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Association between Occupational Risks of Exposure to Pesticides and Respiratory Symptoms among Organic and non Organic Farmworkers

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Abstract Respiratory problem is one of the main occupational health challenges faced by farmworkers, it can occur while preparing and applying pesticides and during tasks in recently sprayed fields. Symptoms associated with different respiratory problems include coughing, wheezing and airway inflammation are commonly observed among farmworkers who are occupationally exposed to pesticides. In low and middle-income countries, epidemiological evidence for the association between occupational exposure to pesticides and respiratory diseases in adults is limited. The study employed a cross-sectional survey that ran from January to February 2021 using face to face semi-structured questionnaire administered to farmworkers who were working on flower and coffee farms in Arusha and Kilimanjaro. Approximately 384 farmworkers were randomly selected to participate in this study. The study included organic and non-organic farmworkers who were directly engaged in agricultural activities and exclude supporting staff such as human resource managers who were not engaged directly in agricultural activities. The results indicate that non-organic farmers were at high risk of developing respiratory symptoms than organic farmworkers. Non-organic farmers were significantly associated with cough, rhinitis, and shortness of breath among farmworkers [adj. OR (95% CI) 31.94 (12.04, 84.70), 4.44 (2.61, 7.56) and 6.44 (1.98, 20.95)] respectively. However, there should be a systematic collection of data about poisoning cases occurring in the farm areas with a large number of employees so that effective measures can be taken to protect the farmers from chronic illnesses associated with pesticide exposure, particularly respiratory problems in this case.

Keywords: *respiratory symptoms, occupational pesticides exposure, farmworker*

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1. Introduction

Pesticides are consumed annually worldwide in controlling pests and pest-induced diseases to increase productivity in agriculture settings [1]. Pesticides such as herbicides, insecticides, fungicides, bactericides, and rodenticides are widely used in controlling pests [2]. Occupational pesticide exposure is one of the main occupational health hazards facing farm workers worldwide [3,4]. Pesticides entering the body through inhalation may result in major problems in the respiratory system [2]. Exposure to these pesticides occurs during the production, transportation, preparation, and application of pesticides in the agricultural setting [2,5]. A person using these chemicals needs to wear personal protective equipment (PPE) as recommended by the United Nations Environmental Protection Agency [6]. According to [7], about 300 million people are reported to suffer and die from chronic respiratory diseases such as asthma and 210 million people suffer from the chronic obstructive pulmonary disease (COPD). In Tanzania epidemiological evidence on the association between occupational exposure to pesticides and respiratory diseases among farmworkers is limited. Therefore, this study aimed at addressing the relationship between pesticide exposure and the occurrence of respiratory symptoms among farmworkers in Tanzania. The study findings may enable decision-makers and responsible ministries to make informed decisions for better management and control of exposure to pesticides for improved health and economic

development of individual farmworkers and the nation at large.

2. Materials and Methods

2.1. Description of the Study Area

The current study was conducted in Arusha and Kilimanjaro regions (Figure 1). It focused on purposively selected estates for coffee and flowers plantation. In the Arusha region, the study was conducted in Arumeru District, involving Burka estate, Selian coffee estate, and Derkker bruin flower farm (in Arusha and Kilimanjaro) while in the Kilimanjaro region the study was conducted at Moshi Rural District in Machari coffee estates and Bondeni flower farms. These regions were selected because of the availability of large-scale farmers on flower and coffee farms.

2.2. Study Design

This was a cross-sectional study whereby farmworkers from flower and coffee plantations were asked to participate. In this study, coffee farms included two farms where farmers were applying pesticides (non-organic) and one farm that served as an organic farm because farmers were not applying pesticides. On the other hand, all selected flower farms used pesticides and therefore denoted as nonorganic farms. Despite the desire to include control farms, it was not viable since none of the flower farms in the study area were farming without the use of pesticides.

In this study, occupational exposure to pesticides, respiratory symptoms, demographic and confounding factors were collected through a structured questionnaire. Moreover, confounding factors were identified as determinants of outcomes of interest. Farmers engaged in the organic farm were considered as a control group (non-exposed group) while those engaged in non-organic farming were considered as an exposed group. Both male and female farmworkers aged between 18 and 48 years and working in flower and coffee plantations in Arusha and Kilimanjaro region.

2.3 Sample Size

The sample size for respondents was calculated based on the proportions of the total number of farmworkers employed on each selected farm: Burka coffee estate (n=350), Selian Coffee Estate (n=246), Machari Coffee Estate (n= 1451), Dekker bruins in Arusha (n=238), Dekker bruins in Moshi (n=476) and Bondeni flower (n= 134). This resulted in a study population of 2895 farmworkers.

The following formula was used to obtain the total sample size for the study (Daniel, 1999)

$$n = N * X / \left(X + N - 1 \right)$$

Where,

$$X = Z\alpha / 22 - * p * \left(1 - p \right) / MOE2,$$

Zα/22 is the critical value of the Normal distribution at α/2 (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), MOE is the margin of error, p is the sample proportion, N is the population size =2895 farmers and n = 384 respondents

We also considered a non-response rate of 1% = 385*0.01=3.85=4 respondents

Hence resulted in a total sample size of 389 respondents.

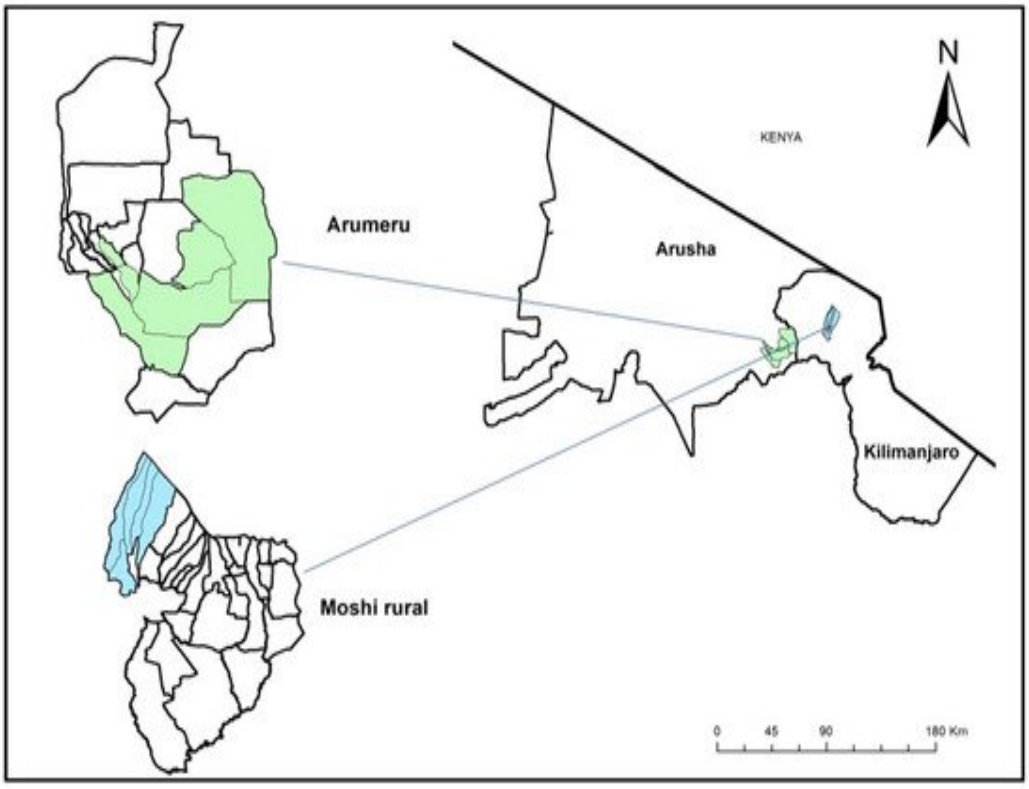

Figure 1. Map showing the study area

Table 1. Study Location, Farm type, Type of crop, study population and Sample size

Location	Name of farm	Type of farm	Type of crop	Classification	Estimated population	Sample size
Arusha	Burka coffee estate	Open field	Coffee	Non-organic	350	47
	Selian coffee estate	Open field	Coffee	Non-organic	246	33
	Dekker bruins flowers	Closed field /greenhouse	Flowers	Non-organic	238	32
	Dekker bruins flowers	Closed field /greenhouse	Flowers	Non-organic	476	64
Kilimanjaro	Bondeni flowers	Open fields	Flowers	Non-organic	134	18
	Machari coffee estate	Open fields	Coffee	Organic	1451	195

2.4. Sampling Technique

In the quantitative research design, we used simple random sampling whereby a stratified sampling was used to get the number of participants in each farm as shown in Table 1.

For qualitative sampling, a purposive sampling technique was used to identify study participants from the sampling population of 389. Therefore, twenty-four participants of which twelve were working on the non-organic farm and the other twelve were working on an organic farm. These participants were selected based on their experience regarding pesticide exposure and the development of respiratory symptoms in the occupational setting.

2.5. Inclusion and Exclusion Criteria

Farmworkers (pesticide sprayers, storekeepers, mixers, pickers and pruners) directly engaged in farming activities from flower and coffee plantations were included in the study. Farm administrators and other supporting staff such as human resources who are not engaged in agricultural activities were excluded.

2.6. Data Collection

2.6.1. Demographic Characteristics and Respiratory Symptoms

Detailed questionnaires on socio-demographic aspects, lifestyle factors and respiratory health were included. The socio-demographic and lifestyle factors included sex, age, education, marital status, parental history of respiratory problems, cigarette smoking (past and current smokers), sharing room with smokers, use of cleaning detergent, a vegetable garden at home and treatment of domestic pesticides for the past three (3) months. These variables were defined as confounding variables to be used in the analysis of the association between occupational exposure to pesticides and the prevalence of respiratory symptoms among our study participants.

In this study, cough, rhinitis, wheeze, shortness of breath and cough with phlegm were considered respiratory symptoms if they persisted for over three (3) months. These symptoms were included in this study because they were reported in previous studies [8,9,10].

2.6.2. Occupational Exposure Assessment

A questionnaire is base on categories such as types of farming (non-organic farming vs. organic farming), large farming system and working area (greenhouse vs. open field), occupational status (sprayers and mixer vs. organic farmers flower pickers), mix and spray pesticides (yes vs. no), washing spray instrument after pesticides application (yes vs. no), taking bath after work (yes vs. no), wearing protective gear (yes vs. no) and washing hands after work (yes vs. no) was administered to farmworkers directly engaged in farming activities. Farmers who used pesticides were considered the exposed group while those who did not use pesticides were considered the non-exposed (control group).

2.7. Statistical Data Analysis

Data were analysed using statistical software namely Stata version 15 and NVivo version 12 for qualitative analysis specifically content and thematic analysis (analysis of major themes and contents). The descriptive analysis of quantitative data included the use of descriptive statistics, measures of frequency and counts with diagrams. Inferential statistics was employed by using a model in assessing the influence of factors on exposures to occupational risks. The Binary logistic regression was used to assess the association of the outcomes of interest with occupational exposure to pesticides from non-organic farms in coffee and flowers, which were defined as the types of farming, large farming system and working area, occupational status, mix and spray pesticides, washing spray instrument after pesticides application, taking bath after work, wearing protective gear and washing hands after work.

The analyses were performed with and without adjustment for the potential confounding factors described above and the impact of the potential confounders. The association estimates were assessed by comparing the adjusted and unadjusted estimates. The associations are presented as odds ratios (ORs) with 95 percent confidence intervals (CIs); Wald tests were used to determine the statistical significance of the relationships among the categorical exposure variables.

The data were also analysed qualitatively to determine the study participant's awareness of the effects associated with occupational exposure to pesticides and increased risk of respiratory symptoms. In this aspect, we used the following questions; when do you experience respiratory problems? And how do farmers protect themselves during farming activities?

2.8. Ethical Approval and Participation

Ethical approval for this study was obtained from the Research and Publication Committee of Sokoine University of Agriculture, Tanzania. Informed consent was obtained from the participants before the commencement of the interview.

3. Results

3.1. Description of the Respondent and Occupational Exposure Characteristics

Participants in the exposed group and control group were 194 exposed and 195 non exposed, which is equivalent to 49.9 percent and 50.1 percent respectively. Most of the participants had Primary education while only few had Secondary Education. Based on age, most farm workers in this study had the age between 38-48.

About 41% (n=80) were non-organic coffee and 100% (n = 195) were organic farmers in coffee. The occupational status of the study participants based on the pesticide exposure was as follows: 26% (n=30) were flower pickers and 50 % (n = 57) were sprayers and mixers in non-organic flowers, 5% (n=4) and 25% (n=29) of the study participants in non-organic coffee and non-organic flowers were pesticides mixer and sprayers. 61% (n= 69) and 23% (n = 18) of study participants in non-organic flower and non-organic coffee respectively washed spray instruments after pesticide application. Moreover, 23 % (n =18) and 36% (n=41) of the study participants in non-organic coffee farms and non-organic flower farms take a bath after work. (Table 2 and Table 3).

Table 2. Demographic characteristics of all respondents (N=389) divided between exposed in flower and coffee (n = 194) and non-exposed in coffee (n=195)

Variables		Percentages (%)		
		Exposed (flower) (n = 114)	**Exposed (Coffee) (n= 80)**	**Non-exposed (Coffee) (n=195)**
Sex	Female	41	89	72
	Male	59	11	28
Age group	18 -28	22	30	26
	28 – 38	24	29	19
	38 – 48	54	41	55
Educational level	Informaleducation	3	2	14
	Primary	79	94	78
	Secondary	18	4	8
			19	10
Marital status	Single	22	19	10
	Married	77	78	84
	Widow	1	1	0
	Divorced	0	2	6

Table 3. Occupational Exposure Characteristics for all study participants in the exposed group Coffee (N= 80), Exposed group flower (N= 114) and Non exposed (Organic) group coffee (N= 195)

Variables			**Percentage (%)**
Type of farming (N=389)	Organic farms in coffee	195	50
	Non-organic farms in coffee	80	21
	Non-organic in flowers	114	29
Farming system and working area (N=389)	Open field farms in coffee (exposed)	80	20
	Open field farms in coffee (non-exposed)	195	50
	Open field farms in flower	18	5
	Closed field/ Greenhouse in flower	96	25
Occupational status (N=389)	Organic farms in coffee Pruners	195	50
	Flower pickers	30	8
	Sprayers in flower farms	57	15
	Storekeepers in flower farms	12	3
	Another occupational status (parkers and graders) in flowers farm	95	24
Mix and Spray pesticides (N=33)	Non-organic farms in coffee	4	12
	Non-organic farms in flower	29	88
Washing spray instruments After Pesticides Application(N=80)	Non-organic in coffee farms	18	23
Washing spray instruments After pesticides application (N = 114)	Non-organic in flower farms	69	61
Taking shower after work(N=59)	Non-organic coffee farms	18	31
	Non-organic flower farms	41	69

Table 4. Association between Behavioral characteristics and farm type (exposed and non-exposed)

Behavioral characteristics	Prevalence (%)		Asymp. Sig. (P-value)
	Exposed in coffee (n= 80)	Non-Exposed in coffee (n = 195)	
Smoked cigarette	0	14	0.002
Current smoker	0	14	0.000
Sharing room with a smoker	19	34	0.037
Use of cleaning detergents at home	88	82	0.009
Vegetable garden at home	66	63	0.000
Domestic pesticides treatment	14	24	0.026

Table 5. Association between Respiratory Symptoms and Farm type

Respiratory symptoms	Prevalence (%)		
	Exposed in coffee (n = **80**)	Non-Exposed in coffee (n = 195)	
Rhinitis – Farm type	56	26	0.000
Coughing sign – Farm type	46	5	0.000
Bring up phlegm – Farm type	15	0	0.000
Chest wheezing condition – Farm type	19	0	0.000
Shortness in breath – Farm type	13	5	0.033

Table 6. Chi-square test of Association between Respiratory Signs and types of Crops (n=194) at a 0.05 level of significance

Respiratory Symptoms	**Prevalence based on types of crops (%)**		**P-Value**
	Coffee	**Flower**	
Rhinitis	23	36	0.551
Coughing sign	19	23	0.287
Bring up phlegm	7	10	0.638
Chest wheezing	8	9	0.589
Shortness in breath	5	5	0.401

3.2. Association/Relationship Analysis

3.2.1. Association between Behavioral Characteristics and Farm Type (Exposed and Non-exposed)

There was a statistical association between smoking cigarettes (P = 0.002), current smoker (P = 0.000), sharing a room with a smoker (P=0.037) and domestic pesticide treatment (P = 0.026), use of cleaning detergent at home (0.009) and having a vegetable garden at home (P 0.000) and the farm type (exposed and non-exposed) (Table 4).

3.2.2. Association between Respiratory Symptoms and Farm Type (Exposed and non-exposed)

Results showed a statistical association between respiratory symptoms and type of farm. All respiratory symptoms had a P value of less than 0.05 (Table 5).

3.2.3. Chi-square Test between Respiratory Signs and Type of Crops

Results showed that neither practicing non-organic coffee nor non-organic flower has no significant association with the respiratory symptoms as all p-values were >0.05 (Table 6).

3.3. Inferential Statistics for Occupational Exposure's Assessment towards Pesticides

The results showed a statistical association between type of farming (non-organic coffee) and increased risk of cough [adj. OR (95% CI) 76.65 (15.36,382.37), Rhinitis 3.90 (2.04,7.46) and 10.97 (1.76,68.21). In non-organic flowers, there was a statistical association between non-organic flower farming and increased risk of cough 77.25 (20.36,293.13) and Rhinitis 6.66 (3.30,13.45) but there was no statistical association between non-organic flower farming and shortness of breath 3.08 (0.04,256.79) (Table 7 and Table 8).

3.3.1. Occupational Status

Pruners and Pickers

In non-organic farming (coffee) there was a statistical association between pruning of coffee and increased risk of cough 76.65 (15.36), rhinitis 3.90 (2.04, 7.46) and shortness in breath 10.97 (1.76.68.21) and also in non-organic flowers, there was a statistical association between the picking of flowers and increased risk of cough 148.29 (30.62, 718.04), rhinitis 7.79 (2.87, 21.14). However, there was no statistical association with the increased risk of wheezing 0.70 (0.14,3.50) and cough with phlegm 0.63 (0.16,2.42).

Mix and Sprayers of Pesticides

There was a statistical association in non-organic coffee between mixing and spray of pesticides and increased risk of cough 20.85 (1.91,227.68), wheeze 309.98 (14.27,6735.34) and cough with phlegm 22.57 (2.16,235.41). In-organic flowers, there was also a statistical association with increased risk of cough 4.58 (1.68, 12.54) and rhinitis 4.74 (1.83.12.29). However, no statistical association was observed in non-organic flowers with shortness of breath at 9.38 (0.07, 1196.29) and cough with phlegm at 3.49 (0.81, 15.09).

3.3.2. Safety Behavioral Characteristics

Taking Bath after Work

There was a statistical reduction in risk for cough 0.19(0.071, 0.50) and 0.31 (0.17, 0.56) when the participants take shower after work on the coffee farm. However, no statistical reduction in risk for shortness of breath 0.38(0.10, 1.48) and cough with phlegm 0.32(0.06, 1.70) when the study participant take shower after work on the coffee farm. In non-organic flowers, there was a statistical reduction in the risk of cough 0.33 (0.16, 0.68) and rhinitis 0.44 (0.26, 0.75) when the study participants take shower after work. However, no statistical significance was observed for wheeze 0.37(0.10, 1.43), shortness of breath at 12.85 (0.39, 422.13), and 0.44(0.14, 1.45) when the participants take shower after work.

Wearing protective gear

There was no statistical risk reduction for cough 0.57 (0.23, 1.45), rhinitis 0.58 (0.30, 1.11) and shortness of breath 0.37 (0.06, 2.31) when the study participants wear protective gear in non-organic coffee farm. We observed no statistical risk reduction for cough 2.01 (0.98, 4.12), Rhinitis 1.45 (0.83, 2.55), wheeze 0.76 (0.193, 2.96), shortness of breath 0.40 (0.01, 10.86) and 0.30 (0.80, 1.09) for participants wearing personal protective equipment in non-organic flower.

Washing Hand after Work

We observed a statistical association between participants washing hands after work on the coffee farm with increased risk of cough 5.27(1.07, 25.99), wheeze 1.06 (0.26, 4.39), shortness of breath 0.38 (0.10, 1.48) and cough with phlegm 0.32 (0.61, 1.70) in non-organic farms. However, no association was observed between participants washing hands and increased risk of cough 2.09 (0.22, 19.47) in non-organic farms. In non-organic flowers, the results indicate no statistical association between washing hands after work and increased risk of cough 1.18 (0.39,3.52) and rhinitis 0.70 (0.31,1.58).

3.4. Tabulated Results from Thematic and Content Qualitative Analysis of Respondents

The findings of qualitative data indicated that the risk of developing respiratory symptoms among farmworkers in the greenhouses (exposed group) depends on the extent of pesticide exposure and the nature of the work such as picking, mixing, grading, and spraying. According to farmworkers, pickers get respiratory symptoms during either entering or going to the nearby greenhouse. Furthermore, sprayers and mixers are reported to get this problem the first time of exposure to pesticides but with time they adapt to this condition; thus, ending up getting respiratory symptoms including rhinitis especially when they use foliar to treat plants.

Information on the proper wearing of safety gear and handling of pesticides during pesticide application showed that sprayers wear safety gears appropriately and thus seemed less exposed to pesticides and therefore had less risk of getting respiratory symptoms as compared to the control group. Farm workers in greenhouses lacked ventilation facilities that allow free movement of air as a result; too much sweating seems to elicit skin irritations.

Table 7. Biological Association of occupational exposure to pesticides and increased risk of respiratory symptoms among farmworkers in coffee (organic farming (n = 195) and coffee (non organic farming (n = 80) plantation (N =275)

Respiratory Symptoms	Cough Adjusted OR (95% CI)[a]	Rhinitis Adjusted OR (95% CI)[a]	Wheeze Adjusted OR (95% CI)[a]	Shortness of breath Adjusted OR (95% CI)[a]	Cough with Phlegm Adjusted OR (95% CI)[a]
Types of farming					
Organic farming in coffee	ref	ref	ref	ref	ref
Non-organic farming in coffee	76.65 (15.36, 382.37)	3.90 (2.04, 7.46)	-	10.97 (1.76, 68.21)	-
Occupational status in Coffee farms					
Pruning in organic	Ref	Ref	ref	Ref	ref
Pickers in non-organic	76.65(15.36, 382.37)	3.90 (2.04, 7.46)	-	10.97 (1.76, 68.21)	-
Mix and spray pesticides in the coffee farm					
No	ref	ref	ref	ref	ref
Yes	20.85 (1.91, 227.68)	-	309.98 (14.27, 6735.34)	-	22.57 (2.16, 235.41)
Taking bath after work in the coffee farm					
No	ref	ref	ref	ref	ref
Yes	0.19 (0.071, 0.50)	0.31 (0.17, 0.56)	1.06 (0.26, 4.39)	0.38 (0.10, 1.48)	0.32 (0.06, 1.70)
Wearing protective gear in the coffee farm					
No	ref	ref	ref	ref	ref
Yes	0.57 (0.23, 1.45)	0.58 (0.30, 1.11)	-	0.37 (0.06, 2.31)	-
Washing hands after work on the coffee farm					
No	ref	ref	ref	ref	ref
Yes	2.09 (0.22, 19.47)	5.27 (1.07, 25.99)	1.06 (0.26, 4.39)	0.38 (0.10, 1.48)	0.32 (.061, 1.70)

[a]Adjusted OR for sex, age, education, marital status, parental with respiratory problem, sharing room with smokers, cleaning detergent, vegetable garden and domestic pesticides treatment.

Table 8. Biological Association of occupational exposure to pesticides and increased risk of respiratory symptoms among farmworkers in coffee (organic farming (n = 195) and flower (non-organic farming (n = 114) plantation (N = 309)

Respiratory Symptoms	Cough	Rhinitis	Wheeze	Shortness of breath	Cough with Phlegm
	Adjusted OR (95% CI)[a]	Adjusted OR (95% CI)[a]	Adjusted OR (95% CI)[a]	Adjusted OR (95% CI)[a]	Adjusted OR (95% CI)[a]
Types of farming					
Organic farm in coffee	ref	ref	**ref**	**ref**	**ref**
Non-organic farming in the flower farm	77.25 (20.36, 293.13)	6.66 (3.30, 13.45)	-	3.08 (0.04, 256.79)	-
Farming system and working area					
Open field in coffee	ref	ref	ref-	ref	**ref**
The closed field in flower	77.25 (20.36, 293.13)	6.66 (3.30, 13.45)	-	3.08 (0.04, 256.79)	-
Occupational status in flower farms					
Pruners in organic coffee	ref	ref	ref	**ref**	ref
Pickers	148.29 (30.62, 718.04)	7.79 (2.87, 21.14)	0.70 (0.14, 3.50)	-	0.63 (0.16, 2.42)
Others	47.76 (9.16, 249.09)	9.15 (2.96, 28.23)	0.48 (0.06, 3.96)	-	0.24 (0.03, 1.93)
Store	-	-	-	-	-
Sprayers	78.89 (19.64, 316.82)	5.074 (2.32, 11.11)	-	9.38 (0.07, 1196.29)	-
Mix and spray pesticides in the flower farm					
No	ref	ref	ref	ref	ref
Yes	4.58 (1.68, 12.54)	4.74 (1.83, 12.29)	6.30 (1.29, 30.72)	0.07 (0.01, 24.28)	3.49 (0.81, 15.09)
Taking bath after work in the flower farm					
No	Ref	ref	ref	ref	ref
Yes	0.33 (0.16, 0.68)	0.44 (0.26, 0.75)	0.37 (0.10, 1.43)	12.85 (0.39, 422.13)	0.44 (0.14, 1.45)
Wearing protective gear in the flower farm					
No	ref	ref	ref	ref	ref
Yes	2.01 (0.98, 4.12)	1.45 (0.83, 2.55)	0.76 (0 .193, 2.96)	0.40 (0.01, 10.86)	0.30 (0.08, 1.09)
Washing hands after work in the flower farm					
No	ref	ref	ref	ref	ref
Yes	1.18 (0.39, 3.52)	0.70 (0.31, 1.58)	-	-	-

[a]djusted OR for sex, age, education, marital status, parental with respiratory problem, smoked cigarette, current smoker, sharing room with smokers, cleaning detergent, vegetable garden and domestic pesticides treatment.

4. Discussion

This study revealed the association between occupational exposure to pesticides and respiratory symptoms including cough, cough with phlegm, rhinitis, wheeze, and shortness of breath among farmworkers aged between 18 and 45 years in coffee and flower plantations.

Occupational exposure to pesticides is correlated with various respiratory pathologies such as chronic obstructive pulmonary diseases and various respiratory manifestations of cough, wheezing, rhinitis, shortness of breath and dyspnea as previously described [6,11]. The study conducted by [12] reports the increase of the risk in the health problems including respiratory symptoms among the farmworkers who applied pesticides. In this study behavioral characteristics such smoked cigarette, current smoker, sharing room with a smoker, use of cleaning detergent at home, vegetable garden at home and the use of pesticides at home were considered as factors which may also exacerbate respiratory symptoms among farmworkers. Self-behaviors such as smoking among farmworkers, have been reported with previous studies to be the source of respiratory health problems [13].

The number of women employed as farmworkers was higher compared to men, also female farmworkers were at greater risk for adverse health outcomes including respiratory problems than male farmworkers, the same outcome also reported by [14].

The uses of PPE were depending on the nature of work, in this study only men farmworkers employed as pesticides mixers and sprayers were using PPE while women farmworkers including flower pruners and coffee pickers were not using PPE due to several causes including uncomfortableness', inconvenience and excessive heat. [15] this indicate women were at great risk of pesticides exposure than men. This finding is similar to a study conducted among the Latina farmworkers which found that the pesticide exposure to be twice as high in women as in men [16].

Farm workers employed as pruners in flower and pickers in non-organic coffee had an increases risk of cough, rhinitis and shortness of breath. In this study we noticed that flower pruners went into the greenhouse without wearing of person protective equipment's few hours after spray of the pesticides, further it was observed that most of the greenhouses did not have enough ventilation. These findings are similar to a study conducted in Ethiopia which was investigating if the occupational exposure to pesticides was associated with respiratory health effect in commercial farming system [11].

Despite of wearing of person protective equipment's, it was found that pesticides mixers and sprayers were at increased risk of developing respiratory symptoms. This finding is in agreement with a study by [17] on self-reported symptoms and Pesticide Use among Farm Workers.

In this study results showed that neither practicing non-organic coffee nor non-organic flower has no significant association with the respiratory symptoms as all p-values were >0.05 all the adjusted behavior characteristics such as smoking of cigarette were associated with increased risk of developing respiratory symptoms, hence neither working in organic farm nor in non-organic farm the exposures risk was considered to be the same. The other findings have been relatively nonspecific both in term of the agent causing the respiratory symptoms [18]. Also in this case, it is difficult to conclude that a farmworker had a respiratory symptoms resulted from exposure to pesticides if a farmer smoke, use cleaning detergents at their homes or sharing bedroom with smoker.

In this study, it was noticed that participants who took showers after work had decreased risk of cough and rhinitis in the coffee and flower plantations. Moreover, study participants who wear protective gear had lower risk of cough, rhinitis and shortness of breath though the difference was statistically insignificant (P > 0.05). These findings were in line with the findings in studies conducted in Turkey which suggest the reduction of respiratory symptoms for participants wearing personal protective equipment among farmworkers [18,19,20,21]. In this study, it was noticed that participants who took showers after work had decreased risk of cough and rhinitis. [19], revealed the increase of respiratory symptoms among farmworkers took bath after work. The time interval of showering after pesticides application also can rise or decrease the respiratory symptoms depend on the type of pesticides used [22]. Moreover, in this study the participants who wear protective gear had lower risk of cough, rhinitis and shortness of breath though the difference was statistically insignificant (P > 0.05). Other studies also have been reported the decrease of respiratory symptoms among the farmworkers in the use of personal protective gears [18,19,20,21].

In the view of published literature, it was suggested that pesticide management and regulations, educational programs on safety precautions and reinforcement of safety behaviours, especially the proper use of personal protection gears in the workplace are effective measures of preventing respiratory symptoms and diseases related to occupational exposures to pesticides [18].

5. Conclusions

In this study organic farming was defined as a chemical-free agriculture practices which avoid the use of synthetic inputs, and relying on natural substances which are typically originated from animal or plants. While non organic farming involve the use of synthetic substances which are manufactured by chemicals and industrial processes and may include products not found in nature or simulation of products from natural sources, hence the farmworkers in organic farmers were not exposed to the chemicals while non organic farmworkers were exposed to chemicals.

In this study it was observed that the prevalence of respiratory symptoms was higher among farmworkers in non-organic farming than in organic farming. This study strongly recommend for adherence to OSHA guidelines on occupational safety in relation to pesticides uses. To implement these guidelines, employers should provide regular on-the-job training to their employees

Employers should have a close follow-up on employees' complaints regarding respiratory symptoms, as most of the symptoms were found to be associated with other diseases such as malaria. A close follow-up will prevent farmers from chronic respiratory symptoms.

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Consent for Publication

All the authors consented for the publication of this manuscript.

Availability of Data and Materials

The datasets used for this study are available from the corresponding author upon reasonable request

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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