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Respiratory Symptoms of California's Dairy Workers

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Abstract. While research has documented the adverse impact of agricultural work on the respiratory health of farmers, few studies have reported on the respiratory health of dairy workers. Additionally, we are not aware of any published studies addressing the health impacts associated with large dairies in the western United States. The present investigation is a cross-sectional survey carried out at 13 dairies throughout the San Joaquin Valley. Data were collected from 232 dairy workers and 52 employees of a control facility (a vegetable processing plant) during a three-month period in 2008. Survey data collected included: socioeconomic status, respiratory health history, respiratory exposure history, work history, and current health symptoms. The dairy and control populations were almost all immigrant Latino and were similar in demographics, with two primary exceptions: dairy workers had higher incomes and had lived in the United States longer than the control employees. A substantial proportion of workers had never sought medical attention in the United States. Dairy work in California was associated with a significantly increased prevalence of asthmatic symptoms but not with significantly increased chronic cough, phlegm, or wheezing.

Keywords. Agriculture, dairying, California, respiratory health, asthma.

1 Introduction

Dairy work has been associated with respiratory health problems and decreased lung function (Heller *et al.* 1986; Malmberg 1990; Dalphin *et al.* 1998; Chaudemanche *et al.* 2003; Venier *et al.* 2006; Gainet *et al.* 2007; Kawada and Suzuki 2008). Exposure to complex mixtures of contaminants is believed to be associated with these harmful effects. Cows and/or their waste emit gases such as hydrogen sulfide, methane, and ammonia, in addition to smog-forming volatile organic compounds (Senate Office of Research 2004). Anaerobic bacteria aid in the fermentation and decomposition of organic material (manure, feed, etc.) associated with pollutants. These pollutants, in turn, are associated with inflammation, immune, irritant, and neurotoxic problems in humans (Schenker 1998). Farm work, including dairy work, has been related to acute effects of particulate matter and gas exposures in European animal confinement buildings (Iversen *et al.* 1994; Radon *et al.* 2001). Airway inflammation, a non-atopic reaction resulting in asthma-like symptoms, is the most commonly found detrimental respiratory condition in these facilities (Iversen *et al.* 1994). This airway inflammation is thought to be the result of exposure to particulate matter, specifically endotoxins (cell wall fragments of gram-negative bacteria).

Sufficient exposure to organic particulate matter may result in dose-dependent organic dust toxic syndrome consisting of

acute systemic and lung function impairments; symptoms include fever, influenza-like conditions, dry cough, and chest tightness. Endotoxins found in the particulate matter are thought to be the primary factor producing this reaction. Other sources of organic particles that may contribute to adverse respiratory effects include animal dander, feces, minor components of animal feed, and glucans (Schenker 1998). Long-term exposure to endotoxins is associated with chronic bronchitis and reduced lung function (Omeland 2002). Although these studies have demonstrated the association between dairy work and decrements in respiratory health, none has looked specifically at dairy work in California. California dairies are unique. Although the facilities are open-air, the average herd size is substantially larger than in the midwestern United States or Europe. With this unknown combination, it is worthwhile to investigate the respiratory health effects among workers on large California dairies.

2 Study Design and Methods

2.1 Eligibility Criteria

The present study is a cross-sectional survey that was carried out in 13 dairies throughout the San Joaquin Valley from June to September 2008. A facility number was assigned to all dairies within the San Joaquin Valley that house over 1,000 milking cows ($N = 480$). The facilities visited were randomly selected. Within each facility all of the workers were recruited. To be included in the study, dairy workers had to be between the ages of 18 and 65; able to work a fully monitored, six-hour shift;

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work around cows; able to perform spirometry; and male. The control facility (a vegetable processing plant) was selected based on a similar worker population with a night shift; all eligible employees were recruited. The eligibility criteria for control facility employees were identical to those of the dairy workers, with two exceptions: they were not exposed to cows or other respiratory hazards such as cleaning chemicals. Only one dairy facility refused to participate in the study; the high participation rate among facilities may be attributed to the study's principal investigator, who had worked closely with dairies prior to this project. Approximately 90% of eligible dairy and control employees agreed to participate in the study.

2.2 Study Overview

The project protocol was approved by the University of California, Davis Institutional Review Board. Written informed consent was obtained from each participant before beginning the study. During the three-month study period, data were collected from 232 dairy workers on 13 dairies (the number of workers per dairy varied with the actual size of the operation) and 52 employees of a vegetable processing plant. After data entry and cleaning, 226 dairy workers and 49 control employees were included in analyses. Survey data included socioeconomic status, respiratory health history, respiratory exposure history, work history, and current health symptoms.

Prior to beginning the work shift, participants completed a lung function test (spirometry) and a brief questionnaire to determine demographic information, current health symptoms, asthma and atopy, long-term respiratory conditions (chronic cough, phlegm, persistent wheeze, etc.), and exposures external to dairies. At the end of the work shift, each worker completed a second spirometry test and a post-shift questionnaire. The post-shift interview included a time-activity log for the work shift, current health symptoms, smoking/tobacco use, alcohol use, exposures at work, personal protective measures, work activities and history, and a self-assessment of health. Each subject participated in the study for one day; that is, each participant had one pre- and one post-shift interview.

2.3 Questionnaires

The questionnaires were based on validated instruments from the European Community Respiratory Health Study (ECRHS) survey (European Community Respiratory Health Study 2000), the American Thoracic Society-Division of Lung Disease (ATS-DLD) questionnaire (Ferris 1978), the International Study of Asthma and Allergies in Childhood (ISAAC) survey (Asher *et al.* 1995), and the Tuomi work ability index (Tuomi *et al.* 1997). All of the forms were administered by trained interviewers and available in both English and Spanish. In addition, all of the questionnaires were reviewed to identify errors, outliers, and missing information by the study coordinator, the field staff, and/or the graduate student prior to data entry. Field staff was consulted to fix errors and fill in missing information when possible.

2.4 Respiratory Outcomes

The primary respiratory health outcomes (chronic bronchitis, chronic cough, persistent wheeze, asthma, hay fever, eczema, and rhinitis) were determined using the questionnaire responses. In keeping with conventional definitions (Schenker *et al.* 2005), chronic bronchitis was defined as producing phlegm on most days of the week for three or more months for two or more years. Chronic cough was defined as having a cough on most days or nights for three or more months. Persistent wheeze was defined as the chest sounding wheezy or whistling on most days or nights or the chest sounding wheezy or whistling with colds and apart from colds. Unfortunately there are no standardized definitions of asthma or the other respiratory outcomes. In this study, asthma was defined as doctor- or health professional-diagnosed asthma or exercise- or allergen-induced cough, wheeze, shortness of breath, or chest tightness. Hay fever was determined by a question asking the participants if they have ever had hay fever. Similarly, eczema and rhinitis were defined by single questions relying on participants self-reporting the conditions.

2.5 Statistical Analyses

Descriptive analyses were performed for all demographic variables and potential covariates to characterize the dairy workers' respiratory health. Logistic regression was performed to assess associations of independent variables with key outcomes, including chronic conditions (asthma, atopy, chronic bronchitis, chronic cough, persistent wheeze), as well as to model the presence of respiratory symptoms during the work shift. Backward selection was used to build the regression model, with the significance level for independent variables to stay in the model set to 0.10. All statistical analyses were performed using Statistical Analysis System Software Version 9.2.

The primary predictor of interest was whether the participant worked on a dairy or at the control facility. In regression analyses, smoking was considered in the form of two variables: pack-years smoking and current smoking status (current, former, or never smoker). Other candidate independent variables included: age, education level, number of days worked since last day off, and years spent in the United States.

3 Results

Both dairy and control populations were relatively young. Almost all participants were Latino. Only a small proportion of the sample was born in the United States; the vast majority emigrated from Mexico. Dairy participants had spent significantly more time in the United States. Although dairy workers had less formal education than the control employees, they earned more bi-weekly. More dairy workers were current smokers compared to control employees, but the difference was not significant. Similarly, pack-years of smoking was not significantly different between the two populations (table 1).

Table 1. Demographics

| | Dairy Workers (N = 226) | | Control Workers (N = 49) | |
|---------------------------------|----------------------------|--------|-----------------------------|--------|
| | Mean (SD) | Median | Mean (SD) | Median |
| Age (years) | 33.3 (11.1) | 31.0 | 34.8 (12.1) | 32.0 |
| Years in U.S.* | 12.1 (9.0) | 10.0 | 8.9 (7.9) | 5.5 |
| Pack-years | 7.2 (14.4) | 2.3 | 6.2 (10.9) | 1.6 |
| | n | % | n | % |
| Two-week income‡ | | | | |
| \$0-750 | 9 | 4.2 | 20 | 40.8 |
| \$751-1,000 | 96 | 44.2 | 21 | 42.9 |
| \$1,001-1,500 | 100 | 46.1 | 4 | 8.2 |
| \$1,500+ | 12 | 5.5 | 4 | 8.2 |
| Yearly family income‡ | | | | |
| \$0-10,000 | 14 | 6.6 | 10 | 22.2 |
| \$10,001-20,000 | 43 | 20.3 | 19 | 42.2 |
| \$20,001-30,000 | 124 | 58.5 | 9 | 20.0 |
| \$30,001-50,000 | 29 | 13.7 | 6 | 13.3 |
| \$50,001+ | 2 | 0.9 | 1 | 2.2 |
| Education | | | | |
| None | 11 | 4.9 | 0 | 0 |
| Primary (grades 1-6) | 115 | 50.9 | 20 | 40.8 |
| Junior high (grades 7-9) | 66 | 29.2 | 16 | 32.7 |
| High school (grades 10-12) | 30 | 13.3 | 10 | 20.4 |
| Some college (grade > 12) | 4 | 1.8 | 3 | 6.1 |
| Ethnicity | | | | |
| Latino | 206 | 94.1 | 44 | 97.8 |
| Non-Latino | 13 | 5.9 | 1 | 2.2 |
| Country of origin | | | | |
| United States | 7 | 3.1 | 3 | 6.1 |
| Mexico | 201 | 88.9 | 46 | 93.9 |
| Other Central/ South America | 12 | 5.3 | 0 | 0 |
| Portugal | 6 | 2.7 | 0 | 0 |
| Smoking status | | | | |
| Current smokers | 62 | 27.4 | 7 | 14.3 |
| Former smokers | 44 | 19.5 | 10 | 20.4 |
| Never smokers | 120 | 53.1 | 32 | 65.3 |

*p < 0.05

‡p < 0.001

Dairy workers were significantly more likely to seek medical help at a clinic compared to controls. The majority of workers (both dairy and control) sought medical attention at either a clinic or with a doctor, nurse, or physician's assistant. However, there was a substantial proportion of workers who had never sought medical attention in the United States (table 2). It is interesting to note that none of the participants (dairy or control) had sought help from community health workers (*promotores*) or healers (*curanderos*).

Table 2. Health Services Accessed in the United States Ever

| | Dairy Workers (N = 226) | | Control Workers (N = 49) | |
|------------------------------------|----------------------------|------|-----------------------------|------|
| | N | % | N | % |
| Community/free clinic | 6 | 2.8 | 3 | 6.1 |
| Clinic* | 103 | 47.5 | 14 | 28.6 |
| Doctor/nurse/physician's assistant | 39 | 18.0 | 14 | 28.6 |
| Hospital emergency room | 23 | 10.6 | 4 | 8.3 |
| Pharmacy | 5 | 2.3 | 1 | 2.4 |
| Never sought medical help | 43 | 19.7 | 13 | 26.5 |

*p < 0.05

When asked about their perceived physical ability versus the demands of their job(s), there was no significant difference between dairy and control employees. However, dairy workers who were current smokers were significantly more likely to report a higher level of physical ability, specifically "good" or "very good," compared to control employees; among former and never smokers, the difference was not significant (results not shown). Similarly, there was no difference between the two groups when asked to assess their current health status. However, control workers who were former or never smokers were significantly more likely to respond "fair" when asked to assess their current health status. Interestingly, the difference was not significant among current smokers (results not shown). When asked to compare their health to others their age, both dairy and control workers responded "good" most frequently; the difference was not significant. Participants were asked to report their work ability on a scale of one to ten and the majority of participants responded between eight and ten (table 3).

Table 3. Physical and Health Self-Assessment

| | Dairy Workers (N = 226) | | Control Workers (N = 49) | |
|--|----------------------------|------|-----------------------------|------|
| | N | % | N | % |
| Physical ability versus work demands | | | | |
| Very good | 78 | 34.5 | 9 | 18.4 |
| Good | 132 | 58.4 | 31 | 63.6 |
| Moderate | 14 | 6.2 | 9 | 18.4 |
| Poor | 1 | 0.4 | 0 | 0 |
| Health self-assessment | | | | |
| Excellent | 63 | 27.9 | 14 | 28.6 |
| Good | 115 | 50.9 | 19 | 38.8 |
| Fair | 48 | 21.2 | 16 | 32.7 |
| Health compared to same age group | | | | |
| Excellent | 60 | 26.5 | 19 | 38.8 |
| Good | 131 | 58.0 | 22 | 44.9 |
| Fair | 35 | 15.5 | 8 | 16.3 |
| Current work ability (0-10 point scale) | | | | |
| 1 | 1 | 0.4 | 0 | 0 |
| 5-6 | 6 | 2.7 | 0 | 0 |
| 7-8 | 71 | 31.4 | 17 | 34.7 |
| 9-10 | 148 | 65.5 | 32 | 65.3 |

Table 4. Baseline Respiratory Conditions

| | Current/Former Smokers | | | | Never Smokers | | | |
|--------------------|----------------------------|------|-----------------------------|------|----------------------------|------|-----------------------------|------|
| | Dairy Workers (N = 106) | | Control Workers (N = 17) | | Dairy Workers (N = 120) | | Control Workers (N = 32) | |
| | N | % | N | % | N | % | N | % |
| Chronic bronchitis | 2 | 1.9 | 0 | 0 | 5 | 4.2 | 0 | 0 |
| Chronic cough | 2 | 1.9 | 0 | 0 | 3 | 2.5 | 1 | 3.1 |
| Persistent wheeze | 2 | 1.9 | 0 | 0 | 2 | 1.7 | 1 | 3.1 |
| Asthma* | 43 | 40.6 | 2 | 11.8 | 44 | 36.7 | 7 | 21.9 |
| Hay fever | 13 | 12.3 | 1 | 5.9 | 15 | 12.5 | 5 | 16.1 |
| Eczema | 13 | 12.3 | 1 | 5.9 | 8 | 6.7 | 4 | 12.5 |
| Rhinitis | 24 | 22.9 | 1 | 5.9 | 16 | 13.3 | 6 | 18.9 |

*p < 0.05

Table 5. Acute Respiratory Symptoms

| | Current Smokers | | | | Former/Never Smokers | | | |
|-------------------|---------------------------|-----|----------------------------|------|----------------------------|------|-----------------------------|------|
| | Dairy Workers (N = 62) | | Control Workers (N = 7) | | Dairy Workers (N = 164) | | Control Workers (N = 42) | |
| | N | % | N | % | N | % | N | % |
| Eye irritation* | 2 | 3.2 | 2 | 28.6 | 9 | 5.5 | 4 | 9.5 |
| Blurred vision | 2 | 3.2 | 0 | 0 | 5 | 3.1 | 1 | 2.4 |
| Nasal irritation | 2 | 3.2 | 1 | 14.3 | 21 | 12.8 | 1 | 2.4 |
| Throat irritation | 4 | 6.5 | 1 | 14.3 | 22 | 13.4 | 2 | 4.8 |
| Cough | 6 | 9.7 | 1 | 14.3 | 23 | 14.0 | 7 | 16.7 |
| Phlegm | 5 | 8.1 | 0 | 0 | 25 | 15.2 | 2 | 4.8 |
| Tingling fingers | 0 | 0 | 0 | 0 | 3 | 1.8 | 2 | 4.8 |
| Rash | 0 | 0 | 0 | 0 | 3 | 1.8 | 0 | 0 |
| Wheeze | 0 | 0 | 0 | 0 | 5 | 3.1 | 0 | 0 |
| Chest tightness | 3 | 4.8 | 0 | 0 | 8 | 4.9 | 1 | 2.4 |

*p < 0.05

There was a low prevalence of chronic respiratory conditions such as chronic bronchitis, chronic cough, and persistent wheeze. Among current and former smokers, dairy workers were significantly more likely to have asthma compared to control workers. The trend was similar among participants who had never smoked, although the difference did not achieve statistical significance. Prevalence of hay fever, eczema, and rhinitis was higher than chronic conditions, but the differences between dairy and control workers were not significant (table 4).

Dairy and control workers were asked about symptoms experienced during their work shift. Nasal irritation, throat irritation, and cough were the most frequently reported symptoms among both dairy workers and control employees. Control workers who were current smokers were significantly more likely to report eye irritation than dairy employees; among former and never smokers, the difference was not significant (table 5).

Dairy work was significant when eye irritation during the work shift and asthma were the primary outcomes in separate logistic regression models; dairy work was not significant in modeling other acute outcomes (e.g., cough, nasal irritation,

etc.). After adjusting for smoking status, dairy work had an odds ratio of 0.33 associated with eye irritation. Age, pack-years smoking, days back at work, education level, and years spent living in the United States were not significant for eye irritation or asthma. Similarly, smoking was not significant in the model for asthma. Dairy workers had an odds ratio of 2.73 associated with asthma compared to control employees (table 6).

Table 6. Dairy Work

| | OR | 95% CI |
|-----------------|------|-----------|
| Eye irritation* | 0.33 | 0.11-0.96 |
| Asthma* | 2.73 | 1.26-5.90 |

*p < 0.05; eye irritation OR has been adjusted for smoking status

4 Discussion

We found dairy workers self-reported better health compared to control workers after controlling for smoking status. It is

possible that the more physical, rigorous demands of dairy work compared to a vegetable processing plant might select the healthier workers (or result in participants feeling healthier than individuals performing less physically demanding tasks). Less educated individuals tend to self-report worse health status compared to higher educated groups, but subjects with higher incomes tend to have better self-assessed health (Markides and Martin 1979; Ailinger 1989; Markides and Lee 1991; Hirdes and Forbes 1993; Shetterly *et al.* 1996). Although of borderline significance, dairy workers had less formal education compared to control employees (55.8% of dairy workers had attended primary school or less, compared to 40.8% of controls). However, dairy workers had significantly higher incomes than control employees. This combination indicates that a higher income might influence self-reported health more than education status among the study subjects.

Given that the study population is young (average age in the early 30s), it is not surprising that the prevalence of chronic conditions is low. It is interesting, however, that asthma and asthmatic symptoms are significantly more common (roughly twice as frequent) among dairy workers than among control employees. This could be an indication of airway inflammation, which is a common effect of working in confined animal operations (Iversen *et al.* 1994). The results indicate that the control facility is associated with eye irritation; this could be due to the control employees processing garlic during the study period. However, with the small sample of control workers displaying eye irritation ($N = 6$, or 12% of control employees), it is difficult to draw conclusions based on these results.

The study participants were relatively young and, for the most part, light or infrequent smokers. Therefore, it is not entirely surprising that smoking, either pack-years or current status, was rarely significant in modeling respiratory outcomes. Among current and former smokers, dairy workers' median pack-years measured 2.33, with controls' median pack-years measuring 1.60. Fully half of current smokers in the control facility smoked only one cigarette per day, and half of current smokers in the dairies smoke three or fewer cigarettes per day. Previous studies of light smokers and/or young adults generally show a dose-response association between respiratory outcomes and smoking (Rosengren *et al.* 1992; Kawachi *et al.* 1994; Prescott *et al.* 2002; Bjartveit and Tverdal 2005; Amigo *et al.* 2006; Vianna *et al.* 2008). However, the strictest study criteria set the cutoff for current smokers at four cigarettes per day (Rosengren *et al.* 1992; Kawachi *et al.* 1994; Bjartveit and Tverdal 2005). None mentions pack-years and most have older populations (Rosengren *et al.* 1992; Kawachi *et al.* 1994; Prescott *et al.* 2002; Bjartveit and Tverdal 2005) than the current participants. Analyses of our data setting the cutoff between light and heavy smokers at the median level of cigarettes per day did not result in any significant findings (results not shown). This could be due to a small sample size: only seven participants had chronic bronchitis, and only six had persistent wheeze regardless of smoking status. Considering less chronic conditions such as acute symptoms or phlegm production for three months (non-chronic bronchitis) also resulted in non-significant findings in regard to smoking status (results not shown). Small sample size could be a factor, or it may be that three cigarettes per

day for a short duration (< 2.5 pack-years) is not enough exposure to result in adverse chronic respiratory symptoms in this young population.

5 Conclusion

5.1 Findings

This is the first study to look specifically at the respiratory health of dairy workers in California. The worker demographics between the dairy and control facility were similar, with the majority of participants being Latino males from Mexico. Dairy work in California was found to be associated with an elevated prevalence of asthmatic symptoms but not with most chronic respiratory conditions. The low prevalence of chronic respiratory conditions is not surprising given the young age of the population.

5.2 Research to Practice

Our findings will be presented to the California dairy community, including dairy owners and workers. We will document if task-specific risk factors are associated with a decrement in lung function in the hopes of directing future research to ultimately design and target interventions to protect dairy worker respiratory health.

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