses (8, 11, 13, 16, 18). Peaks of these exposures are associated with stall mucking (6, 15, 20). The results of this study support our hypothesis that use of straw by itself as bedding would be associated with increased adverse respiratory health effects in farm workers.

The results of the study show a significantly higher number of both upper and lower respiratory symptoms in farm workers who work with horses compared to those who do not. This is consistent with the findings of Mazan et. al, who found a strong association between exposure to the horse barn environment and self-reporting respiratory symptoms (10).

Interestingly, while they found being exposed to a barn environment for 10 or more hours per week a significant predictor for respiratory symptoms, our analysis of hours per week spent in the barn found no similar significant association (10). This likely is because tasks such as stall mucking occur predominately during the morning shift, and the highest dust and microbial exposures are experienced in a matter of hours (6).

Older respondents (classified as over the age of 40) also stated lower occurrence of upper and lower respiratory symptoms compared to younger age groups. This could be due to the healthy worker/survivor effect, which states that current workers generally display less adverse health conditions because unhealthy workers are often excluded from the workforce. In this study, two thirds of the older workers had worked on horse farms longer than nine years, as opposed to less than a quarter of the youngest workers. Other studies have found a decreasing prevalence of asthma with increasing number of years worked in agricultural occupations (21). Younger workers may also be tasked with dustier jobs, such as mucking and sweeping, than older workers having more seniority, thus increasing their exposures to organic dusts and gases.

Females also showed increased odds for lower respiratory symptoms compared to males. Review of relevant literature of respiratory health in horse farm workers does not find similarly significant differences in symptoms by gender (4, 22). Another study showed asthma rates among women farmers in New Zealand were nearly twice that of males, but the reasoning for this difference in not well understood (21). This may be accounted for in part due to lower usage of respirators in females compared to males (23).

In this study, the finding that smoking is related to a reduced frequency of upper and lower respiratory symptoms is not corroborated in other literature, however the effects of smoking on decreased respiratory health has been well documented in the general population. In a study of US farmers, Hoppin et al. found that US farmers had higher prevalence of respiratory symptoms even after controlling for smoking, which may indicate that some other exposure may have a stronger effect on the respiratory health of farmers (24). Continued occupational exposure of farm workers to organic dust and gases may influence respiratory symptoms more strongly than a history of smoking. Swanberg et. al suggested that smokers may also be more tolerant of respiratory symptoms and not report them as often as nonsmokers (5). Smoking may also suppress allergic reactions in the lungs, leading to reduced symptoms in some respondents (5).

Infrequent or no use of a dust mask was also associated with increased upper and lower respiratory symptoms. This is in correlation with findings in other studies (15). Even when dust masks are provided for use by supervisors, workers often minimize the risk of respiratory hazards, and problems are often credited to allergies, and not exposure to dust or other air pollutants (25). A study of Latino farm workers in California found that men were more likely to use dust mask than women when engaged in dusty working conditions, even though overall use was low (23). In light of the increased odds of respiratory symptoms among females in this study, more effort may need to be made to increase usage and availability of respiratory protection, especially during activities generating heavier concentrations of particulate matter such as mucking and sweeping (6).

Type of Bedding Used

Use of sawdust only in stalls showed a mild protective effect compared to straw for lower respiratory symptoms, but this failed to meet statistical significance. Had the sample of workers exposed to sawdust only been larger, associations may have been stronger. It is possible the protective effect could be due to decreased excretion of respirable dust, ammonia, and other organisms in sawdust compared to straw, as found in other studies (13, 15, 16, 26).

Bedding type alone is unlikely to be the only factor in determining increased respiratory risks to barn workers. Ventilation and air exchange rates in the barn and stabling area may be more important than the substrate used (9, 15, 27). The activities in a stable, including horse and human activity, type of feed, and bedding materials can cause particles in the air to stay suspended for a long time, especially during peak activities such as mucking and sweeping (9). In one study, installation of a mechanical ventilation system in the barn lowered rates of ammonia, ultrafine particles and horse allergen in the air (9). Curtis et. al found that when stalls were being mucked, bedding type was a significant source of variation between the number of particles in the air with straw being worse compared to a paper-based bedding, and at higher ventilation rates the number receded to baseline levels more quickly (11, 15). Walender et al. also found that increased air exchange resulted in verifiable reduction in levels of carbon dioxide, ammonia, ultrafine particles, and horse allergen but noted an increase in air endotoxin levels (27). They did not find significant effects in humans, though a tendency was found towards reduced inflammation markers (27). If higher rates of airborne particles during peak activities increases respiratory risks, then increasing air flow likely could positively impact the respiratory health of farm workers.

Many studies also point out the association of weather and management regime in relation to respiratory symptoms in workers (2, 11, 13, 15). There is often less ventilation during the winter months and higher particle load in the air due to the horses being in the stable more often, as such respirable dust and beta glucans are often increased during this time (2). The study found that air particle load was higher in February and March than September (2). Barn build structure is also important, and in climates with low ventilation and summer wind speed, the air clearance may be worse during the summer months if horses are constantly moving in and out of the barn (11). Morning shifts often are when most stall and barn cleaning tasks are completed, and are associated with higher dust and microbial exposures (6). The movements of horses themselves generate airborne particulate, and lower levels were found when horses were out of their stalls and increased when they were stabled (6, 13, 17). In barns where horses are stabled for longer periods, stalls are cleaned less frequently and thus more soiled; also air ventilation rates are lower, therefore air particulate levels may need closer monitoring than those in which the horses spend more time outdoors and ventilation is high.

Limitations

Latino thoroughbred farm workers are a group who have not been recipient to much research interest despite their higher propensity for respiratory symptoms and disease (4). While it addressed a gap in current literature, the study was not without limitations. The data used in the study was self-reported data, and as such presents the possibility for recall bias and misclassification. Respondents may fail to recall past respiratory symptoms or other covariates examined. The small sample size for some of the covariates and the uneven sample sizes for the bedding types also potentially limited the statistical power and increased chances for type II

error. Despite these limitations, this study builds upon literature presenting the respiratory hazards to horse farm workers and serves as a good starting point for dialogue on the respiratory health of Latino horse farm workers.

CONCLUSION

Literature has shown the exposure to gases, organic dust and other microbial contaminants found in horse farms can have negative effects on respiratory health (6, 12). Nearly half the workforce on US thoroughbred farms are Latino, a population that are historically underserved and have high rates of respiratory issues (4, 5, 23). The results of this study failed to accept the hypothesis that use of straw alone as a bedding type would be associated with higher rates of upper and lower respiratory symptoms. The evidence here and in other studies presents the need for further research in Latinos horse farm workers and respiratory symptoms and morbidities. Suggestions for further research study include collection of specific respiratory indicators such as nasal lavage and lung function tests of workers compared with more specific barn demographic information, such as number of horses, ventilation sources and rates, mucking and cleaning schedules, bedding type and source, as well as specific dust concentration measurements. Consideration of barn use and management regime may also be influential, such as a training barn in which horses are frequently stabled versus a breeding barn in which horses spend more time out on pasture. Attention also needs to be given to methods to increase usage of dust masks, as their use appear to significantly lessen the presence of respiratory symptoms.

Table 1: Risk and Demographic Factors by Upper and Lower Respiratory Symptoms

Factor	N	Percent/(Mean +\- SD)	Range	% with Upper Respiratory Symptoms (Freq)	Upper Respiratory Symptoms Significance	% with Lower Respiratory Symptoms (Freq)	Lower Respiratory Symptoms Significance
Age (years)		(35.4 +/- 9.6)	18-65		0.09		0.063
30 and younger	80	35.9		53.8 (43)		58.8 (47)	
31-40	78	35.0		61.5 (48)		55.1 (43)	
Over 40	65	29.2		43.1 (28)		40 (26)	
Sex					0.24		0.001
Male	193	85.8		51.3 (99)		47.7 (92)	
Female	32	14.2		62.5 (20)		78.1 (25)	
Smoking Status					0.007		0.06
Current	37	16.5		40.5 (15)		35.1 (13)	
Former	59	26.3		69.5 (41)		59.3 (35)	
Never	128	57.1		48.4 (62)		53.1 (68)	
Job Duties					0.0006		0.0008
Hors-Related	203	90.2		56.7 (115)		55.7 (113)	
Non-Horse Related Jobs Only	22	9.8		18.2 (4)		18.2 (4)	
Years Working On Horse Farms		(10.5 +/- 7.3)	.75-39		0.74		0.32
Less than 9 Years	112	49.8		51.8 (58)		55.4 (62)	
Greater than 9 Years	113	50.2		54 (61)		48.7 (55)	
Years Worked on Current Farm		(5.4 +/- 4.6)			0.04		0.94
Less than 4 Years	111	49.3		46 (51)		52.3 (58)	
Greater than 4 years	114	50.7		59.7 (68)		51.8 (59)	
Hours Per Week Working in Barn		(22.9 +/- 13.7)	0-56		0.91		0.88
Less than 20 hours per Week	115	51.3		53 (61)		51.3 (59)	
More than 20 hours per Week	109	48.7		52.3 (57)		52.3 (57)	
Dust Mask Usage					0.001		0.06
Never, Seldom, Sometimes	157	69.8		59.9 (94)		56.1 (88)	
Often, Always	68	30.2		36.8 (25)		42.7 (29)	
Type of Bedding Used in Stalls					0.05		0.07
Straw Only	153	68.0		51 (78)		52.3 (80)	
Sawdust Only	18	8.0		33.3 (6)		27.8 (5)	
Straw + Shavings/Sawdust	54	24.0		64.8 (35)		59.3 (32)	
Hay Storage in Barn					0.14		0.07
None in Barn	5	2.2		40 (2)		100 (5)	
Separate Room	44	19.6		38.7 (17)		52.3 (23)	
Overhead Hay Loft	144	64.0		55.6 (80)		47.9 (69)	
Separate Building	32	14.2		62.5 (20)		62.5 (20)	

Table 2: Bivariate Analysis: Respiratory Symptoms by Bedding Type
Significance P-value listed (** <.05)

Respiratory Symptom	N with symptoms (%)	Straw Only (%)	Sawdust Only (%)	Straw + Shavings/Sawdust (%)	Significance
Upper Respiratory Symptoms:					
nasal irritation	93 (41.3)	62 (40.5)	4 (22.2)	27 (50)	0.114
throat irritation	101 (44.9)	67 (43.8)	2 (11.1)	32 (59.3)	0.001
sinus trouble	55 (24.4)	29 (19)	4 (22.2)	22 (40.7)	0.008
Any of the above	119 (52.9)	78 (51)	6 (33.3)	35 (64.8)	0.05
Lower Respiratory Symptoms:					
Dry Cough	74 (32.9)	50 (32.7)	2 (11.1)	22 (40.7)	0.063
Productive Cough	59 (26.2)	41 (26.8)	3 (16.7)	15 (27.8)	0.687
Wheezing	14 (6.2)	13 (8.5)	0 (0)	1 (1.9)	0.161
Chest Tightness	21 (9.3)	15 (9.8)	0 (0)	6 (11.1)	0.394
Shortness of Breath	1 (0.4)	16 (10.5)	1 (5.6)	1 (1.9)	0.232
Difficulty Breathing	17 (7.6)	17 (11.1)	0 (0)	0 (0)	0.008
Any of the above	117 (52)	80 (52.3)	5 (27.8)	32 (59.3)	0.067
Any Upper or Lower Respiratory Symptoms	139 (61.8)	94 (61.4)	7 (38.9)	38 (70.4)	0.059

Table 3a: Logistic Regression Upper Respiratory Symptoms OR (adjusted) 95% Confidence Interval

Variable	Estimate B	P-value	OR	95% Confidence Interval
Age (years)				
30 and younger	0.4925	0.1734	1.64	(0.81-3.33)
31-40	0.6983	0.0575	2.01	(0.98-4.13)
Over 40			1	
Sex				
Male	-0.8993	0.042	0.41	(0.17-0.97)
Female			1	
Smoking Status				
Never	0.2536	0.5346	1.29	(0.58-2.87)
Former	1.0237	0.0316	2.78	(1.09-7.08)
Current			1	
Dust Mask Usage				
Never, Seldom, Sometimes	1.0147	0.0023	2.76	(1.44-5.29)
Often, Always			1	
Type of Bedding Used in Stalls				
Straw Only			1	
Sawdust Only	-1.041	0.0624	0.35	(0.12-1.06)
Straw + Shavings/Sawdust	0.4279	0.2259	1.53	(0.77-3.07)

Table 3b: Logistic Regression Lower Respiratory Symptoms OR (adjusted) 95% Confidence Interval

Variable	Estimate B	P-value	OR	95% Confidence Interval
Age (years)				
30 and younger	0.8251	0.0245	2.28	(1.11-4.68)
31-40	0.6357	0.0816	1.89	(0.92-3.86)
Over 40			1	
Sex				
Male	-1.5918	0.0012	0.2	(0.08-0.53)
Female			1	
Smoking Status				
Never	0.7937	0.0608	2.21	(0.97-5.07)
Former	1.0835	0.0244	2.96	(1.15-7.59)
Current			1	
Dust Mask Usage				
Never, Seldom, Sometimes	0.6885	0.0405	1.99	(1.03-3.85)
Often, Always			1	
Type of Bedding Used in Stalls				
Straw Only			1	
Sawdust Only	-1.1406	0.049	0.32	(0.10-1)
Straw + Shavings/Sawdust	0.295	0.3919	1.34	(0.68-2.64)

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