Effect of Exposure to Grain Dust on Pulmonary Function of Selected Animal Feed Mill Workers in Kiambu County, Kenya

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Abstract**—**Steady growth in the animal feed production in Kenya accompanied by the rise of the unregulated animal feed mills raised the levels of grain dust hazards to the workers. These hazards and the health outcomes have not been well studied and documented in Kenya. The overall objective of the study was to assess the effects of exposure to grain dust on the pulmonary function of selected animal feed mill workers in Kiambu County, Kenya. The study adopted a case-control study design. 81 animal feed mill workers participated in the assessment of their lung function and respiratory symptoms using spirometry and a questionnaire. Another 81 workers from the milk processing companies formed the matched control group. Data collected was processed and analysed in SPSS. The mean predicted lung function values were significantly lower for the animal feed mill workers compared to the control workers for all the parameters ($p<.05$). Obstructive lung abnormality was recorded among the target group and none in the control group. The most prevalent symptom among the respondents was the stuffy, itchy, and running nose (53.77%), followed by watery and itchy eyes (30.48%), phlegm first thing in the morning during cold periods (13.70%), and cough first thing in the morning during cold periods (12.33%). This study concludes that declined lung function among the animal feed mill workers is associated with exposure to grain dust. The study recommends medical examinations for the workers and adherence to the set safety and health guidelines by the workers.

Keywords**—**spirometry, respiratory symptoms, FVC, FEV_1

I. Introduction

OCCUPATIONAL exposures to grain dust contribute to approximately 12% of deaths linked to chronic obstructive airway diseases [1]. These diseases induced by grain dusts attack the respiratory system and are influenced by the type of dusts, dose, duration of exposure, and genetic factors [2], [3]. In Kenya, no public data existed in which actual grain dust concentrations had been investigated in relation to lung health among workers in the animal feed industry; thus, little awareness and practice on safety and health standards had been made. Thus, there was a need to assess the effect of exposure levels to grain dust on the pulmonary function of the workers.

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Grain dust might contain a large number of contaminants. The contaminants that might be contained are metabolites of fungi and silica, bacterial endotoxins, insects, mites, mammalian debris, pesticides, and herbicides [4]. Exposure to grain dust in various quantities has been reported to cause either acute or chronic respiratory ailments [5].

A decreased pulmonary function had been reported in Egypt as a significant health concern to feed milling workers due to the significant bio-contamination in their work environment [6]. In an animal food-processing factory in western Turkey, a pronounced higher prevalence in respiratory symptoms and decline in lung functions was observed in exposed workers compared to the controls, attributable to the animal feed dust [7]. However, health challenges occurring because of exposure to grain dust show up less frequently compared to major disabling diseases or accidents hence not being recognized. Because of exposure to grain dust, respiratory diseases present a serious health challenge with significant potential of acute and chronic morbidity, long-term disability, and adverse socio-economic impacts, especially in developing countries [8]. These clinical symptoms are critical and may result in workplace absence, change of job, disability, and finally, work cessation [9]. There was a need to assess the prevalence and impacts of grain dust on animal feed workers' health. This was realized through the assessment of pulmonary functions of the workers. Feed mill workers in Kiambu County, Kenya, like mill workers everywhere, are at a high risk of developing both acute and chronic pulmonary symptoms linked to their occupation. In Kiambu County, feed milling operators are majorly concentrated in urban areas such as where there is the availability of infrastructure. These feed milling industries operate in varied capacities, with the majority being small-scale operators [10]. Occupation-related illnesses have been documented in various regions where workers are exposed to grain dust in industries that generate dust during production [4], [11], [12]. The study aimed at evaluating the pulmonary functions and respiratory effects of selected feed mill workers in Kiambu county Kenya. This study formed a basis for an analysis of preliminary health risks of workers in the feed mills and helps policymakers in improving health and safety strategies in the animal feeds industry.

II. MATERIALS AND METHODS

A. Study design

A case-control study design was adopted to identify the status of lung function between the target group and the control group in relation to the causal factor variable (exposure to grain dust). A cross-sectional study design was used to establish the prevalence of respiratory symptoms among animal feed mill workers in Kiambu County, Kenya.

B. Study variables

1) Outcome variables

Status of lung function reduction among the target group and the control group. Forced Vital Capacity (FVC), Forced Expiratory Volume quantified at the first second (FEV_1), FEV_1/FVC ratio, $FEF_{25-75\%}$ are the measurable parameters that were used to evaluate the lung function [13].

Presence of respiratory symptoms, evidenced by one or a combination of a cough with or without sputum, emphysema, wheezing, rhinitis, itchy eyes and chronic chest diseases.

2) Predictor variables

Gender, age, educational level, work experience, daily work hours, current or previous exposure to dust are the socio-demographics factors of the workers that influenced the likelihood of getting lung function impairment and respiratory symptoms.

C. Study setting

There are thirty-five (35) registered feed milling manufacturers duly registered by the Association of Kenya Feed Manufacturers (AKEFEMA) in Kiambu County, Kenya. Kiambu County covers an estimated area of 2,543.5 km^2 within the central Kenya region, with most millers located in Thika's industrial zone, as shown in Figure 1.

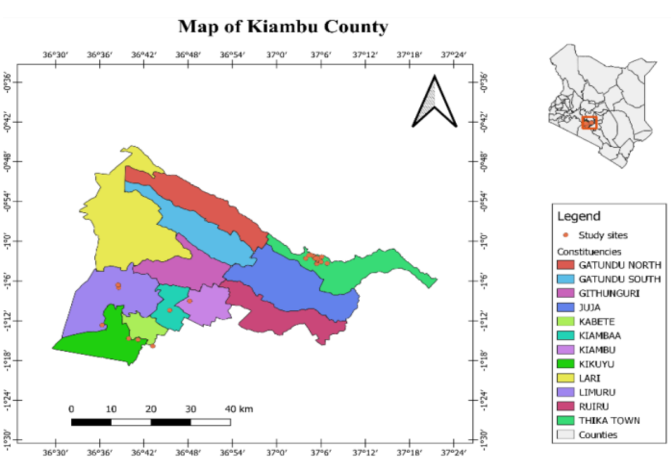

Figure 1: Map of the study area

Three hundred and fifty-five (355) animal feed mill workers from thirty-five (35) animal feed manufacturing facilities were included in the assessment of respiratory symptoms using a questionnaire. Eighty-one (81) respondents were selected from the twelve (12) animal feed millers with more than 20 employees in Kiambu County. 81 workers selected from the three milk processing companies within the county formed a control group since they are perceived not to be exposed to grain dust in their workstations.

For the target group and control group participants to be eligible for the spirometry test, they had to fulfil the inclusion criteria: they should have worked in their specific industry for more than 6 months and were more than 18 years. Participants with the following characteristics were excluded from the study: history of smoking, history of bronchial asthma before joining work, present or past history of severe respiratory infection (extensive pulmonary tuberculosis, bronchiectasis, and COVID-19), and clinical abnormalities of the vertebral column and thoracic cage. Additionally, control group participants who had previously worked in dusty environments were excluded since they could form a source of bias.

The respondents who met the inclusion criteria for the spirometry test were grouped in ranges using their age, gender, and height. These were matched with the control group at a 1:1 ratio until the sample size was attained.

D. Study size

Based on Yamane's formula, three hundred fifty-five (355) respondents at thirty-five (35) feeds mills in Kiambu County formed the sample size [14].

Kelsey's formula was used to calculate the sample size for comparing the cases and controls [15]. The sample size of 81 workers for each group was determined assuming a prevalence of 74.7% as the proportion of cases with exposure as reported in [16] and prevalence of 50% as proportion of controls with exposure since the proportion of the population with the characteristic is unknown [17].

E. Data measurement

1) Interviews

Survey data was collected by trained interviewers who administered the modified version of British Medical Research Council questionnaire to the target respondents [18]. This was used to assess the respiratory symptoms of the workers and its predicators.

2) Pulmonary Function tests

The study used spirometry due to the availability of the equipment and expertise within Kenya. A pre-screening questionnaire was administered to the eligible workers and the control group by the researcher before the test to have an accurate population sample. The researcher was trained on instrument handling and standard operating procedure by a spirometry technician. The target group was matched with the control group in terms of age, gender, height, and weight.

The researcher measured the height using a portable stadiometer, Seca. The participants were to remove any head protective gear, stand steadily against the wall and face straight. The headpiece was then lowered and rested steadily on the participant's head, whereby the reading was measured and recorded.

The researcher measured the bodyweight of the participants using a calibrated digital scale, Seca, with a maximum capacity of 200 Kg on an even ground. The scale was calibrated daily using reference test weights for the minimum and maximum load capacities, and the reading was recorded once the instrument stabilized. The test was repeated five times, and the mean values were taken. The researcher ensured that the location set for calibration was thermally stable and free from magnetic or electrostatic fields. The participants were to remove any footwear before each weighing cycle and reading taken once the scale stabilized.

The researcher performed a spirometry test on each of the stratified randomly sampled feed milling workers. A clean, calibrated, and portable spirometer (Contec SP-10) was used to take the measurements. The workers loosened any tight clothing to achieve the best results. Once the device was on, the researcher selected the testing option, and the worker had to inhale, seal the lips around the mouthpiece and forcefully exhale all air in the least time possible until they could not expel any more air. The device then displayed the results in the form of measured and predicted values. The predicted values were popularized values referenced using a set of variables such as gender, age, height, and ethnicity. The researcher evaluated the predicted values using known standards that provide the benchmark for interpreting spirometry results. The test was performed in a well-aerated location and a standing position [19]. Various lung function parameters were recorded: the Forced Vital Capacity (FVC), Forced Expiratory Volume quantified at the first second (FEV_1), FEV_1/FVC ratio, $FEF_{25-75\%}$. The test results were acceptable if there was no false start, coughing in the first second, and exhalation lasted for at least six seconds. A minimum of three test trials was done to ensure the results were reproducible. The two highest values for the indicators were to agree within 150 ml (0.15 L) after three successful runs [20]. All lung function measurements were done during the day shift between 1000-1700 hours to reduce any diurnal variation that occurs as a response to the circadian rhythm [21].

For interpretation of the spirometry results, the researcher compared the measured value and the reference or predicted value. Normal lung function was considered when FVC and FEV_1 test score was more than or equal to 80% of the reference value and FEV_1/FVC ratio was more than or equal to 70% of the reference value. If the test scores were less than the normal values, this represented a lung function abnormality, either restrictive or obstructive. Obstructive lung disease was determined when FVC and FEV_1 test score was less than 80% of the reference value, and FEV_1/FVC ratio was less than 70% of the reference value. This caused the FEV_1 to be lower than the normal values. Restrictive lung disease facilitates the FVC to lower than the normal values, and it was considered when FVC and FEV_1 test score was less than 80% of the reference value, and FEV_1/FVC ratio was more than 70% of the reference value [22], [23].

F. Reliability and Validity of Research Instruments

The interviewer explained to the respondents the intentions of the research study before administering the same and followed up with phone calls to ensure the success of the study.

The calibration of the spirometer was done using a 3 Litre precision calibration syringe before the first session and after every full data log. The researcher would select the calibration interface on the spirometer's display screen, attach the syringe to the spirometer, and feed the syringe volume into it steadily until the device displayed "REPEAT". Another feeding loop was performed, after which if the calibration is successful; the device would display "OK!" and the display would return to its previous set interface.

G. Data analysis and presentation

Before the analysis, all questionnaires were checked for incompleteness, duplication, and inconsistencies. Firstly, the data collected by using the various instruments were edited and coded to get the relevant data for the study. Quantitative data collected from the questionnaires and lung function tests were analyzed by the use of descriptive statistics using SPSS (Statistical Package for Social Sciences) and presented through percentages, means, standard deviation, and frequencies. The study statistical significance level was at $p<0.05$ or 95% confidence level. A Chi-square test for independence was used to compare the association of significance between two categorical variables. The student's t-test was used to compare the means between a categorical and continuous variable.

Additionally, the researcher performed a binary logistic regression model to establish the relationship between specific predictor variables and the dependent variables to predict the lung function outcome.

H. Ethical Consideration

The principle of voluntary participation was observed by obtaining informed consent from the management of the animal feed manufacturing facilities. The management was guaranteed of confidentiality by the assurance that the data was to be used for academic purposes only. Ethical approval was acquired from Jomo Kenyatta University of Agriculture and Technology's Ethical Review Committee and a research license obtained from National Commission for Science, Technology and Innovation (NACOSTI).

III. RESULTS

A. Socio-demographic characteristics of the matched groups.

Table 1: Socio-demographic data of the matched target group and control group.

	Target group n=81		Control group n=81			
Characteristics	**Frequency**	**%**	**Frequency**	**%**	**χ^2 value**	**P-value**
Gender						
Male	71	87.65%	71	87.65%	0.000	1.000
Female	10	12.35%	10	12.35%		
Age group (years)						
20-29	41	50.62%	41	50.62%	0.000	1.000
30-39	28	34.57%	28	34.57%		
40-49	9	11.11%	9	11.11%		
50-59	3	3.70%	3	3.70%		
Level of education						
Primary	15	18.52%	22	27.16%	13.313	0.001
Secondary	36	44.44%	49	60.49%		
Tertiary	30	37.04%	10	12.35%		
Work experience						
Less than 1 year	10	12.35%	12	14.81%	12.593	0.013
1-5 years	43	53.09%	25	30.86%		
6-10 years	19	23.46%	21	25.93%		
11-15 years	7	8.64%s	12	14.81%		
16 years and above	2	2.47%	11	13.58%		

Both gender and age were matched for the target group and the control group as shown in Table 1; thus, it was not statistically significant different ((*$\chi 2$= 0.000, df= (1, 3),* (*p=1.000*). Both the target group and the control group had more males than females, constituting 87.65% for both of them. 44.44% of the target group and 60.49% of the control group had secondary school education. 37.04% of the animal feed workers and 12.35% of the control group had tertiary education. There was a statistically significant difference in the level of education between the animal feed mill workers and the milk processing workers (*$\chi 2$= 13.313, df=2, p=.001*). Workers with 1-5 years of work experience within the industry from both groups comprised 42%, and they were the leading number of respondents. Workers with 6-10 years' work experience comprised 24.7% for both groups. The difference in work experience was statistically different between the two groups (*$\chi 2$= 12.593*, *df=2*, *p=.013*).

B. Comparison of mean age, weight and height of target and control group.

The study sought to match the ages, weight, and height of the target and the control groups. From the findings, there was no statistically significant difference in their mean values as shown in Table 2.

Table 2: Comparison of mean age, weight and height of target and control group

Characteristics	Target group	Control group	t value	p-value
Age (years)				
Mean ± SD	32.02±7.64	32.48±7.62	0.381	0.704
Weight (Kg)				
Mean ± SD	70.81±9.32	71.22±9.35	0.284	0.777
Height (cm)				
Mean ± SD	172.11±7.29	172.90±7.97	0.659	0.511

C. Pulmonary function of the target group and control group.

1) Lung function parameters among target and control groups

The mean predicted lung function values were lower for the animal feed mill workers than the control workers for all the parameters as shown in Table 3. The differences were significant for FEV_1, FVC, FEV_1/FVC, and $FEF_{25\text{-}75\%}$ between the target and the control groups (*p<.05).*

Table 3: Lung function parameters among target and control groups

Parameter	Target group Mean ± SD	Control group Mean ± SD	t value	P-value
FEV_1 (%)	82.64±21.17	108.06±11.86	9.429	0.000
FVC (%)	88.44±21.76	95.47±13.32	2.478	0.014
FEV_1/FVC (%)	95.42±20.76	113.72±5.91	7.628	0.000
$FEF_{25\text{-}75}$ (%)	80.60±30.69	100.81±10.74	5.594	0.000

2) Lung function classification among the groups

The prevalence of normal lung function was higher in the control group companies than in the target group (88.9% versus 45.7%) as shown in Table 4. Obstructive lung abnormality was observed only among the target group and none in the control group. The differences were statistically significant (*p<.001*). This suggests that there is an association between exposure to grain dust and obstructive lung diseases.

Table 4: Lung function classification among the groups

	Target group n=81		Control group n=81			
Lung function classification	**Frequency**	**%**	**Frequency**	**%**	**x^2 value**	**P-value**
Normal	37	45.7%	72	88.9%	35.773	0.000
Obstructive	10	12.3%	0	0.0%		
Restrictive	34	42.0%	9	11.1%		

3) Prevalence of respiratory symptoms in the target group (n=292)

Out of the 355 questionnaires administered by the interviewers to the 35 animal feed millers, 292 questionnaires from 31 animal feed mill companies were duly completed. This was 82.25% and 88.57% participation rate from the respondents and animal feed mills, respectively.

The most prevalent symptom among the respondents was the stuffy, itchy, and running nose (53.77%), followed by watery and itchy eyes (30.48%), phlegm first thing in the morning during cold periods (13.70%) and cough first thing in the morning during cold periods (12.33%) as shown in Table 5.

Table 5: Prevalence of respiratory symptoms in the target group (n=292)

Characteristics	Frequency	%
Chronic bronchitis	2	0.68%
Pneumonia	19	6.51%
Hay fever	8	2.74%
Other: Breathing difficulty	2	0.68%
Other: Cold allergy	2	0.68%
Cough first thing in the morning during cold periods	36	12.33%
Cough during the rest of the day or at night working hours	21	7.19%
Phlegm first thing in the morning during cold periods	40	13.70%
Phlegm during the rest of the day or at night working hours	23	7.88%
Phlegm on most days or night working hours as much as 3 months in a year	23	7.88%
Phlegm first thing in the morning	25	8.56%
Increased cough and phlegm lasting for 3 weeks or more in a year	14	4.79%
Shortness of breath when hurrying on level ground	23	7.88%
Shortness of breath with other people of your age on level ground	2	0.68%
Shortness of breath walking at your own pace on the level ground	6	2.05%
Breathless to leave the house or on dressing or undressing	2	0.68%
Wheezy or whistling chest	12	4.11%
Whistling sounds improve when you are away from work	6	2.05%
Stuffy, itchy, running nose	157	53.77%
Watery, itchy eyes	89	30.48%

4) Predictors of respiratory symptoms and associated factors in the matched target group (n=81)

The results of the binary logistic regression to ascertain the effects of socio-demographic and occupation variables on the prevalence of respiratory symptoms on the animal feed workers (study group) were as shown in Table 6. The likelihood of getting respiratory symptoms was higher in the age group 30-39 (*p=.045*) compared to the age group ≥ 40 (*p=.016*), which was significant. A similar trend was observed in the work experience variable. Although insignificant for workers with above 6 years of work experience, a negative relationship between the work experience and the probability of getting respiratory symptoms was observed. The odds for workers with 1-5 years (*OR=6.86*, *p=.027*) was more than those with 6-10 years (*OR=5.65*, *p=.085*) and above 11 years (*OR=5.10*, *p=.211*). The chances of getting respiratory symptoms had a significant positive association with workers working between 1 to 5 years (*OR=6.86*, *p=.027*). The other predictor variables were insignificant (*p>.05*).

Table 6: Predictors of respiratory symptoms and associated factors in the matched target group (n=81)

Variables	At least one respiratory symptom Yes	No	Crude Odds ratio (95% CI)	P-value
Gender				
Male	44	27	Reference	
Female	8	2	2.84 (0.33-24.28)	0.341
Age				
20-29	30	11	Reference	
30-39	17	11	0.20 (0.04-0.96)	0.045
≥ 40	5	7	0.10 (0.01-0.64)	0.016
Education level				
Primary	11	4	Reference	
Secondary	23	13	0.45 (0.09-2.10)	0.308
Tertiary	18	12	0.26 (0.04-1.61)	0.147
Work experience				
Less than 1 year	3	7	Reference	
1-5 years	32	11	6.86 (1.24-38.00)	0.027
6-10 years	12	7	5.65 (0.79-40.50)	0.085
11 years and above	5	4	5.10 (0.40-65.49)	0.211
Daily working hours				
Less than 8 hours	4	1	Reference	
8 hours	26	22	0.41 (0.03-4.80)	0.475
8 hours and above	22	6	1.76 (0.13-24.46)	0.674
Exposure to dust at the current job role				
No	43	23	Reference	
Yes	9	6	2.20 (0.39-12.30)	0.371

IV. DISCUSSION

A. Socio-demographic characteristics of the matched groups.

The matched gender and age group in the study were consistent with the study findings conducted among 196 flour mill factory workers in Hawassa city, southern Ethiopia, to evaluate the prevalence of chronic respiratory symptoms, pulmonary function, and associated factors whereby both the target group and the control group had more males than females, and 51% of respondents in both groups were between 20 to 29 years [24]. The study findings on the level of education differed from the study findings conducted in Ethiopia that showed that 73.6% of the workers had primary education, 18.4% attended secondary school, and 8% had more than secondary education [24]. The disparity is a result of the study focusing on flour mill workers and the differing adult literacy rates between Kenya (78%) and Ethiopia (48.6%) [25]. The study findings on the work experience differed from the study conducted among 315 animal feed mill workers in fourteen animal feed mills in the Netherlands to assess the association between organic dust exposure, respiratory symptoms, and chronic pulmonary function changes. The study observed that most of the workers had been employed in the industry for an averagely of 13.7 years [26]. This could be attributed to the different labour laws in Kenya and Netherlands and the employer-employee relationship in the different facilities.

B. Comparison of mean age, weight and height of target and control group

The mean age for the target group (32.02 years) and control group (32.48 years) were comparable with the findings of the authors in [7], that focused on animal feed dust exposure on its workers that indicated the mean age of the target group as 32 years and for the control group as 30 years. The mean weight of the target group (70.81 Kg) and the control group (71.22 Kg) contradicts with the study in the Norwegian grain and animal feed production industry, where the mean weight of the exposed workers was 90 Kg while those of the referents was 83 Kg [27]. This is attributable to the differing average weight in Kenya and Norway, whereby Kenya being in the African region, has a mean weight of 60.7 Kg, and Norway is in the European region has a mean weight of 70.8 Kg [28]. The mean height of the target group (172.11 cm) and the control group (172.90 cm) was in agreement with the results of the study on bioaerosol exposure and respiratory response in the grain and feed workers where the mean height of the exposed workers was 179 cm, and those of the control group was 176 cm [27].

C. Pulmonary function of the target group and control group.

1) Lung function parameters among target and control groups

The low mean predicted lung function values among the animal feed mill workers were consistent with the study conducted in Turkey, where the mean pulmonary function test values (predicted %) of the workers were FVC ± SD (85.23 ± 12.06), FEV_1 ± SD (88.73 ± 13.09) and $FEF_{25-75\%}$ ± SD (88.42 ± 25.94) [7]. These values were significantly lower than those of the control group were attributable to grain dust exposure to workers in the animal feed facilities (p<.05). However, a study carried out by the authors in [27] had contrasting findings where there was no difference in the lung function parameters between the workers and the control group. The possible factors attributable to this are minimized acute effects due to tolerance built over long periods of exposure and healthy worker effect [27].

2) Lung function classification among the groups

Obstructive lung abnormality was recognized only among the target group and absent in the control group. These study findings were similar to studies carried out to assess the respiratory effects among bakery workers in Edo Central Senatorial District, Nigeria, where the prevalence of obstructive lung disease was observed among the bakery workers and none among water company workers who formed the control group [12]. Comprehensive pulmonary function tests can be carried out to a larger population of animal feed mill workers in Kenya, where more observations can be identified.

3) Prevalence of respiratory symptoms in the target group (n=292)

Nasal symptoms were prevalent in more than half of the respondents. These study findings were consistent with the study undertaken among animal feed workers in the Netherlands to assess the lung function changes and occupation-related symptoms associated with grain dust and endotoxin. The most commonly recorded symptom among the animal feed workers was sneezing (21%), followed by nasal irritation (15%) and cough (9%). These symptoms were significantly higher compared to those of the control group ($p<.01$) [26]. Similarly, in Denizli, Western Turkey, a study assessed the prevalence of chronic occupational respiratory symptoms in animal feed workers. The prevalence of respiratory symptoms among the workers was cough (12%), dyspnea (5.6%), and sinusitis (8.3%). The prevalence of the irritation symptoms in the exposed group was pruritus of the eyes (11.1%), skin lesions (7.4%), and nose symptoms (8.3%) [7]. Hence, characterization of the bio-contaminants in the grain dust is important in order to evaluate the effects of specific contaminants on the respiratory health of the animal feed mill workers in Kenya.

4) Predictors of respiratory symptoms and associated factors in the matched target group (n=81)

With increase in age and work experience, the likelihood of getting respiratory symptoms lessened. The study findings were consistent with a study in the Netherlands by the authors in [29], on the dust and endotoxin related respiratory effects in the animal feed industry where the prevalence of the severe respiratory symptoms declined with the increasing years of exposure attributable to the "healthy worker effect". This phenomenon was similar to three case studies. The first one is a follow-up study on the initial survey conducted by the authors in [29] among grain processing and animal feed Dutch workers [30]. The healthy worker effect underestimated the exposure-response relations whereby 156 out of the 320 subjects were lost to follow up. The second one is a pooled study analysis on the comparison of respiratory effects in Dutch and Canadian grain handling facilities associated with dust. Dutch transfer elevator workers were not factored in due to negative confounding related to the healthy worker effect [31]. The third one is a study conducted in Ethiopian flour mills where the chances of respiratory symptoms for workers with 6-9 years of work experience was twice that of workers with more than 10 years. This was attributed to the healthy worker effect [24].

V. LIMITATION

The healthy worker effect is a bias that could occur since the exposed workers who had developed respiratory symptoms might have left employment, leaving the healthier cohort who have low prevalence rates.

VI. CONCLUSION

The study concludes that the mean predicted lung function values were significantly lower for the animal feed mill workers than the control workers for all the parameters, attributable to grain dust exposure to workers in the animal feed facilities ($p<.05$). Obstructive lung abnormality was among the target group and none in the control group. The differences were statistically significant. ($p<.001$). This suggests that there is an association between exposure to grain dust and obstructive lung diseases. The most prevalent symptom among the respondents was the stuffy, itchy, and running nose (53.77%), followed by watery and itchy eyes (30.48%), phlegm first thing in the morning during cold periods (13.70%), and cough first thing in the morning during cold periods (12.33%).

VII. RECOMMENDATION

The animal feed mill facilities should ensure their workers undertake pre-employment and period medical examinations as part of their health surveillance to aid in the early detection of abnormal lung function. Proper interventions that have been taken at an early stage decrease the severity of pulmonary diseases. This is provided by The Factories and Other Places of Work Act (Hazardous Substances) Rules, 2007, and The Factories and Other Places of Work (Medical Examination) Rules, 2005 [32], [33].

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